

EDULINK, ACP Science and Technology, ACP Caribbean & Pacific Research Programme for Sustainable Development

| Results and impacts 2012 – 2018

EDULINK, ACP Science et Technologie, Programme de recherche Caraïbes et Pacifique pour le développement durable

| Résultats et effets 2012 – 2018



ACP-EU Co-operation Programme
in Higher Education (EDULINK II)

Programme de Coopération ACP-UE pour
l'enseignement supérieur (EDULINK II)



ACP-EU Cooperation Programme
in Science and Technology II (S&T II)

Programme de Coopération ACP-UE pour
la Science et la Technologie (S&T II)

ACP Caribbean & Pacific Research
Programme for Sustainable Development

Programme de recherche Caraïbes et
Pacifique pour le développement durable



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EDULINK, ACP Science et Technologie, Programme de recherche
Caraïbes et Pacifique pour le développement durable

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Capacity building in Higher Education, Science, Technology, Research and Innovation

The three ACP-EU Cooperation programmes presented in this catalogue - EDULINK, ACP Science and Technology, and the ACP Caribbean & Pacific Research Programme for Sustainable Development – belong to a series of Intra-ACP Development Cooperation programmes implemented in the context of ACP-EU cooperation. The three programmes share one common goal: they have built capacities in the sectors of Higher Education, Science, Technology, Research and Innovation in the ACP countries in the fields of agriculture, energy, water and climate change.

Both EDULINK and the ACP Science and Technology Programmes started in 2006 and 2008 respectively, but this catalogue highlights the results of the second phases of these programmes which were launched in 2012, in addition to those of the ACP Caribbean & Pacific Research Programme for Sustainable Development which was launched in 2010.

The partnership-based approach in the 78 granted projects, set up as a mechanism to create synergies and build capacities, has proven to be a successful formulae in supporting and consolidating both educational development at higher education institutions (HEIs) and science, technology, research and innovation development at HEIs, research organisations, governmental agencies, non-governmental organisations (NGOs), practitioner organisations and other private sector actors.

A combination of higher education and research institutions (public and private) offering more relevant teaching and training by better equipped and trained individuals and with better resourced research and enhanced science, technology, research and innovation capacities linked to strengthening government policy and supporting the private and public sectors will substantially improve and provide the engines of growth for the agriculture and energy sectors of ACP countries, fitting in the paradigms of sustainable development.

We are proud to present the results of the 78 projects of the EDULINK Phase II (47), ACP Science and Technology Phase II (21), and the ACP Caribbean & Pacific Research Programme for Sustainable Development (10), with the first project having started in August 2012 and the last having finished in October 2018. From the 287 involved institutions, 198 originated from 45 ACP countries.

The results achieved over these six years and the impacts envisaged, some of which have already been realised, present an interesting insight into the effectiveness of the wide variety of initiatives financed by the three programmes. They vary from new curricula and courses to national action plans, electronic platforms and databases within the fields of agriculture, energy, water and climate change. These have also been made available through publications and websites.

These three programmes further contributed to the implementation of the ACP Secretariat's Strategic Management Plan for the period 2017-2020, particularly with respect to the strategic objectives of enhancing intra-ACP cooperation and enhancing ACP-EU relations.

We are confident that the strengthened institutions can further their activities and development to better serve the needs of the ACP countries. This is also true for other institutions who can take stock of all the results presented here.

We invite you to read about the rich variety of activities and results presented in this catalogue and encourage you to communicate with the projects to continue sharing and building further knowledge and partnerships in these sectors.



Dr. Patrick I. Gomes
Secretary-General
Secretariat of the African, Caribbean
and Pacific Group of States
Brussels, February 2019

Higher Education, Science, Technology and Innovation, and Research have long been important aspects of the cooperation between the European Union (EU) and the African, Caribbean and Pacific (ACP) countries, as these are powerful drivers of inclusive and sustainable socio-economic development. The creation, development and diffusion of new skills, knowledge, technologies and innovations, including effective multi-stakeholder collaborations, are critical to meeting local and global challenges alike, as well as reducing inequality both within and between countries.

In recent years, the role that education, research and innovation capacity-building has played in the growth dynamics of successful developing countries demonstrates the socio-economic benefits of increased investments in knowledge and science. The EU and its Member States are committed to continue investing in research and development, including enhancing national innovation systems, on the basis of improved policies and public services, unlocking investments and driving socio-economic development through upgraded research and innovation capacity. A particular emphasis is on skills development, entrepreneurship and access to digital technologies for youth and women, with the aim to harness the projected increase in youth population, support digital innovation capacity, promote girls and women's rights and empowerment, and offer young people opportunities to benefit from technological progress.

EDULINK (Phase II), ACP Science and Technology (Phase II) and ACP Research for Sustainable Development (Caribbean & Pacific) are three successful examples of how the EU cooperation with the ACP countries has addressed these key issues by focusing on institutional development and capacity building, as well as on the creation of new educational tools, practices and policies. The three programmes were funded by the 10th European Development Fund (EDF) and the Development Co-operation Instrument (DCI).

During the past six years, these three programmes have contributed to create the conditions for effective multi-stakeholder partnerships involving education and research institutions, governments, civil society organisations, practitioners and the private sector. They have enabled ACP-wide channels for knowledge creation and knowledge sharing, applied in particular to the agriculture, energy and natural resources management sectors. The added

value of disseminating, exchanging and facilitating the uptake of knowledge between EU and ACP institutions and actors has certainly been proved.

While we look forward to the positive effects of these programmes in the longer term, the EU remains committed to continue promoting education, skills development, research and innovation, and to support the ACP countries efforts in their transition into knowledge-based economies.



Aida Liha Matejcek
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**Directorate-General for International
Cooperation and Development
European Commission
Brussels, February 2019**

Renforcement des capacités dans l'enseignement supérieur, la science, la technologie, la recherche et l'innovation

Les trois programmes de coopération ACP-UE présentés dans ce catalogue – le programme EDULINK, le programme ACP Science et Technologie, et le Programme de recherche Caraïbes et Pacifique pour le développement durable – font partie d'une série de programmes de coopération au développement intra-ACP mis en œuvre dans le cadre de la coopération ACP-UE. Ces trois programmes ont un objectif en commun: ils ont renforcé les capacités dans les secteurs de l'enseignement supérieur, de la science, de la technologie, de la recherche et de l'innovation des pays ACP dans les domaines de l'agriculture, de l'énergie, de l'eau et du changement climatique.

Les programmes EDULINK et ACP Science et Technologie ont été lancés respectivement en 2006 et en 2008. Ce catalogue présente les résultats de la deuxième phase de ces programmes, lancée en 2012, ainsi que ceux du Programme de recherche Caraïbes et Pacifique pour le développement durable, lancé en 2010.

L'approche fondée sur le partenariat adoptée dans les 78 projets subventionnés, mise en place comme mécanisme visant à créer des synergies et renforcer les capacités, s'est avérée une formule efficace pour soutenir et consolider à la fois le développement de l'enseignement dans les établissements d'enseignement supérieur (EES) et le développement de la science, de la technologie, de la recherche et de l'innovation dans les EES, organismes de recherche, agences gouvernementales, organisations non gouvernementales (ONG), organisations professionnelles et autres acteurs privés.

La combinaison d'établissements d'enseignement supérieur et d'instituts de recherche (publics et privés) offrant un enseignement et une formation plus pertinents, dispensés par des personnes mieux équipées et mieux formées et disposant de meilleures ressources pour la recherche et de meilleures capacités scientifiques, technologiques et de recherche et d'innovation liées au renforcement des politiques gouvernementales et au soutien des secteurs privé et public renforcera considérablement les moteurs de la croissance pour les secteurs de l'agriculture et de l'énergie des pays ACP, s'intégrant dans les modèles du développement durable.

Nous sommes fiers de présenter les résultats des 78 projets de la phase II d'EDULINK (47), de la phase II du programme ACP Science et Technologie (21) et du Programme de recherche Caraïbes et Pacifique pour le développement durable (10), le premier projet ayant débuté en août 2012 et le dernier s'étant achevé en octobre 2018. Sur les 287 établissements participants, 198 venaient de 45 pays ACP.

Les résultats obtenus au cours de ces six années ainsi que les effets escomptés, dont certains se sont déjà concrétisés, donnent un aperçu intéressant de l'efficacité du large éventail d'initiatives financées par ces trois programmes. Ces initiatives portent sur des nouveaux programmes et cours, des plans d'action nationaux ou encore des plateformes électroniques et des bases de données dans les domaines de l'agriculture, de l'énergie, de l'eau et du changement climatique. Ces éléments sont également disponibles dans des publications et sur des sites web.

Ces trois programmes ont également contribué à la mise en œuvre du Plan de gestion stratégique du Secrétariat ACP pour la période 2017-2020, notamment en ce qui concerne les objectifs stratégiques de renforcement de la coopération intra-ACP et des relations ACP-UE.

Nous sommes convaincus que les établissements renforcés peuvent poursuivre leurs activités et leur développement afin de mieux répondre aux besoins des pays ACP. Il en va de même pour les autres établissements, qui peuvent faire le point sur l'ensemble des résultats présentés ici.

Nous vous invitons à prendre connaissance de la pléthore d'activités et de résultats présentés dans ce catalogue et vous encourageons à communiquer avec les projets pour continuer à partager et approfondir les connaissances et établir des partenariats dans ces secteurs.



Dr. Patrick I. Gomes
Secrétaire Général
Secrétariat du Groupe des Etats d'Afrique,
des Caraïbes et du Pacifique
Bruxelles, février 2019

L'enseignement supérieur, la science, la technologie, l'innovation et la recherche sont depuis longtemps des aspects importants de la coopération entre l'Union européenne (UE) et les pays d'Afrique, des Caraïbes et du Pacifique (ACP), dans la mesure où ils sont de puissants moteurs du développement socio-économique inclusif et durable. La création, le développement et la diffusion de nouvelles compétences, connaissances, technologies et innovations, notamment des collaborations multipartites efficaces, revêtent une importance capitale pour relever les défis locaux et mondiaux, ainsi que pour réduire les inégalités à la fois à l'intérieur d'un même pays et d'un pays à l'autre.

Ces dernières années, le rôle que l'enseignement, la recherche et le renforcement des capacités d'innovation ont joué dans la dynamique de croissance des pays en développement qui évoluent de façon positive démontre les avantages socio-économiques d'une augmentation des investissements dans le savoir et la science. L'UE et ses États membres ont la ferme intention de poursuivre leurs investissements dans la recherche et le développement, notamment en renforçant les systèmes nationaux d'innovation, sur la base de politiques et de services publics améliorés, en débloquent les investissements et en favorisant le développement socio-économique grâce à une capacité de recherche et d'innovation renforcée. L'accent est mis en particulier sur le développement des compétences, l'esprit d'entreprise et l'accès des jeunes et des femmes aux technologies numériques, dans le but de tirer parti de l'augmentation prévue de la population des jeunes, de soutenir la capacité d'innovation numérique, de promouvoir les droits des filles et des femmes et leur autonomisation et d'offrir aux jeunes des possibilités de tirer profit du progrès technologique.

EDULINK (phase II), ACP Science et Technologie (phase II) et ACP Recherche pour le développement durable (Caraïbes et Pacifique) sont trois exemples fructueux qui illustrent la manière dont la coopération de l'UE avec les pays ACP a abordé ces enjeux clés en se concentrant sur le développement institutionnel et le renforcement des capacités, ainsi que sur la création de nouveaux outils, pratiques et politiques éducatives.

Ces trois programmes ont été financés par le 10e Fonds européen de développement (FED) et l'Instrument de coopération au développement (ICD).

Au cours des six dernières années, ces trois programmes ont contribué à créer les conditions d'un partenariat multipartite efficace associant établissements d'enseignement et instituts de recherche,

gouvernements, organisations de la société civile, professionnels et secteur privé. Ils ont permis de produire et partager des connaissances à l'échelle des ACP, en particulier dans les secteurs de l'agriculture, de l'énergie et de la gestion des ressources naturelles. Et à ce titre, la valeur ajoutée de la diffusion, de l'échange et de la facilitation de l'assimilation des connaissances entre les établissements et acteurs de l'UE et des pays ACP est manifeste.

Si nous nous réjouissons des effets positifs de ces programmes à plus long terme, l'UE reste déterminée à continuer de promouvoir l'enseignement, le développement des compétences et la recherche et l'innovation, ainsi qu'à soutenir les efforts des pays ACP dans leur transition vers une économie de la connaissance.



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**Direction Générale de la Coopération Internationale et du Développement
Commission européenne
Bruxelles, février 2018**

I EDULINK

The EDULINK Programme was designed to foster co-operation in the field of higher education between the countries of the African, Caribbean and Pacific Group of States (ACP States) and the European Union (EU). The objectives were to promote regional and multilateral networking between higher education institutions (HEIs), to foster capacity building, and to support a quality higher education system, which is efficient and relevant to the needs of the labour market and consistent with ACP socio-economic development priorities. The programme was implemented in two phases: Phase I (2006 – 2013) and Phase II (2012 – 2018).

A total of 113 grant contracts were awarded (66 under Phase I and 47 under Phase II). A total of 320 higher education institutions were involved as full partners (170 under Phase I and 150 under Phase II), of which 235 are ACP institutions that have been the beneficiaries of both phases (135 under Phase I and 100 under Phase II).

EDULINK Phase I was financed under the Intra-ACP envelope of the 9th European Development Fund (EDF) with a total EU investment of EUR 30 million. The purpose of the programme was to strengthen the capacity of ACP HEIs on three levels:

- institutional capacity building – policy, management, planning, administrative capacity at national and regional levels;
- institutional cooperation to maximise academic quality and relevance in regional context – joint curriculum development, curriculum upgrades, postgraduate student training and teacher training and exchanges;
- capacity building in research and technology to allow HEIs to improve academic and teaching excellence in priority sectors for local socio-economic developments.

Three competitive calls for proposals awarded grants to 66 projects, which implemented their activities between December 2007 and December 2013.

On average, activities were implemented in 52 ACP and 12 EU countries, with a contract size of EUR 0.45 million, a timeframe of three to four years, and a consortium made up of five partners. 20 projects were led by ACP institutions. The projects covered a wide range of themes: capacity development, environment, agriculture, teacher training, demography, gender and migration, health, ICT, regional integration, and science and research.

EDULINK Phase II was financed under the Intra-ACP envelope of the 10th European Development Fund (EDF) and the Development Co-operation Instrument (DCI) with a total EU investment of EUR 23.3 million. The purpose of the programme was to strengthen the capacity of ACP HEIs on two levels: management / administration and academic.

One competitive call for proposals awarded grants to 47 projects, which implemented their activities between September 2013 and October 2018.

The overall investment into the 47 projects, including the beneficiaries' contributions, amounted to approximately EUR 27.9

million. On average, activities were implemented in 43 ACP and 13 EU countries, with a contract size of EUR 0.48 million, a timeframe of three to four years, and a consortium made up of seven partners. 19 projects were led by ACP institutions. The projects covered two themes: energy access and efficiency, and agriculture and food security.

The EDULINK projects were highly relevant in fostering capacity building and regional integration in higher education in ACP countries. The south–south regional networking has been particularly strong, encouraging staff and student exchanges via the training and joint development and implementation of courses. A rich diversity of results has been achieved:

- The development of new academic curricula, courses and individual modules.
- The upgrading and improvement of existing courses.
- The harmonisation of courses, especially in a regional context.
- The improvement of HEI capacities in terms of skill development and equipment.
- The improvement of academic staff to provide student support and PhD supervision.
- The creation of centres of excellence.
- Professional development including lifelong learning programmes for staff and professionals.
- The introduction of new forms of practical learning and e-learning.
- The creation of vital links between academia and research with government services and the private sector.
- Significant increase in the number of networked institutions in the ACP with collaborative agreements.

The projects have received capacity building in their management and administrative structures as well as their academic offerings with new and improved courses and programmes developed from Bachelor to PhD levels in a variety of thematic areas. Capacity building has included the training of academic, technical, administrative and managerial staff, as well as providing equipment for and upgrading laboratories and ICT. ICT has become an important component of many of the interventions especially under the second phase. Open and distance learning including Massive Open Online Courses (MOOCs) has become a key strategy in the development of the higher education sector.

Perhaps the most significant impact has been in the advances achieved in the student/teacher relationship and modalities of delivering teaching and learning. Training products have been developed, tested and implemented. Institutionally they have been accepted by the HEI hierarchies. New or improved courses have received accreditation or are in the process of accreditation. Often the key to sustainability of these new courses and supporting tools and technologies lies in ensuring financial resources and attracting students (both in fee based and subsidised systems). The evidence so far has been that the developed programmes and courses have been very innovative and student attraction is high for the majority of cases.

I ACP SCIENCE & TECHNOLOGY

The ACP Science & Technology Programme aimed at addressing the scientific divide in ACP countries and at strengthening capacities in the areas of science, technology and innovation (STI), with a particular emphasis on integrated approaches to enable the creation, uptake and use of scientific knowledge in ACP institutions and social and economic actors. Cross-regional and cross-institutional experiences, emphasising the strengthening of networks within the innovation eco-system, were fundamental components of the funded projects. The programme was implemented in two phases: Phase I (2008 – 2013) and Phase II (2012 – 2018).

A total of 57 grant contracts were awarded (36 under Phase I and 21 under Phase II). A total of 283 organisations were involved as full partners (180 organisations under Phase I, 103 organisations under Phase II), of which 217 are ACP institutions that have been the beneficiaries of both phases (141 under Phase I and 76 under Phase II).

The **ACP Science & Technology I** programme was financed by the Intra-ACP envelope of the 9th European Development Fund (EDF) and the Development Co-operation Instrument (DCI) with a total EU investment of EUR 33 million. The purpose of the programme was to strengthen the science and technology capacity of ACP countries on three levels: institutional, administrative and policy making; academic research and technology; and business and civil society.

A competitive call for proposals awarded grants to 36 projects, which implemented their activities between October 2009 and December 2013.

The overall investment into the 36 projects, including the beneficiaries' contributions, amounted to approximately EUR 38.7 million. On average, activities were implemented in 45 ACP and 9 EU countries, with a contract size of EUR 1 million, a time-frame of three to four years, and a consortium made up of seven

partners. 16 projects were led by ACP institutions. The projects covered a wide range of themes: agriculture and agro-industry, energy, environment, health, and STI in general.

The **ACP Science & Technology II** programme was financed by the Intra-ACP envelope of the 10th EDF and the DCI with a total EU investment of EUR 20 million. The purpose of the programme was to build and strengthen the STI capacities of a wide range of ACP organisations.

A competitive call for proposals awarded grants to 21 projects, which implemented their activities between November 2013 and August 2018.

The overall investment into the 21 projects, including the beneficiaries' contributions, amounted to approximately EUR 23.7 million. On average, activities were implemented in 30 ACP and 10 EU countries, with a contract size of EUR 1 million, a time-frame of three to four years, and a consortium made up of five partners. Six projects were led by ACP institutions. The projects covered two themes: energy access and efficiency, and agriculture and food security.

The capacity building activities focused on strengthening management and administrative structures, as well as academic research and policy drafting. They included training of academic, technical, administrative and managerial staff, as well as farmers and entrepreneurs in the agriculture and energy sectors. A number of laboratories were upgraded with new equipment and ICT tools. The project results can be clustered into four broad categories: training / professional development, materials, networking and tools / infrastructure. Several models and mechanisms were developed and applied so as to generate and share knowledge and skills with target groups in rural communities, small and medium-sized enterprises (SMEs), universities, research centres, network organisations and governmental institutions:

TRAINING / PROFESSIONAL DEVELOPMENT

- Courses (students, mid-career professionals, farmers)
- Participatory workshops
- Farmer field schools
- Incubator services
- Multi-dimensional training
- Mentoring schemes
- Study tours

NETWORKING

- Multi-disciplinary team working
- Trans-regional knowledge sharing
- Strategic partnerships
- Discussion fora
- Stakeholder workshops
- STI support and transfer of knowledge networks
- Institutionalised networks

MATERIALS

- Data
- Policy papers
- Curricula
- Project design (value chain, energy)
- Strategy action plans / roadmaps
- Training materials
- Handbooks / guidelines / manuals / toolkits / videos

TOOLS / INFRASTRUCTURE

- Web platforms for knowledge sharing
- Web and mobile application tools
- Technologies (farming, post-harvest, laboratory, teaching)
- Innovation and transfer centres
- Scientific demonstration plants
- Specialised laboratory facilities
- Business model frameworks

The programmes in a nutshell

Some examples of the projects direct effects can be seen in the following domains:

Economic domain: job and business creation (e.g. bio-residues, biochar, chocolate, eco-tourism value chains); improved crop management, yields, storage and value chains; increased entrepreneurial activities; decreased farm inputs; increased farm incomes; crop varieties adapted to climate changes.

Social domain: strengthened relationships between researchers and stakeholders from the private and public sector; empowerment of and increased involvement of women in local communities; energy access and efficiency in local communities.

Environmental domain: increased knowledge on and management of biodiversity, including sustainable use of natural resources; decreased use of agro-chemicals; decreased use of wood for fuel production.

Policy domain: showcasing examples of innovative agricultural and natural resources management; strategic action plans for development and use of various crops; guidelines on the introduction of genetically modified organisms (GMOs); recommendations on agricultural management, animal health research, value chain innovations, agricultural research policy and higher agricultural education; utilisation of science-based evidence in agricultural policy-making; guidelines on intellectual property rights (IPRs) of plant genetic resources; recommendations on renewable energy technologies (RETs) and research roadmaps; national industry standards for RETs; recommendations on improved IPRs regimes in the energy sector; research and technology-transfer strategies.

Relationship building and networking played a central role in the implementation of the projects with several stakeholders. The tools developed within the scope of the projects, the training and research mechanisms, action plans and policy recommendations will continue to be used and adapted. The partners involved in the projects are committed to continue using those outputs and measuring their effects on the target communities in the years to come.

ACP RESEARCH FOR SUSTAINABLE DEVELOPMENT PROGRAMME (CARIBBEAN & PACIFIC COMPONENT)

The objective of the ACP Research for Sustainable Development programme was to contribute to the sustainable development of ACP countries by the means of scientific and technological research. The programme supported research projects particularly in the fields of agriculture and post-harvest, renewable and sustainable energy, water and sanitation, and climate change, so as to improve the resilience of ACP countries. The programme combined an African component managed by the African Union Commission and a Caribbean and Pacific component managed by the ACP Secretariat, with a total EU investment of EUR 20 million from the 10th European Development Fund (EDF).

A competitive call for proposals for the Caribbean & Pacific component of the programme (with a budget of EUR 4.8 million) awarded grants to 10 projects, which implemented their activities between August 2012 and September 2016. A total of 34 institutions have been involved, of which 22 are Caribbean and Pacific institutions that have been the beneficiaries.

The overall investment into the 10 projects, including the beneficiaries' contributions, amounted to approximately EUR 6 million. On average, activities were implemented in 8 Caribbean and Pacific countries and in 7 other countries (EU, Australia, New Zealand), with a contract size of EUR 0.6 million, a timeframe of three to four years, and a consortium made up of four partners. All projects had a Caribbean or Pacific institution as the lead partner.

Project beneficiaries improved their investigation capacities and upgraded their laboratories and ICT means. Scientists and technicians benefitted from training in research methodologies (i.e. laboratory, field, modelling) in the areas of agricultural productivity, germplasm development, energy production, climate change scenarios and water management. Householders and farmers also benefitted from training in the use of research products (e.g. hydrogen stove, farming tools, insect trapping). Public and private institutions and communities were enabled to assess water resources.

Awareness of climate-related changes in the environment and the need to adapt to these changes was raised among the target groups. Longer term impacts are promising due to the increased research capacities and the commitment from the research institutions to continue their scientific and technological activities. Further initiatives in the domains of awareness raising and innovative and effective research are still needed so as to contribute to continued sustainable development in the Caribbean and Pacific countries.

I EDULINK

Le programme EDULINK a été conçu pour favoriser la coopération dans le domaine de l'enseignement supérieur entre les pays du groupe des États d'Afrique, des Caraïbes et du Pacifique (États ACP) et l'Union européenne (UE). Il était avant tout destiné à promouvoir les réseaux régionaux et multilatéraux entre les établissements d'enseignement supérieur (EES) dans l'optique de favoriser le renforcement des capacités et d'accompagner la mise en place d'un système d'enseignement supérieur de qualité, efficace et adapté aux besoins du marché du travail et en phase avec les priorités de développement socio-économique des pays ACP. La mise en œuvre de ce programme s'est déroulée en deux phases: Phase I (2006 – 2013) et Phase II (2012 – 2018).

Au total, 113 contrats de subvention ont été octroyés (66 pour la phase I et 47 pour la phase II). En tout, 320 établissements d'enseignement supérieur ont participé au programme en tant que partenaires à part entière (170 pour la phase I et 150 pour la phase II). Parmi ceux-ci, 235 sont des établissements ACP ayant bénéficié de l'une des deux phases (135 pour la phase I et 100 pour la phase II).

La Phase I d'EDULINK a été financée au titre de l'enveloppe intra-ACP du 9e Fonds européen de développement (FED), le montant total des investissements de l'UE s'élevant à 30 millions d'euros. Le programme avait pour but de renforcer les capacités des EES des pays ACP à trois niveaux:

- renforcement des capacités institutionnelles – politique, gestion, planification, capacité administrative aux niveaux national et régional;
- coopération institutionnelle afin d'optimiser la qualité et la pertinence universitaires dans le contexte régional – élaboration conjointe de programmes d'études, mise à niveau des programmes, formation des étudiants de troisième cycle et formation et échanges des enseignants;
- renforcement des capacités en matière de recherche et de technologie pour permettre aux EES d'améliorer l'excellence universitaire et pédagogique dans les secteurs prioritaires pour le développement socio-économique local.

Trois appels à propositions compétitifs ont octroyé des subventions à 66 projets, dont les activités ont été mises en œuvre entre décembre 2007 et décembre 2013.

En moyenne, les activités ont été mises en œuvre dans 52 pays ACP et 12 pays de l'UE. D'une valeur contractuelle de 0,45 million d'euros et d'une durée de trois à quatre ans, elles ont été organisées dans le cadre d'un consortium composé de cinq partenaires. 20 projets ont été pilotés par des établissements ACP. Les projets couvraient un large éventail de thèmes: renforcement des capacités, environnement, agriculture, formation des enseignants, démographie, genre et migration, santé, TIC, intégration régionale, et science et recherche.

La Phase II d'EDULINK a été financée au titre de l'enveloppe intra-ACP du 10e Fonds européen de développement (FED) et de l'Instrument de coopération au développement (ICD), le montant total des investissements de l'UE s'élevant à 23,3 millions d'euros. Le programme avait pour vocation de renforcer les capacités des EES des pays ACP à deux niveaux: gestion / administration et enseignement universitaire.

Un appel à propositions compétitif a octroyé des subventions à 47 projets, dont les activités ont été mises en œuvre entre septembre 2013 et octobre 2018.

L'investissement total dans les 47 projets, y compris les contributions des bénéficiaires, s'élevait à environ 27,9 millions d'euros. En moyenne, les activités ont été mises en œuvre dans 43 pays ACP et 13 pays de l'UE. D'une valeur contractuelle de 0,48 million d'euros et d'une durée de trois à quatre ans, ces activités ont été organisées dans le cadre d'un consortium composé de sept partenaires. 19 projets ont été pilotés par des établissements ACP. Les projets portaient sur deux thématiques: accès à l'énergie et efficacité énergétique, et agriculture et sécurité alimentaire.

Les projets EDULINK se sont avérés extrêmement utiles pour promouvoir le renforcement des capacités et l'intégration régionale dans l'enseignement supérieur des pays ACP. Par ailleurs, la mise en réseau régionale Sud-Sud s'est révélée particulièrement forte, encourageant les échanges de personnel et d'étudiants au moyen de formations et de l'élaboration et de la mise en œuvre conjointe de cours. Ces projets ont donné des résultats d'une remarquable diversité:

- l'élaboration de nouveaux programmes d'études, cours et modules individuels;
- la mise à niveau et l'amélioration des cours existants;
- l'harmonisation des cours, en particulier dans un contexte régional;
- l'amélioration des capacités des EES en termes de développement des compétences et d'équipement;
- l'amélioration des prestations du personnel universitaire afin d'apporter un soutien aux étudiants et d'assurer l'encadrement des doctorants;
- la création de centres d'excellence;
- le développement de carrière, dont des programmes d'apprentissage tout au long de la vie à l'intention du personnel et des professionnels;
- l'introduction de nouvelles formes d'apprentissage pratique et d'apprentissage en ligne;
- la création de liens vitaux entre d'une part, le milieu universitaire et la recherche et d'autre part, les services publics et le secteur privé;
- l'augmentation importante du nombre d'établissements en réseau dans les régions ACP ayant conclu des accords de collaboration.

Les projets ont bénéficié d'un renforcement des capacités dans leurs structures de gestion et d'administration. Il en va de même pour leurs programmes universitaires, qui offrent des cours et programmes nouveaux et améliorés proposés à tous les niveaux d'enseignement supérieur, de la licence au doctorat, dans un large éventail de domaines thématiques. Le renforcement des capacités comprenait la formation du personnel universitaire, technique, administratif et de direction, ainsi que la fourniture d'équipement de laboratoire, de matériel TIC et leur modernisation. Les TIC sont devenus un volet important dans un grand nombre d'interventions, en particulier dans le cadre de la deuxième phase. L'enseignement ouvert et à distance, notamment les cours en lignes ouverts et massifs (CLOM), est devenu un instrument stratégique dans le développement du secteur de l'enseignement supérieur.

L'amélioration de la relation élève / enseignant et des méthodes d'enseignement et d'apprentissage constituent sans doute la réalisation la plus marquante du programme. Des produits de formation ont été élaborés, testés et mis en œuvre. Sur le plan institutionnel, ils ont été acceptés par la hiérarchie des EES. Des cours nouveaux ou améliorés ont été accrédités ou sont en voie de l'être. La clé pour assurer la viabilité de ces nouveaux cours et des outils et technologies de soutien consiste bien souvent à garantir des ressources financières et à attirer les étudiants (qu'il s'agisse des systèmes éducatifs payants ou subventionnés). Jusqu'à présent, force est de constater que les programmes et les cours élaborés ont fait preuve d'un grand degré d'innovation et que l'attrait des étudiants s'est révélé important dans la majorité des cas.

| ACP SCIENCE ET TECHNOLOGIE

Le programme ACP Science et Technologie visait à réduire la fracture scientifique dans les pays ACP et à renforcer les capacités dans les domaines de la science, de la technologie et de l'innovation (STI), en mettant particulièrement l'accent sur des approches intégrées afin de permettre la création, l'adoption et l'utilisation des connaissances scientifiques dans les établissements et auprès des acteurs sociaux et économiques des pays ACP. Les expériences interrégionales et interinstitutionnelles, qui mettent l'accent sur le renforcement des réseaux au sein de l'écosystème de l'innovation, étaient les pierres angulaires des projets financés. La mise en œuvre de ce programme s'est déroulée en deux phases: Phase I (2008 – 2013) et Phase II (2012 – 2018).

Au total, 57 contrats de subvention ont été octroyés (36 pour la phase I et 21 pour la phase II). En tout, 283 organisations ont participé au programme en tant que partenaires à part entière (180 pour la phase I et 150 pour la phase II). Parmi celles-ci, 217 sont des établissements ACP ayant bénéficié de l'une des deux phases (141 pour la phase I et 76 pour la phase II).

La Phase I du programme ACP Science et Technologie a été financée par l'enveloppe intra-ACP du 10^e Fonds européen de développement (FED) et par l'Instrument de coopération au développement (ICD), le montant total des investissements de l'UE s'élevant à 33 millions d'euros. Le programme visait à renforcer les capacités scientifiques et technologiques des pays ACP à trois niveaux: institutionnel, administratif et politique; recherche universitaire et technologie; et entreprises et société civile.

Un appel à propositions compétitif a octroyé des subventions à 36 projets, dont les activités ont été mises en œuvre entre octobre 2009 et décembre 2013.

L'investissement total dans les 36 projets, y compris les contributions des bénéficiaires, s'élevait à environ 38,7 millions d'euros. En moyenne, les activités ont été mises en œuvre dans 45 pays ACP et 9 pays de l'UE. D'une valeur contractuelle de 1 million d'euros et d'une durée de trois à quatre ans, ces activités ont été organisées dans le cadre d'un consortium composé de sept partenaires. 16 projets ont été pilotés par des établissements ACP. Les projets couvraient un large éventail de thèmes: agriculture et agro-industrie, énergie, environnement, santé, et STI en général.

La Phase II du programme ACP Science et Technologie a été financée par l'enveloppe intra-ACP du 10^e FED et par l'ICD, le montant total des investissements de l'UE s'élevant à 20,8 millions d'euros. L'objectif du programme était de renforcer les capacités STI d'un large panel d'organisations ACP.

Un appel à propositions compétitif a octroyé des subventions à 21 projets, dont les activités ont été mises en œuvre entre novembre 2013 et août 2018.

L'investissement total dans les 21 projets, y compris les contributions des bénéficiaires, s'élevait à environ 23,7 millions d'euros. En moyenne, les activités ont été mises en œuvre dans 30 pays ACP et 10 pays de l'UE. D'une valeur contractuelle de 1 million d'euros et d'une durée de trois à quatre ans, elles ont été organisées dans

le cadre d'un consortium composé de cinq partenaires. Six projets ont été pilotés par des établissements ACP. Les projets portaient sur deux thématiques: accès à l'énergie et efficacité énergétique, et agriculture et sécurité alimentaire.

Les activités de renforcement des capacités étaient axées sur le renforcement des structures de gestion et d'administration ainsi que sur la recherche universitaire et l'élaboration de politiques. Elles comprenaient la formation du personnel universitaire, technique, administratif et de direction, ainsi que des agriculteurs et

entrepreneurs des secteurs agricole et de l'énergie. Un certain nombre de laboratoires ont été modernisés et dotés de nouveaux équipements et outils TIC. Les résultats des projets peuvent être regroupés en quatre grandes catégories: formation / développement de carrière, matériel, mise en réseau et outils / infrastructure. Plusieurs modèles et mécanismes ont été élaborés et appliqués afin de générer et de partager les connaissances et les compétences avec des groupes cibles dans les communautés rurales, les petites et moyennes entreprises (PME), les universités, les centres de recherche, les organisations en réseau et les institutions gouvernementales:

FORMATION / DÉVELOPPEMENT DE CARRIÈRE

- Cours (étudiants, professionnels en milieu de carrière, agriculteurs)
- Ateliers participatifs
- Écoles pratiques d'agriculture
- Services d'incubateur d'entreprises
- Formation multidimensionnelle
- Programmes de mentorat
- Voyages d'études

MISE EN RÉSEAU

- Travail d'équipe multidisciplinaire
- Partage transrégional des connaissances
- Partenariats stratégiques
- Forums de discussion
- Ateliers des parties prenantes
- Soutien à la STI et transfert de réseaux de connaissances
- Réseaux institutionnalisés

MATÉRIEL

- Data
- Policy papers
- Curricula
- Project design (value chain, energy)
- Strategy action plans / roadmaps
- Training materials
- Handbooks / guidelines / manuals / toolkits / videos

OUTILS / INFRASTRUCTURE

- Plateformes web pour le partage des connaissances
- Outils d'applications web et mobiles
- Technologies (agriculture, après-récolte, laboratoire, enseignement)
- Centres d'innovation et de transfert
- Installations de démonstration scientifique
- Laboratoires spécialisés
- Cadres de modèle d'affaires

Quelques exemples des effets directs des projets sont visibles dans les domaines suivants:

Domaine économique: création d'emplois et d'entreprises (par ex., biorésidus, biochar, chocolat, chaînes de valeur de l'écotourisme); amélioration de la gestion des cultures, du rendement, du stockage et des chaînes de valeur; augmentation des activités entrepreneuriales; diminution des intrants agricoles; augmentation des revenus agricoles; variétés de cultures adaptées au changement climatique.

Domaine social: renforcement des relations entre les chercheurs et les parties prenantes des secteurs privé et public; autonomisation et participation accrue des femmes dans les communautés locales; accès à l'énergie et efficacité énergétique dans les communautés locales.

Domaine environnemental: amélioration des connaissances et de la gestion de la biodiversité, y compris l'utilisation durable des ressources naturelles; diminution de l'utilisation des produits agrochimiques; diminution de l'utilisation du bois pour la production de combustibles.

Domaine politique: présentation d'exemples de gestion innovante des ressources agricoles et naturelles; de plans d'action

stratégiques pour le développement et l'utilisation de diverses cultures; de lignes directrices sur l'introduction des organismes génétiquement modifiés (OGM); de recommandations sur la gestion agricole, la recherche en matière de santé animale, les innovations dans la chaîne de valeur, la politique de recherche agricole et l'enseignement supérieur agronomique; de l'utilisation de faits scientifiques dans l'élaboration des politiques agricoles; de directives sur les droits de propriété intellectuelle (DPI) des ressources génétiques végétales; de recommandations sur les technologies des énergies renouvelables (TER) et de feuilles de route de recherche; de normes nationales industrielles pour les TER; de recommandations concernant l'amélioration des régimes de DPI dans le secteur de l'énergie; de stratégies en matière de recherche et de transfert technologique.

Le renforcement des relations et la mise en réseau ont joué un rôle central dans la mise en œuvre des projets avec plusieurs parties prenantes. Les outils développés dans le cadre du projet, les mécanismes de formation et de recherche, les plans d'action et les recommandations politiques continueront d'être utilisées et adaptées. Les partenaires associés aux projets se sont engagés à continuer d'utiliser ces produits et d'en mesurer les effets sur les communautés cibles au cours des années à venir.

PROGRAMME DE RECHERCHE ACP DE RECHERCHE POUR LE DÉVELOPPEMENT DURABLE (VOLET CARAÏBES ET PACIFIQUE)

L'objectif du Programme de recherche ACP pour le développement durable était de contribuer au développement durable des pays ACP par le biais de la recherche scientifique et technologique. Ce programme a apporté son concours aux projets de recherche, en particulier dans les domaines de l'agriculture et de l'après-récolte, des énergies renouvelables et durables, de l'eau et de l'assainissement et du changement climatique, afin d'améliorer la résilience des pays ACP. Le programme, qui combinait un volet africain géré par la Commission de l'Union africaine et un volet Caraïbes et Pacifique géré par le Secrétariat ACP, a été financé au titre du 10e Fonds européen de développement (FED), le montant total des investissements de l'UE s'élevant à 20 millions d'euros.

Un appel à propositions compétitif pour le volet Caraïbes et Pacifique du programme (doté d'un budget de 4,8 millions d'euros) a octroyé des subventions à 10 projets, dont les activités ont été mises en œuvre entre août 2012 et septembre 2016. Au total, 34 établissements ont participé au programme et, parmi ces bénéficiaires, 22 sont des établissements des Caraïbes et du Pacifique.

L'investissement total dans les 10 projets, y compris les contributions des bénéficiaires, s'élevait à environ 6 millions d'euros. En moyenne, les activités ont été mises en œuvre dans 8 pays des Caraïbes et du Pacifique et dans 7 autres pays (UE, Australie, Nouvelle-Zélande). D'une valeur contractuelle de 0,6 million d'euros et d'une durée de trois à quatre ans, ces activités ont été organisées dans le cadre d'un consortium composé de quatre partenaires. Tous ces projets avaient un établissement des Caraïbes et du Pacifique en tant que partenaire chef de file.

Les bénéficiaires du projet ont amélioré leurs capacités d'enquête et modernisé leurs laboratoires et moyens TIC. Les scientifiques et techniciens ont bénéficié d'une formation aux méthodologies de recherche (laboratoire, terrain, modélisation) dans les domaines de la productivité agricole, du développement du plasma germinatif, de la production énergétique, des scénarios de changement climatique et de la gestion de l'eau. Les ménages et les agriculteurs ont également bénéficié d'une formation sur l'utilisation des produits de la recherche (par ex., cuisinière à hydrogène, outils agricoles, piège à insectes). Les établissements publics et privés et les communautés ont été en mesure d'évaluer les ressources en eau.

Les groupes cibles ont été sensibilisés aux changements liés au climat intervenant dans l'environnement et à la nécessité de s'y adapter. Les effets à plus long terme sont prometteurs grâce au renforcement des capacités de recherche et à l'engagement des instituts de recherche à poursuivre leurs activités scientifiques et technologiques. D'autres initiatives dans les domaines de la sensibilisation et de la recherche innovante et efficace sont encore nécessaires pour poursuivre sur la voie du développement durable dans les pays des Caraïbes et du Pacifique.



Key figures / Chiffres clés

45	ACP countries involved (34 from Africa, 8 from the Caribbean, 3 from the Pacific) Pays ACP participants (34 d'Afrique, 8 des Caraïbes, 3 du Pacifique)
15	EU countries involved Pays de l'UE participants
5	Other countries involved Autres pays participants
174	HEIs involved EES participants
48	Research organisations involved Organismes de recherche participants
36	Other organisations involved Autres organisations participantes
2,500	Students trained Étudiants formés
3,150	Academic and teaching staff trained Personnel universitaire et enseignant formé
11,450	Administrative and technical staff trained Personnel administratif et technique formé
11,650	End-users engaged and trained (farmers, practitioners, entrepreneurs, scientists, agricultural extensionists, public servants) Utilisateurs finaux engagés et formés (agriculteurs, professionnels, entrepreneurs, scientifiques, vulgarisateurs agricoles, fonctionnaires)
400	University curricula, courses and modules developed or revised Programmes, cours et modules universitaires élaborés ou révisés
600	Manuals, guidelines, maps, toolkits, protocols and policy papers produced Manuels, lignes directrices, cartes, boîtes à outils, protocoles et documents d'orientation élaborés
40	Technologies developed (ICT, farming, laboratory) Technologies développées (TIC, agriculture, laboratoire)
30	Databases created Bases de données créées
10	Models developed Modèles développés
10	Agricultural crop lines detected Variétés de cultures agricoles recensées
120	Infrastructures established (laboratories, greenhouses, incubators, germplasm banks, liaison desks, ICT) Infrastructures mises en place (laboratoires, serres, incubateurs d'entreprises, banques de plasma germinatif, bureaux de liaison, TIC)
60	Jobs created Emplois créés
30	Spin-offs created Entreprises dérivées créées
450	Presentations (conferences, symposia) Présentations (conférences, symposiums)
400	Publications (scientific journal articles, books, conference proceedings) Publications (articles de revues scientifiques, livres, actes de conférences)



ACP-EU Co-operation Programme
in Higher Education (EDULINK II)

*Programme de Coopération ACP-UE pour
l'enseignement supérieur (EDULINK II)*



AgIM – Agriculture Information Management and Precision Farming



Training activities at the Universidade de Cabo Verde

SUMMARY OF RESULTS

A Master of Science programme in Agriculture Information Management and Precision Farming has been developed, introduced and officially accredited in Cape Verde and Mozambique. Graduates will be able to utilise their skills in geographic information systems (GIS) and precision farming, a field considered strategically relevant and consistent with Cape Verde's and Mozambique's socio-economic development priorities.

BACKGROUND

The economies of Cape Verde and Mozambique are dependent upon agriculture. They lack not only the skilled professionals to develop the sector, but also the institutional means to produce adequately skilled professionals. In order to redress this situation, the AgIM programme was developed and implemented with the objective to improve the quality of agricultural education and provide expertise in the subject areas of information management and precision farming.

The strategy is rooted in maintaining academic quality, including a common framework for quality assurance and strengthening institutional capacity via the transfer of skills in scientific, didactical, technological and administrative domains.

METHODOLOGY

Stakeholder analysis

Teaching, administrative, financial, IT staff, smallholder farmers; rural communities; national geographical information data producers and providers; commercial organisations, agribusiness, fair trade unions; agricultural public departments.

Creating academic and management capacities in university faculties

An Academic Capacity Building Plan was developed, including the training of academic and administrative staff as well as a common framework for quality assurance.

Procurement of equipment and software

Equipment considered necessary to teach the practical courses included 17 laptops, 11 GPS devices and 2 drones.

Developing the AgIM master curriculum

The AgIM master curriculum was constructed, dealing with all aspects of curriculum design, structuring and organisation.

Establishing and managing two pilot demonstration projects

The demonstration plots in Mozambique and Cape Verde served as a dual resource for educational and research purposes that also enabled the development of a 'Repository of practice' that was stored on the project website and included in a short documentary.

Quality Assurance Board

The Quality Assurance Board ensured project activities met and exceeded international standards, and that the curriculum structure and content, as well as the learning / training events, were consistent with the current state of science and technology in AgIM.

The delivery of three editions of the AgIM Master Programme

An e-learning platform was developed and on-campus lectures, tutorial sessions and seminars were held and evaluated.

Promoting and dissemination activities

Promotional activities were designed and executed to mainstream and sustain good practices of precision farming education in developing countries.

PROJECT IMPLEMENTATION PERIOD

September 2013 – September 2017

CONSORTIUM

- Universidade Nova de Lisboa - Information Management School (NOVA IMS), Portugal
- Universidade Católica de Moçambique (UCM), Mozambique
- Universidade de Cabo Verde (UniCV), Cape Verde

Associated partners:

- Esri Portugal, Portugal
- Trimble Inc, USA

PROJECT CONTACT

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PROJECT WEBSITE

<http://agim.novaims.unl.pt/en/>

RESULTS

→ Outputs

Documents (available on project website)

- *Boas práticas em agricultura de precisão em países em desenvolvimento - A experiência do Projecto AgIM.*

Capacity building

- 39 administrative, management and ICT personnel trained in educational technologies.
- 18 students from 1st edition selected as assistant teachers for 2nd edition.
- 33 academic staff trained in problem-based learning and curriculum development theories.
- 46 technical staff trained in state-of-the-art precision farming.
- 41 beneficiaries from community (farmers) trained using developed curricular units.

Training and research facilities

- 2 Precision Farming Pilot Demonstration Projects: 1 in Cape Verde and 1 in Mozambique.

Platforms

- 1 platform supporting e-learning component: <http://moodle.agim.novaims.unl.pt>

Visibility

- 6 editions of AgIM newsletter.
- 2 publicity videos (one for each partner country).
- 2 international conferences.

Publications

- AgIM: Ensino pos graduado em gestão de informação Agrícola e Agricultura de Precisão em Cabo Verde e Moçambique

(I Jornadas Lusófonas CTIG 2014, Coimbra, Portugal).

- Including Geospatial tools for agriculture Education in Developing countries: A case for Cape Verde and Mozambique (6th International Conference on cartography & GIS, Albena, Bulgaria).
- Blended learning education on precision farming in developing countries: the example of Cape Verde and Mozambique (17th International multidisciplinary scientific geo-conference, Albena Bulgaria).
- Comparison of spatial interpolators for variability analysis of soil chemical properties in Cuamba, Mozambique (African Journal of Research).

↑ Outcomes

- Accreditation of the AgIM Master Programme in Cape Verde.
- Accreditation of the AgIM Master Programme in Mozambique.
- Facilities fit for purpose to deliver information management and precision farming education.

🎯 Impacts

Usage

- The Escola Superior de Ciências Agrárias e Ambientais of UniCV and the Faculty of Agriculture of UCM are able to deliver the AgIM master course with complete autonomy and enjoy access to up-to-date learning materials and equipment.
- A repository of practice has been established that will support the adaptation of existing agricultural curricula, as well as the further exploration of precision farming concepts, methods and techniques.

Policy implications

- The increased number of qualified professionals with an enhanced understanding of small-scale producers' needs will be able to contribute more effectively to decision-making processes. Utilising opportunities presented by advances in precision farming will support producers manage inputs and yields more efficiently, profitably and sustainably, improving food security and sustain good practices in natural resource management.

Sustainability

- An increase in the number of qualified professionals will contribute to more precise and efficient use of agricultural inputs. UniCV and UCM have skilled teaching staff able to deliver the course independently and have access to up-to-date materials and equipment.

TESTIMONIAL



**José Bofana, Teacher,
Centro de Investigação
Agrária e Desenvolvimento
Sustentável, Universidade
Católica de Moçambique,
Mozambique**

“The project has improved the technical capacity of teaching staff, providing us with reinforced knowledge in the field of spatial analysis techniques and with new teaching methodologies. We are also now working closely with the private sector and small-scale producers to increase their ownership of new production methods.”



Training activities at the Universidade Católica de Moçambiques.

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L³EAP – LifeLong Learning for Energy security, access and efficiency in African and Pacific SIDS



SUMMARY OF RESULTS

The scientific, technical and management capacities of the universities of Mauritius and of the South Pacific on energy security, access and efficiency have been enhanced. Capacities have been built to design, develop and implement mentored online lifelong learning courses (LLL). In both Mauritius and the South Pacific knowledge and skills have been developed that will enable staff to modernise their educational and research programmes and build relevant capacity in the energy sector.

BACKGROUND

Small Islands Developing States (SIDS), but also other developing countries, especially in the Global South, still face distinctive challenges to ensure sustainable livelihoods for their current population as well as future generations. One of these challenges relates to energy: access to affordable energy, the reliable supply of sustainable energy and the efficient use of energy. Despite significant potential for the production of renewable energy and the availability and cost-effectiveness of existing energy efficiency technologies, the Global South still shows a heavy reliance on fossil fuels to meet its energy demands, not least due to a lack of skilled human resources in the energy sector, which continues to hamper introduction of sustainable energy technologies in SIDS.

L³EAP offers tailor-made capacity building on a short-term basis to strengthen local resources and improve skills to better meet the demands of the local energy-related labour markets in island countries. The project's ultimate aim was to contribute to energy access, security and efficiency, as well as to diffuse renewable energy technologies in African and Pacific SIDS.

METHODOLOGY

Needs study

An energy sector survey investigated the views of energy practitioners on areas that required training and up-skilling. A HEI staff survey sought the views of trainers on their capacity-building needs for delivering quality, market-oriented training.

LLL course development

Development of Lifelong Learning (LLL) course programme and curriculum, structure, management, finance and marketing.

International pilot teaching modules

Development, implementation and evaluation of innovative joint international teaching modules.

ICT and e-learning

As ICT is a valuable way to bridge distances between learners, instructors, academics and practitioners, this approach was suitable for reaching the island-based target groups.

University staff capacity building

Specific training courses were held in Fiji, Mauritius and Germany on curriculum development for LLL, online courses, e-learning and blended learning. Seminars were organised for capacity building in managing international research projects.

Dissemination and networking

Promotional materials were developed, including website, brochures, posters and newsletter. Dissemination and networking events were organised or attended.

PROJECT IMPLEMENTATION PERIOD

October 2013 – March 2017

CONSORTIUM

- Hamburg University of Applied Sciences, Germany
- University of Mauritius, Mauritius
- University of the South Pacific, Fiji

PROJECT CONTACT

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PROJECT WEBSITE

www.project-l3eap.eu

RESULTS

→ Outputs

Capacity building

- Dedicated LLL programme adapted and made locally relevant: generic course focused on the SIDS context and courses addressing specific local needs.
- 84 academic/teaching staff trained in LLL development and delivery.
- 175 technical staff trained in LLL e-course management.
- 124 sector employees trained in sustainable energy for SIDS.
- 1,750 individuals completing online course 'Sustainable Energy for SIDS'.

Documents

- LLL needs assessment of SIDS energy sectors report: Experiences and Recommendations for Implementing LLL Concepts for the Energy Sector in ACP Region.

Publications

- Wolf F. *et al.*, 2018. Scalable online capacity-building for geographically dispersed learners: Designing the MOOC 'Sustainable Energy in Small Island Developing States (SIDS)'. In: Pandey, U.C., Inrakanti, V. (Eds.), Open and Distance Learning Initiatives for

Sustainable Development. (AETID Book Series, IGI Global: Hershey, USA).

- Raghoo P., *et al.*, 2017. Lifelong Learning (LLL) for Energy Practitioners in Small Island Developing States (SIDS): The Pivotal Role of Education in Energy Efficiency and Demand Side Management. In: Leal Filho W. (eds) Climate Change Adaptation in Pacific Countries. Climate Change Management. Springer, Berlin, pp. 353-368.
- Wolf F. *et al.*, 2016. Sustainable energy generation and use in SIDS and beyond - introducing the L3EAP online learning approach. *Braz J Sci Technol* (2016) 3:2.

↑ Outcomes

- Improved understanding of the LLL needs of Small Island Developing States.
- Strengthened capacity of university staff to develop and implement LLL courses
- Technical capacity of public and private sector to deploy energy solutions in SIDS

🎯 Impacts

Usage

- Competency-based interdisciplinary online modules and online facilitation:
 - The online learning approach in capacity building and delivery was effective in the context of SIDS and remote island populations.
 - The dissemination activities and availability of an online educational resource (OER) led to many requests to use the materials further.

Policy implications

- For HEIs there is a growing need to provide online access to educational resources and courses. Development of massive open online courses (MOOC) improves

performance via online learning.

- The LLL approach facilitated the provision of interdisciplinary knowledge and skills to islanders and has encouraged a learning community of experienced practitioners.

Sustainability

- The cost-free stand-alone course allows for replication and dissemination.
- Collaborating with the Hamburg Open Online University (HOOU) ensures free access and content use via the HOOU platform. HOOU promotes the L³EAP online course as a lighthouse project and initiated a follow-up project, building on the L³EAP results and experiences.



TESTIMONIAL



Rakesh Bootun,
Power Plant Chemical
Engineer, Quatre-Bornes,
Mauritius

“Mauritius is an isolated small island with a developing economy and depends on expensive imported fossil fuels for power generation. Increasing energy conversion efficiency is vital to Mauritius’ energy security. The L³EAP project has a very important role to play as regards energy security and efficiency. It will definitely help the country as a whole.”

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Financed by the European Union

Enhancing Capacities on International Agriculture Agreements for Development of Regional Agriculture and Food Markets



ECIATA seminar participants visiting a fish farm to enhance knowledge on sanitary standards for fish farming.

PROJECT IMPLEMENTATION PERIOD

October 2013 – November 2016

CONSORTIUM

- College of Agriculture Education (CAGRIC), University of Education, Winneba, Ghana
- University of Liberia, Liberia
- Federal University of Agriculture, Nigeria
- Njala University, Sierra Leone

Associated partners:

- University of Capo Verde
- University of Ouagadougou

PROJECT CONTACT

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PROJECT WEBSITE

www.eciata-winneba.com

SUMMARY OF RESULTS

Certificate level training courses were developed and mainstreamed into partner HEIs curricula that will form the basis of a future Masters/PhD Programme in International Agricultural Trade Policy. 300 West African officials have been informed on international trade agreements, including WTO, Economic Partnership Agreements (EPAs), the ECOWAS Trade Liberalisation Scheme (ETLS) and the ECOWAS Agriculture Policy (ECOWAP) that impact the West African agricultural sector.

BACKGROUND

Agricultural policy and food security are major priorities for the regional and national policies of West African countries. The West Africa region, which has potential in terms of agriculture, livestock and fisheries, nevertheless faces food security problems due to vulnerable ecological and climatic conditions. Regional disparities, local production deficits, as well as a lack of market fluidity and competition are also factors that limit the potential. The ECOWAS Agricultural Policy (ECOWAP) has been adopted by the governments of the region with the objective of meeting the food security needs of the region's population and also to develop the economies of the member States and reduce poverty. This project contributes to this strategy by strengthening the academic capacities of regional universities to assist governments in the negotiation and implementation of international agriculture trade agreements and to enhance the competitiveness and growth of the agriculture sector in general.

METHODOLOGY

Needs-assessment

A study was conducted to determine the institutional weaknesses in terms of agriculture policy implementation and negotiation capabilities. Stakeholders include HEIs, government ministries, ECOWAS officials, ECOWAS Parliament and Commission and farmers associations.

Training courses

As a result of the study, new training courses were developed to enhance capacities and knowledge of trade policy issues impacting

on the agriculture sector. Training activities centred on inter-institutional networking, increased mobility of teaching staff on joint field surveys, improved academic frameworks and excellence on agriculture trade agreements, its negotiations and implementation.

Development of new postgraduate curriculum

Recommendations were used as inputs towards the development of new postgraduate curriculum and training courses.

The curriculum would target post-graduate students, government officials, private agri-businesses, civil societies and parliamentarians on agriculture-related trade agreements. Training courses on negotiation would be targeted at government officials.

Implementation of new curriculum

The first pilot training certificate programme was held in Ghana in October 2017. Following the pilot Certificate Course attended by over 40 participants in Ghana, the partners are now in the process of integrating the course modules into their school curriculum whilst exploring the option of converting the certificate course into a full Masters Programme in International Agriculture Trade Policy.

Policy coherence conference

The conferences and workshop held discussed policy coherence in the agriculture sector with others in areas such as gender and environment to ensure that trade agreements implemented in the agriculture sector would achieve coherence with existing national and regional policies on gender and environment.

RESULTS

→ Outputs

Capacity building

- 300 government officials, private sector and civil society stakeholders sensitised to the benefits of trade agreements in the agriculture sector.
- 9 training courses on International Trade Policies in agriculture, including: CAADP/ECOWAS Common Agricultural Policy; Introduction to WTO Agricultural Agreements; EPAs; Trade Facilitation; SPS; TBT; TRIPS; Private Standards; Rules of Origin; Trade Remedies and Commercial Diplomacy.
- 2 courses on Trade and Gender, and Trade and Climate Change.

- New training curricula on International Trade Agreements including modules, reading notes, time-tables and exam structures and questions.

Documents

- Recommendations for the development of curriculum and training materials for government officials.
- Recommendations on the role of universities in the implementation of the regional ECOWAS agriculture policy.
- 4 national and 1 regional reports on insti-

tutional capacity needs related to trade agreements.

Networking

- 20 postgraduate students and teaching staff facilitated in regional mobility and exchange.

Visibility

- 6 national stakeholder meetings on the impact of trade agreements within the context of the EU-ECOWAS Economic Partnership Agreements and WTO.

↑ Outcomes

- Enhanced capacity of officials to implement national and regional policies in agriculture and trade.

- Inter-institutional capacity to develop curricula and training courses in trade negotiations and agriculture.

- Academic frameworks related to the implementation of trade agreements, negotiations and policy implementation.

🎯 Impacts

Usage

- Universities have started mainstreaming the course modules into their academic curriculum and have enhanced awareness of the quality standards that are governed by trade agreements. For example on organic farming, eliminating child labour, health and safety of workers and promoting gender equality. Farmers are being encouraged to adopt these beneficial practices that will enable them to exploit potential opportunities in international trade.

Policy implications

- Better informed officials are able to be more effective in the negotiation and implement better trade agreements and policies. Better policy reforms will result in relevant and effective regulation in the agriculture sector that will benefit farmers, create employment and protect the environment.

Sustainability

- There is the intention to replicate the training programme in other partner countries and to upgrade the certificate level training course into a full Masters/PhD Programme in International Agriculture Trade

Policy. Further assistance is being sought from the EU ERASMUS+ Programme to develop the certificate course into a full Masters MSc Programme in International Agriculture Trade Policy related to the implementation of the EPAs in the agriculture sector. In addition, 160 students and government officials would be supported to undertake an MSc in International Agricultural Trade Policy. The aim is to have qualified trade policy experts in the partner universities to support the roll-out and implementation of the Masters/PhD Programme in International Agricultural Trade Policies.

TESTIMONIAL



Sarah Edewor,
Doctoral student,
Department of
Agricultural Economics
and Farm Management,
Federal University of
Agriculture, Nigeria

“I am able to effectively direct my research in international agricultural trade and as a result make relevant recommendations that may be used to formulate policy.”



ECIATA participants visiting a vegetable farm, Ashanti-Mampong, Ghana.

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Financed by the European Union

Strengthening Human Resource Capacity to Foster Agricultural and Rural Innovation in Eastern Africa



Documentation of field experiences for E-content development.

PROJECT IMPLEMENTATION PERIOD

September 2013 – September 2016

CONSORTIUM

- Makerere University, Uganda
- Sokoine University of Agriculture, Tanzania
- Egerton University, Kenya
- Agreenium, France
- Wageningen University, The Netherlands
- University of Copenhagen, Denmark
- RUFORUM, Uganda

Associated partners:

- Inter-University Council of East Africa, Uganda
- Association for Strengthening Agricultural Research in Eastern and Central Africa, Uganda

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PROJECT WEBSITE

www.ariphdprogram.org

SUMMARY OF RESULTS

The project enhanced the quality of training of Agricultural and Rural Innovation (ARI, a programme set up through a previous EDULINK project) and AgTrain PhD programmes through student and staff exchange between African and European universities, and converting selected modules for online delivery. 19 academic, 6 administrative staff and 79 students participated in the joint delivery of 10 modules with 51 and 69 student and staff exchanges. The 10 modules were updated and 6 of them converted and tested for online delivery. 3 e-learning laboratories were equipped, and 19 academic and 6 administrative staff trained to facilitate online learning. Additionally, 3 national stakeholder platforms were established to align ARI with development needs.

BACKGROUND

Innovations in agriculture are resulting from the co-ordinated actions of multiple stakeholders including farmers, researchers, private sector and civil society organisations.

East African countries are transforming their agricultural systems to promote innovations that enhance agricultural growth and reduce poverty. However, the innovation systems approach is a relatively new field that requires the development of competent human resources to generate the knowledge to design and effectively implement agricultural development programmes. Universities need to develop capacities to produce the desired human resources.

To address this challenge, a regional PhD programme in Agricultural and Rural Innovation (ARI) has been implemented. The programme seeks to reduce the cost of student and staff mobility through online delivery of modules and establishing national stakeholder platforms for continuous guidance.

METHODOLOGY

The PhD students from the 3 African universities converged at Makerere University for joint course work. A team of instructors comprising of representatives from each African university and one European university taught (and reviewed) each module to allow exchange of knowledge and experiences. European instructors provided technical expertise in developing and testing online versions of ARI modules. National stakeholder platforms in African countries

convened each year to guide alignment of ARI with development needs through the following actions:

- **Development of mobility implementation plan:** A master plan developed to map schedules for the mobility of students and staff for each cohort.
- **Joint implementation of ARI programme:** Recruitment of students and logistical requirements for necessary adjustments in module delivery.
- **Review and update of the ARI modules:** Instructors integrated feedback in reviewing modules, taking into account course outline, content and mode of delivery.
- **Training of staff in e-content development and online delivery:** The development of e-content requires new preparation and delivery skills.
- **Peer review and uploading of e-content:** Modules subjected to peer review by persons familiar with online learning, tested and uploaded.
- **Procurement and equipping of student computer laboratory:** Each of the 3 African universities was provided with IT equipment to ensure access to e-learning.
- **Orientation of students in online learning:** Prepare students to effectively use computer-aided learning. University of Copenhagen has extensive experience in creating online educational fora, which effectively overcome initial hesitation and lack of openness in the sharing of ideas.
- **Identification of potential employers for national platforms:** Intended to articulate the capacity and research needs of the rural development agencies.

RESULTS

→ Outputs

Capacity building

- 10 modules jointly implemented and updated.
- 79 students of ARI and AgTrain participated in the joint modules delivery.
- 66 staff participated in joint module delivery.
- 51 student and 69 staff mobilities implemented.
- 6 online modules developed and tested.
- 19 academic and 6 administrative staff oriented in online module delivery.
- 3 national stakeholder platforms established.

- 5 PhD students graduated with ARI PhD in January 2018 at Makerere University.

Facilities

- 3 e-learning laboratories equipped.

↑ Outcomes

- Students are able to gain perspectives in development research through community and stakeholder engagement.
- Establishment of e-learning resources enables cost-effective collaborative teaching within ARI programme partner universities.
- Stakeholders challenge the universities with critical areas of research and are willing to fund research.

🎯 Impacts

Usage

- Teams of instructors jointly teach modules to provide different perspectives to the content and its application. This approach to teaching is now a best practice within the African partner universities.

The East African Community is in the process of developing policies for harmonisation of education in the region and the ARI programme provides a good model for harmonisation of curricula and facilitation of credit transfer.

with enhanced capabilities in constructing academic theories around development issues, framing research and generate knowledge for problem solving and facilitate critical thinking will attract the best international students from across the African continent.

Policy implications

- The foreseen policy implication is in developing policies and guidelines for credit transfer among East African Universities.

Sustainability

- The capacity of the partner universities to implement a competitive PhD program



Innovation in agronomic practices.



Community feedback meetings with ARI and Agtrain students.



ARI and Agtrain PhD students field orientation preparations.

TESTIMONIAL



Dr. Maurice O. Udoto
Senior Lecturer
Department of
Agricultural Education
and Extension,
Egerton University,
Njoro, Kenya

“The ARI programme is a well-conceived project for training top-level managers in agricultural and rural development in Africa. The innovation systems approach, emphasising complex process-based systems is appropriate given that the sector’s growth and develop-

ment is influenced by complex interactions among public, private, and civil society actors, while knowledge flows within the system are conditioned by a variety of rapidly changing institutions.”

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Strengthening University Capacity to Enhance Competitiveness of Agribusiness in East and West Africa



Ajok Winnifred, a graduate student, explaining her roles in her placement to Gulu University staff and a visitor from Maastricht School of Management.

SUMMARY OF RESULTS

Entrepreneurship has been mainstreamed into the different undergraduate curricula of the faculties involved and departments have implemented practical agri-entrepreneurship courses for undergraduate students. A new Master programme (Master of Science in Agri-enterprise Development) which is hands-on and student centred in its curriculum delivery has been developed and implemented in the universities of Gulu and Egerton. Two cohorts of students have been admitted.

BACKGROUND

To be able to meet the challenges of the 21st century, there is a need to change the mindset of farmers to incorporate value addition in their production and enable agri-enterprise development and wealth creation for rural households.

Smallholder agricultural commercialisation may be enhanced meaningfully by connecting agricultural education and research more closely to the needs of farmers and the food industry. However, the role of agricultural education and training in fostering agribusiness growth in developing countries is relatively underexplored. An approach that integrates the efforts of universities, research institutions and industry should be adopted. This vision of agriculture calls for rethinking the roles of producers, the private sector and training institutions.

The project aimed to improve the relevance of agricultural science teaching and outreach from the theoretical to the needs of agribusiness by including entrepreneurship in curricula and enhancing collaboration between universities and the private sector, thereby reducing the difficulties faced by agricultural science students in finding employment as a result of the gap between what is taught and the requirements of the labour market.

METHODOLOGY

Sensitisation of faculty, students, and industry players on the importance of agri-entrepreneurship was done with workshops and brochures.

Review of existing agricultural science curricula to include agri-entrepreneurship

- Desk research and exchange visits to the University of Copenhagen to identify best practices in entrepreneurship training.

Training of academic staff and other stakeholders

- Training on curriculum delivery methodologies. Staff were trained on innovation and entrepreneurship delivery methodologies.
- Staff were also trained on cluster mapping and development.

Customisation of learning resources for agri-entrepreneurial training

- Modules were developed to be used for training the MSc in Agri-enterprise Development students.

Development of agri-innovation clusters

- Agri-cluster mapping and development were conducted by surveying the clusters to establish the various actors and their roles and challenges.
- Training sessions were conducted with the actors to enable them to operate more efficiently.

Establishment of university-industry linkages

- Academic staff exchange programmes, student placements, establishing an entrepreneurship scheme and agri-innovation cluster.

Establishment of entrepreneurship fund scheme

- Guidelines were developed on the management of the fund scheme.
- Students developed business plans which were assessed for viability.
- Students were supported in establishing and running their agri-enterprises.

PROJECT IMPLEMENTATION PERIOD

October 2013 – April 2016

CONSORTIUM

- Egerton University, Kenya
- Gulu University, Uganda
- Mekele University, Ethiopia
- University of Portharcourt, Nigeria
- University of Copenhagen, Denmark

PROJECT CONTACT

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patmapenzi@yahoo.com

PROJECT WEBSITE

www.c-aed.net



RESULTS

→ Outputs

Capacity building

- 146 faculty staff trained on entrepreneurial and innovative curriculum delivery methodologies.
- 2,000 students trained on entrepreneurship and business plan development.
- 500 farmers trained on farm management.
- 268 farmers trained in 4 agro-innovation clusters: Carrot-potato cluster, Kenya; Tomato-onion cluster, Ethiopia; Rice cluster, Uganda; Cassava cluster, Nigeria.
- Master of Science in Agri-enterprise Development programme: 9 modules; 53 students enrolled (of which one for a PhD in Egerton University sponsored by the World Bank funded project 'Centre of Excellence in Sustainable Agriculture and Agribusiness').
- 21 agri-enterprises providing part-time employment to students and 33 employees

Networking

- 21 agri-enterprises have been started by students and a fund scheme has been piloted to fund future student agri-enterprises.
- 57 linkages have been established between participating universities and the private sector through student placements, internships and agribusiness clinics offered to farmers and farmer groups

Documents

- Farmer training manuals:
 - Group dynamics, farm records, and enterprise choice (Egerton University).
 - 2 manuals on pig and poultry production (Gulu University).
 - 1 manual on cassava processing (University of Port Harcourt).
 - 2 manuals on sheep production (Mekele

University).

- 1 manual on principles and practices of entrepreneurship and farm accounting (Mekele University).

Visibility

- 1,000 information brochures on project activities and expected results. The brochures were distributed during university open days.
- Newsletters distributed to students and staff detailing progress of project activities (300 copies).

↑ Outcomes

- Faculties are competent in developing and delivering agri-entrepreneurship training.
- Agricultural science graduates from the partner universities are competitive in the labour market.
- Universities and the private sector are collaborating in curriculum development and placement of students.

🎯 Impacts

Usage

- Different academic staff and students from various disciplines embrace agri-entrepreneurship, with departments incorporating practical courses into their curricula.
- Other universities are borrowing from the experiences of this project, especially in the preparation of the MSc in Agri-enterprise Development. Enrolled students have trained over 2,000 other students leading to a large number of requests for seed funding to establish small agri-enterprises.
- Students gained practical experience and

universities are able to establish stronger links with farmers, owners and communities.

Policy implications

- Encouraging university-industry linkages and university partnerships and cooperation through shared knowledge, curriculum review and development improves the quality of higher education offered and a greater participation of African academic staff in international research and scientific networks.

Sustainability

- Agri-entrepreneurship training is mainstreamed into the faculties of agriculture in the participating universities and student placement/internship and community engagement are mainstreamed into the curricula.
- Lecturers have embraced the innovative curricula delivery methodology and are delivering courses. Egerton and Gulu Universities have developed and implemented the MSc in Agri-enterprise Development.

TESTIMONIAL



Christopher Nzuki,
horticulturalist and owner
of a company promoting
sustainable beekeeping,
Kenya

“This programme has revolutionised graduate agricultural science training through encouraging skills in entrepreneurship. Moreover, the students work with farmers and agri-enterprises throughout their period of study and this gives them practical skills and helps

them engage with the community. The collaboration between industry and university staff in the development and delivery of the curriculum is also a break from the norm and this has enabled the students to interact with industry players.”

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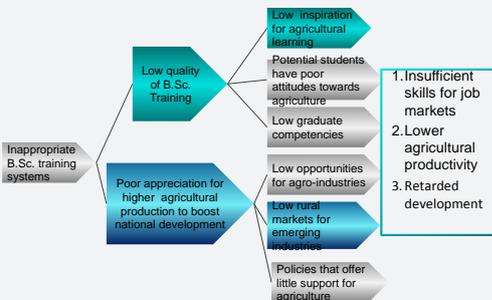
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PREPARE-BSc – Enhancing the Quality of Graduates of Agriculture and Veterinary Sciences to Meet Tomorrow’s Food Security Challenge in East Africa

Figure 1. Effects of inappropriate B.Sc. Training systems



SUMMARY OF RESULTS

Lecturers trained in didactics and aligning curricula to learning outcomes, and formal student mentorship programmes established.

Links established between secondary schools and universities, including open days for secondary school students to visit universities in order to improve their preparedness for university education.

Links with industry established including the involvement of industry partners in developing and implementing training and academic programmes focused on graduate competence.

Consequences of inappropriate undergraduate training.

PROJECT IMPLEMENTATION PERIOD

October 2013 – March 2017

CONSORTIUM

- University of Nairobi, Kenya
- Sokoine University of Agriculture, Tanzania
- Makerere University, Uganda
- University of Copenhagen, Denmark

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PROJECT WEBSITE

preparebsc.uonbi.ac.ke

BACKGROUND

Africa urgently needs to upgrade the quality of its human resource base within agriculture to address its growing food security challenges. The success of African agriculture to meet productivity challenges depends on the human capital available within the sector.

Universities and other agricultural tertiary education institutions have been slow to respond effectively to the changing socio-economic needs. PREPARE-BSc aimed to improve the quality and relevance of courses offered at the undergraduate level and produce graduates with the relevant skills required by the sector. The project has introduced a complete shift in the methods used in training graduates from a very theoretical approach to a problem-solving and experiential learning, hands-on training and exposure to real-life situations via student placements and staff mobility within the agricultural industry.

METHODOLOGY

Situation analysis

Surveys were conducted to deduce: perceptions, motivations and aspirations of high school students, parents and teachers; industry employer perceptions and expectations; and training attitudes and conduct of the university community.

Harmonisation of administrative systems

The partners exchanged copies of rules and guidelines currently in use for the teaching of undergraduates and then undertook a review in light of the available information.

Training of lecturers in didactics and student mentorship

Two Training-of-Trainers (TOTs) workshops were held, each lasting five days, which also developed training materials.

Curricula review

Project team members conducted reviews of seven undergraduate curricula.

Establish linkages between universities and industry players

The project facilitated the creation and formalisation of linkages with industry that would allow for their contributions to university education to be recognised.

Student mentorship programmes

Each regional university organised students into peer mentorship groups whose leaders were trained in selected issue-related topics. In turn, the student mentors organised wider mentorship activities.



RESULTS

→ Outputs

Capacity building

- 16 university staff (3 female, 13 male) trained via TOTs using 5 training modules on curriculum alignment to learning outcomes.
- 263 university staff (89 female, 174 male) trained on new learning approaches.

Mentorship clubs and social media

- 46 students from the 3 universities formed a regional club to mentor agriculture students. They used Facebook and WhatsApp to share information and acted as youth ambassadors to motivate secondary school students to follow agricultural careers.

Rules and regulations

- Print and electronic copies of training guidelines.

Publications

- 3 survey reports on expected outcomes of agricultural education and solutions to training challenges.
- 5 training manuals on didactics and mentorship.

Networking

- Private-public collaborations initiated and formalised with agricultural sector companies.

Dissemination

- 14 universities participated in a 2-day regional dissemination workshop.
- University staff and lecturers competent in developing and delivering competence-based and problem-solving methods of training to students.
- Partner HEIs are producing graduates with relevant skills and competencies required by the modern African agricultural sector.
- Partner HEIs have higher quality and relevant courses and as such are more competitive in attracting prospective students.

↑ Outcomes

- University staff and lecturers competent in developing and delivering competence-based and problem-solving methods of training to students.
- Partner HEIs are producing graduates with relevant skills and competencies required by the modern African agricultural sector.
- Partner HEIs have higher quality and relevant courses and as such are more competitive in attracting prospective students.

🎯 Impacts

Usage

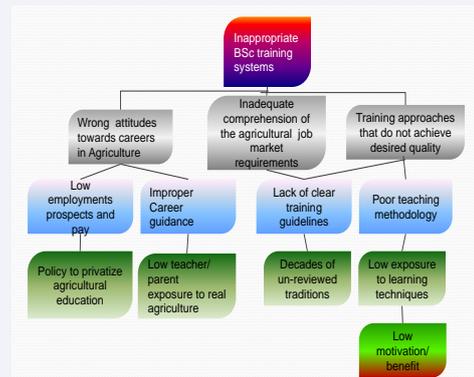
- University staff have been sensitised to engage and activate student-centred problem-based learning in close partnership with industry in order to deliver competent graduates that meet labour market demands.

Policy implications

- The project has systematised effective links with industry, which the partner HEIs have adopted and are now formalising the system throughout their institutions.

Sustainability

- Improved programmes and graduate quality will increase partner university attractiveness. They have in-house capacity to continue improving the quality of agricultural education and sustain student mentorship activities through clubs and under university mentorship policies. All of which would be financed through student activity budgets and club-generated revenue.



Causes of inappropriate BSc training.

TESTIMONIAL



Prof. Samuel Githigia,
Chairman of veterinary
pathology, microbiology
and parasitology
department
University of Nairobi
Kenya

“The project has enabled new teaching and evaluation methods to be implemented with support and engagement from the highest levels of administration. Personally, I have become familiar and am now able to implement learner-centred teaching methods. This includes setting learner-centred objectives and outcomes. I now see myself as part of the larger picture in the goal of achieving food security. I see that my impact on the students has a potential influence on the future.”



Participants of the PREPARE - BSc regional youth congress.

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Financed by the European Union

R.U.S.S.A.D.E. – Réseau des Universités Sahéliennes pour la Sécurité Alimentaire et la Durabilité Environnementale

SUMMARY OF RESULTS

A network was established between four Sahelian universities in Burkina Faso, Chad and Niger with Turin in Italy. Scientific, technical and didactic collaborations have been developed in the fields of sustainable development and environmental protection. A new Master's course following the international LMD system (Licence-Master-Doctorate) is now available in the strategic fields of livestock, crop production, food security and sustainable management of natural resources. Didactic structures have been improved and experience shared.

BACKGROUND

In Sahelian countries, poverty and the resulting malnutrition present a challenge when it comes to maintaining social peace and stability and promoting human development. Food insecurity is the result of a widespread and severe scarcity of productive resources and affects the most vulnerable part of the population.

The main goal of the project was to improve the knowledge and know-how of HEIs (Higher Education Institutions) from Sahelian countries to assure food security. An education specialised in individual sectors produces efficient technicians, but it is inadequate to deal with complex problems that require an integrated approach between different disciplines. The structure of the Master's programme encourages a multidisciplinary approach and increases students' understanding and builds on their previous experiences. Problem solving and team work is more efficient using an interdisciplinary approach.

The mobility of teachers and students was encouraged, promoting the sharing of skills and delivery of programmes according to local needs and employment markets.

Civil society and policy makers were targeted to promote a greater awareness of the connections between human choices, natural processes and environmental modifications.

METHODOLOGY

Creation of a higher education network

Strengthening the partner HEIs in applied scientific research and quality of education, promoting skills exchanges between teachers and students.

Connecting innovative teaching strategies for agri-food production to other key themes, such as: land management, transformation and degradation of the physical environment, supply and protection of water resources, and management of waste and pollutants.

Stakeholder analysis

Stakeholders benefit from: sustainable technologies applicable in the Sahelian context, with a low impact on the environment; the latest scientific and methodological knowledge to acquire cognitive and social skills; the promotion of teamwork with civil society institutions involved in sustainable development.

Adoption of training modules

Training modules and field experience help students to benefit from a multidisciplinary approach and acquire a greater awareness and understanding of complex problems.

Diffusion of results and evaluation

Interviews with teachers and students reveal that such training promotes the acquisition of technical skills, awareness of local issues and consciousness that a local intervention affects the entire region.



Practical experience with a solar cooker at the University Abdou Moumouni campus, Niamey, Niger.

PROJECT IMPLEMENTATION PERIOD

October 2013 – April 2017

CONSORTIUM

- Centro Interdipartimentale di Ricerca e Cooperazione tecnico Scientifica con l'Africa (CISAO), Università degli Studi di Torino, Italy
- Centre Régional d'Enseignement Spécialisé en Agriculture (CRESA), Université Abdou Moumouni de Niamey, Niger
- Université Polytechnique de Bobo Dioulasso (UPB), Burkina Faso
- Institut Universitaire des Sciences et Technologies d'Abéché (IUSTA), Chad

Associated partners:

- Regione Piemonte – Settore Affari Internazionali e Cooperazione decentrata
- Terre Solidali Onlus

PROJECT CONTACT

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PROJECT WEBSITE

www.russade.eu – www.cisao.unito.it



RESULTS

→ Outputs

Capacity building

- Master in Food Security and Environmental Sustainability (20 didactic modules).
- 47 teachers (8 female, 39 male) and academics interacted in distance and co-presence teaching, sharing skills to prepare didactic material.
- 10 students (1 female, 9 male) enrolled in the Master's programme and received diplomas.
- Agreements signed between the HEIs and local and international institutions for graduates' recruitment.

Website and e-platforms

- Project website (www.russade.eu) supporting a restricted access Moodle platform with didactic documents from the Master's programme.
- CISAO website (www.cisao.unito.it) with project information.

Publications/documents/articles

- 14 papers in Italian and international congress proceedings.
- 2 papers in reviews and books.
- 12 papers in a special RUSSADE project

section in the JUNCO review (<http://www.ojs.unito.it/index.php/junco/issue/view/231>).

Visibility

- 8 conferences about RUSSADE topics in Italy, Niger and Chad.
- 4 meetings with students and civil society in Italy, Niger and Burkina Faso.

↑ Outcomes

- Official accreditation of the Master's programme
- HEIs able to offer multidisciplinary courses at Master's level
- Academic courses relevant to local and regional sector requirements

🎯 Impacts

Usage

- The reinforced capacity of the HEIs ensures the training of more skilled professionals who can effectively participate in sustainable development and poverty reduction strategies in their countries.
- All graduates of the Master's programme have been employed after their studies.
- The stakeholders experienced the role of education as an engine of social progress and economic development.

participated in the conferences. Their raised awareness of the links between poverty, food security and environmental degradation will contribute to the elaboration of development plans, taking into account the core elements of economic growth, social inclusion and environmental protection.

scholarships. The network will mitigate some of these limitations by sharing resources and responsibilities.

Policy implications

- Academic administrators, policy makers and ministries (Higher Education and Research; Agriculture; Environment) and members of civil society have been involved in project implementation and

Sustainability

- The partners are determined to offer new editions of the Master's programme with an interdisciplinary approach ensuring the sustainability of the course. A lack of financial resources is a limiting factor in terms of covering management costs, mainly for teachers' mobility and students'



The graduation of the first cohort of students of the Master's programme RUSSADE 2016.

TESTIMONIAL



Dr. Ardjoun Khalil Djalal,
Teacher and researcher
in IUSTA, Chad

“This project can help us to create new relationships and develop an educational platform to support practical and professional training of skilled labour. With the cooperation of all stakeholders, the educational objectives were defined. A holistic approach to Food

Security and Environmental Sustainability was adopted, as was a policy of teacher collaboration in Teaching Units. I hope that the teachers involved will be able to work together to improve its content and provide better training.”

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EGALE – Gathering universities for quality in education

SUMMARY OF RESULTS

Transition to the Licence-Master's-Doctorate (LMD) system was achieved by developing the skills of administrative and managerial staff to international standards for HEI management. PhD curricula were developed in the field of Agriculture and Food Security, as well as courses on Internationalisation, the LMD system, and PhD development. An e-learning system was introduced at the HEIs. Agreements were drawn up for the SEADD-VALCOBIO international consortium, involving the universities of Torino, Comoros and Madagascar (Antananarivo, Toamasina and Mahajanga).

BACKGROUND

The project was set up to support sustainable development for food security in Madagascar and Comoros, by strengthening the capacities of local Higher Education Institutions (HEIs) as contributors to regional strategic plans in agriculture. The specific aim was to improve the capacities of the HEIs to train qualified human resources in the field of sustainable agriculture and food security at both administrative and academic levels. To achieve this aim, the project has facilitated the transition of academic programmes within the partner institutions to the international Licence-Master's-Doctorate (LMD) system.

The project has also sought to overcome the isolation of Madagascar and Comoros by increasing scientific knowledge exchanges within the partnership, by strengthening the linkages with the local Ministries of Education and by establishing an international consortium for programme development, research, and staff-exchange in the field of food security and sustainable agriculture. This included the development of an e-learning system.



Field trip: Overview of agriculture and fishing in Comoros.

METHODOLOGY

International consortium and skills development

Training administrative and technical staff on the Internationalisation process and Bologna process included managerial and administrative skills for internationally funded projects and the provision of support to students and university staff. Skills development also included the development and planning of an international PhD programme on agriculture, food security and the environment.

Improvement of academic capacities

Academic staff were selected to increase their scientific and pedagogic expertise. Their training included developing skills in the management and delivery of distance learning programmes, thereby increasing the capacity of the partner HEIs to offer higher education to a wider population via a distance learning platform.

Networking and visibility

Awareness of local stakeholders was raised via various media to enhance future sustainability.

Monitoring and Evaluation

The project was assessed on a regular and strategic basis to ensure its continued relevance and ongoing benefits to the target group.

EU-ACP networking and scientific knowledge exchange during the International Symposium, ISSEDD – Toamasina (Madagascar).

PROJECT IMPLEMENTATION PERIOD

October 2013 – June 2017

CONSORTIUM

- University of Torino, Italy
- Ecole Normale Supérieure (ENS), Université de Antananarivo, Madagascar
- Ecole Supérieure des Sciences Agronomiques (ESSA), Université de Antananarivo, Madagascar
- Institut Supérieur des Sciences Environnement et Développement Durable (ISSEDD), Université de Toamasina, Madagascar
- Faculté des Sciences et Techniques, Université des Comores (FST-UDC), Comoros

Associated partner:

- Fondazione CRUI per le Università Italiane, Italy

PROJECT CONTACT

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PROJECT WEBSITE

Facebook Page: Projet Egale
<http://www.egale.unito.it/>



UNIVERSITÀ DEGLI STUDI DI TORINO



RESULTS

→ Outputs

Capacity building

- 22 female and 16 male administrative/technical staff trained through 3 e-learning modules on management developed to international standards.
- 16 female and 14 male academic staff trained through 4 scientific e-learning modules on:
 - research planning;
 - horticulture and fruit production chains;
 - environment protection;
 - tropical farming and climate change;
 - food security and food safety.
- 6 co-tutored PhD theses (4 month mobility period in Italy). 5 lectures given by the PhD students at UNITO, 3 manuscript drafts, 3 abstracts presented at international congresses.
- E-learning platform introduced as an

official means for course delivery at the partner HEIs.

Visibility

- 1 mid-term scientific symposium (Madagascar) and 1 final scientific workshop (Comoros).

↑ Outcomes

- Improved academic knowledge of food security and sustainable agriculture.
- Improved research and laboratory techniques adopted by 6 PhD students.
- International consortium 'Réseau pour la Sécurité Alimentaire, Développement

Durable, Valorisation et Conservation de la Biodiversité (SEADD-VALCOBIO) established.

🎯 Impacts

Usage

- At ISSEDD, 20 PhD applications have been received for the year 2016-2017 and student enrolment has doubled for the same year compared to 2014-2015.
- FST-UDC is planning to introduce scientific training to the e-learning system and partner HEIs are looking to further utilise the e-learning system to manage other courses.

international quality assurance, the introduction of e-education and promoting student mobility and exchanges.

Sustainability

Policy implications

- Increased administrative and academic capacities in sustainable agriculture and food security will contribute to the national strategies of Comoros and Madagascar in higher education, specifically tailoring higher education to local needs,

- SEADD-VALCOBIO is committed to increasing its membership, especially from the countries of the Indian Ocean. The University of Mahajanga (Madagascar) has already successfully acceded and HEIs in Mauritius and Reunion are in the process of acceding.
- A joint application with the University of Antananarivo under Erasmus+ (International Credit Mobility, Madagascar) was awarded a grant.



Delivery of certificates to part of the trained administrative staff (ENS).



Informative measures on processed local food during project visibility activity at Comoros.

TESTIMONIAL



Claude Omer Andrianarimanana,
Director, University of Antananarivo,
Madagascar

“Open online distance learning will help to resolve the shortages of resources and infrastructure whilst increasing the intake capacity of the institution. The training is less expensive compared to what currently exists and by training more PhD students we are able to increase the number of teachers available. PhD students will benefit from mobility to other universities due to the recognition of diplomas and experience.”

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PROCEED-CARIBBEAN – Promotion of Capacity and Energy Education Development in the Caribbean Region



SUMMARY OF RESULTS

The institutional capacity of Caribbean HEIs (staff and PhD students) was enhanced on energy related issues and climate change. BSc and MSc curricula have been improved to respond to the challenges of energy access and efficiency in the Caribbean. Sustainable energy has been promoted amongst energy sector stakeholders and mainstreamed into national energy policies and development plans.

BACKGROUND

The PROCEED project concentrated on the capacity building of partner higher education institutions (HEIs) located in Barbados, Jamaica and Cuba as regards energy access and efficiency. The project has contributed to regional integration and capacities through institutional networking and fostering information exchange.

The aim was to enhance the capacity of the Caribbean HEIs to be more responsive to the labour market and increase their effectiveness in contributing to national plans and regional co-operation in energy efficiency, access and sustainability.

Barbados, Cuba and Jamaica are highly dependent on expensive fossil fuel imports for their electricity production. This dependence has adverse social, environmental and economic consequences with respect to sustainable development.

The core of the project was, therefore, to train HEI staff to enable them to better understand the potentials of sustainable energy resources and to increase institutional capacities on energy related issues and climate change. The challenge was to reach a wider audience within the energy sector and demonstrate alternative and viable energy development paths.

METHODOLOGY

To improve capacities to deliver multidisciplinary energy education and promote sustainable energy resource use, the methodology entailed training of trainers and organising workshops and networking events.

3 workshops and 12 sets of trainings were conducted for academic staff and students of the partner HEIs along with participants from ministries, utility companies and the private sector.

Updating curricula, teaching methods and tools

Teaching methods and tools (equipment and software) were upgraded so that the skills and expertise acquired are relevant to the development of the energy sector.

Trainings targeted academic staff and PhD students to increase their capacities in curricula development (BSc and MSc programmes).

Project management training

Administrative staff were trained to enhance their administrative, financial and project management capacities.

Networking

Regional and national institutional partnerships were strengthened and networking between public and private sector was used to promote sustainable energy policies.

LINDA process (Long-Range Integrated Development Analysis).

PROJECT IMPLEMENTATION PERIOD

October 2013 – June 2017

CONSORTIUM

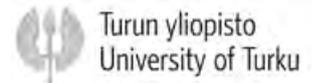
- University of Turku, Finland
- Tampere University of Technology, Department of Automation Science and Engineering, Finland
- University of the West Indies, Mona Campus, Barbados
- University of Oriente, Cuba
- University of Technology, Jamaica

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PROJECT WEBSITE

<http://ffrc.utu.fi/en/>
<http://sdfutures.fi/wp-content/uploads/2015/04/proceed-english.pdf>



RESULTS

→ Outputs

Capacity Building

- 244 participants (62 female) trained in:
 - socio-economic and political aspects of energy access;
 - renewable energy technology and energy efficiency;
 - energy modelling and planning of energy efficiency;
 - quality assurance, accreditation;
 - teaching pedagogics;
 - management and financial administration.
- Curricula development:
 - Energy efficiency (modelling, renewable energy technical efficiency, system level efficiency);

- Energy access (pricing in the Caribbean context and governance issues).

Publications

- Moore W. et al., 2015. Identifying Inconsistencies in Long-Run Development Plans: The Case of Barbados' Vision for Energy Development. CBB Working Paper No. WP/15/13.

Conference papers

- Decomposition analysis of Cuban energy production and use: Analysis of energy transformation for sustainability.
- Future energy development in Cuba

Scenarios for assessing the alternative economic development paths

- From Vision to Reality: A Backcasting Model of Jamaica's Renewable Energy Target.
- Renewable Energy Development in Jamaica: A case for reducing CO₂ emissions.
- Jamaica's energy future: Meeting 2030 target?

Energy Models

- 3 Long-Range Integrated Development Analysis (LINDA) frameworks – developed in collaboration with Ministries of Energy, electricity and utility companies and academia (Cuba, Jamaica, Barbados).

↑ Outcomes

- Increased academic capacity in the education on socio-economic and political aspects affecting energy access.

- Increased academic capacity in renewable energy technology, modelling and planning

- Improved pedagogic capacities in modern technology and impacts on energy efficiency

🎯 Impacts

Usage

- Teachers have access to the latest research-based knowledge and skills to deliver lectures on the key questions.
- The energy models designed ensure relevance with national and socio-economic development priorities and provide tools to carry out practical and effective energy analysis of renewable energy technologies.
- The quality of teaching in energy efficiency, energy economics and forecasting

and scenario building has improved significantly.

- Students and staff are now competent in developing and utilising modelling frameworks such as HOMER and LINDA.

Policy Implications

- The engagement of ministries, electricity companies and central banks and the provision of tools for energy planning has

been decisive in mainstreaming sustainable energy into national policies and determining sustainable energy goals.

Sustainability

- The quality of teaching received by future professionals in the energy sector will increase their awareness of how local resources can be utilised and what is required to meet sustainable energy goals.

TESTIMONIAL



Alecia Evans
Assistant lecturer
University of the
West Indies,
Jamaica

“PROCEED’s most interesting development has been the amalgamation of various research interests, academic backgrounds and nationalities into a knowledge bank. The Caribbean countries involved are learning from each other’s challenges and successes while forging a combined strategy to tackle the effects of climate change. An excellent initiative to increase co-operation amongst the Caribbean islands and their EU counterparts.”



Santiago oil power plant, Cuba.

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ValueSeC – Value Chain Development for Food Security in the Context of Climate Change - A contribution through strengthening capacity in higher education in Eastern Africa

SUMMARY OF RESULTS

A total of 111 graduate students and 18 teaching staff have developed skills in problem-based learning and interdisciplinary research in the context of climate change adaptation and food value chains. Six existing curricula have been revised and have successfully completed the approval process at university level in Kenya and Ethiopia. The new techniques of problem-based learning and interdisciplinary research have been integrated into the methods utilised by researchers at the partner HEIs.



Dissemination workshop in Mitunguu Meru (Kenya) involving students and stakeholders.

PROJECT IMPLEMENTATION PERIOD

November 2013 – February 2017

CONSORTIUM

- Humboldt-Universität zu Berlin, Germany
- Haramaya University, Ethiopia
- University of Nairobi, Kenya
- Karatina University, Kenya

Associated partner:

- Information Training & Outreach Centre for Africa, Kenya

PROJECT CONTACT

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PROJECT WEBSITE

www.valuesec.hu-berlin.de

BACKGROUND

In Kenya and Ethiopia, the share of agricultural production marketed through co-ordinated value chains is insignificant whilst post-harvest losses are high. Most farmers are unable to meet quality standards and often lack access to market information and technology that facilitates sustainable practices, and adoption of resource-saving and innovative cultivation techniques to adapt to adverse changes in climate.

The capacity of Higher Education Institutions (HEIs) in Kenya and Ethiopia to respond to these issues and provide expertise related to food value chains in the context of food security, poverty reduction, climate change adaptation and mitigation, needs to be strengthened.

In response to this need, ValueSeC sought to enhance the technical and didactical competences of academic staff, particularly female staff, at the participating HEIs. This will allow for the integration of problem-based learning and participatory approaches related to value chains, climate change, food security and poverty reduction into existing graduate study programmes.

Inter-institutional networking and academic partnerships within East Africa, as well as with European HEIs, were encouraged so as to generate research and improve capabilities to effectively influence policy recommendations.

METHODOLOGY

Competence network

Stakeholder workshops were conducted among local government institutions, farmers associations, cooperatives, research centres and NGOs. Liaison offices have been established in each partner university, and a concept note on the competence network was developed. These activities resulted in the establishment of a competence network platform with members from partner universities and different local stakeholders.

Staff and student exchange

Exchange of staff and postgraduate students was conducted through joint study projects, trainings, research visits and workshops at the African partners and between the African and European partner universities.

Training

Post-graduate students and staff received trainings on value chain research and climate change adaptation, problem-based learning, and soft skills. The training courses were organised at their home universities as well as in partner universities. Afterwards, the training materials were distributed to all partners.

Curricula review

In all partner universities, existing agri-business curricula have been reviewed and revised, after consultation with stakeholders, to integrate issues of climate change, value chain and food security. Senior professors and PhD holders have been involved in the review process.

RESULTS

→ Outputs

Capacity building

- 3 liaison offices have been established serving as a link for cooperation between partner universities and local stakeholders, facilitating joint study projects and dissemination of outcomes.
- 2 joint study projects: Graduate students received training over two semesters on problem-based learning and organisational skills. Two African-German student groups conducted joint research in Kenya and Ethiopia on interdisciplinary themes.
- 8 stakeholder workshops enabled the identification of the needs and problems of the local communities, and served as a platform to strengthen cooperation and disseminate project outcomes to different groups in the area.

- 42 graduate students and 8 staff members completed exchanges through research visits and joint study project activities.
- 111 graduate students and 18 staff members were trained in food value chains, problem-based learning, interdisciplinary research, and climate change adaptation.
- 6 existing curricula were revised to include issues of climate change adaptation, food security and interdisciplinary research.
- 1 new curriculum and 4 training modules have been developed.

Website and e-platform

- Project website.
- Moodle platform.

Publications

- Adamseged M.E. and Bokelmann W. (eds.), 2018. Value Chain Development for Food Security in the Context of Climate Change: Perspectives and Lessons from a North-South Capacity Building Project. Berlin: Verlag Dr. Köster.

Visibility

- Conferences (national and international), symposiums, dissemination workshops, website, brochures, posters to communicate project activities, outputs and outcomes.

↑ Outcomes

- HEIs competent in delivering problem-based learning and interdisciplinary research.
- Stakeholders are knowledgeable of climate change adaptation techniques.
- Strong partnerships between HEIs and research institutes and stakeholders.

🎯 Impacts

Usage

- Universities are incorporating themes of food value chain, climate change and food security as well as methods of problem-based learning and interdisciplinary research into both the existing curricula and newly developed modules. As a result, researchers in the partner universities are increasingly using problem-based learning and participatory approaches when investigating food value chains, climate change and food security issues.

Policy implications

- Due to the new proclamation in Ethiopia, HEIs need to harmonise their educational programmes/curricula. The three revised curricula, which include food value chain, climate change and food security issues, are highly likely to be launched by all HEIs in Ethiopia. In Kenya, revised curricula need the approval of the national educational authority and may get benchmark status for other curricula to be revised accordingly.

Sustainability

- The establishment of the competence network forms the basis for strong institutional linkages among the partner universities and local stakeholders. The network has the following aims: (a) continue to initiate partner activities after the end of the project; (b) provide a platform for disseminating project results and outcomes; (c) initiate new collaborative projects.

TESTIMONIAL



Dr. Degye G. Habteyesus,
Associate Professor of
Agricultural Economics,
Haramaya University,
Ethiopia

“We have improved the research capacity of postgraduate students and academic staff. On a personal level, I have obtained considerable benefit from the experience shared through staff exchange and trainings. The preparation of training modules has been particularly valuable for me to improve my teaching and research abilities, including the mentoring and supervision of my postgraduate students.”



Staff-student exchange: Student joint study project in the Ethiopian Rift Valley.

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FSTinAC – Strengthening Capacity for Food Science and Technology Teaching, Learning and Research to Add Value to Indigenous Foods For Food Security in Africa and the Caribbean

SUMMARY OF RESULTS

- The Botswana Food Science and Technology Association has been established.
- Partner Higher Education Institutions are able to generate quality research in food science and technology focusing on indigenous foods.
- Four courses have been converted to online, approved and now accredited. Two courses have been improved.
- Collaborations have been established with the local stakeholders.
- The capacity of university staff was improved, some got part-time jobs.

BACKGROUND

FSTinAC aimed to foster capacity building and regional integration in the field of higher education in the thematic areas of agriculture and food security specifically looking at locally developed practices and focusing on smallholder agriculture and rural livelihoods. FSTinAC supported the strengthening of the Higher Education Institutions' (HEIs') capacities for research and teaching, focused on post-harvest technology, and value addition of indigenous crops and species important for the livelihoods of local populations in the south and west African and Caribbean regions. These species have significant potential and could contribute to food security, diversification and income generation.

FSTinAC involved south-south collaboration between Botswana, Ghana and Trinidad and Tobago and north-south cooperation with the University of Maribor, which has recognised expertise in added value and studying the health benefits of foods. By building this capacity, the next generation of researchers, as well as small and medium-sized enterprises, will contribute to improving food security and the diversification of rural livelihoods.

METHODOLOGY

Human capital development

The project offered innovative Food Science and Technology graduate programmes with a focus on post-harvest technology and agro-processing.

Creation of new and upgraded graduate curricula

Existing academic programmes were reviewed and upgraded and are now delivered using innovative online technology. This allows students to enrol in courses at partner universities.

Increased inter-institutional networking

The project developed south-south and south-north collaborations

Institutional strengthening to pursue research

Collaborations with stakeholders were formed to identify the resource needs of partner institutions to enable them to focus on underutilised indigenous foods.

Short courses/seminars for training agri-businesses

Strengthening of entrepreneurial business capacities, particularly women-owned agri-businesses, through exposure to new technologies, introducing new products and teaching how to add value to these products.

Enhanced food science networks and collaboration

The project helped to strengthen networks within the partner countries. A new innovation network was established in Botswana which brought together stakeholders in the expectation sharing know-how and capacity.



Breadfruit

PROJECT IMPLEMENTATION PERIOD

October 2013 – April 2017

CONSORTIUM

- University of Botswana, Botswana
- University of the West Indies, Trinidad and Tobago
- University of Maribor, Slovenia
- University of Ghana, Ghana

PROJECT CONTACT

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Gaborone
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PROJECT WEBSITE

www.fstinac.net



RESULTS

→ Outputs

Capacity building

- 4 online programmes developed and now offered in Trinidad and Tobago.
- 1 Masters programme introduced in Slovenia.

Networking

- A Food Science and Technology Association was established and is now operating in Botswana.
- The Food Science and Technology Association in Ghana was strengthened.
- Several academic-industry linkages were created to establish co-operation in research on indigenous foods and exploring development opportunities for innovative food products.

Databases/Websites

- A web portal created for the M.Sc Agri-Food Safety and quality assurance in Trinidad and Tobago for the purpose of increasing the visibility of the postgraduate programme. It includes an overview of the programme, the skills and competencies to be acquired by learners, career prospects, detailed course outlines, a brief profile of the lecturers teaching the course, as well as the admission criteria and application forms for the institution.

Visibility

- Hosein, H and Badrie, N., 2016. Effects of binding agents on compositional and physicochemical properties, and consumer

acceptance of breadfruit (chataigne) (*Artocarpus camansi Blanco*) seed patties. International Breadfruit Conference 'Commercialising Breadfruit for Food and Nutrition Security', 5-10 July 2015, Port-of-Spain, Trinidad and Tobago. *Tropical Agriculture*, Volume 93 Special Issue 1, July 2016 International Breadfruit Conference.

↑ Outcomes

- Partner HEIs able to generate quality research in food science and technology focusing on indigenous foods.
- Entrepreneurs empowered with skills to utilise, add value and market local indigenous food resources.
- The Botswana Food Science and Technology Association established.

🎯 Impacts

Usage

- The students and partner communities have continued to access online courses offered in Trinidad and Tobago.
- The Food Science and Technology Association promotes indigenous foods, science and technology and provides an established link between academia (research) and industry.
- The entrepreneurs are able to apply the acquired technologies to enhance their businesses and benefit from local natural resources.



Morama



African Mango

TESTIMONIAL



Nigel Chad Butts,
Post-graduate student in
the M.Sc Agri-Food Safety
and Quality Assurance,
The University of the
West Indies, Trinidad
and Tobago

"I have benefitted from the training received under the M.Sc Programme 'Agri-Food Safety and Quality Assurance' and conducted research on 'The Sensory and Physiochemical Evaluation of Pepper Sauces in the Very Hot Category produced in Trinidad and Tobago versus Foreign Brands' for which I have received a prize from the Ministry of Agriculture, Land and Fisheries in recognition of the potential of added value within the food industry."

ACP-EU Co-Operation Programmes in the fields of Higher Education and Science, Technology and Research

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SASEI – Southern African Sustainable Energy Initiative

SUMMARY OF RESULTS

- Southern African Sustainable Energy Network (SASEN).
- Master of Sustainable Energy Systems at NUST.
- Bachelor of Engineering with specialisations in Renewable Energy Engineering at UB.
- Short courses in Sustainable Energy at NUL.

BACKGROUND

The southern African region lacks the professional capacity to develop and implement effective strategies and policies in the energy sector. By establishing the regional initiative, it was anticipated that a more implementation-based, policy-informing process would be facilitated, which would raise the necessary questions concerning the current food security response mechanisms, adaptation and options for sustainable practices. Specific challenges to be addressed in the development of national strategies on access and application of sustainable energy sources were:

- Improved network co-ordination for data management.
- Competitive technology advancement and adaptation (local application) considering regional consumer dynamics and consumption habits.
- General trend analysis in the energy sector, monitored to develop an improved understanding of energy consumption, demand, impacts and vulnerability of ecosystems and societies.
- Knowledge management support and international co-operation required to improve sustainable management of renewable sources.

METHODOLOGY

Situational baseline studies

Desktop studies to establish the energy situation in partner countries. Each Higher Education Institution (HEI) reviewed the energy situation in their respective countries through a literature review. The source documents were mainly the policies and strategies in place, as well as other relevant reports.

Stakeholder consultations

Needs assessment workshops and benchmarking to establish relevant training programmes and curricula. Stakeholder workshops in each country were conducted with representatives of national education and energy stakeholders. As a result of deliberations, an energy report was produced and needs assessed of the three participating African countries.

Training and material development

- Curricula development for Bachelor's and Master's in Sustainable Energy Systems.
- Training-of-trainers courses for staff and beneficiaries in sustainable energy.
- Student renewable energy research projects year.
- Create University–Industry linkages

Curricular development

Development of a Master of Sustainable Energy Systems degree (MSES) at NUST; a Bachelor of Engineering degree in Renewable Energy Engineering at UB; and the development of short courses in Sustainable Energy at NUL.

Publications and reports

- Energy situation report in partner countries published.
- Conference proceedings.
- Journal established.

Networking and best practise analysis

- North-South and South-South knowledge sharing.
- Creation of a platform for international co-operation between universities, for capacity building and regional integration in the energy sector.



PROJECT IMPLEMENTATION PERIOD

October 2013 - May 2017

CONSORTIUM

- Namibia University of Science and Technology (NUST), Namibia
- National University of Lesotho (NUL), Lesotho
- University of Botswana (UB), Botswana
- Hochschule Darmstadt, Germany

Associated partners:

- Ministry of Higher Education, Namibia
- Namibia Qualifications Authority, Namibia

PROJECT CONTACT

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Windhoek
Namibia

PROJECT WEBSITE

<http://sasei.nust.na>

RESULTS

→ Outputs

Capacity building

- A training-of-trainers (TOT) programme (20% female) with training materials. 25 academic/teaching staff trained on:
 - Energy efficiency and management.
 - Photovoltaic power systems.
 - Energy economics.
 - Renewable energy resource assessment.
- Staff exchanges initiated among partner institutions to enhance experience and skills development.
- 66 external (non-HEI) professionals and 12 academic/teaching staff trained during short courses.
- 10 accredited short courses in Sustainable Energy (NUL).
- Solar photovoltaic systems short course included a practical demonstration of installation of the solar system.

Documents

- Energy report based on a needs assessment in the partner countries, detailing the requirements for capacity building in the energy sector.
- Factsheet.
- Policy brief.
- Energy data manual.
- Energy Data Requirements for Sustainable Development: A Survey of Botswana, Lesotho and Namibia.

Publications

- Journal of Renewable Energy and Energy

- Efficiency of Southern Africa (JREEESA)
- IRES publications were published in JREEESA Vol.1.
- Conference Journal publication in Energy Procedia (Elsevier).

Networking

- Registration (February 2016) of the international journal of the Southern African Sustainable Energy Network (SASEN).

Visibility

- International Renewable Energy Symposium (IRES), Windhoek, 2015.
- International Renewable Energy Conference (IREC), Gaborone, 2016.

Website

- Project website.

↑ Outcomes

- SASEN facilitates knowledge alliances linking HEIs decision makers and key industry players
- HEIs are competent in the development of curricula in sustainable and renewable energy.
- Staff have knowledge and skills in sustainable and renewable energy systems.

🎯 Impacts

Usage

- Professional short courses in Sustainable Energy will contribute to the development of the renewable energy sector in the southern African region.
- The National University of Lesotho is further developing a curriculum with an MSc in Sustainable Energy based on the short courses it has developed.
- and regional planning, development and implementation of sustainable energy systems and projects.
- The SASEN conferences attracted regional and international scientists, politicians, government officials, private companies and academics. Combined with the project activities capacity in national and regional planning, development and implementation of sustainable energy systems and projects has been enhanced.

Policy implications

- Capacity has been enhanced for national

Sustainability

- A pool of expertise has been created, whilst SASEN will continue administration of some of the activities. The courses developed will continue to be offered and will be supported via student tuition fees. Strong support has been received from the governments, especially ministries responsible for energy as well as regional offices, such as the SADC Centre for Renewable Energy and Energy Efficiency (SACREEE).

TESTIMONIAL



Aili Shigweda,
Lecturer, Department of
Electrical Engineering,
NUST, Namibia

“The project perfectly aligns with our institution’ and Namibia’s development goals which aim to increase access to clean energy and develop capacity in sustainable energy research and training. I expect to see an increase in the number of collaborative research published in

reputable journals and a better management of sustainable energy resources in the region as a result of the knowledge gained and network established. The public’s interest in the programme is overwhelming.”

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Implemented by the ACP Secretariat Financed by the European Union

Enhancing nutrition and food security through improved capacity of agricultural higher education institutions in East and Southern Africa

SUMMARY OF RESULTS

Academic staff of Higher Education Institutions in east and southern Africa acquired improved skills for curriculum development and innovative teaching methods. Management skills of deans, heads of department and researchers were also strengthened and a model regional MSc Postharvest Technology curriculum initiated. Quality assurance roles for students and professional associations have been introduced and institutionalised. New inter-institutional networks between HEIs in ESA and the EU have been established and significantly strengthened.

BACKGROUND

Higher Education Institutions (HEIs) are the major suppliers of trained manpower for the agricultural sector in east and southern Africa (ESA). However, the state and the effectiveness of their training programmes has not met expectations, leading to poor performance of the sector.

Therefore, efforts to improve agricultural productivity, to ensure food security and reduce malnutrition need to integrate research and training programmes amongst other key intervention areas and take into consideration the increasingly young population that seems to be less attracted to agricultural careers.

Interventions to improve curriculum development skills, innovative teaching skills and methods in academic staff, will improve the quality of programmes on offer. By delivering these new and revamped curriculums, improved study programmes will produce individuals with the skills required by the national and regional labour markets with eventual outcomes of improved productivity and reduced malnutrition.

METHODOLOGY

Baseline survey

A survey was carried out in HEIs to determine capacity gaps and good practices for upscaling.

Strengthening curriculum development

Key training themes for food security were identified and a model MSc postharvest curriculum designed. The curriculum recognises commonalities in the ESA agro-ecologies that can define common knowledge areas in curriculum.

Training of academic staff

Academic staff were trained to strengthen skills in curriculum design and modern teaching skills integrating ICT.

Training of management and administrative staff

Managers and administrators were trained in management and planning to enhance their capacity to support agricultural training and research.

Improving teaching capacity

Capacity for high quality teaching was improved by installing ICT equipment and software, greenhouses and refurbishing laboratories.

Consultation of stakeholders

Curriculum design engaged stakeholders (students, private sector, professional bodies) to obtain their needs and input.

Inter-institutional networking

Inter-institutional networks were facilitated between agricultural HEIs in ESA and the EU to share experiences and capacities. EU institutions provided skills in integrating modern approaches, use of ICT and effectively engaging the private sector.



Training activity at South Eastern Kenya University.

PROJECT IMPLEMENTATION PERIOD

September 2013 – March 2017

CONSORTIUM

- Kenyatta University, Kenya
- South Eastern Kenya University, Kenya
- Chinhoyi University of Technology, Zimbabwe
- Università Politecnica Delle Marche, Italy
- Leibniz Universität, Hannover, Germany

Associated partners:

- Jomo Kenyatta University of Science and Technology, Kenya
- University of Nairobi, Kenya
- Meru University College of Science and Technology, Kenya
- Masinde Muliro University, Kenya
- Uganda Martyrs University, Uganda

PROJECT CONTACT

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PROJECT WEBSITE

www.edulink-esa.net

RESULTS

→ Outputs

Capacity building

- 150 academic staff from 5 Kenyan, 3 Ugandan and 3 Zimbabwe HEIs improved skills for curriculum development and innovative teaching methods.
- 1 new regional curriculum in MSc Post-harvest Technology was developed, and existing curriculum reviewed/ revised in at least 3 institutions.
- ->70% students regularly providing feedback for quality assurance, a significant increase compared to <20% previously.
- 3 Memoranda of Understanding (MoUs)

and various collaboration agreements between HEIs in ESA and the EU have supported new proposals for grant funding to various organisations.

- >20 managers in agricultural HEIs were trained in regional workshops and a benchmarking visit to the EU.
- Initiation of 'Association of agriculture professionals in research, academia and private sector' in Kenya to support teaching and research.
- 4 manuals published and widely dis-

seminated on: (i) Agriculture teaching excellence in HEIs; (ii) Curriculum development for agriculture teaching in HEIs; (iii) Management of agriculture teaching and research in HEIs; (iv) Career guide for youth in agriculture.

Visibility

- Conferences, dissemination of publications, project and institutional websites, social media, and articles in newsletters.

↑ Outcomes

- Agriculture teaching and research in ESA fit for purpose with effective quality assurance mechanisms.

- Academic staff have skills to design and implement high quality curriculums.

- Students fully engaged in institutional quality assurance mechanisms.

🎯 Impacts

Usage

- Increased awareness amongst HEIs and staff regarding the need to improve the quality of teaching and research has a wide impact on other academic programmes beyond agriculture.
- The engagement of stakeholders will become increasingly recognised as key in quality assurance for academic and training programmes.

enable movement and exchange of capacity. Joint accreditation mechanisms for academic programmes will enable institutions to specialise in areas of comparative advantage while investing in harmonised measures for quality assurance.

Sustainability

- The networks established will sustain positive impact on teaching and research capacity of HEIs in ESA.
- The activation and invigoration of professional bodies will sustain impact on the quality of agriculture teaching, research and professional practice in ESA.

Policy implications

- A key focus area for cooperation in ESA is academic mobility of students and staff. Development of regionally coordinated curriculums contributes to the desire to



Training during a benchmarking visit at the Università Politecnica delle Marche (Italy) by Deans and Heads of Departments from 8 HEIs in Kenya, Uganda and Zimbabwe.



Project launch workshop held at Kenyatta (November 2013).

TESTIMONIAL



Ms. Njeri Njau, PhD candidate in JKUAT and part-time teacher in the School of Agriculture, Kenyatta University, Kenya

“The EDULINK Project has been impactful on our capacity as institutions and professionals in agriculture research and training. Students, staff and administrators in universities will be able to implement and sustain actions for high quality training, research and mentorship, with effective quality assurance measures. The networks established between institutions and the region are invaluable and the synergy will make agriculture training more effective in Kenya and across the ESA region.”

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FSBA – Food Security and Biotechnology in Africa



FSBA mid-term meeting in Burkina Faso.

PROJECT IMPLEMENTATION PERIOD

September 2013 – February 2017

CONSORTIUM

- University of Groningen, The Netherlands
- University of Eldoret, Kenya
- University of Nigeria, Nigeria
- University of Ouagadougou, Burkina Faso

Associated partners:

- African Biosafety Network of Expertise (ABNE), Senegal

PROJECT CONTACT

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PROJECT WEBSITE

www.rug.nl/fwn/edulink-fsba

SUMMARY OF RESULTS

The education and outreach capacity of the African partner Higher Education Institutions in agricultural biotechnology has been strengthened through the development of 120 hours of Master's level courses, 3 outreach workshop programmes and 3 country policy briefs. Project management and financial administration skills of the African partners were strengthened by in-house training and guidance in writing project progress reports.

BACKGROUND

Improving the food security situation in Kenya, Nigeria and Burkina Faso is necessarily a long-term process that requires policy changes, technological investments, as well as (most importantly) a change in perception of local populations (producers and consumers) on the use of biotechnology in food production.

The project, therefore, aimed to provide independent fact-based knowledge of all aspects of the use of biotechnology in agriculture: historical, technical, political, regulatory and ethical.

METHODOLOGY

The adopted two-legged approach consisted of formal and informal contacts with a wide range of local stakeholders in the target countries and frequent contacts with scientists working in the same field in the partner and other institutions.

Joint curriculum development and elaboration of outreach workshop programmes

Six new Master's level courses of 20 hours were developed on the sustainable application of biotechnology in African food production. The courses were taught fully or partially in each African partner Higher Education Institution (HEI), embedded in

the wider university curricula. They have been made available to the wider (academic) public by placing them on an open website in French and English.

Organise stakeholder meetings and other outreach events

Stakeholders in food production and the sustainable use of biotechnology were consulted in order to gear the course content to those food security issues that prevail in their daily practice. Also, outreach events were organised, and students visited rural areas, stakeholder organisations, genetically modified organism (GMO) testing institutes and containment facilities. During stakeholder meetings with media coverage the prospects for sustainable biotechnology were presented and discussed by the partners' staff, student representatives, and a selection of the target countries' most prominent actors in the food security and biotechnology field.

Produce outreach materials

Outreach materials have been developed targeted to the different stakeholder groups.

Supportive and networking activities

Training events were held on management and financial administration, the acquisition of equipment, the organisation of a kick-off, mid-term and synthesis meeting, as well as the translation of course and outreach materials.

RESULTS

→ Outputs

Capacity building

- Course support material for 6 interrelated Master's level courses of 20 hours each, in the field of agricultural biotechnology in Africa, in English and in French, in c. 90 files:
 - Food security, agricultural systems and biotechnology.
 - Biotechnology: history, state of the art, future.
 - Public response to the rise of biotechnology.
- Regulation and policy approaches to biotechnology.
- Ethics and world views in relation to biotechnology.
- Tailoring biotechnology: towards societal responsibility and country-specific approaches.
- 10 academic staff trained in agricultural biotechnology in Africa.
- 14 administrative and technical staff trained in financial project management.

Visibility

- Outreach materials (flyers, brochures, etc.) developed and distributed to stakeholders.
- 3 outreach workshop programmes developed for 3 different stakeholder groups.
- 3 target-country-specific policy briefs produced and widely published in newspapers and on the web.
- 3 stakeholder meetings and 2 roundtables with media coverage held in each target country.

↑ Outcomes

- Strengthened interlinkages and synergy among African partners and stakeholders.
- Improved management / administration capacity of the partner HEIs.
- Upgraded teaching capacity of the academic staff with new course materials.
- Increased knowledge and skills of lecturers, students and researchers in the field of agricultural biotechnology.

🎯 Impacts

Usage

- Improving food security through the application of biotechnology is a long-term process that requires many political and technological changes which can only take place if there is broad acceptance by consumers and producers. The project has laid a foundation for this by developing teaching materials designed to instruct future policy makers, and by informing future stakeholders. The conditions have been facilitated to initiate societal acceptance, whereby the evolution of scientific, technological and institutional developments may flourish.

Policy Implications

- The country-specific policy briefs and the outreach workshops directly address the target countries' policy makers and broader populations with regard to the potential of biotechnological crops in improving food security. The three policy briefs have been widely communicated through news media and the internet and are expected to reach a wide readership. The three outreach workshops' programmes were designed for different target audiences and thus help to reach the final beneficiaries in an efficient way. Finally, the Master's level materials developed by the project are expected to have a direct impact on thousands of students in the final stage of their studies, many of whom are likely to enter careers in government or in the food industry.

Sustainability

- Sustainability is ensured by the incorporation of the Master's level courses within the broader curricula of the three partner universities. The University of Ouagadougou has planned to introduce the whole set of 120 hours of course modules as a curriculum on its own. The universities of Eldoret and Nigeria will introduce the six 20-hour modules into existing curricula.
- ABNE may boost sustainability by effectively endorsing the course by either incorporating the course materials on their website or advertising them and providing a link to the University of Groningen's website where the course is available.

TESTIMONIAL



Prof. Jerry Ugwuanyi,
University of Nigeria,
Nigeria

“The team has built strong links in Africa. This is noteworthy since the quality and quantity of such collaboration between African HEIs is low. The project, however, has provided excellent experience in the development of higher degree curriculum across international borders that will become very useful in biotechnology education. There are now more opportunities for collaboration and I look forward to the growth of this exciting collaboration in research, training and curriculum development.”



Discussing the pros and cons of biotech cotton with local farmers in Burkina Faso, 2015.

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DairyChain – Strengthening Capacity of Higher Education Institutions in Eastern and Western Africa to Enhance Efficiency in the Dairy Value Chain

SUMMARY OF RESULTS

A Master of Dairy Science and Technology (MDairyScTech) has been developed and implemented as a competency based curriculum, with scientific and academic staff trained in competence and outcome-based learning methodology. The African Dairy Academy has been established to enhance research and training and collaboration between the industry and the partner Higher Education Institutions (HEIs).

BACKGROUND

In Ghana, Kenya and Nigeria livestock contributes significantly (30-50%) to agricultural sector GDP. However, the dairy sub sector contributes relatively little. All three countries rely on imported dairy products. Nigeria, for example, expends about \$ 1 billion on the importation of dairy products. Dairy development and marketing patterns in Kenya, Nigeria and Ghana suggest that only a small proportion of the total output of dairy products actually enters the marketing system. Most output is consumed within producing households, particularly in the traditional livestock sector.

There is a need for innovation in the dairy sector. Agricultural Higher Education Institutions (HEIs) need to strengthen their capacity to meet demand, boost production, add value and become competitive with imports. The transformation needs to be knowledge-led and market oriented.

The project was set up to build the capacity of HEIs in eastern and western Africa to deliver competent graduates in the dairy sector through curricula that are entrepreneurial, gender sensitive, practical and relevant to the needs of the labour market and with a focus on poverty reduction.



Students milking during their practical session at Egerton University, part of the competence-based curriculum.

METHODOLOGY

The project reinforced exchange and collaboration between HEIs in Kenya, Nigeria, Ghana and Europe with a focus on institutional capacity building and development of the Dairy Value Chain concept. A key component was the introduction of interdisciplinary teaching and the acquisition of problem-solving skills by students.

Stakeholder and labour market needs assessment

A survey was conducted for curriculum design based on competence profiles, skill development and assessment of the dairy labour market needs.

Academic capacity and educational development

Knowledge and skills development included competence- and outcome-based learning and e-learning. Curricula were reviewed for entrepreneurial, gender-sensitive and practical components.

AM DairyScTech was developed with a system for quality assurance. Academic staff exchange supported human resource development and built interdisciplinary partnerships and networks.

HEI-labour market linkages

Achieved through study research projects, internships and mentoring programmes.

Visibility and knowledge transfer

Research outputs were presented to concerned stakeholders and published as papers or posters. Three conferences were organised to disseminate results and a Dairy Academy was established.

Regional conference 'Transforming Dairy Education and Training for Health and Wealth in Africa', Nakuru, Kenya (September 2015).

PROJECT IMPLEMENTATION PERIOD

October 2013 – April 2017

CONSORTIUM

- Egerton University, Kenya
- Obafemi Awolowo University, Nigeria
- University of Education, Ghana

Associated partners:

- Wageningen University, The Netherlands
- Kenya Agricultural and Livestock Research Organisation (KALRO), Kenya
- Ministry of Agriculture and Irrigation, Kenya
- International Livestock Research Institute (ILRI), Kenya

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PROJECT WEBSITE

www.dairychain.org
www.dairychain.coelib.org

RESULTS

→ Outputs

Capacity building

- An undergraduate curriculum was developed to form the basis of the Master of Dairy Science and Technology (MDairy-SciTech).
- Teaching staff trained on competence based learning methodologies, including its application in the dairy sector, labour needs assessment, curricula design and participatory approaches.
- Technical staff trained in dairy production (assisted reproductive technologies, dairy farm assessment and product processing).
- 40 student internships and mentorships, hosted by various firms throughout the dairy industry.

African Dairy Academy

- Established as a network of dairy scientists and researchers in order to foster collaboration between governments and HEIs in undertaking research and capacity building. The objectives are to facilitate multi-disciplinary research and promote evidence-based policy development.

Research projects

- 20 student research projects aimed at enhancing skills in dairy as well as exploring solutions within the dairy sector.

Publications

- 6 papers in peer-reviewed journals and presented at conferences.

Documents

- Report on labour market needs to guide curricula review.
- Guidelines for industrial attachment / internship / mentorship..

Visibility

- Project website.
- 3 mentor databases.
- Participation in conferences and multiplication symposia.

↑ Outcomes

- Curriculum fit to deliver competent graduates with relevant skills for the development of the dairy sector.
- Teaching staff able to design and deliver competence-based curricula.
- Greater co-operation between dairy industry and academia, including in jointly conducted and supported research.

🎯 Impacts

Usage

- Teaching staff have been enhanced in delivery of competence-based curricula and their attitude towards students has greatly improved.
- Students have the opportunity to be exposed to more practical modes of learning as opposed to pure theory, and enrolment in animal science programmes has increased.
- More research is conducted jointly with the industry seeking scientifically supported solutions in dairy management.

Policy implications

- Results have shown the importance of internship and mentorship programmes as part of training for the industry. The guidelines developed may inform national policy on training of dairy science students.
- One of the partner countries internships are being institutionalised in all undergraduate programmes. To this extent, the government is preparing a working paper towards implementing a tax rebate on parties that offer internship positions to fresh graduates.

Sustainability

- Linkages between HEIs and industry were institutionalised through memoranda of understanding and the Africa Dairy Academy.
- The partners have established a Centre of Excellence for Livestock Innovation and Business (www.coelib.org) with funding from the Dutch Government.

TESTIMONIAL



Joel Khobondo,
Lecturer, Department of
Animal Sciences, Egerton
University, Kenya

“Kenya is currently reviewing its curricula from primary school to university level. The experience gained and expertise learnt will be very instrumental in conducting a constructive review of the government educational sector. The country is at the forefront of curriculum change, so other countries in the region will borrow a lot of expertise and experience from us.”



Teams from Kenya, Ghana and Nigeria meeting on curriculum development.

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CarEnTrain – Mainstreaming Energy Efficiency and Climate Change in Built Environment Training and Research in the Caribbean

SUMMARY OF RESULTS

Nine Continuous Professional Development (CPD) courses and 15 degree programmes have been revised, including 56 courses and the development of 22 new courses. 2,106 students were trained and 384 urban professionals engaged with the partnership in urban policy development.

BACKGROUND

Regional climate change mitigation policy and university curricula and research focus on the promotion of renewable energy rather than the improvement of energy efficiency. This is true particularly in the transportation sector which is the largest consumer of energy. The project, therefore, aimed to improve regional capacity to address climate change by providing professional and undergraduate training and networking with an emphasis on energy efficiency. This topic was to be mainstreamed into existing curricula and the continuous professional development courses in Urban and Transportation Planning and Engineering and Architecture.

In addition, inter-institutional networking and regional capacity in energy and the built environment within the Caribbean higher education institutions needed to be increased. To this end, the existing network of regional universities, individuals and organisations working in the urban sector was mobilised and communication mechanisms created or strengthened, such as the Caribbean Urban Forum (CUF), the BlueSpace website and social media platforms.

engaged via focus groups and individual interviews to assess how energy is used in order to inform the curriculum review process.

Procurement

The revision of courses required the updating of the reading materials required by students.

Call for papers on energy efficiency

Land use planners, academics, municipal managers and other urban professionals were targeted for capacity building and policy dialogue. Climate change and energy efficiency were topics in the Call for Papers, providing opportunities for research.

Professional training courses

Professional training courses introduced the concept of urban design as a means of reducing energy efficiency which was seen as a gap in knowledge in existing regional training.

Repository of information

The publication of books from conferences and dissemination to relevant organisations highlighted the existing best practices in the Caribbean region.

Monitoring of the policy environment

A baseline policy/legislative framework related to energy and climate change was established and updated periodically.

Webinars on the urban sector

A series of webinars were conducted to share information on diverse topics related to planning, some of which had a direct correlation with energy efficiency and climate change.

METHODOLOGY

Dialogue for curriculum improvement

The project partners discussed the nature and scope of curriculum review required at their universities focusing on the topics of climate change and energy efficiency.

Curriculum review

National stakeholders in Jamaica, Guyana, Suriname and Trinidad and Tobago were



Building at Sir Arthur Lewis Community College, Saint Lucia, showing historic design feature which can minimise energy usage.

PROJECT IMPLEMENTATION PERIOD

October 2013 – April 2017

CONSORTIUM

- The University of the West Indies, Trinidad and Tobago
- University of Technology (UTECH), Jamaica
- Anton de Kom University of Suriname (AdeKUS), Suriname
- University of Guyana (UG), Guyana
- University of Antwerp (UA), Belgium

PROJECT CONTACT

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PROJECT WEBSITE

www.bluespacecaribbean.com

RESULTS

→ Outputs

Capacity building

- 20 academic staff (10 female) trained in Continuous Professional Development (CPD) courses.
- 9 Professional Development courses in energy efficient urban design (77 female, 132 male).
- 15 revised/new curricula, 56 revised courses and 22 new courses reaching 2,087 students (666 female, 1,421 male).
- Strengthening the planning framework in the Caribbean region (2016).
- Living labs as leverage for a sustainable transition (2016).
- Spiegelhalter T., 2015. Inventory of Existing Programmes of the Built Environment and the Assessment of Best Practices in Training in Energy Efficiency (E-copy).
- Spiegelhalter T. *et al.*, 2016. Towards Carbon-neutral Design Education and Best Practice Training for Built Environment Programs in Caribbean Higher Education (E-copy).

Papers available at www.bluespacecaribbean.com or requested at info@bluespacecaribbean.com

Databases/website

- Database of Caribbean urban sector professionals.
- Database of publications on energy and climate change in the Caribbean.
- Database of Caribbean legislation/policies on energy and climate change as it relates to the Caribbean.
- Project website.

Publications

- Conference reports, proceedings and analysis of proceedings Caribbean Urban Forums 2014-2016:

↑ Outcomes

- HEIs have capacities in teaching and research in climate change and energy efficiency.
- Urban planning professionals are able to apply the understanding of energy efficiency issues.
- Regional energy policy dialogue informed with pro-poor and gender-sensitive urban energy issues.

🎯 Impacts

Usage

- Regional universities and planners are currently engaged in the development of a system for accreditation for Caribbean land use planners which includes participation in CPD. This network is engaged with the international community in developing regional interventions to implement the SDGs, COP21 and the New Urban Agenda from Habitat III.

Policy implications

- The strengthening of the network provides opportunities for consensus building and training facilitating improved urban policy in the Caribbean. The network of planners and policy makers has participated in an exercise to create an urban policy framework for the Caribbean Development Bank (CBD).

Sustainability

- The network has helped to establish the Caribbean Planners Association and has increased the membership from three to eight national planners associations. The network's collaboration is now sought out by regional associations, such as CARICOM, the OECS and the CDB as a partner in developing and implementing urban policy and programmes in the region.

TESTIMONIAL



Kene Moseley,
National Agricultural
Research & Extension
Institute (NAREI), Man-
grove Restoration and
Management Programme,
Georgetown, Guyana

“There is a need for government to collaborate with academic institutions to ensure development planning is integrated. The project will benefit Guyana by increasing the number of trained personnel in the field of urban planning and management who will be available to lead the country's development in a sustainable manner focusing on climate change mitigation and adaptation and energy efficiency.”



Teaching material for an urban design course.

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Financed by the European Union

Capacity building in applied renewable energy technologies in Guyana and Suriname



Knowledge exchange during a fieldtrip to the laboratory of the Federal University of Western Pará, Brazil (March 2017).

PROJECT IMPLEMENTATION PERIOD

October 2013 – October 2017

CONSORTIUM

- Anton de Kom University, Suriname
- Katholieke Universiteit Leuven, Belgium
- University of Guyana, Guyana

PROJECT CONTACT

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PROJECT WEBSITE

<http://renewableenergy-edu.org>

SUMMARY OF RESULTS

A joint MSc programme in Renewable Energy Technology (RET) was developed, as well as a certificate programme for mid-career professionals with decision-making authorities. University laboratories were upgraded with new equipment for hydropower, biomass, solar and wind energy research. The renewable energy debate in Guyana and Suriname has been stimulated and the Regional Universities Network for Research and Education in Sustainable Energy has been enhanced.

BACKGROUND

Guyana and Suriname have made use of and promoted renewable energy. Suriname, for instance, has a hydro-electric dam and Guyana plans to provide all hinterland villages with renewable energy. However, policies do not support the development of technical expertise within the wider Caribbean region. Renewable energy expertise has to be imported due to the lack of local experts, relevant courses and qualified staff to deliver such programmes. Theoretical courses on their own are not enough and students require practical skills. A basic research infrastructure needs to be made available to perform scientific investigations in the renewable energy domain.

The project aimed to improve institutional capacities to deliver academic programmes in applied renewable energy technologies with specific emphasis on hydropower, biomass, solar and wind energy. In addition, the research infrastructure needed to be strengthened and capacity built to review and recommend relevant policy and legislative structures that facilitate the use of renewable energy sources by public and private entities. In support of this the regional integration in the specific fields of renewable energy technologies needed to be fostered at the academic and professional levels.

METHODOLOGY

Curriculum development

The joint MSc programme in RET and detailed course outlines were developed based on initial stakeholder consultations, internal curriculum assessments and review of external programmes.

Training

4 Lecturers were trained at the Universities of Gent and Leuven (Belgium) in preparation for the implementation of the MSc programme.

Quality assurance

The existing quality assurance system at AdeKUS was used and adapted in areas of perceived weakness.

Delivery of MSc programme

In the programme courses, students were exposed to structured lectures, ICT, and laboratory and field work. Students from Guyana visited AdeKUS for additional lectures, laboratory work and fieldwork. Students had the opportunity to do part of their internship in Belgium, the Netherlands and Brazil. Exams were held simultaneously.

Improvement of research facilities

Equipment was purchased to improve the laboratory facilities with respect to facilitating advanced research in the renewable energy domain.

Visibility

Regular stakeholder meetings and one-to-one interactions with key stakeholders were held. To increase awareness of renewable energy, international symposia with experts, policy makers and stakeholders were held.

RESULTS

→ Outputs

Capacity building

- MSc programme in RET.
- 14 students enrolled at AdeKUS and 9 at UG (1 female student per university); students from other master programmes took elective courses.
- 4 staff members received advanced training in: energy conversion of biomass; applied control; biomass combustion and gasification; production of liquid biofuels; pyrolysis; wind power systems.
- A certificate level programme for mid-career professionals in the private and public sector with renewable energy knowledge.

Publications

- 2 articles on hydro-energy and sustainable energy development in the academic

e-journal of Suriname.

- 2 publications on thematic research within RET (in preparation).

Database

- Each student has collected significant amounts of data, which are in the process of being incorporated in a central database which will be made publicly accessible on the university website.

Networking

- An increasing number of specialists are interacting at national and international levels, e.g. between companies, governmental institutions and universities.

Visibility

- 4 stakeholders meetings.
- 2 launches of the master programme.
- Several press interactions.
- 2 international conferences (including 1 paper).
- 1 international congress.



Construction of a solar energy installation by students for the research thesis of a student at AdeKUS, Paramaribo, Suriname (April 2017).

↑ Outcomes

- Both universities are capable of delivering quality programmes in renewable energy.
- Increased research capacity due to improved laboratory equipment.
- Enhanced interaction of regional professionals and academics.

🎯 Impacts

Usage

- The programme is currently followed by 19 students (17 male, 2 female).
- Research infrastructure is fit for purpose and linked to educational programmes in renewable energy.
- Continued increase in national awareness of the importance of renewable energy for socio-economic development.

universities. Since most of the students are / will be working at managerial level in the public and private sector, they are in a position to influence policy. Overall, students, policy makers and professionals will be more aware of the technological and sustainability issues related to renewable energy.

continue to be offered and tailored where needed.

Policy implications

- Universities can effectively influence policy and legislative structures related to renewable energy in the public and private sphere as a result of increased capacity within the

Sustainability

- The programme is fully integrated into the academic offerings of both universities. There is significant public interest in the continuation of the programme. It will



Knowledge exchange during a fieldtrip to Brazil (March 2017). The hydro-energy station in Santarem.

TESTIMONIAL



Oswald van Cleemput,
Emeritus Professor,
University of Gent,
Belgium

“This project is oriented towards renewable energy and technology, a field of utmost importance for countries in development. The programme deals with a topical theme and is relevant for further development. This pro-

ject is relevant because energy and technology are moving so fast and it is so important that programmes like this are not overlooked at university level.”

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ENERGY-AGRO-FOOD – Energy - Agro-food Synergies in Africa: New Educational Models for Universities



The International Intensive School on Bioenergy in East Africa (Mekelle, Ethiopia).

PROJECT IMPLEMENTATION PERIOD

October 2013 – April 2016

CONSORTIUM

- University of Bologna, Italy
- University of Pavia, Italy
- Université d'Auvergne, France
- University of Nairobi, Kenya
- Addis Ababa Institute of Technology, Ethiopia
- Mekelle University, Ethiopia
- Sokoine University of Agriculture, Tanzania

PROJECT CONTACT

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PROJECT WEBSITE

<http://www.east-app.com/index.php/en/>

SUMMARY OF RESULTS

New university teaching modules in the fields of Energy and Agro-food were implemented with the following outcomes:

- Increased capacity of the universities to offer innovative higher education programmes.
- Enlarged network of interrelationships among university, professional and administrative worlds.
- Reliable conditions to boost professional skills, strengthen innovation, and raise sustainability in the bioenergy-agricultural sectors.

BACKGROUND

Although a number of curricula on agriculture and energy are in place in the African partner universities (especially at the Master level), they are characterised by:

- limited inter-disciplinary and holistic approaches;
- distance from the evolving socio-economic, environmental and technological scenarios; and
- inadequate provision of PhD and Lifelong Learning programmes.

Therefore, the project aimed to introduce an interdisciplinary approach integrating different scientific fields (technical, didactic, economic, social, historical, policy and environmental) and to provide theoretical, operational, normative, methodological and cultural skills. In order to introduce this approach, the capacities of the partner universities needed to be upgraded and academic staff's competences and expertise improved. Moreover, the enhancement of the higher education required the introduction of specific teaching modules in the fields of energy and agro-food consistent with the needs of the regional and local labour market.

METHODOLOGY

Needs and opportunities of the local and regional labour market were analysed with reference to the agricultural, food and bioenergy sectors. The analysis was done via field visits, dedicated meetings with professionals and policy makers, and a review of the regional and international literature.

The consortium promoted the capacity building for academic and administrative staff by linking each African partner university with a European partner university and organising dedicated study periods in the EU. Moreover, new didactic learner-centred methodologies were tested through the project's International Intensive School of Bioenergy in East Africa.

The design and implementation of the university courses were carried out through a multilateral approach centred in the African partner universities. The approach focused on refinement, integration, and testing of the new teaching modules, the implementation of the internship platform, and the preparation of a joint publication.

Visibility and dissemination were ensured by the project and the university partners' websites, newsletters, local magazine features, and the design and development of an original internship web platform.



RESULTS

→ Outputs

Capacity building

- 11 MSc courses revised in subject areas, including agriculture, energy, natural resource management, and food sciences.
- 18 modules developed.
- 3 guidelines published:
 - Innovative Teaching Methodologies in East Africa and EU;
 - Quality Assurance systems at higher education level in East Africa and EU;
 - Internship management in East Africa and EU.

- 1 International Intensive School on Bio-energy in East Africa to train students and test new university didactic methodologies.

Publications

- 1 joint publication as additional didactic material: Bionergies in East Africa between challenges and opportunities, Proceedings of the Final Conference on the Energy-Agro-Food Nexus in East Africa, 2016.

Databases/website

- An internship platform to support students looking for internships in the East African region, enhancing the interrelationships between universities and public and private stakeholders, and boosting job placement opportunities.
- Project website.

↑ Outcomes

Universities are able to:

- understand needs of the agri-food and energy sectors;

- design and implement teaching modules and materials for masters, PhDs, and lifelong learning;

- offer multi-disciplinary programmes for postgraduates and lifelong learning.

🎯 Impacts

Usage

- A broad view of the potential for biomass use in energy production and of the opportunities offered by the food-energy nexus has been achieved.
- Both a regional and international perspective of the issues has been gained and has facilitated additional inputs for research and for co-operation with other universities and stakeholders.

‘energy-smart’ food production processes can reduce supply chain dependence on fossil fuels and competition between energy and food production.

Sustainability

- Sustainability of the project and, in particular, of the developed modules will be ensured by exploiting the bilateral cooperation agreements. This will be done through updating the website and internship platform to enhance collaboration between academic and labour spheres, and publishing joint scientific articles.

Policy implications

- The agro-food value chain plays a pivotal role in the sustainable energy production and consumption: promotion of



Bioenergy micro-plant.



Desta Alcohol and Liquor Factory-biogas plant, Mekelle, Ethiopia (March 2014).

TESTIMONIAL



Zenebe Gebreegziabher,
Associate Professor,
Department of
Economics, Mekelle
University, Ethiopia

“In Ethiopia as a result of the project, the quality and relevance of the academic programmes in bioenergy and the agro-food sector has been enhanced. Staff are better trained in the design of academic programmes and in delivering these programmes to students. Existing MSc programmes in energy technology and related fields have been strengthened by the innovative teaching methods introduced.”

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ENERGISE – Enlarged Network in Education and Research for a Growing Impact of Sustainable Energy engineering on local development

SUMMARY OF RESULTS

- Overview of the current status of education in energy engineering extended to the 3 partner countries.
- Upgrading of faculty members competences in innovative technologies and modern renewable energies.
- Collective design and delivery of an upgraded market-driven high quality Sustainable Energy Engineering Master of Science.
- Regional and integrated network of HEIs open to public and private stakeholders for promoting efficiency and access to energy.
- South-South knowledge transfer for curricula upgrading in the energy field and a multi-stakeholders dissemination plan.



South-South Knowledge Transfer Dedicated Seminar, Arusha, Tanzania (March 2017).

PROJECT IMPLEMENTATION PERIOD

October 2013 – April 2017

CONSORTIUM

- Politecnico di Milano (POLIMI), Italy
- Jimma University (JU), Ethiopia
- Technical University of Kenya (TUK), Kenya
- Technical University of Mombasa (TUM), Kenya
- Dar Es Salaam Institute of Technology (DIT), Tanzania

PROJECT CONTACT

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PROJECT WEBSITE

<http://www.edulink-energise.polimi.it/welcome>

BACKGROUND

The energy access rate is extremely low in Ethiopia, Kenya and Tanzania, especially in the rural areas. At the Higher Education Institution (HEI) level there is also a lack of experience and up-to-date knowledge in the energy field. Therefore, the enhancement of HEIs capacities in promoting energy programmes, joint research and effective networking are required to promote appropriate strategies for local energy access.

ENERGISE aimed at promoting innovative and labour-driven curricula in energy engineering and increasing the number, quality and skills of specialised energy engineers. These future professionals should be able to promote appropriate technologies and engage with the complex challenges of access to energy, specifically to sustainable energy.

Training sessions were tailored for faculty members (live and on a dedicated e-collaborative platform) to foster capacity building on new teaching methodologies and on Distributed Energy Systems, based on renewable energy sources.

The long-term vision is a new generation of African innovators in the energy sector. The project dealt first with innovative teaching methodologies for preparing future professionals, who should then be able to promote sustainable and innovative solutions for local energy systems.

METHODOLOGY

Baseline study on education in energy engineering

The actual curricula situation and needs, including a quality assurance system and specific requirements for laboratories were assessed. The analysis of the assessment including feedback from stakeholders determined the definition of the curricula upgrading and capacity building.

Skills development

The competences in innovative technologies and modern renewable energies were upgraded. Staff capacity in advanced teaching method was built.

Design and delivery of a MSc Energy Engineering

Joint curricula were developed. Facilities were upgraded with appropriate technology for teaching laboratories and set-up and identification of a quality assurance system. The pilot of the MSc in Sustainable Energy Engineering in Ethiopia was launched.

Establishing a network

A network was established promoting efficiency and access to energy of HEIs, stakeholders and the public, as well as an e-collaborative platform linking HEIs and private and public stakeholders with joint events and projects.

Dissemination plan

Participatory project management together with the organisation of stakeholder meetings were successful ways to constantly share information and disseminate project activities.

RESULTS

→ Outputs

Capacity building

- 150 staff trained with ex-cathedra lessons, hands-on sessions and project management.
- 4 harmonised curricula for the MSc in Sustainable Energy Engineering with general guidelines for the development of new curricula.
- 5 staff exchanges lasting 4-5 months at POLIMI during which research activities in different areas were carried out.
- 4 student exchanges. Twinned theses between the partner universities developed.
- Guidelines for Quality Control systems

for teaching including key elements from shared materials, and principles from Bologna and Copenhagen processes.

- Pilot MSc in Sustainable Energy Engineering officially approved and running at Jimma University since October 2015.

Documents

- Assessment of the current status of energy engineering in the partners countries.
- ENERGISE quality system guidelines.
- Scientific paper 'Energising the higher

education system in Africa for promoting sustainable energy development tailored to local context'.

- White paper on the ENERGISE experience.

Visibility

- E-collaborative platform.
- Project website.
- Creation of pages and groups on: Facebook, LinkedIn, Researchgate.
- Rollup and project flyer.

↑ Outcomes

- Engineering faculties have the capacity to deliver quality programmes in energy engineering focused on sustainability.

- Faculty members are competent in the design and delivery of innovative teaching techniques.

- Regional HEIs are collaborating in teaching and research in energy engineering and innovative technology.

🎯 Impacts

Usage

- TUM and TUK in Kenya have implemented the new curricula in Sustainable Energy Engineering. Their Senates have approved the new curricula which are now under the examination of the local authorities for final approval.

Policy implications

- The trainings and courses developed in Sustainable Energy, Water-Energy-Food Nexus and Green Economy will enable the HEIs to contribute effectively to the socio-economic development policies of their countries.

Sustainability

- Further trainer-training programmes have been organised (Jimma University) using teachers trained during the project so as to guarantee a multiplier effect of the knowledge obtained.



Staff training in Nairobi (February 2015).



Fist management meeting at Jimma University, Ethiopia (July 2014).

TESTIMONIAL



Adedoyin Adeleke,
Centre for Petroleum,
Energy Economics and
Law, University of
Ibadan, Nigeria

“The need for capacity building related to sustainable energy in Africa is widely acknowledged, however limited practical effort has been implemented. The EDULINK project is an effective approach to sensitise and motivate stakeholders to initiate new curricula capable of providing energy engineers with skills and

competences that are required to exploit the abundant resources on the continent.”

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Embedding Entrepreneurship in African Management Education

SUMMARY OF RESULTS

A strategic alliance between HEIs in Sierra Leone, Kenya and Italy aimed at the execution of a Master in Social Entrepreneurship at UNIMAK, Sierra Leone.

Academic and administrative staff have been trained in the design and implementation of an entrepreneurial management programme.

The MBA editions have been attended by 33 students (edition 1), 39 students (edition 2) and 36 students (edition 3 – ongoing).

The support offered to UNIMAK has included the installation of an e-learning platform and training on the use of said platform.

BACKGROUND

Since the end of its 11 year civil war in March 2002, Sierra Leone's economy has been recovering largely due to the rehabilitation of arable land and increased private investment. However, the poor infrastructure, weak education system, lack of markets and weak capacity to manage resources mean that its full potential is currently untapped. This is particularly true in the northern province with over 50% of the population where the majority of the people are involved in running family businesses or working as smallholder farmers and cattle herders. Makeni hosts the only provincial university in the country.

Sierra Leone has approximately 41,300 square kilometres of agricultural land of which 25% is classified as arable. Only 15% of the arable land is currently under cultivation. It is a country of significant economic potential with a long coastline and possesses the climatic and geographic ingredients necessary for sustaining productive agriculture and fishing industries.

The aim, therefore, was to facilitate UNIMAK to train and support young, local entrepreneurs involved in the start-up of economically viable and environmentally sustainable businesses in the sectors of agriculture and energy access and efficiency.

METHODOLOGY

The project aimed at strengthening the academic, management and administrative capabilities of UNIMAK in implementing and running the MBA with a focus on agrifood and energy access.

In order to transfer the necessary skills, a training methodology previously successfully implemented at Tangaza College in Nairobi, Kenya, has been transferred (with significant recourse to South-South exchanges) enabling UNIMAK to autonomously manage a higher education programme.

The training process consisted of the following steps:

- Capacity assessment and identification of the new competencies necessary for the staff at UNIMAK.
- Development of a training and supervision programme.
- Training: 'preparatory training', 'training on the job', 'distant training' and 'monitoring and supervision'.
- Follow-up on training results and acquired competencies through a rolling assessment during the academic year.



MBA class edition 1.

PROJECT IMPLEMENTATION PERIOD

October 2013 – October 2018

CONSORTIUM

- Università Cattolica del Sacro Cuore (UCSC), Milan, Italy
- University of Makeni (UNIMAK), Sierra Leone
- Tangaza University College, Nairobi, Kenya

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PROJECT WEBSITE

<http://altis.unicatt.it/altis-mba-global-mba-in-impact-entrepreneurship-makeni-sierra-leone>
<http://e4impact.org/mba-sierra-leone/>

RESULTS

→ Outputs

Capacity building

- 20 UNIMAK academic staff trained in designing and implementing an economically sustainable entrepreneurial management programme in the sectors of agriculture and energy access.
- 20 UNIMAK staff trained in selecting business models, structuring viable business plans and supporting of the start-up of agricultural and energy based businesses.
- 3 UNIMAK management staff trained in managing an economically sustainable entrepreneurial management programme on agriculture and energy access.
- A complete mapping of the Sierra Leonean business ecosystem with 50 plus partners and over 300 prospective students.
- Remote interaction training sessions.
- 4 workshops in Accra (Ghana) with 8 UNIMAK lecturers trained by 4 UCSC lecturers and 4 Tangaza lecturers.
- 2 training sessions on Renewable Energies and Agriculture and Food business - Makeni with UCSC lecturers.
- Business Coaching in Accra (Ghana) and Makeni (Sierra Leone).

- The 3 MBA editions have been attended by:
 - 33 students (edition 1)
 - 39 students (edition 2)
 - 36 students (edition 3 – ongoing)
- Installation of the ICT laboratory at UNIMAK.

Networking

- 12 networking events.
- Establishment of the E4Impact Foundation, a strategic alliance between HEIs in SL, Kenya and Italy.

↑ Outcomes

- Accreditation of MBA in Social Entrepreneurship from Tertiary Education Commission of Sierra Leone.
- UNIMAK leading HEI in Sierra Leone in entrepreneurship related to agriculture and energy access.
- UNIMAK capable of training social entrepreneurs in the agrifood and energy sectors.

🎯 Impacts

Usage

- 108 Sierra Leonean entrepreneurs have attended the MBA programme enabling them to connect their business projects with the latest scientific and academic knowledge.
- A repository of practice has been established and will support the adaptation of existing curricula as well as the development of other business-related programmes.

Policy implications

- The increased number of qualified professionals with an enhanced understanding of social entrepreneurs' needs will be able to contribute more effectively to the decision-making process.

Sustainability

- UNIMAK is capable of delivering the MBA with complete autonomy with up-to-date learning materials and equipment.



Kenyan lecturer in Sierra Leone.



MBA Business Model Competition.

TESTIMONIAL



Peter A.B. Lansana,
Lecturer, University
of Makeni.
Sierra Leone

“The project has enabled me to sharpen my managerial skills and broaden my vision of social entrepreneurship in Sierra Leone. The final beneficiaries are benefiting from the training, coaching, mentorship and networking and the stakeholders have been introduced to strategies in running private businesses. Benefits

will be evident by training entrepreneurs that will contribute to the economic development of the country.”

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Construction en synergie avec les milieux socioprofessionnels de masters innovants en agronomie durable en réseau dans 3 EES de l'Afrique de l'Ouest



Presentation of books at the Université Abdou Moumouni (FAUAM), Niger.

PROJECT IMPLEMENTATION PERIOD

October 2013 – October 2017

CONSORTIUM

- Institut National Polytechnique Félix Houphouët-Boigny, Ivory Coast
- Université d'Abomey-Calavi, Faculté des Sciences Agronomiques (FSAUAC), Benin
- Faculté d'Agronomie-Université Abdou Moumouni (FAUAM), Niger
- Montpellier SupAgro, Institut national d'études supérieures agronomiques de Montpellier, France

PROJECT CONTACT

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PROJECT WEBSITE

http://www.inphb.edu.ci/site_old/Magrinn%20-%2020125%20z125/index.php

SUMMARY OF RESULTS

A two year master's degree programme, conforming to the LMD system has been developed, implemented and accredited in Benin, Ivory Coast and Niger. The programme has strengthened linkages between the participating Higher Education Institutions providing specialisations which students are able to take advantage of and receive credits for at their home institutions. The programme has also encouraged the collaboration of agricultural sector stakeholders with universities to produce quality graduates.

BACKGROUND

The employability of graduates from West African countries is relatively low. The main reasons for this situation are the inadequacy of training programmes at Higher Education Institutions (HEIs) linked to the employment needs and a lack of dialogue between academic and socio-professional circles. In this context, the project aimed to develop a strategy based on a constructive dialogue between these different partners. This was done on the basis of a diagnostic survey, both at national and regional level in the context of the international LMD (Licence-Master's-Doctorate) reform in order to propose relevant curricula at master level.

Dialogue between academics and professionals has not always been easy. By utilising a participative approach with stakeholders in the development of the new masters allowed for the establishment of a co-operative approach to the trainings. An additional challenge was attracting females who account for only 18% of African agricultural scientists.

The aim was to improve innovation of graduate studies in agronomic sciences and match the training of future scientific professionals with the requirements of the agricultural and environmental sectors.

METHODOLOGY

Stakeholder analysis and participation

A two-year master's degree in the LMD model was developed. The first year was the same for each HEI and covered the general field of 'Agricultural production'. The second year varied per HEI.

Identification of academic and training content

Content was identified by the needs analysis conducted and designed using a participatory approach to ensure relevance and adherence to the LMD system.

Training for faculty and laboratory technicians

Faculty staff and laboratory technicians need to be sufficiently qualified and have a sound understanding of the LMD system, including the design and delivery of courses. Trainings were delivered on how to organise, manage and monitor work placement schemes.

Academic exchanges

To formalise links between HEIs, students were enabled to pursue a specific curriculum of their choice in one of the partner HEIs whilst obtaining the diploma M2 of their establishment of origin.

Gender strategy

Implementation of specific measures to integrate women into masters programmes. Concrete actions were put in place to encourage a proactive HEI policy.

Management Training

Training elaborated for the management of international projects.



RESULTS

→ Outputs

Capacity building

- 3 master curricula designed:
 - Niger: Plant production.
 - Benin: Agricultural entrepreneurship.
 - Ivory Coast: Agribusiness.
- 2 masters implemented in Niger and Ivory Coast with 29 students (14 female).
- 1 master awaiting the resumption of classes in Benin with 10 students (6 female).
- 3 computer rooms (1 per country) to facilitate student learning.
- 1 videoconferencing room for the common communication platform in Ivory Coast.
- 3 computer servers (1 per country).
- 70 university staff (5 female) trained in designing and delivering online courses.
- 50 laboratory technicians (14 female) trained in efficient laboratory management.
- 3 administrative staff trained in supporting graduates in finding a job and to follow their progress in their careers.
- 20 staff trained in project management (3 female).
- 7 staff trained in financial administration (4 female).
- 1 collaborative management platform for the exchanges between teachers and

students from the 3 countries and the online delivery of courses.

Infrastructure

- 3 computer rooms (1 per country) to facilitate student learning.
- 1 videoconferencing room for the common communication platform in Ivory Coast.
- 3 computer servers (1 per country).

Visibility

- 1 website.

↑ Outcomes

- Partner HEIs have academic and technical capacity to deliver a regional LMD master programme in sustainable agriculture.
- Partner HEIs have the administrative capacity to manage academic mobility and work placement programmes.
- HEIs possess expertise and resources to produce master level graduates with current and relevant skills.

🎯 Impacts

Usage

- The methods developed to devise new curricula have been recognised at the institutional level and adopted by other faculties including the School of Agronomy and School of Industry. The developed models are being replicated at the regional level.

Policy implications

- The number of females enrolled in the master programme has increased. The most spectacular example is that of Niger, where the open master has 10 registered females out of a total of 22 students

(45.45%). In terms of the integration of graduates into employment, the rates will be revealed due to the participation of sector stakeholders in the elaboration of trainings, course content and work placements.

- In Ivory Coast, the project methodology used was cited as an example of good practice by the Cabinet Director of the Ministry of Higher Education and Scientific Research.

Sustainability

- Two of the open masters have been approved institutionally and are integrated into the academic offer of these institutions. The third master is in the process of accreditation.
- The three open computer rooms reinforce existing resources and the videoconferencing rooms facilitate exchange between the three institutions.



Capacity building of laboratory technicians at the Faculty of Agricultural Sciences of Benin.



Project Closing Ceremony.

TESTIMONIAL



Prof. Benjamin Yao,
Director of the doctoral
School of INP-HB,
Ivory Coast

“This project was a great experience for us. We contributed to increasing the capacity of our institutions in terms of human resources and equipment and we are proud to have raised awareness of the importance of gender in our institutions. We have helped increase the ratio of female students. We hope that scholarships will be given to start doctoral studies and as a result more women will be integrated into the teaching staff.”

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PESCADO – Pioneering Education for Sustainability of Caribbean Aquaculture Development & Opportunities



Master students implementing research on fish feeding with BIOFLOC.

PROJECT IMPLEMENTATION PERIOD

October 2013 – April 2017

CONSORTIUM

- Universidad ISA (Instituto Superior de Agricultura), Dominican Republic
- University of Guyana, Guyana
- University of Stirling, United Kingdom

PROJECT CONTACT

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PROJECT WEBSITE

www.isa.edu.do

SUMMARY OF RESULTS

A BSc. in Aquaculture and Aquaponics in Guyana and a MSc. in Aquaculture and Aquaponics in the Dominican Republic have been developed and implemented, with the first cohort in September 2016. 384 fish farmers and technicians (46.1% female) were trained in both Guyana and the Dominican Republic in support of the academic programmes. The virtual Institute of Aquaculture & Aquaponics (INAQUAP) has been created and now supports several projects including the incorporation of three foundations.

BACKGROUND

The overall project objective was to support the development of a successful inland fishing and aquaculture industry in the Caribbean. The economic rationale is to create a modern viable and self-sustaining industry that can attract private investment, generate employment and attract bright students to the profession. This would be done by progressing from being a bulk product farming sector to one that creates value added products and meets the food dividend of the local population.

The creation of Bachelor and Master Degree programmes in aquaculture at Higher Education Institutions (HEIs) in the Caribbean and the establishment of a virtual institute of aquaculture and aquaponics in the Caribbean region will bring academia, private enterprise and the public sector closer. This will allow for collaboration on the development of the sector, introducing opportunities for entrepreneurial activity and businesses for fish farmers and producer groups to enter the fish supply chain.

METHODOLOGY

Baseline and stakeholder survey

Participative methodology to determine academic and sectorial needs and opportunities in the Caribbean Aquaculture sector.

Capacity building

Development of the Bachelor's Degree (Guyana) and Master's Degree (ISA Dominican Republic) curriculum in Aquaculture with a focus on entrepreneurship skills.

Professional development

Training university staff in the programme subjects, integrating faculty and research extension training between students, faculty and fish farmers.

Virtual Institute

Establishing foundations for the Institute of Aquaculture and Aquaponics and centralisation of Caribbean research data.

Enrolment

Admissions of students and piloting delivery of BSc and MSc degrees.

Enterprise Incubator

Defining and piloting the establishment of a student committee and setting up of producer groups.

Model Business Plans

Creating supply chain links for commercial Aquaculture.



Construction of a Fish Processing Plant at Universidad ISA, Dominican Republic, November 2013 to June 2014.

RESULTS

→ Outputs

Capacity building

- BSc. Aquaculture and Aquaponics (Guyana).
- MSc Aquaculture and Aquaponics (Dominican Republic).
- 39 lecturers and academic staff trained (55% female, 45% male).
- 384 Fish farmers, producers, technicians, students trained in Aquaculture (46% female, 54% male).
- Fundación Parque Palo Amarillo.
- Asociación para el Desarrollo de la Acuiponía en República Dominicana (ADARD).
- Movimiento Ecológico de los Ríos y Recursos Naturales (ECORENA).
- Virtual Institute of Aquaculture and Aquaponics.

Networking

- Incorporation of three associations with more than 200 stakeholders:

Producción Animal (CIMPA) to support the Master degree programme.

- First certified export of a fish farm to USA in 2016.

Publications

- Corniel S. *et al.*, 2019. Diagnóstico Técnico, Social y Económico del Sector Productivo Acuícola de la Provincia Santiago, República Dominicana. Caribbean Journal of Aquaculture and Aquaponics (CAJAQUAP), Universidad ISA, Febrero 2019.

Facilities

- Fish processing plant and aqua nursery facilities at ISA and the Centro de Investigación para el Mejoramiento de la

↑ Outcomes

- Universities are able to respond to the demands of the aquaculture sector with new knowledge, skills and practices.
- Increase in students interested in aquaculture and research in aquaculture projects.
- Significant increase (120%) in the growth of the aquaculture sector, especially in the Dominican Republic.

🎯 Impacts

Usage

- HEIs are able to assist fish farmers and producer groups to be more successful by applying the new knowledge, skills and practices learnt.
- New public-private initiatives are contributing to the reform of aquaculture management systems.
- Trained lecturers and training materials are in demand by international institutions, especially to assist in Haiti.

Institute of Aquaculture and Aquaponics will professionalise the aquaculture sector and reinforce the capacity to plan the sustainable growth of the sector.

Sustainability

- The academic programmes are accredited by the national authorities.
- The programmes respond to real needs and are creating significant demand.
- The public authorities have been involved from the start and ensure funding for students with scholarships.
- The Caribbean Council of Higher Education in Agriculture will use the results to

create new joint programmes with other Caribbean HEIs.

Policy implications

- The academic programmes in Guyana and Dominican Republic will contribute to further research and along with the virtual



Fish farm in Guyana: Tilapia and Tambaqui nursery facilities.

TESTIMONIAL



Diogenes Castillo Berroa,
Engineer in Animal
Production, Dominican
Institute of Agricultural
and Forestry Research,
Dominican Republic

“This project will result in more advanced research in aquaculture and will improve the information available to further develop production and research strategies. The Dominican Republic’s aqua resources are plentiful but underutilised. Aquaculture accounts for 10% of local demand. PESCADO provides us with the opportunity to develop these resources effectively and sustainably.”



Aquaponics system at the Faculty of Agriculture and Forestry of the Guyana University.

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Financed by the European Union

MAINBIOSYS – Mainstreaming the Biofarming System in Ethiopian and Ugandan Higher Education Institutions

SUMMARY OF RESULTS

Universities have acquired skills to train competent experts in sustainable agriculture, via the transfer of knowledge and research methodology and the development of six replicable demonstration plots. Academics are now able to incorporate new concepts into their curricular programmes, ensuring their students acquire competencies in innovative solutions in bio-farming and sustainability. Laboratory experiences and exchanges at Unimol have improved the technical and research skills of academic staff.

BACKGROUND

MAINBIOSYS aimed to address the issues that hinder progress in the agricultural sectors of Ethiopia and Uganda, specifically: the shortage of qualified academic staff with capacities to produce innovative and advanced applied research in natural sciences and agriculture; and improve agricultural production practices to promote sustainable growth processes and enhance the socio-economic conditions of the population.

The goal was to transfer knowledge and research methodologies and develop a research network among African and EU Higher Education Institutions (HEIs) to enhance capacities to train competent and professional experts in sustainable agriculture.

The 'Bio-farming' approach aims at developing sustainable human settlements and self-maintained agricultural systems modelled on natural ecosystems. Bio-farming draws from several disciplines including organic farming, agroforestry, integrated pest management, urban agriculture, sustainable development, and applied ecology. The primary agenda of bio-farming is to assist people to become more self-sufficient through the design and development of productive and sustainable farms and gardens.

METHODOLOGY

HEIs were provided with with competences to effectively apply advanced research methodologies and promote development processes. By reducing the competencies gap in natural science and agriculture, partners will be capable of acting as sustainable growth engines or transferring scientific knowledge to improve socio-economic conditions.

Needs assessment

Focused on activity definitions and training contents.

Training cycles

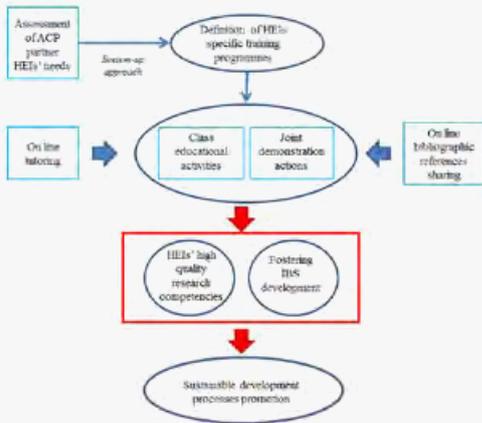
Delivered in components of bio-farming, such as agro-ecology, soil microbiology, agronomy, irrigation, composting, animal production, plant protection (pathology and entomology), medicinal plants, forestry, food technology, and economics (related to food production, socio-economics and local markets analysis). Training included lectures and practical field and laboratory courses.

Joint demonstration actions

Two topics chosen by each partner from among the main components of a bio-farming system, with practical and experimental activities.

Staff and student exchange to Italy

Training programmes for postgraduate students and researchers consisted in participation in conferences and seminars, laboratory experience and work experience on model farms and research institutes.



Schematic diagram illustrating the methodology approach employed in the MAINBIOSYS project.

PROJECT IMPLEMENTATION PERIOD

October 2013 – April 2017

CONSORTIUM

- Università degli Studi del Molise (UNIMOL), Italy
- Gulu University, Uganda
- Addis Ababa University, Ethiopia
- Hawassa University, Ethiopia

Associate partners:

- Bioeconomy Africa, Ethiopia
- African Bioeconomy Capacity Development Institute, Ethiopia

PROJECT CONTACT

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PROJECT WEBSITE

www.mainbiosys.unimol.it



RESULTS

→ Outputs

Capacity building

- Research needs assessment and training plan included innovative topics such as community based platforms, sustainability assessment, adaptation to climate change and modelling agricultural systems.
- 10 university staff (2 female, 8 male) from Ethiopia and Uganda visited UNIMOL on exchange to gain experience in bio-farming research and techniques for periods ranging from 2 weeks to 2 months.
- 150 staff units from Ethiopia and Uganda trained during 330 training hours organised in the partner universities, divided between a biofarming training school and 11 cycles

of training activities.

- 6 demonstration actions (4 in Ethiopia and 2 in Uganda) including the preparation for experimental sites.

Tools

- Online tutoring and bibliographic references system.

Documents

- Biofarming pictorial handbook.

Networking

- Official agreements signed between Ethi-

opian HEI and UNIMOL, in particular doctoral student exchange agreement and funding of research projects.

- 3 academics from Uganda and Ethiopia attended PhD programmes in UNIMOL.
- Improved co-operation achieved between African HEIs and local stakeholders, through close collaboration in the realisation of demonstration actions.

Visibility

- Website and web platform.
- 3 dissemination conferences.

↑ Outcomes

- Academics able to incorporate new concepts and innovative methods into undergraduate and MSc curricula.

- Academics have technical and laboratory skills to conduct innovative research in sustainable agricultural practices.

- Students and future practitioners have competencies in innovative sustainable agricultural practices.

🎯 Impacts

Usage

- The demonstration actions at the ACP bio-farming sites are considered key components and “showcases” for new advances in scientific applications in rural and sustainable development to be demonstrated to students, stakeholders and farmers.

accompanied by requirements for highly trained and skilled academic and technical staff. This project has been able to bridge the two national agendas by fostering a close co-operation amongst the HEIs and associate NGOs.

Sustainability

- Networks have been built between the various partners, associate partners and other stakeholders including government.

The NGO Bioeconomy Africa (BEA), for example, has a network of permanent biofarms that can be utilised by the HEIs for research and training.

- A PhD exchange programme between the African and EU HEI's was established with students attending UNIMOL Department of Agriculture, Environment and Food Sciences.

Policy implications

- The university systems in Ethiopia and Uganda are facing huge growth,

TESTIMONIAL



Engdawork Assefa,
Assistant Professor,
Centre for Environment
and Sustainable
Development, Addis
Ababa University,
Ethiopia

“I have significantly increased my skills and knowledge from the research training and field work experience. Subsequently, I have shared this experience with my students and the community at large. PhD students can apply the knowledge and skills they acquire in research and are able to apply them in our extension activities at our demonstration sites.”



Practical training carried out at the Hawassa University about the use of Rhizobia bacteria to produce biofertilizer.



A mini biogas plant restored within the MAINBIOSYS project at the demonstration site of Gulu University. Currently, the plant powers up the poultry and pig units of a school.

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Financed by the European Union

Development of a Regional Master Programme in Pig Production and Food Security in Caribbean Countries



Visit to a pilot slaughterhouse in Spain.

PROJECT IMPLEMENTATION PERIOD

October 2013 – October 2016

CONSORTIUM

- Universitat de Girona, Spain
- Universität Leipzig, Germany
- Universidad ISA (Instituto Superior de Agricultura), Dominican Republic
- Universidad Nacional Pedro Henríquez Ureña, Dominican Republic
- Universidad Central "Marta Abreu" de las Villas, Cuba
- Université Chrétienne du Nord d'Haiti, Haiti

PROJECT CONTACT

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PROJECT WEBSITE

www.udg.edu/edulinkII/

SUMMARY OF RESULTS

A Master course on pig production and food safety has been approved at Universidad ISA (Dominican Republic) and Universidad Central "Marta Abreu" de las Villas (Cuba). Qualifications of academic staff have been upgraded and capacity building for administrative managers has been achieved ensuring a quality programme and a new generation of experts in production and food security domains.

BACKGROUND

Swine production in the Caribbean is concentrated mainly on small producers utilising backyard production systems with few commercial or technically advanced farms.

In the Dominican Republic, production is facing serious environmental challenges, high production costs and health management challenges. In Cuba, swine production is increasing as a meat source and thus both training and educational programmes are needed to increase knowledge of swine production systems. In Haiti, food security is a major challenge and there is a need to train more professionals competent in livestock production systems.

The project aimed to introduce an interdisciplinary master degree programme in pig production and food safety in the partner Higher Education Institutions (HEIs) in the Dominican Republic, Cuba and Haiti and establish close cooperation with the national legal authorities to enhance the quality of education in food security related programmes. The aim of the partner HEIs is to become competent in pig production systems in accordance with EU and international standards and facilitate the mobility of staff and students.

METHODOLOGY

SWOT Analysis

Comprehensive analysis of current academic offerings in both Caribbean and EU countries in the field of animal production, livestock and food.

Training courses

Definition and programming of training courses for teachers and tutors and for academic and administrative managers. Training courses in pig aspects such as health, nutrition, reproduction, welfare, environmental management and also food safety.

Academic and administrative management

Capacity building for academic and administrative management through provision of manuals based on European administrative management.

Continuous education courses

Capacity building for continuing education providers. Training in production systems and pig diseases. Development of continuing education modules for external students and stakeholders in the areas of food safety and swine production.

Curricula development

Development of the Master Programme, including academic planning, learning methodologies, competencies and skills definition and continuous assessment systems.

Implementation of the Master

Piloting the course in Cuba and the Dominican Republic.

Dissemination

Necessary to attract students and to ensure the sustainability of the Master Programme, including the development of a web portal, distribution of brochures and media coverage.

Administrative unit

Inter-university administrative office where companies may announce graduate jobs.

RESULTS

→ Outputs

Capacity building

- 25 academic staff trained in curricula development and management.
- 11 academic staff achieved upgraded qualifications in competence-based curricula development in higher education.
- 2 MSc programmes developed and approved (Cuba and Dominican Republic).
- 12 technical staff trained in aspects of livestock and food safety.
- 4 technical staff achieved upgraded qualifications in managing pig production systems more efficiently.

Networking

- Cooperation between universities and livestock sectors has been established.

Documents

- Manual entitled 'WP4: Capacity building for ACP management, administration, students and companies' exemplifying European legislation.
- 27 lectures related to nutrition (6), health (6), reproduction (6), animal welfare (3), production systems (3), food safety (2) and environmental management (1).

Website

- 1 web portal.

Publications

- 2 scientific articles.

Visibility

- Participation in AGROCENTRO conference focused on the food sector.

↑ Outcomes

- HEIs in Cuba, Dominican Republic and Haiti able to develop a master programme by adapting the European model.
- Knowledge is acquired in the efficiency, management and development of the food and pig production sectors.

🎯 Impacts

Usage

- New generation of better-prepared, graduated students will improve the efficiency of the sector.
- Mobility is encouraged when the background and expertise of students are increased. Mobility will expose staff to skills and innovative tools and techniques and will enable them to disseminate their research.
- New networks between Caribbean and European universities will improve and increase the access to PhD studies.
- Better relationships between universities and the private sector will offer more opportunities within the livestock sector.

Policy Implications

- Students graduating from the courses will contribute to the livestock and food sectors, which will contribute to the improvement of the efficiency and management of the pig production sector.
- The exchange of information will enable the adaptation, improvement and possible harmonisation of policy and legislation related to the sector within the Caribbean region.

Sustainability

- In the Dominican Republic, the Master syllabus should be submitted to the Ministry for accreditation, which will then rely on

the enrolment of a sufficient number of students to sustain the course financially. In contrast, in Cuba once the government approves a Master course, it commits funding.



Launch of master programme at Universidad ISA.

TESTIMONIAL



Fausto Solis de los Santos,
Professor and researcher,
Universidad ISA,
Dominican Republic

“This programme is very relevant for our countries, and specifically for the Dominican Republic, as we lack qualified human resources to manage our pig operations and slaughter houses. This programme will significantly increase the academic level of professionals involved in pig production and food safety in the Dominican Republic and the Caribbean and will contribute to both the national and regional development of the sector.”



Edulink participants at 2nd meeting coordination in Santiago de los Caballeros (Dominican Republic).

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eLEFANS – E-Learning Network on Food and Nutrition Security with partner universities in Eastern Africa and Europe

SUMMARY OF RESULTS

A cooperation network between participating institutions and stakeholders in five e-learning centres was established, 15 specialised Food and Nutrition Security e-learning courses and modules were developed, backed up by five media databases, seven trainings for 33 staff members in designing and use of e-learning courses and an e-learning platform for sharing resources. The five e-centres have been equipped and academic staff has been trained in developing e-learning courses on a Moodle platform.



E-learning training, Makerere University, Uganda (June 2015).

PROJECT IMPLEMENTATION PERIOD

December 2013 – June 2017

CONSORTIUM

- Ulm University, Germany
- Makerere University, Uganda
- Jomo Kenyatta University of Agriculture and Technology, Kenya
- Hawassa University, Ethiopia
- Egerton University, Uganda
- Kenyatta University, Kenya
- Justus Liebig University Giessen, Centre for International Development and Environmental Research (ZEU), Germany

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PROJECT WEBSITE

www.Elefans.org

BACKGROUND

Food and Nutrition Security (FNS) is a highly complex issue requiring professionals to have a sound knowledge of the political, economic, social and cultural environment in which they work. They also require skills enabling them to carry out quick, accurate assessment and analysis of food insecure groups so that they can then select measures to mitigate food insecurity and improve the situation in the short and long term.

Given that the main problem at partner institutions is the lack of qualified staff, e-learning elements would be included in Bachelor's and Master's curricula in order to support and enhance the quality offered by the East African Higher Education Institutions (HEIs) based on national and international standards.

The fact that e-learning can be used by a large number of students spread across different locations (also for distance learning) makes it an efficient tool. Its relevance to the labour market was ensured by the involvement of stakeholders to oversee quality and continuity, and to organise appropriate training for all participants and beneficiaries so as to guarantee effective utilisation of the e-courses.

METHODOLOGY

Design of didactic curricular courses and Stakeholder meetings

To create awareness of e-learning, a needs assessment was conducted to prioritise courses to be developed and digitalised.

e-learning centres

Establishment of five e-learning centres, one in each of the participating HEI, including the procurement of software and equipment.

Trainings

FNS and Information and Communication Technology (ICT) experts were trained in the development of e-courses and pooling resources, to take advantage of each other's expertise. Students were trained in the use of e-learning content.

Development of e-courses, e-modules and databases

Authors from different institutions worked together to create high quality e-courses in the field of FSN. The e-content was reviewed in several steps by experts in specific subjects. The e-courses and modules were tested by students and their feedback was incorporated in the final versions.

e-learning Moodle platform

An e-learning platform (eLEFANS) was established for sharing teaching expertise and resources (five e-courses, 10 modules and five databases).

Resource sharing, courses transfer and academic (virtual) mobility

The exchange of information, knowledge and human resources (specialist experts) formed a basis for the development and testing of the e-courses, e-modules and databases.



RESULTS

→ Outputs

Capacity building

- 7 trainings for 33 university staff members, FNS experts and IT experts (16 female, 17 male) in designing and use of e-learning courses.
- 10 trainings for students on the use of Moodle for using e-courses / modules and databases.
- Formation of 20 groups for e-course, e-module and database development.
- 5 e-courses, 10 e-modules and 5 databases.

Platform

- 1 e-learning platform (elefans.org) with 40 discussion fora.

Facilities

- 5 e-learning centres, each equipped with electronic devices (21-23 computers, 2

tablets, 1 laptop, 1 scanner, 1 printer, 1 LCD projector, 1 video camcorder).

Network

- A network of stakeholders, FNS experts, IT experts and universities in East Africa and Germany.

↑ Outcomes

- Stakeholders aware of and co-operating to facilitate e-learning adapted to the needs of the labour market.
- University staff competent in the development and use of e-learning resources and in exploiting international co-operation.
- Students stimulated in the use of e-courses and e-modules.
- eLEFANS platform is well established with around 100 active members.
- African and EU HEIs and stakeholders sharing resources in an international network of FNS and IT experts.

🎯 Impacts

Usage

- The established e-learning programme will play a critical role in training and upgrading skills of teachers for use in the future, bridging the lecturer gap at institutions both in terms of quality and quantity. It enables experts in different areas of FNS to lecture at other institutions.

Policy implications

- The close co-operation of partners and stakeholders has ensured consistency with

government policies to develop e-learning capacities as an efficient way to stimulate learner-centred education, increase student catchment areas and initiate multi-institutional collaboration and curriculum development.

- Experts able to conduct problem-focused research will contribute to national and regional policies and be involved in planning, designing and implementing development projects.

Sustainability

- A well-functioning network of experts and stakeholders is attracting more donors, thereby ensuring the continuity of the e-programme on FNS.
- Capacity has been enhanced to produce more competent FNS professionals to work as trainers, researchers and policy makers.

TESTIMONIAL



Fikadu Reta Alemayehu,
Director, School of
Nutrition Food Sciences
and Technology, Hawassa
University, Ethiopia

“Electronic and internet technology has a huge potential to expand education, improve resource sharing and provide cost-effective and flexible teaching and learning. Thus, even if online learning has some current limitations, the opportunities are huge. The project has given me skills and exposure to online teaching and I am confident that e-learning will offer a more efficient and wider coverage of education to citizens in Ethiopia.”



Participants at launch of e-centre and e-training,
Makerere University, Uganda (June 2015).

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Financed by the European Union

HEEMS – Reinforcement of higher education as a tool to foster efficient use of energy applied to the poverty reduction within the marine sector through capacity building and regional integration

SUMMARY OF RESULTS

A diagnosis of academic programmes and academic staff capabilities in São Tomé and Príncipe, Cape Verde and Mozambique regarding their renewable energy sectors has been produced. Staff, students and other stakeholders have been trained in renewable energy subjects with six modules in renewable energy tailored for massive open online courses (MOOCs).



Signature of Agreement at the rectorate of the Universidade de Vigo.

PROJECT IMPLEMENTATION PERIOD

October 2013 – April 2016

CONSORTIUM

- Universidade de Vigo (UVigo), Spain
- Centro Politécnico (CP), São Tomé and Príncipe
- Universidade de Cabo Verde (UniCV), Cape Verde
- Instituto de Emprego e Formação Profissional (IEFP), Cape Verde
- Universidade Eduardo Mondlane (UEM), Mozambique
- Universidade Zambeze (UNIZAMBEZE), Mozambique

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<http://heems.uvigo.es>

BACKGROUND

Cape Verde, Mozambique and São Tomé and Príncipe have an acute shortage of engineers specialised in the energy sector. In order to increase the number of specialists who are capable of actively working in the energy field, it was necessary to train academic staff to have the capacity to resolve practical energy issues, with a specific focus on the marine sector. Academic performance was enhanced with training programmes linked to the labour market and via curricular development

Increasing institutional capacities was achieved thanks to the review and elaboration of specific curricula adapted to the sector requirements. Capacity was further increased by incorporating practical modules into the curriculum that may be taught through targeted demonstration projects and further developed and tested through-out inclusion on courses. The project also reinforced networking at regional and international levels both between Higher Education Institutions (HEIs) and other sectorial associations, private companies and governments.

METHODOLOGY

The capacity of HEIs at both the management and academic levels was strengthened by improving staff capacity and academic curricula via two approaches:

- Increasing the capabilities of the HEI and academic staff.
- Reviewing and elaborating specific curricula, including the incorporation of practical modules and their adaption to the specific needs of the fisheries sector.

Networking was reinforced between the HEIs and other institutions and civil society groups.

A diagnosis of the academic programmes and capacities of academic staff in the energy field lead to outputs such as adaptation of academic curricula, and specific staff training on using a digital campus and promoting the use and learning of ICT. A regional seminar was used for training in renewable energies and lead to the transfer of knowledge to stakeholders and civil society. A transversal activity was the promotion of national and regional inter-institutional co-operation on renewable energy and in this regard a memorandum of understanding between the HEIs and some stakeholders was signed.



Working meeting with students from São Tomé and Príncipe.

RESULTS

→ Outputs

Capacity Building

- University staff trained in:
 - Design and scaling of energy storages system.
 - Solar complementary technology.
 - Industrial pollution: assessment, prevention and control, environmental management of industrial installations.
 - Management and treatment of waste and industrial emissions.

Curricular development

- New curricula in renewable energy (60 ECTS credits).

Demonstration projects

- Photovoltaic recharge system for cellular telephony.
- Solar cook and oven.

- Training prototype of small wind turbines.
- Solar training prototypes of photovoltaic installations.
- Storage systems with batteries.
- Electric boat KAIKEL for the local fishermen communities.

Documents

- Review of the energy sector and stakeholders in Mozambique, Cape Verde, São Tomé and Príncipe.
- Guidelines on:
 - Energy experiments.
 - Assembling photovoltaic equipment for charging mobile telephones.
 - *Utilização de Sistemas de propulsão eléctrica em pequenas embarcações utilizadas na pesca artesanal em Cabo Verde.*

Networking

- HEI agreements on:
 - training, research and exchange initiatives;
 - joint projects and PhD training.

Publications

- Sánchez A. *et al.*, 2014. Reinforcement of Energy Knowledge in Higher. European Journal of Sustainable Development (2014), 3, 4, 181-188.

Visibility

- 1 conference: Sustainable energy applied to poverty reduction strategies within marine sector development - São Tomé and Príncipe, Centro Politécnico, 13 to 17 July 2015.

↑ Outcomes

- Students, staff and stakeholders are aware of and have competencies in renewable energy issues and technology.
- HEIs and staff have capacity and competence in the use of ICT for the delivery of training and academic courses.
- Partner HEIs have the capacity to define and develop academic programmes in sustainable energy.

🎯 Impacts

Usage

- The training prototypes for student practical learning are being continually tested by the partners. The Department of Fisheries of São Tomé and Príncipe continue testing the boat with local fishermen and the wind turbine and photovoltaic installations are being tested by academic teams in order to incorporate them in new academic programmes.
- The online courses are being replicated for use by teachers from the Universidad

Pontificia Católica de Río Grande do Sul in Brazil.

Policy implications

- The conference has laid the foundations for cooperation at national and international levels between the project partners and stakeholders including governments from São Tomé and Príncipe, Cape Verde and Mozambique.



International Seminar on Renewable Energies.



Heems equipment and practical training on instalment.

TESTIMONIAL



Peregrino do Sacramento da Costa, Rector, University of São Tomé and Príncipe, São Tomé and Príncipe

“With the implementation of this project, the University of São Tomé and Príncipe will train more staff with expertise in developing activities related to energy and environmental protection, as well as enabling more low-income people to use these technologies to their benefit, particularly small businesses, which will benefit from fuel savings, etc.”

ACP-EU Co-Operation Programmes in the fields of Higher Education and Science, Technology and Research

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ADECEA – Establishing and Piloting Postgraduate Programmes for Supporting Agricultural Development in Post Conflict Countries of Central and Eastern Africa

SUMMARY OF RESULTS

The project strengthened the partnership between institutions, facilitated staff networking and established demand driven postgraduate training in three post conflict countries of eastern and central Africa (D.R. Congo, Burundi and Madagascar). It piloted two of the four developed academic programmes and also supported capacity building of academic staff. The new postgraduate programmes were aligned to the 3-2-3 License Master Doctoral system.

BACKGROUND

Food insecurity and poor health are among the drivers of emergence of conflict and one of the best ways of reducing this risk is to invest in socio-economic areas and increase access to food and nutrition as part of an overall peace building strategy. In this regard strengthening academic and administration capacities of higher education institutions becomes key to revitalising the agricultural sector and economic development.

Currently, universities in the three countries are running the Licence (5 years undergraduate training) Master (3 years) Doctorate (4-6 years) systems which need to align to the new LMD system of 3-2-3 years to meet international standards and facilitate integration at regional (eastern and southern Africa) and international levels. Capacity will be built via the development of demand-driven postgraduate programmes to address agriculture and food security issues.

Due to a lack of qualified professionals to spearhead agricultural development in the three countries, resources have been mobilised to train staff to run the developed programmes and support research. Human resources in the RUFORUM network have been identified to support teaching at the Catholic University of Bukavu, D.R. Congo.

METHODOLOGY

Engagement of university management and relevant government officials fostered by the MSc programmes developed under the programme. Partnerships facilitated resource mobilisation for the established MSc programmes, while participation of staff from the target universities in other countries ensured learning and contributed to improved undertaking of subsequent similar activities in the other countries. Pegging of project regional events on other RUFORUM conferences enabled exploitation of synergies and enhanced efficiency of the project. Scoping studies, interviews, training and advocacy were applied to collect data. Training, regional sharing events and publications were used to disseminate project information.

North-South and South-South staff exchanges

Exchange visits supported scoping studies and curriculum development, provided a learning experience for staff, and catalysed resource mobilisation to support the MSC programmes.



Project meeting in Madagascar.

PROJECT IMPLEMENTATION PERIOD

October 2013 – March 2017

CONSORTIUM

- Makerere University, Uganda
- Université Catholique de Bukavu, D.R. Congo
- Université du Burundi, Burundi
- Université d'Antananarivo, Madagascar
- RUFORUM, Uganda
- AGREENIUM, France
- Montpellier SupAgro, Institut national d'études supérieures agronomiques de Montpellier, France
- University of Ghent, Belgium

PROJECT CONTACT

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PROJECT WEBSITE

<http://postconflict-adecea.net/>



Project meeting in Uganda.

ADECEA PROJECT



RESULTS

→ Outputs

Capacity building

- Developing and piloting MSc programmes.
- Developing course modules and resource materials.
- Short skills enhancement for students and staff (academic and administrative).
- Alignment of programmes in Burundi, DRC and Madagascar to the LMD system.
- Training of MSc students (2 female, 26 male).

Contributions to policy briefs

- African Higher Education Week: Transforming Tertiary Agricultural Education. A Platform for the Way Forward, Maputo-Mozambique 19-25 July 2014.
- A Consultative Meeting with Key Stakeholders on AUC MoU with RUFORUM and Draft Implementation Plan & Strategy for STISA-2024 Pillar One – “Eradicating Hunger and Achieving Food Security in Africa” in Windhoek: , Windhoek, Namibia, 26-28 August 2015.
- Principals and Dean call, Khartoum, Sudan, 8-10 June 2015.

- Ministerial Communiqué on Higher Education, Science, Technology and Innovation in Africa, Cape Town, South Africa, 20-21 October 2016.
- African Higher Education week communiqué: Linking Agricultural Universities with Civil Society, the Private Sector, Governments and other Stakeholders in support of Agricultural Development in Africa, Cape Town, South Africa, 21 October 2016.

↑ Outcomes

- Rectors, Deputy Rectors and Deans are able to effectively deal with change and resolving conflict.
- Staff with improved skills are able to support the new MSc programmes.
- Alignment to LMD has enhanced the mobility of students within the region.

🎯 Impacts

Usage

- There has been an increase in the number of MSc and PhD students attending the participating universities.
- For the first time, students from the participating countries are attending courses within the RUFORUM network.
- A 20% increase in PhD students is anticipated in the region in 5 years.

Policy implications

- Co-operation agreements have been signed between the targeted universities and other institutions in Africa and Europe.
- The aligned programmes are ready for Africa-wide harmonisation and standardisation.

Sustainability

- Programme-running costs are covered by tuition fees and the number of guest lecturers reduced over time.
- Through partnerships financial resources are leveraged for research and support of student training.
- The establishment of National Forums in Burundi and D.R. Congo will bring together stakeholders involved in the agricultural sector, and thus provide platforms for ensuring development of demand-driven MSc programmes, and collect stakeholder views to inform the development of programmes.



Project meeting in DR Congo.



Project stakeholder meetings in Burundi.

TESTIMONIAL



Jean Rasoarahona,
Former Dean, School of
Agricultural Sciences,
University of Antananarivo,
Madagascar

“The Master will enhance the skills available within Madagascar. The University and the School of Agricultural Sciences will benefit from a greater visibility on the national and regional level. For my own part as Dean, this project has helped me enhance regional cooperation.”

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ANEER – African Network for Education in Energy Resources

SUMMARY OF RESULTS

A diagnostic study on the situation of the energy sector in Angola and Mozambique was concluded with recommendations to adapt courses to the labour market requirements and gender considerations. Academic and management skills have been strengthened in the field of energy efficiency in two higher education institutions. Qualifications of teaching staff have been improved and six specific energy-related courses have been adapted, implemented and approved in both countries.

BACKGROUND

Angola and Mozambique have abundant natural and energy resources, including oil and gas. However, the majority of the population do not have access to these resources with less than 20% enjoying regular access to domestic energy. Energy distribution is inefficient, expensive, and unstable. In both countries, there is a demand for qualified technicians and energy professionals.

On the other hand, most of the Angolan and Mozambican population use natural biomass (wood or coal), resulting in an over-exploitation of natural resources. The lack of monitoring mechanisms and management knowledge from government administrations is a threat to the environment.

Focused on energy access and efficiency, the intervention aimed to build high-quality tertiary education capacity in two Higher Education Institutions (HEIs) in Angola and Mozambique. The secondary objective was to build on the existing relationships of the partnership and expand the network to other institutions and stakeholders in the sector.

METHODOLOGY

Study on energy implementation and natural resource use and efficiency

Identification of labour market needs, design of the academic curriculum including gender approach and awareness of other institutions related to the management of natural resources with energy objectives.

Teacher training programmes

Training in innovative education techniques such as blended learning and in new technologies such as web resources and virtual campus.

Management training

Management and planning capacities, including creation of teacher mobility plans, adaptation of curricula and coordination with other universities.

Training of technicians

Technicians employed by governmental and administrative services trained in energy efficiency technology and natural resource management

Curricula improvement

Modules designed according to the recommendations of the study and institutional interests. Specific energy-related disciplines implemented in both countries through the common Virtual Classroom

Establishing a network of education on energy

A virtual platform 'African Network for Education in Energy Resources' (ANEER) including a free documentation centre, the virtual campus and a web viewer (African Geobussola) with important cartographic information related to the management of natural resources for energy purposes.



Delivery of the training course certificates to local technicians in Gaza province, Mozambique.

PROJECT IMPLEMENTATION PERIOD

October 2013 – October 2017

CONSORTIUM

- University of Córdoba, Spain
- José Eduardo dos Santos University (FCA-UJES), Angola
- Higher Polytechnic Institute of Gaza (ISPG), Mozambique

PROJECT CONTACT

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PROJECT WEBSITE

<http://www.aneer.org>

RESULTS

→ Outputs

Capacity building

- 12 teachers (9 male, 3 female) trained in energy efficiency.
- 6 new modules in Forestry Engineering and Agronomic Engineering Degree.
- 102 student placements (80 male, 22 female) in energy efficiency and natural resources management.
- 17 professionals (12 male, 5 female) trained in biomass transformation processes and energy efficiency applied to processes.

Common virtual campus

- 1 virtual campus for forums, questions, assessment and subjects.

Virtual platform

- ANEER: <http://www.aneer.org>
- Digital Documentation Centre, virtual campus (African Geobussola).

Documents

- Study of Angola's energy reality: labour market needs in the energy sector.
- Study of Mozambique's energy reality: labour market needs in the energy sector.

Visibility

- "Scientific August 2013": New Technologies in Interuniversity Cooperation: Scientific and Academic Networks for Sustainable Energy Development in Angola and Mozambique.

- "Scientific August 2016": Study of Angola's energy reality: labour market needs in the energy sector.
- "Scientific August 2016": African-Geobussola platform: a platform for the formation and exchange of energy information in Angola and Mozambique.
- Workshop at ISPG (December 2015): African-Geobussola platform: "Study of the energy reality of Mozambique: labour market needs in the energy sector".
- VI Scientific Conferences of ISPG in August 2017: "New technologies in inter-university cooperation: scientific and academic networks for sustainable energy development in Angola".

↑ Outcomes

- Study on energy implementation and natural resource use and efficiency.
- Teachers competent in the delivery of academic programmes in energy efficiency in agronomy and forestry engineering.
- HEI staff competent in the use of new technologies and in the management of HEI networks and administration of courses.

🎯 Impacts

Usage

- The increase in the number of qualified higher-education teaching personnel will benefit the university community.
- The 102 students enrolled in the adapted courses will improve the energy sectors in Angola and Mozambique.
- The reported good practices could be incorporated in the political decision making in the energy sector.

Sustainability

- The incorporation into the curricula of new disciplines related to energy management and efficiency places the two participating institutions in the top rank of HEIs working in natural resources management in Angola and Mozambique.

Policy implications

- The newly qualified professionals will increase the number of local staff incorporated into companies and public institutions.



Visit to a biomass processing plant during the teacher mobility programme.



Professional training course in biomass transformation processes (improved kitchens) in the rural community of Chichongue, Mozambique.

TESTIMONIAL



Prof. Arão Raimundo Finiasse, Instituto Superior Politecnico of Gaza, Mozambique

"We aim to improve the forestry engineering curriculum at ISPG and train new professionals and strengthen the monitoring and evaluation mechanisms to prevent the over exploitation of natural resources. On a personal level my teaching skills have been enhanced and I am able to improve the design of classes I teach, especially in the discipline of Environmental Impact and Geographic Information Systems."

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CAP4INNO – Knowledge transfer capacity building for enhanced energy access and efficiency in the Caribbean

SUMMARY OF RESULTS

A greater awareness and increased knowledge and skills about innovation, intellectual property and patent databases as sources of technical information for technology surveillance in Caribbean countries (Dominican Republic, Jamaica and Trinidad and Tobago) has been achieved, as well as a culture shift in relation to 'innovation thinking'. The revision of existing courses and development of new courses has increased the understanding and knowledge of innovation and knowledge transfer among students.

BACKGROUND

Energy costs in the Caribbean are amongst the highest in the world, approximately three to four times than in North America and Europe. New, more effective and efficient technologies are urgently needed to broaden the access to energy and make it more affordable for vulnerable sections of society. Caribbean countries currently have weak innovation systems and a lack of resources to boost research and development.

There is a need to create support mechanisms for the development, transfer and diffusion of environmentally sound technologies. In order to address the situation, CAP4INNO has targeted these issues by increasing awareness of the qualification and training needs required of Higher Education Institution (HEI) staff and students in the energy sector. It focused on improving the qualifications of staff in order to modernise academic and research programmes and deliver new innovative courses. Inter-institutional networking was also reinforced as co-operation among stakeholders.



METHODOLOGY

Creating the knowledge base

An in-depth analysis of training needs of Caribbean HEI's academic staff in Energy, Knowledge Transfer (KT) and Innovation in the energy sector was conducted. Identification of the skill sets and tools needed in the region to develop and implement innovative energy solutions for an efficient regional energy sector.

Capacity building

Capacity building workshops conducted with HEI staff and the replication of these workshops in partner countries in order to build capacities for both management and academic staff in areas relating to Intellectual Property (IP), Innovation, Ideas Evaluation, Entrepreneurship and aspects of Patenting in the Renewable Energy discipline.

Modernising curricula and training offer

Action Plan for curriculum modernisation and the joint development of materials for new transversal courses. Pilot courses conducted for professionals and an e-learning platform established with course implementation.

Networking and promotion of regional uptake

Students' innovative energy-efficient ideas competition and presentation of winning idea at the final CAP4INNO conference on renewable energy. Organisation of round table for stakeholders in renewable energy in each partner country.



Replication workshop "UWI towards a more innovative university" Cave Hill campus, Barbados, in July 2015.

PROJECT IMPLEMENTATION PERIOD

October 2013 – January 2017

CONSORTIUM

- Universidad de Alicante (UA), Spain
- University of Technology (UTech), Jamaica
- Instituto Tecnológico de Santo Domingo (INTEC), Dominican Republic
- The University of the West Indies (UWI), Jamaica

Associated partners:

- World Intellectual Property Organization (WIPO), Switzerland
- Jamaica Intellectual Property Office, Jamaica
- Oficina Nacional de la Propiedad Industrial, Dominican Republic
- Intellectual Property Office, Trinidad and Tobago

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PROJECT WEBSITE

www.cap4inno-project.org

RESULTS

→ Outputs

Capacity building

- 167 academics, researchers and managers trained in KT, innovation, entrepreneurship and IP Management
- 177 students trained in innovation and KT.
- 86 professionals in the energy public and private sector trained in innovation
- 1 new pilot course on Sustainable Energy Innovation, Implementation and Entrepreneurship delivered
- 5 existing courses revised including training materials and new competences.

Documents

- 3 strategies for integrating Innovation, KT, IP Management and Entrepreneurship learning contents into partner HEI's curricula.

Networking

- 3 national round tables on energy access and efficiency with key stakeholders in the energy field.
- Conference 'Applying and Developing Renewable Energy Technology for the Benefit of the Caribbean' to promote effective collaboration in the Caribbean Region.

Publications

- Universidad de Alicante, 2017. Towards a Sustainable Energy Sector in the Caribbean and the Role of Higher Education Institutions.

Databases/Website

- 1 online training platform with 3 training modules (Idea Evaluation, Stakeholders engagement and Caribbean innovation in Renewable Energy).
- 1 website.

↑ Outcomes

- Awareness among university staff on innovation, IP and patent databases.
- Enhanced student and professional innovative skills to face the challenges of energy access and efficiency.
- Awareness of the value and potential of renewable energy alternatives.

🎯 Impacts

Usage

- Stakeholders in the energy sector are collaborating on energy access and efficiency and in modernising curricula in order for HEIs to offer the necessary skills in the energy sector.

Policy implications

- Recommendations for enhancing energy access and efficiency through innovation and KT have been drafted and presented during the CAP4INNO final conference and in the 4th Biennial National Science, Technology and Innovation Conference organised in collaboration with the Scientific Research Council of Jamaica.

Sustainability

- The West Indies Renewable Energy Group at UWI will coordinate renewable energy projects at UWI.
- The Technology Transfer Office at UTech will transfer results of innovative research to the market.
- At UTech and with the support of WIPO, a Technology and Innovation Support Centre will provide services to the public. INTEC's Professorial Development Department will be in charge of follow up for course development.



Poster Sessions, 3rd Joint Stakeholders' Conference, EU-ACP collaborative programmes.



Presentation of the Cap4inno project, International Conference on Sustainable Energy Development, INTEC, 23/24 October 2014, Santo Domingo, Dominican Republic.

TESTIMONIAL



Natasha Corbin,
The University of the
West Indies, Barbados

“One of the primary benefits is the improved knowledge and capacities of staff members with respect to the exploitation of innovative solutions in energy access and efficiency in the Caribbean. It has also fostered collaboration amongst the stakeholders and greater awareness of organisations engaged in the sector and the university programmes in intellectual property, entrepreneurship, innovation and renewable energy and energy efficiency.”

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IP4GROWTH – Enhancing Intellectual Property Capacities for Agricultural Development

SUMMARY OF RESULTS

Contribution to agricultural and socio-economic development of west African countries through Intellectual Property management applied to agriculture and use of Geographic Indications (GIs). This has resulted in increased knowledge and capacities of HEI academics on the application of these knowledge-based tools and raised awareness of the utility of GIs to protect key products and improve competitiveness. As a result there is increased cooperation between rural communities, HEIs and national IP offices.

BACKGROUND

West African countries face particular challenges when it comes to agricultural innovation, structured practices, trade policy or Intellectual Property (IP) management. The target countries are characterised by a heavy dependence on natural resources, exposure to climate hazards and undiversified small economies with high levels of poverty, and political fragility. This has a negative effect on successful integration and competitiveness and undermines the role of agriculture in development, growth and employment.

IP4GROWTH has targeted these issues by strengthening Higher Education Institutions' (HEIs) capacities in IP management, and by fostering relationships between HEIs, national IP offices and rural communities. The overall aim was to stimulate rural development through the increased use of IP rights in agriculture.

METHODOLOGY

Comparative needs analysis and market diagnosis

Analysis carried out upon a benchmarking, comparative, basis to facilitate HEIs' awareness and openness to new ideas, methods and practices. It also determined the basis for discussions with stakeholders and impact at the policy level. The methodology used was based on the AIDA method (Attention, Interest, Desire and Action; widely used in marketing), adapted to international projects

focused on IP management in HEIs and small and medium-sized enterprises (SMEs).

Capacity building and training

Training of HEI staff by means of tailor-made modules in IP management and agriculture to gain insight and ability to replicate trainings to benefit students, researchers and other stakeholders and HEIs.

Knowledge transfer

Provide the target groups with efficient and integral Info-service (website, paper-based resources, helpline point) for improving knowledge on IP for agricultural development. Collection of reference documents, guides and resources to improve their understanding and skills in IP management.

Dissemination and networking

Dialogue with stakeholders to stimulate discussion for improving IP management practices in HEIs and the promotion of activities, results and outputs.

Community engagement

Linking IP management for agricultural growth with the particular needs of the local farming communities.



Round Table on the practical aspects of implementation of Geographic Indications, Regional Conference, Abidjan, Ivory Coast (September 2017).

PROJECT IMPLEMENTATION PERIOD

October 2013 - October 2016

CONSORTIUM

- Universidad de Alicante (UA), Spain
- Queen Mary and Westfield College (QMW), University of London, United Kingdom
- Université Ouaga 2 (UO2), Burkina Faso
- Université Felix Houphouët Boigny de Cocody (UFHB), Ivory Coast
- Université de Thiès (UT), Senegal

Associated partners:

- Organisation Africaine de la Propriété Intellectuelle (OAPI), Cameroon
- Réseau des organisations paysannes et des producteurs agricoles de l'Afrique de l'Ouest (ROPPA), Burkina Faso

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PROJECT WEBSITE

<http://www.ip4growth.eu/>



RESULTS

→ Outputs

Capacity building

- 255 people trained in Intellectual Property Rights (IPR) applied to Research and Agriculture:
 - 3 training modules for partner academics.
 - 9 replication seminars for academics from partner institutions and neighbouring universities, NGOs, small businesses and members of rural associations, with the support of national IP offices.

Awareness raising

- 16 rural agricultural and artisanal communities visited to identify potential products that could be protected as GIs.
- 3 informative sessions on GIs for farmers and artisans in rural communities to identify products that could be protected as GIs and provide guidance on the steps to take.
- 1 regional conference on IP for Agricultural Development – with academics, national IP offices, rural communities, agricultural associations, NGOs, students and policy makers from Burkina Faso, Ivory Coast and Senegal.

Documents

- 2 informative brochures on GIs (French)
- 2 guidelines (English and French):
 - Intellectual Property Management – A Guide to Relevant Aspects.
 - Intellectual Property Management in West Africa – Guide for Agricultural Development through use of Geographical Indications in Burkina Faso, Ivory Coast and Senegal.

↑ Outcomes

- Increased knowledge on IP rights applied to the agricultural sector (GIs)
- Awareness on IP rights mechanisms to obtain GIs
- National IP offices, HEIs and rural communities better integrated to achieve added value of agricultural products via IP rights.

🎯 Impacts

Usage

- Researchers at the Institut CIRES of the Université Félix Houphouët Boigny are continuing to work with rural artisanal communities in Ivory Coast on the potential impact of GIs.
- Professors at Université Ouaga II and Université de Thiès have modified the content of their courses to better incorporate the knowledge acquired on IP for Agriculture.

Policy implications

- The relationships developed between the HEIs, national IP offices and OAPI will

provide expertise in Intellectual Property Rights related to agriculture and inform policies and provide support for the identification and protection of products.

Sustainability

- The relationships established with national stakeholders and the rural communities they worked with will serve as a strong basis for future initiatives in this field, and partners are searching for the best mechanism to continue these collaborations.



Meeting with artisans to discuss possibility of protecting Ivory Coast Toiles de Korhogo as Geographical Indications.



Chapeau de Saponé, product of Burkina Faso that could potentially be protected as a Geographical Indication.

TESTIMONIAL



Dr. Serigne Modou Sarr,
l'Institut Supérieur de
Formations Agricole et
Rurale, Université de
Thiès, Senegal

« Nous avons constaté que beaucoup de producteurs ignorent les notions d'indicateurs géographiques ou de la propriété intellectuelle. Ils ne connaissent pas les démarches leur permettant de protéger leurs produits contre le piratage ou la contrefaçon. Les formations reçues peuvent contribuer efficacement à l'amélioration des compétences des communautés locales par le biais des formations et de partage d'informations. »

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SUCCEED Network – East African Higher Education Network on Sustainable and Energy Efficient Campus Development



Analysing data from a preliminary Energy Audit walkthrough at Makerere University.

PROJECT IMPLEMENTATION PERIOD
October 2013 – April 2017

CONSORTIUM

- University of Alicante (UA), Spain
- Université du Burundi (UB), Burundi
- Moi University (MOI), Kenya
- University of Rwanda (UR), Rwanda
- Mzumbe University (MZU), Tanzania
- Makerere University (MAK), Uganda

Associated partners:

- Inter-University Council for East Africa (IUCEA)

PROJECT CONTACT

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PROJECT WEBSITE

<http://www.project-succeed.eu>

SUMMARY OF RESULTS

10 new online courses have increased the academic offer available in energy-related courses. The creation of 5 Energy Efficiency Units, organisation of over 40 internal, local and national round tables and the formation of the 'East African Higher Education Network on Sustainable and Energy Efficient Campus Development' (EA-SUCCEED Network) has resulted in increased awareness amongst university staff and students and has created opportunities for co-operation with stakeholders involved in the energy sector.

BACKGROUND

The East African Region experiences serious energy deficits and high-energy costs. On average only 27% of the region's population have access to electricity. This leaves the region with a high dependence on biomass or fossil fuels, energy insecurity and high-carbon emissions. These unsustainable practices hinder progress in socio-economic development.

Common factors throughout the region include:

- Lack of national and regional policies in energy efficiency and renewable energy.
- Poor infrastructure to produce, store and distribute energy.
- Lack of professionals with expertise in energy efficiency and renewable energy.

Universities, as providers of research and education should be central to providing expertise and solutions to these challenges. The SUCCEED Network has therefore targeted east African universities as 'living laboratories' as key actors in promoting energy sustainability and efficiency.

METHODOLOGY

Institutional building activities

Establishing new energy units to target top level management and inform application campus policy with regard to energy efficiency.

Academic capacity building

Targeted students and lecturers and facilitated the capacity of the academic staff to modernise their educational programmes and increase the course offer in renewable energy.

Co-operation building

Promoted co-operation activities in energy efficiency and renewable energy with relevant stakeholders in the energy sector.

Networking

Supported strategic alliances between east African Higher Education Institutions (HEIs) and created the East African Higher Education Network on Sustainable and Energy Efficient Campus Development.

Online platform

Sharing of good practices (policies, processes, technologies and tools) and facilitation of collaborative e-learning scheme for lecturers (creation of courses) and students (online courses), as well as promotion of dialogue and interaction with local and national stakeholders.



RESULTS

→ Outputs

Capacity building

- 71 research and teaching staff trained in renewable energy, energy efficiency (Campus Policies and Processes, Technologies and Tools, Audits), fundraising for energy projects, and methodology and online courses design.
- 10 online courses on Energy (pending accreditation)
- 5 Energy Efficiency Units created and equipped

Documents

- 17 energy audits on campus buildings
- 3 good practice reports published on sus-

tainable campuses, presenting 28 good practices in total.

Publications

- Beans C. and Driha O., 2015. Revision of Campus Sustainability and Energy Efficiency Policies and Processes in European Union Universities.
- Beans C., 2016. Guidelines for Sustainability and Energy Efficiency in Higher Education Institutions.
- Universidad de Alicante, 2017. Blueprint for Cooperation in Energy Access and Efficiency in East Africa.

Networking

- 47 round tables with stakeholders.
- East African Higher Education Network on Sustainable and Energy Efficient Campus Development.

Visibility

- International Conference 'Fostering Cooperation in Energy Efficiency and Accessibility in East Africa' with over 60 participants from 12 countries.

Databases/websites

- Online platform hosting training courses.
- Website.

↑ Outcomes

- Awareness raised on energy sustainability and efficiency potential on university campuses in East Africa.
- Energy Efficiency Units in partner institutions responsible for raising energy awareness and implementing energy audits.
- Increased dialogue and cooperation between East African universities and with stakeholders.

🎯 Impacts

Usage

- The expanded offer on energy courses brings energy related issues to a wider group of students than the traditional engineering and physics students.
- Students have benefited directly from being involved in the energy audits. They gained valuable hands-on experience during their undertaking as well as during the preparation and presentation of reports.

Policy implications

- Partners are developing energy efficiency policies for their institutions:
 - University of Rwanda has approved an energy efficiency policy developed by their Energy Efficiency Unit.
 - Makerere University has issued instructions for energy saving measures to be implemented and new energy guidelines for student residences as a result of the energy audits.

Sustainability

- The EA-SUCCEED Network will provide a framework for future initiatives and co-operation with stakeholders.
- Support from higher management ensures the continuation of the courses and further development of the network.



Discussing energy issues with internal campus stakeholders at Mzumbe University.

TESTIMONIAL



Prof. Aurelia Ngirwa Kamuzora, Mzumbe University, Tanzania

“The project has raised awareness and strengthened capacities in energy efficiency and renewable energy for students and staff. Previously we had no contact with the Tanzania Industrial Research and Development Organisation (TIRDO), a public research and development organisation. Thanks to this project, we are opening up to the private sector. This will help us better understand the requirements for skilled workers and to prepare our students with relevant qualifications.”

ACP-EU Co-Operation Programmes in the fields of Higher Education and Science, Technology and Research

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Financed by the European Union

CAPACITY4FOOD – Integrated Soil Fertility Management for Food Security: matching capacities in Anglophone West African Nation HEIs with local needs

SUMMARY OF RESULTS

Awareness and knowledge has been enhanced on Integrated Soil Fertility Management for food security at west African universities. The capacity and skills of teachers and trainers to deliver Integrated Soil Fertility Management principles and practices to students and wider stakeholders has been increased.

BACKGROUND

Despite the fact that the west African region has large amounts of land, labour and biodiversity, high levels of hunger, malnutrition and environmental degradation persist. Food security is a global concern and challenge for human welfare and economic growth and particularly so in sub-Saharan Africa. Soil fertility has been described as the single most important constraint to food security in Africa, and its decline is not just a problem of nutrient deficiency. Decline in soil fertility is a result of physical and biological degradation, inappropriate cropping systems and the uncontrolled impacts of pests and diseases.

CAPACITY4FOOD has responded to this situation by integrating Integrated Soil Fertility Management (ISFM) for food security into the university curricula of the partner Higher Education Institutions (HEIs) with the intention of increasing the number of ISFM experts to improve agricultural practices throughout the region. The establishment of a regional network in ISFM includes the establishment of regional centres of excellence and creating capacities to deliver targeted activities at both local and regional levels. The project also aimed at improving regional links between the partner HEIs in order to exploit the specific specialisations and comparative advantages of each HEI.

METHODOLOGY

Needs analysis

Analysis of the ISFM and food security situation in each partner HEI, and HEI links with local smallholders and government authorities.

Regional network of centres of excellence for ISFM

Each partner country developed its own centre of excellence to develop and share ISFM technologies to help increase agricultural productivity, income and stimulate business to help ensure food security in west Africa.

Trainings

Trainings were delivered by the University of Alicante and the courses were implemented in the centres of excellence for university staff and the academic community, as well as for other stakeholders such as local smallholders and local government actors.

Networking

CAPACITY4FOOD forged links between the HEIs and with other relevant stakeholders such as smallholders and government authorities. National matching events had the purpose of bringing HEI staff and students together with local farmers and promote graduate employability through direct meetings with farmers and local recruiters. Regional round tables focused on regional co-operation to influence future priorities for national/regional legislation in agriculture.



Demonstration plot as a powerful tool to raise awareness on sustainable land management in farmer's adoption of Integrated Soil Fertility Management (ISFM) in Njala, Sierra Leone (July 2015).

PROJECT IMPLEMENTATION PERIOD

October 2013 – October 2016

CONSORTIUM

- Universidad de Alicante, Spain
- University of Dschang, Cameroon
- University of The Gambia, Gambia
- University of Ghana, College of Agriculture and Consumer Sciences, Ghana
- Federal University of Technology Akure (FUTA), Nigeria
- University of Njala, Sierra Leone

PROJECT CONTACT

University of Alicante
International Project Management office
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PROJECT WEBSITE

www.capacity4food-project.eu



CAPACITY4FOOD



Universitat d'Alacant
Universidad de Alicante



RESULTS

→ Outputs

Capacity building

- 250 trainer-of-trainers, lecturers, technicians and students trained in 4 training programmes:
 - ISFM.
 - Biophysical and socio-economic analysis of farmer fields and livelihoods.
 - Maximising stakeholder engagement.
 - Hands-on learning.
- 900 students trained in ISFM and engaged in networking activities with local communities and stakeholders.

- 90 local authority officials trained in ISFM and networking with stakeholders.
- 5 academic modules.
- 20 trainings replicated.

Networking

- 5 centres of excellence at each partner university: providing assistance to the academic and professional community in ISFM; mandated to establish and maintain relationships with local farmers and

- authorities; and raising awareness of ISFM.
- Regional network of centres of excellence in ISFM for food security.

Documents

- Needs analysis report.

Visibility

- Website.
- 3 regional stakeholder round tables.
- 2 international conferences.

↑ Outcomes

- University staff, local communities and community and authorities aware of ISFM principles and practices.

- Trainers (farmers) able to deliver trainings and disseminate information on ISFM principles and practices.

- HEIs capable of delivering quality learning in sustainable land management.

🎯 Impacts

Usage

- The centres of excellence at the partner HEIs are key resources for training in sustainable land management and offer services that respond to the needs of the universities and local stakeholders.

Policy implications

- Increased regional integration has increased the available human and material resources and has provided access to a larger pool of knowledge and teaching materials.
- A pool of trained professionals will be able to advocate on the benefits and needs of the local farmers for effective ISFM practices.
- FUTA has mainstreamed the ISFM principles in the undergraduate and postgraduate

curricula in the Department of Crop, Soil and Pest Management.

Sustainability

- In July 2017, FUTA's centre of excellence has trained 100 youth and women farmers in ISFM practices for cassava and other crop production under the Third National Fadama Development Project (World Bank).
- In 2018, FUTA's centre of excellence submitted proposals for the conduct of land validation for the Sugarcane Fuel Ethanol project in Kaduna, Kogi and Kebbi states (Nigeria) to the Nigerian National Petroleum Corporation (NNPC).



Integrated soil fertility management (ISFM) techniques at demonstration plots with local farmers in Dschang, Cameroon (September 2015).



Improving soil fertility through ISFM practices in Akure, Nigeria (July 2015).

TESTIMONIAL



**Prof. Fritz Oben,
University of Dschang,
Cameroon**

“The University of Dschang is recognised in Central Africa for its expertise in training agronomists, thus the project has significant importance to the university because of its priorities in researching soil fertility manage-

ment. Farmers are willing to come for training if the opportunity arises and the requests by farmers via our centre of excellence attest to the positive impact trainings have had.”

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FISHERMAN – Capacity building for sustainable fisheries management in the southwest Indian ocean

SUMMARY OF RESULTS

Competence in sustainable fisheries management was built at partner Higher Education Institutions (Comoros, Madagascar, Mozambique, The Seychelles and Tanzania). The development, accreditation and implementation of five study programmes in Sustainable Fisheries Management in line with national and international standards was achieved. The HEIs have increased their ability to deliver quality education and research in the fisheries sector.

BACKGROUND

The current coastal and marine resources in the South-Western Indian Ocean (SWIO) region are under increasing pressure, exacerbated by weak expertise in fisheries management, inadequate coordination and a weak resource exploitation strategy. Higher Education Institutions (HEIs) from Madagascar, Mozambique, Tanzania, Comoros and The Seychelles lack the expertise and suffer from poor infrastructure for research in fisheries management. To ensure the effective management of coastal and marine resources, the HEIs have a key responsibility to provide well-trained and well-equipped practitioners and professionals in the field.

The need for training and qualifications in the fisheries sector is evident across all areas, from outdated and inappropriate legislation to weaknesses in governance structures. The challenge of illegal, unreported and unregulated fishing takes advantage of the lack of effective monitoring, control and surveillance and undermines conservation and management of fish stocks.

The project aimed to support the partner HEIs in preparing a new generation of skilled professionals in sustainable fisheries management, address institutional capacities and improve the quality and relevance of the academic offering.

METHODOLOGY

Assessment

Analysis of the existing fisheries management educational provision in the HEI landscape and evaluation of the existing data, including the legal frameworks and national/regional strategies and policies in management of marine resources.

Capacity building on curriculum development

Curriculum development trainings for academic staff introduced to contents, delivery methodologies, tools and requirements for a proper curriculum development.

Development of basic curriculum

Basic curriculum developed that serves as a blueprint for the five programmes in fisheries management.

Development of master courses

Courses within the master programmes fully developed (accession, contents, teaching and assessment methods, calendar, bibliography, etc.).

Implementation of master programmes

New programmes delivered at partner HEIs.

Regional online platform on fisheries management

Online platform established to combine the presentation of the project and consortium with a research database for students, researchers and teaching staff.

Establishment of IT repository of reference material

Training of IT administrators and teaching staff in the operation and use of the repository.



Fishermen in Mozambique.

PROJECT IMPLEMENTATION PERIOD

October 2013 – October 2016

CONSORTIUM

- Universidad de Alicante, Spain
- University of Algarve, Portugal
- University of Seychelles, Seychelles
- University of the Comoros, Comoros
- University of Dar es Salaam, Tanzania
- University of Eduardo Mondlane, Mozambique
- University of Toliara, Madagascar

Associated partners:

- Southwest Indian Ocean Fisheries Commission (SWIOFC)

PROJECT CONTACT

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PROJECT WEBSITE

www.fisherman-project.eu



RESULTS

→ Outputs

Capacity building

- 5 study programmes in the field of fisheries at partner HEIs developed, accredited and implemented:
 - Specialisation in Marine Biology (Comoros).
 - Master in Sustainable Fisheries and Aquaculture (Madagascar).
 - Master in Sustainable Fisheries (Mozambique).
 - Specialisation in Marine and Fisheries Science (Seychelles).
 - Master in Sustainable Fisheries and

Management (Tanzania).

- 60 student applications received and more than 50 students enrolled.
- 150 teaching and IT staff trained in concepts related to curriculum development, international standards, innovative teaching methodology and IT tools.

Databases

- FISHERMAN Online Repository of teaching/ learning/research materials.

Networking

- Support gained and solid synergies set up with South West Indian Ocean national authorities (Ministries of Higher Education and Fisheries and International Organisations).
- 2 regional conferences on ‘Sustainable Fisheries in the South-Western Indian Ocean: the importance of the Education, Management and Governance’ attracted educational and non-educational professionals in the field, as well as other complementary initiatives.

↑ Outcomes

- HEIs trained to develop and implement master level programmes in line with international quality standards.
- HEI staff with IT skills and abilities to deliver quality teaching with emphasis on data analysis.
- FISHERMAN study programmes accreditation.

🎯 Impacts

Usage

- The official recognition of the course and quality in the development of curricula to international standards has led to a high demand from prospective students to subscribe to the courses.
- Some partner universities are defining the next level of Sustainable Fisheries Education (master or PhD).

importance of further education within sustainable fisheries management. Higher Education and Fisheries authorities of the partner countries have been working with universities towards this common goal. This will have a long term impact on the improvement of policies related to Fisheries Management in the SWIO region.

the payroll of partner universities.

- Partner universities are exploring additional funding mechanisms for student grants and other funding sources to continue cooperation.

Policy implications

- The FISHERMAN project was widely disseminated to raise awareness on the

Sustainability

- By being fully endorsed by the HEIs and national authorities, teaching staff are on



Typical fishing boat, Qualimane, Mozambique.



Fishnet, Qualimane -Mozambique.

TESTIMONIAL



Kelly Hoareau, Director, Blue Economy Research Institute, University of Seychelles, Seychelles

“The project has assisted us with the development of our Year 3 specialisation in Marine and Fisheries Science. The project has provided equipment and staff have benefited from trainings. Our specialisation would not have been possible without this project that has increased our capacity to offer the course as a degree specialisation as well as a short course for external development.”

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EPIC – Renewable energy in Pacific islands: Developing Skills and Capacity

SUMMARY OF RESULTS

By means of a twin-track approach, the EPIC project has developed and accredited 2 joint master programme degrees in Renewable Energy Management in Fiji and Papua New Guinea and established 2 Centres of Renewable Energy to foster stakeholder cooperation, cross-cutting research and general awareness on RE issues. As such, in both countries EPIC contributed to bridging the gap between the existing policies on renewable energy targets and the human and institutional capacities to achieve them.

BACKGROUND

Dependency on fossil fuels hinders economies of the Pacific islands. In fact, in these countries oil reaches 80% of the total energy consumption. This phenomenon exacerbates the pre-existing vulnerability to climate change of these islands. As such, countries such as Fiji and Papua New Guinea, are striving to increase their Renewable Energy (RE) production in order to secure more affordable, reliable and sustainable energy supplies. The institutional commitment at national and regional level has crystallised by setting RE as the priority for their sustainable development strategies.

However, little has been done to equip stakeholders (private sector, academics and civil servants) with the necessary RE skills, knowledge and capacities for this challenge. In order to underpin developments in the RE field, policymakers are currently shifting towards the promotion of capacity building, training and networking activities in this area.

In particular, Higher Education Institutions (HEIs) play a key role in educating the next generation of young RE professionals by means of offering of RE curricula within the existing education and training systems. HEIs are also able to foster research and cooperation in the RE field, driving evidence-based policymaking and programming.

METHODOLOGY

Needs analysis

Mapping of relevant stakeholders through interviews and data collection. As such, RE studies programmes and markets needs were identified.

Academic capacity building

Introducing teaching and academic staff into curriculum development, strengthening individual research capacity and updating RE knowledge. Devising context-specific teaching materials and the organisation of guest lecturers.

Institutional building activities

2 Centres of Renewable Energy (CORE) established in Fiji and Papua New Guinea to strengthen research capacity and promote sustainable development policies in the area of RE. The project assisted in the selection of the CORE staff and provided equipment for the centres, such as the installation of a Power Plant for research on solar energy, and a CORE website.

Developing and accrediting a Joint Master programme in Renewable Energy Management (REM), by elaborating RE curricula with a regional dimension and then implementing the programmes with teaching support from EU partners.

Dissemination and networking

Arranging site visits to EU partner countries to incentivise networking dynamics and knowledge transfer. Organising 2 final conferences in both Pacific countries to disseminate project achievements.



Guest lecture in University of Fiji for the pre-enrolled students and teaching staff of the Renewable Energy Management (REM) master programme (July 2016).

PROJECT IMPLEMENTATION PERIOD

October 2013 - November 2016

CONSORTIUM

- University of Alicante (UA), Spain
- University of Papua New Guinea (UPNG), Papua- New Guinea
- University of Fiji (UF), Fiji

Associated partners:

- Applied Geoscience and Technology Division of Secretariat of the Pacific Community

PROJECT CONTACT

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PROJECT WEBSITE

<http://www.epic-project.eu/>



RESULTS

→ Outputs

Capacity and institutional building

- 17 RE courses implemented
- 100+ academic staff and students trained in RE
- 2 accredited REM master programme curricula.
- 20+ students enrolled in new RE master programmes each year.
- 8 teaching and academic staff trained in study visits to EU partner.
- 55 students attended roundtables, seminars and workshops.
- 2 Centres of Renewable Energy (CORE).
- 2 power plants running in CORE.

Visibility and networking

- 1 paper presented at The University of the South Pacific International conference 'Analytical Assessment of the current situation of RE in Fiji'.
- 2 regional conferences with 100+ attendees each and the participation of senior officials from Fiji and Papua New Guinea governments, European organisations and other international organisations.
- 6 posters presented during the regional conference by project partners; 2 posters presented during one international conference in Scotland and 1 poster presented during a workshop in Colombia.

- 4 students and scholars involved in international exchanges.
- 2 international projects undertaken by UF CORE.
- 5 international projects undertaken by UPNG-CORE.
- 4 collaboration agreements with international universities.

Websites

- 1 project website.
- 2 CORE websites.

↑ Outcomes

- Increased knowledge on RE applied to the Pacific Islands context.
- Awareness on RE and its role as an enabler of sustainable development in the area.
- National and regional policymakers, HEIs and private sector better coordinated to meet RE targets.

🎯 Impacts

Usage

- The enhanced RE knowledge and networks of the participants led to:
 - 4 staff participated in managerial training at UA and later secured a project funded by USAID.
 - Members of the UPNG-CORE are currently working on designing a carbon-neutral campus in their own institution.
 - UPNG-CORE has also engaged in the 'China-South Pacific Island Countries Technology Transfer Centre (CSPTTC)' initiative to advance on RE applied technology.

Policy Implications

- COREs, academic staff and students from the master programmes will provide key expertise to support sustainable development strategic planning, apply skills to RE technology implementation, inform RE policy-making and assist government officials to lobby at national, regional and international level for more cooperation in RE provision.

Sustainability

- The relationship with national and regional stakeholders, HEIs and private sector in Fiji and Papua New Guinea, will provide a strong basis for future RE actions in the Pacific.



Renewable energy experts attending the trainings at study visit to the University of Alicante (November 2013).



Official launch of the Centre of Renewable Energy at the University of Papua New Guinea (April 2017).

TESTIMONIAL



Prof. Noel Mobiha,
External consultant,
University of Papua
New Guinea, Papua
New Guinea

“This project will combine efforts from the government, academia, higher education, research and development, donors and financiers, industries, and both national and international interest communities to address the topic of clean renewable energy in the region.”

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RENet – Renewable energies Education Network

SUMMARY OF RESULTS

Three programmes developed and/or revised:

- MSc degree for UEH designed and curricula developed.
- A new academic track in renewable energy within the MSc in Electro-mechanic Engineering developed and approved.
- UO has opened a new expert course in Renewable Energy within the framework of its MSc in Energy Efficiency.

Professional courses developed with a training-of-trainers programme.

Laboratories designed and equipped in each of the three partner universities and an e-learning platform developed.

BACKGROUND

Despite different economic and social realities, the lack of access to energy and dependency on imported resources are distinctive elements in the Cuban and Haitian scenario. In Cuba, whilst 96% of the population have access to electricity, generation is 90% dependent on imported fossil fuels. The Cuban authorities are pursuing a policy of energy independence via two ways: a) by increasing the share of renewable energy and b) by improving energy efficiency. Haiti by contrast experiences the lowest electricity coverage in the region. The lack of energy access is critical to reconstruction and development.

RENet's aim was to improve the graduate and postgraduate academic capacity of the partner universities in the fields of energy access and efficiency. New academic and technological tools have been implemented to respond to societal needs and the labour market. By facilitating south-south networks of co-operation, the academic and institutional links amongst the project partners and associates have been strengthened.

Activities included the design and implementation of new postgraduate programmes, revision of existing programmes and the creation of linkages to sustain the new academic capacities of the Cuban and Haitian partner Higher Education Institutions (HEIs).

METHODOLOGY

Design and implementation of a new postgraduate degree in Renewable Energy

Improvement of the postgraduate and graduate academic capacities in energy access and efficiency. Developing parallel activities in each partner HEI, including identification of needs and available capacities (academic, financial and infrastructure), design of curriculum and establishing academic co-operation between institutions.

Design of training of trainers programme

Training of professors in subjects such as thermal solar energy, Photovoltaics (PV) technology, hydro energy, hybrid systems, biomass and biofuels, and energy audits so to enable autonomous course delivery.

Design and implementation of professional courses

Training professionals in energy access and efficiency is a core necessity for the two countries and the region to improve access to the labour market.

Establish or improve renewable energy laboratories

Improvement of laboratory equipment for practical training in renewable energy and for research. Academics and students facilitated to share research and teach more effectively.

Create academic and institutional links

Creating academic and institutional links between partners, associates and entities from other countries working in renewable energy.



Training-of-trainers course in UEH on 'Solar and Wind energy potential assessment'.

PROJECT IMPLEMENTATION PERIOD

October 2013 - June 2017

CONSORTIUM

- Universidad Carlos III de Madrid, Spain
- Université d'Etat d'Haiti (UEH) Haiti
- Universidad de Oriente (UO), Cuba
- Instituto Superior Minero-metalúrgico de Moa (ISMMM), Cuba

Associated partners:

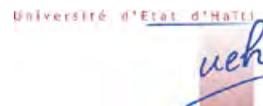
- Fundación Energía sin Fronteras, Spain
- Agenzia per la Promozione della Ricerca Europea, Italy
- Cubasolar, Cuba

PROJECT CONTACT

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PROJECT WEBSITE

www.renetedulink.net



RESULTS

→ Outputs

Capacity building

- UEH: a 2-year postgraduate degree in renewable energies divided into 4 semesters (15 courses and a MSc thesis).
- Adaptation and improvement of contents of pre-existing subjects in UO and ISMMM.
- 10 different vocational courses.
- Specific academic materials for courses like Power System Analysis (advanced), Thermal energy or PV energy systems.
- 3 workshop courses, totalling 20 hours,

attended by 37 Haitian and Cuban professors.

- 100+ alumni attended the training-of-trainers programme in UEH. 63 trainees trained in at least one complete energy module. Each alumnus attended an average of 4 courses, or 12.5 sessions, or 50 hours.

Publications

- Several research works presented at CIN-AREM'2015 (Nov 2015, Moa, Cuba) related to the RENet research lines (energy

efficiency and renewable energies).

- 3 communications in Expociencia 2017, Cuba.
- A poster in VII Congreso Universidad y Cooperación al Desarrollo, 'La Universidad y los Objetivos de Desarrollo Sostenible', UAM (Spain), March 2017

Platform

- A platform supporting e-learning (<http://renet.idisc.es/>).

↑ Outcomes

- HEIs have the capacity to address energy challenges faced in Cuba, Haiti and the Latin American region.
- HEIs have fit-for-purpose laboratories enhancing research capacities including installation and maintenance skills.
- Professionals have effective skills and the ability to pursue their qualified development.

🎯 Impacts

Usage

- New postgraduate degree and training-of-trainers programme contributes effectively to improve academic capacities. Applying the results of laboratory work will facilitate new academic and technological tools.
- The online platform will host most of the developed training-of-trainers courses, academic materials and training modules. The platform will be accessible for at least 5 years and it will allow new members and institutions to join the network and share academic materials.

Policy implications

- The development of postgraduate specialisation in renewable energy will contribute to the promotion of renewable energy resources. The Cuban government, for example, has committed to increase electricity generation, mainly, from wind and solar energy to 24% by 2030. This will require HEIs to train academic staff and technicians to respond to this challenge.

Sustainability

- The consolidated Cuba-Haiti cooperation will allow for the joint development of

academic and research activities and contribute to their academic capacities.



Photovoltaic mobile module at ISMMM.

TESTIMONIAL



Yvens Chérémont,
Teacher, Director of
Energy Research Unit and
Alternative Technologies,
Université d'Etat d'Haiti

“RENet has reinforced the technical capacity of UEH in teaching as well as the ability to provide community services. UEH has begun to offer energy efficiency services to the private sector and we have started to work closely with other UEH entities to evaluate the energy efficiency of their buildings to improve energy consumption.”

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SAPHE – Strengthening Agroforestry Programmes in Higher Education for Food Security in Sub-Saharan Africa



Shepherd from Ethiopian highlands.

PROJECT IMPLEMENTATION PERIOD

October 2013 – July 2017

CONSORTIUM

- Universidad de Valladolid, Spain
- Hawassa University, Ethiopia
- Arba Minch University, Ethiopia
- Institut Polytechnique Rural de Formation et de Recherche Appliquée, Mali
- Université Dan Dicko Dankoulodo de Maradi, Niger

Associated partners:

- Ethiopian Environment and Forest Research Institute, Ethiopia
- Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria (INIA), Ministerio de Economía y Competitividad, Spain
- Centro de Investigación y Tecnología Agroalimentaria de Aragón (CITA), Spain

PROJECT CONTACT

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Department of Vegetable Production and Forest Resources
Higher Technical College of Agricultural Engineering
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34004 Palencia
Spain

PROJECT WEBSITE

www.sapheaffrica.com,
www.agroforestryafrica.com

SUMMARY OF RESULTS

Designed and delivered quality study programmes: MSc in Agroforestry and Master in Geo-Information technology, in high level skills required by the national and regional labour markets.

Upgraded qualifications of academic and library and information science staff of four African universities through training programmes on Agroforestry, Geo-Information Technology, Agroforestry and HIV/AIDS, Agroforestry and Gender Issues, and Information Literacy for Agri-Food.

Improved institutional frameworks through academic internationalisation.

BACKGROUND

Student enrolment in agriculture in Ethiopia, Mali and Niger is low considering the large rural population dependent on agrarian activities. Capacities exist at the BSc level but the Higher Education Institutions (HEIs) are unable to translate this to higher academic levels due to the lack of qualified lecturers, up-to-date teaching resources and adequate facilities.

Improving these capacities would enable the progression of BSc students to MSc level and beyond, preparing postgraduates with the knowledge and skills to contribute to their national and regional development goals that are relevant to the horn of Africa and Sahel regions.

The SAPHE proposal has responded with the design and implementation of the MSc programmes in Agroforestry and in Geo-Information Technology along with the three short-courses on Information Literacy, Agroforestry and HIV/AIDS and Agroforestry and Gender. The aim was to enhance the skills of the academic and library and information science (LIS) staff and students and strengthen the institutional capacities of the HEIs to deliver MSc-level education focused on Agroforestry and Geo-Information Technology.

METHODOLOGY

Thematic interinstitutional working groups (partners and associates) were established to develop templates and didactic materials for the various foreseen courses and to review the specialised training materials developed under consultancies (Master in Geo-Information Technology).

Specialist short courses in agroforestry and cross-training programmes, including: Geo-Information Technology, Information Literacy, Agroforestry and HIV/AIDS, and Agroforestry and Gender were designed and delivered by experts to the academic staff of the HEIs.

Library resources and equipment were procured for both laboratories (Agroforestry and Remote Sensing & Geographic Information System - GIS) including forest inventory equipment, software, and spectrophotometry and microscopy equipment.

The visibility of the EU contribution was ensured through the implementation of the Communication and Visibility Plan; including project brochures and leaflets, news published in the press, radio and television, website, etc.

RESULTS

→ Outputs

Capacity building

- 40 academic and research and LIS staff from the 4 HEIs trained in agroforestry and cross-training programmes, including: Geo-Information Technology, Information Literacy, Agroforestry and HIV/AIDS, and Agroforestry and Gender.
- 4 prospective trainers from the 4 HEIs attended and successfully passed the international Erasmus Mundus Master Programme in Mediterranean Forestry and Natural Resources Management (MEDFOR) at the University of Valladolid (October 2015 / February 2016).

Networks

- More than 80 academic, research and LIS staff from the 5 HEIs collaborating in preparing and reviewing didactic materials for 31 advanced courses (MSc in Agroforestry - 16 courses, Master in Geo-Information Technology - 12 courses, Information Literacy, Agroforestry and HIV/AIDS, and Agroforestry and Gender).

Laboratories

- 4 laboratories for Agroforestry and GIS & Remote Sensing equipped with library resources and forest inventory equipment, software, and spectrophotometry and microscopy equipment.

Documents

- Study guides for the 16 courses of the MSc in Agroforestry, and cross-cutting short courses on 'Information Literacy for Agri-Food', 'Agroforestry and HIV/AIDS' and 'Agroforestry and Gender issues' and 12 courses of the Master in Geo-Information Technology.
- Specialist short courses in agroforestry and cross-training programmes' didactic materials and presentations.

Visibility

- Outreach activities, briefings, project brochures and leaflets, press conferences.
- Web portal.

↑ Outcomes

- MSc in Agroforestry (including cross-cutting short courses) and Master in Geo-Information Technology launched at partner HEIs.
- Staff competent in delivering MSc-level programmes in Agroforestry (including cross-cutting short courses) and Geo-Information Technology.
- Improved institutional frameworks through academic networking and internationalisation.

🎯 Impacts

Usage

- The 4 HEIs are using the didactic materials generated (courses of the MSc in Agroforestry, courses of the Master in Geo-Information Technology, and the Short Courses on 'Information literacy in university environments with Open Source tools for Agri-Food', 'Agroforestry and HIV/AIDS' and 'Agroforestry and Gender issues', and the Specialist Short Courses) and have launched their own programmes.

Policy implications

- HEIs have strengthened their capacities to prepare postgraduates with the knowledge and skills needed to contribute to their national and regional development goals that are relevant to the horn of Africa and Sahel regions.

Sustainability

- Ensured through the programmes' implementation at the universities, delivered by trained academic/research and LIS staff

- from the 4 sub-Saharan universities.
- The improved institutional frameworks through academic networking and internationalisation will also help with the sustainability of the programmes.



Market, Ethiopia.



Working session on Agroforestry and Gender Issues, Addis Ababa, Ethiopia.

TESTIMONIAL



**Taffa Soumanou,
Abdouramane,
Dembele, Bakary
Desire and Bekele,
Daba Misgana**

“In the framework of SAPHE we had the opportunity to attend the specialised module: ‘Adaptive forestry strategies to provide good and services while coping with global change challenge’ at the University of Valladolid. After completing this training, we are able to disseminate the acquired knowledge at home in our ongoing academic tasks.”

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LeNS.es – the Learning Network on Sustainable energy systems

SUMMARY OF RESULTS

Curricular and lifelong learning capacity was built on 'System Design for Sustainable Energy for All' with the inclusion of equity and gender issues:

- Four pilot and four permanent curricular courses have been implemented in the participating African HEIs.
- Four lifelong learning modules have been implemented targeting local stakeholders in the participating African countries.
- An Open Learning E-Platform has been established.
- An international conference was organised and an international students' design prize awarded.
- The book 'Designing Sustainable Energy for All' has been published (open access).



Sustainable Energy for All by Design conference, Cape Town, South Africa (September 2016).

PROJECT IMPLEMENTATION PERIOD

October 2013 – October 2016

CONSORTIUM

- Politecnico di Milano, Italy
- Brunel University, United Kingdom
- Delft University of Technology, the Netherlands
- Cape Peninsula University of Technology, South Africa
- Makerere University, Uganda
- University of Botswana, Botswana
- University of Nairobi, Kenya

PROJECT CONTACT

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PROJECT WEBSITE

www.lenses.polimi.it

BACKGROUND

Expertise on how to design, engineer and implement locally-based Sustainable Energy System Design & Engineering is generally limited within the participating African countries. This is linked to the problem of connecting academic knowledge with local needs and priorities and developing appropriate curricular courses and lifelong learning modules.

The project aimed to contribute to human resources and curriculum development in the field of Sustainable Energy for All, by enabling African Higher Education Institution (HEI) teachers to deliver didactic curricular courses and lifelong learning modules to enable students and professionals to develop locally-based, secure and cleaner energy services, based on the promising models Sustainable Product-Service System (S.PSS) applied to Distributed Renewable Energy (DRE). To achieve the stated aims while promoting local knowledge and know-how in the topic, exchange activities (i.e., four pilot courses, four permanent curricular courses and four lifelong learning courses) have been implemented. An Open Learning E-Platform (OLEP) was also implemented supporting a multi-polar production and dissemination of knowledge among African and European HEIs with an open access ethos.

METHODOLOGY

Design of didactic curricular courses and supporting learning resources

Joint development of syllabuses, learning resources and tools.

Implementation of didactic curricular courses

Implementation of four pilot and four permanent didactic curricular courses at the participating African HEIs.

Design of lifelong learning modules

Joint development of syllabuses, learning resources and tools.

Implementation of lifelong learning modules

Implementation of four pilot lifelong learning modules targeted at local companies, non-governmental organisations (NGOs) and research bodies.

Open Learning E-Platform

Development and management of a web platform for the decentralised production and collation of learning resources.

Dissemination of project results

Final conference and teachers' workshop; students design award set-up and implementation; editing and publication of a didactic book on 'System Design for Sustainable Energy for All' (SD4SEA).

POLITECNICO DI MILANO



DIPARTIMENTO DI DESIGN



RESULTS

→ Outputs

Capacity Building

- 4 pilot and 4 permanent didactic curricular courses on System Design for Sustainable Energy for All (SD4SEA).
- 4 pilot lifelong learning modules on SD4SEA.
- 10 courses with 100 lectures with slides (143 presentations) and videos (100, average 30 minutes) and contributions by 37 professors / lecturers / researchers and 40 students' projects and 30 case studies cases on SD4SEA.

Databases/websites/platforms

- Open Learning E-Platform (OLEP): www.lenses.polimi.it
- A modular e-package for educators /

researchers.

- Learning resources (videos and slides of complete courses, design tools, case studies, promising projects) downloadable in open access and available to modify and reuse.

Networking

- LeNS Africa Universities network with 14 HEIs from 8 countries.

Documents

- Guidelines for the design and implementation of didactic curricular courses and lifelong learning modules (available at www.lenses.polimi.it).

Visibility/Conference

- Conference 'Sustainable Energy for All by Design', 28-30 September 2016, Cape Town.
- A design competition for young designer projects awarded best (sustainable) concepts.
- 50 groups of winners and 'promising projects' (published in the catalogue 'A world of Sustainable Energy for All in Africa', open access and available at www.lenses.polimi.it).

Publications

- Vezzoli C. *et al.*, 2018. Designing Sustainable Energy for All. Springer, London.

↑ Outcomes

- A new generation of designers / engineers are primary actors in actively promoting SD4SEA.

- Researchers and educators have open access to knowledge, study approaches, strategies, methods and tools related to

SD4SEA.

- LeNS Africa Universities network able to diffuse SD4SEA in members' curricula.

🎯 Impacts

Usage

- DRE, if directly managed by final local communities and organisations, can potentially bring about a democratisation of access to energy and increased participation.
- Gender equality issues have been considered in the project, favouring the creation of local design and engineering consultancies capable of (co)designing and (co) developing energy systems.

Policy implications

- Initiatives related to co-operation in higher education both at national and international level will be implemented by the LeNS Africa Universities network.

Sustainability

- The OLEP platform supports a process of mutual learning, facilitating access, exchange, review and update of knowledge among HEIs and is intended as a

learning-by-sharing mechanism among researchers and educators.

- The book 'SD4SEA' will also support the sharing of knowledge and know-how, along with related approaches, methods and tools.



The first two lifelong learning courses with companies and practitioners have been successfully completed at the Cape Peninsular University of Technology (17-22 February 2016) and the University of Nairobi (5-8 April 2016). A total of 17 companies and consultants working in the renewable energy sector attended the training sessions. The other courses were implemented at the University of Botswana (2-6 May 2016) and Makerere University (18-22 July 2016).

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JENGA – Joint Development of Courses for Energy-efficient and Sustainable Housing in Africa

SUMMARY OF RESULTS

Flexible and experimental teaching methods were introduced, aimed at academic capacity building for energy efficiency and low-carbon technologies in construction. Existing curricula for architecture education were enhanced by introducing design-build projects, a special type of problem-based learning. Through joint studio teaching, staff members were exposed to international developments and for the first time students experienced hands-on activities embedded in their academic training.

BACKGROUND

JENGA aimed at academic capacity building and knowledge transfer in the field of sustainable housing, addressing the fact that the building sector accounts for 40% of global energy consumption and 30% of greenhouse gas emissions.

Supply and generation of electricity cannot keep pace with the growing demand of households and production processes. Higher energy prices coincide with inefficiency in the use of energy, particularly in the domestic sector. Energy has become one of the limiting factors for sustainable development. The amount of energy used in a building for cooling, heating and lighting is directly related to its design layout, construction and materials used. The objective of JENGA was to implement strategies for practical education on energy efficiency in construction at schools of architecture in East Africa, introducing the method of problem-based learning through the implementation of design-build courses into existing curricula in Kenya, Uganda and Rwanda. Central elements were the analysis of best practice examples and design models of all scales to improve students' understanding of the needs and challenges of sustainable building in their own regional, social and climatic contexts.

METHODOLOGY

Design/construction courses

Implementation of new criteria into existing courses, based on sustainable, low-carbon building techniques. In parallel to the courses, practical workshops and excursions to prepare design-construction studios.

Teacher training

Staff members received training on course content and teaching methods, like group work, practical applicability, or problem based teaching.

Upgrading of courses

6 courses on BA level and 4 courses on MA level adapted.

Enhance knowledge and technology transfer

For energy efficiency in design, construction and operation of buildings through practical projects for the specific needs of the targeted regions..

Harmonisation and quality assurance

Interdisciplinary exchange of ideas about building in Africa. Similar courses at partner universities in East Africa were linked in order to increase mobility of students and academic staff.

Upgrade of teaching material and equipment

The materials testing laboratories at UMU and JKUAT, and the environmental laboratory at JKUAT catalogued and evaluated for recommended upgrades.

Disseminate the results

Academic and political institutions targeted via workshops, presentations and an international conference (SFC2016).



Students and staff experienced hands-on activities in class.

PROJECT IMPLEMENTATION PERIOD

October 2013 – April 2017

CONSORTIUM

- University of Applied Sciences Augsburg, Germany
- Jomo Kenyatta University of Agriculture and Technology (JKUAT), Kenya
- Uganda Martyrs University (UMU) - Faculty of the Built Environment, Uganda
- University of Rwanda - College of Science and Technology (UR-CST), Rwanda
- Stellenbosch University (SU), South Africa

Associated partners:

- UN Habitat, Kenya
- American University Cairo (AUC), Egypt

PROJECT CONTACT

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PROJECT WEBSITE

<http://www.jenga-network.org>
<https://www.facebook.com/people/Jenga-EU/>



Design models of all scales were used as part of problem-based teaching.

RESULTS

→ Outputs

Capacity building

- 12 teachers trained in practical teaching methods.
- 15 academic and technical staff exposed to activities linking theoretical knowledge to architectural studio design.
- 45 students participated in applied research projects and excursions, increasing their practice-based knowledge.

Design-build projects

- 330 students engaged in design-build projects exhibiting energy efficient design,

local and low-carbon technologies and materials. Projects reflected densification in urban sprawl areas, context-related design and resilience of buildings to challenges of changing climatic conditions.

Documents

- JENGA Handbook, containing a selection of teaching instructions, examples and documentation of best practices.
- SFC2016 Conference Proceedings, available in a digital and a printed version in

the libraries of participating and other universities.

Visibility

- Results published at national and international conferences and discussed with practitioners and stakeholders during public workshops.
- Activities advertised at partner and associate universities with posters and T-Shirts, UN Habitat newsletters and through local reports and articles.

↑ Outcomes

- Participants informed about better design for economic and social, political, cultural and environmental contexts.
- Policy makers and practitioners made aware of sustainable building technologies.
- Increased capacity for teaching methods at partner HEIs

🎯 Impacts

Usage

- The ideas and challenges of innovative and practice-oriented education in architecture schools have fostered awareness for energy efficiency and have been taken up by a series of curriculum development workshops organised by UN Habitat.

Policy implications

- SFC2016 conference, held at UN Headquarters in Nairobi, addressed an international audience of academics, professionals and government stakeholders. With a focus on East and South African countries, UN Habitat sessions and JENGA results’

presentations, it promoted regional and local knowledge transfer.

Sustainability

- 2 HEIs involved have shown their ability to implement new teaching methods into existing courses. UMU has continued staff training and successfully started small-scale, locally sustained projects.
- The potential establishment of a East African-German University of Applied Science may be a significant step in upscaling the results and sustainability of the programme.



Design models of all scales were used as part of problem based teaching.



Results were presented to academics, professionals and government stakeholders during public events.



Design build experimental house Kenya.

TESTIMONIAL



Achilles Ahimbisibwe,
Faculty of the Built Environment,
Uganda Martyrs University, Kampala,
Uganda

“The faculty of the Built Environment at Uganda Martyrs University seeks to improve students’ competencies and provide quality and contextually relevant architecture. This process has seen much improvement in the delivery of studio courses, and two specific courses have arisen as a result of the earthen construction training. We continue to review and adjust approaches in other courses to build towards better outcomes in studio projects.”

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PEESA – Programme on Energy Efficiency in Southern Africa

SUMMARY OF RESULTS

Advanced curricular on energy efficiency aligned with European quality standards for engineering education, including:

- 3 MTech Master programmes in energy efficiency developed and implemented;
- 3 MEng Master programmes in energy efficiency developed;
- 69 students recruited in the implemented Master programmes;
- 94 teaching staff members involved in international exchanges;
- 10 teaching staff members trained in online courses;
- 123 academic staff members trained in quality teaching;
- 11 scientific papers published.

BACKGROUND

In Africa, the transition towards a knowledge economy provides significant opportunities for higher education. Higher education should, therefore, focus on these government- and market-driven demands. Education in engineering in particular will play a key role in building Africa's future technological innovation. This transition, also driven by globalisation, industry and employability, calls for developing an interdisciplinary approach and the ability to combine theory and practice.

Whilst educational institutions in southern Africa may possess the necessary scientific and technological capacity, they often lack the innovative capacity to develop programmes that have a true impact on the opportunities that exist. There is, therefore, a need to facilitate this process of strengthening capacities ranging from scientific and technological capacity development, adapting existing technologies to local conditions, making research results accessible to African users, and fostering an institutional networking culture between EU and African partners.

The PEESA project (Programme on Energy Efficiency in Southern Africa) targeted the development and implementation of master engineering programmes at CPUT, NUST, VUT and TUT aligned to EU quality standards.

METHODOLOGY

Guidelines on engineering programme design

Methodology for engineering curriculum design: planning of objectives and learning

outcomes, and credit allocation according to EUR-ACE® Framework and national standards of the African countries.

Curricula and syllabus development

Preparation of curricula. Updated syllabuses and teaching materials of courses and modules with ECTS (European Credit Transfer System) credits mapped to learning outcomes. Textbooks for areas of programme specialisation purchased.

Train-the-trainer blended course

Educate faculty developers and teachers in interdisciplinary approaches in the field of energy efficiency.

Evaluation against HEQC and EHEA

External evaluation by peers against EU and national standards requirements: Africa's Higher Education Quality Council (HEQC) and the European Higher Education Area (EHEA).

Quality monitoring

Purchase of software and communication instruments to conduct professional video conferences and platform for exchanging information and material.

Disseminating results

Outputs published through project website and platform, as well as in papers and presentations on national and international events.

Implementing and promoting the Master's programme

African partners implement train-the-trainer course and the master programmes introducing teaching materials and methodologies.



Visit to Windhoek Brewery, Photovoltaic Roof Plant, Namibia.

PROJECT IMPLEMENTATION PERIOD

October 2013 – March 2017

CONSORTIUM

- Hochschule Wismar, University of Applied Sciences and Technology, Business and Design, Germany
- Ernst-Abbe-Hochschule Jena University of Applied Sciences (EAH Jena), Germany
- Hochschule Flensburg (HSF), Germany
- Cape Peninsula University of Technology (CPUT), South Africa
- Namibia University of Science and Technology (NUST), Namibia
- Tshwane University of Technology (TUT), South Africa
- Vaal University of Technology (VUT), South Africa
- European Network for Accreditation of Engineering Education (ENAE), Belgium

PROJECT CONTACT

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PROJECT WEBSITE

<http://peesanust.na/>

RESULTS

→ Outputs

Capacity building

- 3 MTech Master programmes in Energy Efficiency.
- 3 MEng Master programmes in Energy Efficiency.
- 1 train-the-trainer online programme at master/PhD level.
- 94 teaching staff members involved in international exchanges.
- 123 academic staff members trained in quality teaching.
- 10 academic and teaching staff members (3 female, 7 male) trained in online didactics.
- 38 students (12 female, 26 male) enrolled in the programmes.

Documents

- Guidelines on Engineering Programme Design in alignment with European Qualifications Frameworks, European Standards

for Accreditation of Engineering Programmes and Southern African Quality and Accreditation Standards.

- Evaluation paper of 4 Master degree programmes in Energy Efficiency in Southern Africa.
- Trainer programme including teaching material.

Networking

- Platform Blackboard: <http://www.blackboard.com/higher-education/index.html>

Publications

- 11 scientific/educational papers.

Visibility

- Project website.
- 7th International Conference on Engineer-

ing and Business Education (7th ICEBE) in Shijiazhuang (China), October 2014.

- German-African Energy Forum in Hamburg (Germany), April 2015.
- PEESA Dissemination Conference in Windhoek (Namibia), September 2015.
- 8th International Conference on Engineering and Business Education (8th ICEBE), Fredrikstad, (Norway), October 2015.
- Communication Event in Deutscher Bundestag in Berlin (Germany), May 2016.
- ‘Domestic Use of Energy’ Conference in Cape Town (South Africa), February 2016.
- DAAD 3rd Network Meeting of the Projects in the University-Business-Partnership Programme in Bonn (Germany), November 2016.

↑ Outcomes

- Updated quality assurance system aligned to EU quality standards.
- Southern African partner HEIs have the capacity to develop and deliver advanced engineering curricula.
- African partner faculties capable of designing and delivering quality online training and online didactics.

🎯 Impacts

Usage

- CPUT, NUST, TUT and VUT have developed the Master’s programme in Sustainable Energy which will address national needs for capacity building in renewable energy, and will produce graduates with the ability to analyse, design, evaluate and maintain highly sophisticated renewable energy systems. The programme will enable the students to use and share not only their specialised knowledge, but also their social competences in real-life working scenarios.

Policy implications

- The use of the engineering Master programmes aligned with national and local requirements and conditions, the EUR-ACE® accreditation standards by Southern African universities and the Train-the-Trainer online course, provide the right skills for employability, the skills to work with business and employers, thereby sustaining good practices in energy efficiency management.
- The Master programmes will also make

meaningful and substantial contributions to the vision of NUST as well as national economic agendas.

Sustainability

- The Southern African partner universities will offer the developed Energy Efficiency Master’s programme regularly.
- PEESA continues and is sustained by:
 - PEESA II: Project Hochschulkooperation ‘Energy Efficiency in Southern Africa’, supported by Bundesministerium für Bildung und Forschung, Germany.
 - PEESA III: ERASMUS+ Personalised Engineering Education in Southern Africa.

TESTIMONIAL



Anthony Staak,
Deputy Vice-Chancellor
for Teaching and Learning,
Cape Peninsula University
of Technology, South
Africa

“The experience gained from the project will help pave the way for the introduction of more professional masters degrees at our institution. Staff members at the institution have benefitted from the training courses on curriculum development, accreditation and on-line learning and will be able to apply the expertise gained to bring about improvements in other areas as well.”

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Concerted fit-for-purpose PhD training in aquaculture and fisheries to improve food security and livelihoods in Sub-Saharan Africa

SUMMARY OF RESULTS

The capacity to host a regional academic programme for a PhD training programme in aquaculture and fisheries at LUANAR (Malawi) has been enhanced:

- An international academic advisory board for quality assurance has been established.
- Implementation of best practices for graduate programmes is in place.
- A framework for the establishment of an international programmes office is in place.
- Curriculum for PhD in aquaculture and fisheries science has been revised and piloted.

BACKGROUND

There is a general global decline in capture fisheries, but more so in Southern Africa. Fish consumption has declined from 14.7 kg/capita/year in 1970 to less than 7.0 kg/capita/year in 2004. Therefore, governments in the region have embarked on developing aquaculture at both smallholder and commercial levels. However, all these interventions require well-trained and qualified people to address the various problems in these areas. They will need to understand the dynamics of the problems surrounding aquaculture and capture fisheries management before they can come up with remedial interventions.

The project mobilised regional partnerships and expertise to revise the PhD curriculum in aquaculture and fisheries science. The capacity of LUANAR to host regional academic programmes was strengthened through exchange programmes and the establishment of an international academic advisory board. In order to pilot the revised PhD curriculum, sustained admission of PhD students, both male and female needed to be maintained. Therefore, marketing of the PhD programme was intensified through RUFORUM and synergies were established with other projects in order to provide scholarships for PhD students.

METHODOLOGY

A framework for engaging national, regional and international partnerships for PhD training in Aquaculture and Fisheries Science was established by mobilising regional partnerships through Memorandums of Understanding (MoUs).

Practices were identified and incorporated to help the participating universities; strengthen their general and financial administration of Graduate Programmes; ensure the quality of the programmes; and establish practices and procedures to market graduate training throughout Africa.

The curriculum of the existing PhD at LUANAR was reviewed and course modules updated. The process included a study to obtain feedback from the current group of PhD students / graduates, lecturers and key stakeholders, i.e. industries and areas of the public sector that can potentially employ them. The feedback concerned the current PhD programme, course content, training delivery, field attachment of students, etc.

A key concern of universities in Africa is the poor delivery of academic programmes. To address this gap, a course retooling to handle issues related to students' supervision was conducted.

Dissemination of project outputs included a project website, press releases, scientific publications in journals, conferences...



A PhD student from Rhodes University learning the skills of setting a fishing Gillnet in Lake Sibaya, Kwazulu Natal, South Africa.

PROJECT IMPLEMENTATION PERIOD

October 2013 – October 2017

CONSORTIUM

- Lilongwe University of Agriculture and Natural Resources, Malawi
- Makerere University, Uganda
- University of Eldoret, Kenya
- Rhodes University, South Africa

Associated partners:

- World Fish Center, Malawi
- NEPAD-Fish Node, Malawi
- National Agriculture Organisation, Uganda
- Regional Universities Forum for Capacity Building in Agriculture (RUFORUM), Uganda

PROJECT CONTACT

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PROJECT WEBSITE

www.bunda.luanar.mw/edulink



RESULTS

→ Outputs

Tools

- Aquaculture technologies (catfish seed production and low cost fish feed formulations) disseminated to farmers for their adoption.

Networking

- MoUs for engaging regional partnerships for PhD training in Aquaculture and Fisheries Science.

Capacity building

- 5 course modules updated within the curriculum of the PhD programme in Aquaculture and Fisheries: Aquaculture nutrition and feed technology; Aquaculture production systems and engineering; Fish

reproduction and breeding; Fish bioenergetics; Advanced resources economics and management.

- 18 academic staff members (5 female, 13 male) participated in university exchange programmes to identify gaps and strengths in current PhD training.
- PhD graduates trained using the revised curriculum in aquaculture and fisheries (2 female, 10 male).

Management

- LUANAR serves as a regional Higher Education hub for aquaculture and fisheries.
- A Regional Academic Advisory Board.

Publications

- Yatuha J., 2018. Reproductive strategies of smooth-head catfish *RwiziRufuha* wetland system, south-western Uganda, *African Journal of Aquatic Science*, 43:2.
- Kemigabo C., 2017. Effects of protease enzyme supplementation on protein digestibility of legume and/or fish meal-based fish feeds. *International Journal of Fisheries and Aquaculture* 9(7), 73-80.

Visibility

- Project website.
- Presentations at RUFORUM biennial conferences.

↑ Outcomes

- Enhanced quality of lectures and graduates trained.
- Enhanced capacity of LUANAR for effective delivery of the regional PhD

programme in Aquaculture and Fisheries.

- Enhanced quality control (through the Regional Academic Advisory Board).

- A cost-effective regional PhD programme ensuring higher staff retention in the continent.

🎯 Impacts

Usage

- The trained PhD graduates will be able to guide teaching and research in fisheries and aquaculture.

Policy implications

- With a general decline in capture fisheries in the region, the governments have prioritised investments in the aquaculture sector. The technologically skilled fit-for-purpose

graduates will significantly contribute towards solving regional challenges.

Sustainability

- The setting up of an international academic programmes office has helped LUANAR to become a centre of excellence in aquaculture and fisheries science in Africa by the World Bank ('ACE II' programme).



Aquaponics at NARO, Kampala, Uganda.

TESTIMONIALS



Chloe Kemigabo, PhD student at LUANAR from Uganda

“The training has improved my skills in conceptualising research issues and develop research projects”.



Kwado Kesse Mireku, PhD student at LUANAR from the University of Cape Coast, Ghana

“I am impressed with supervision of graduate students. My supervisor visited me in Ghana at my university and that motivated me greatly.”

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EU-ACP Networking for Academic Excellence in Agriculture and Food Security



Selling Siyakhana farm products.

PROJECT IMPLEMENTATION PERIOD

October 2013 – January 2017

CONSORTIUM

- University of Witwatersrand (WITS), South Africa
- Center for Health Education and Appropriate Health Technologies (CESTAS), Italy
- Euro-Mediterranean University (EMUNI), Slovenia
- University of Namibia (UNAM), Namibia
- Lilongwe University of Agriculture and Natural Resources (LUANAR), Malawi

Associated partners:

- Wits Health Consortium T/A Siyakhana Initiative for Ecological Health and Food Security, South Africa

PROJECT CONTACT

Ms. Barbara Herweg
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SUMMARY OF RESULTS

Research and training in agriculture and food security have been designed that foster inter-institutional networking for southern African universities. An interactive multi-disciplinary online platform focused on food security has been established and three institutional reports and one combined report have provided specific overviews of women's access to education and food security status.

BACKGROUND

The challenge of inadequate human capacity and few resources to meet training needs is a major hindrance in addressing pertinent issues within the subject of food security. Currently, staff are insufficiently trained and Higher Education Institutions (HEIs) lack the capacity to adapt and incorporate emerging issues into existing curricula. These inadequacies are reflected in the quality teaching and a lack of innovation-orientated research. Developing these human and technological resources (including online courses) are necessary in order to effectively address food security issues in Africa.

As a response to the challenge, professional development and training programmes have been initiated and in order to incorporate emerging issues and take advantage of ICT tools, university curricula have been reviewed. A particular priority has been to improve access for women to quality information and labour market opportunities within the agricultural and food sectors.



Siyakhana food garden.

METHODOLOGY

Networking and joint programme design

Activation of online platform, selection of scientific committee members, structuring and validation of the online course.

Teacher training course for HEIs academic staff

Selection of participants and implementation of the online course. Common problems tackled paying attention to requests by partner universities in terms of human capacity and ability to meet training needs at country level. A broader understanding of relevant issues through knowledge acquisition, intellectual enquiry, debate, and team/individual research will be promoted encouraging participants to explore factors influencing sustainability.

Upgrading of curricula

Review of the existing curricula, re-formulation and organisation of curricula review by stakeholders.

Research and tools for gender equality

Data collection, surveys on gender and food security interventions, labour market requests and women's access to quality information and learning, diagnosis and plan elaboration.

Dissemination and demonstration of project best practices and models

Design of a dissemination plan, use of project platform for external users, creation of the Sub-Saharan Universities Network, organisation of closing seminars.

RESULTS

→ Outputs

Capacity building

- Joint course structured and validated at WITS and LUANAR. 6 months duration and consisting of 4 modules: principles of food security and food systems; policy and intervention strategies; food security research and knowledge systems; and monitoring and evaluation. A strong cross-cutting theme in gender-related issues has been incorporated.
- 24 teachers selected and trained via the joint online course.
- 23 certificates issued for course completion.

Documents/Publications

- Women, Food Security and Education: Case Studies from South Africa.
- Gender Equality Research: Women, Food Security and Education in Malawi.
- Gender and Food Security Interventions, Labour Market and Women Access to Higher Education in Namibia.
- Women, Education and Food Security: Case studies from Malawi, South Africa and Namibia - Summary of findings.
- Brochure: Networking for Academic Excellence in Agriculture and Food Security.
- Poster presentation: 'EDULINK II – EU-ACP Networking for academic excellence in Agriculture and Food Security',

Sustainable Food Systems: Agriculture, Environment and Nutrition Conference, 20-21 June 2016 (University of Tel Aviv).

- Conference presentation: 'Walking the tightrope' – the balancing act between the funders and the researchers' goals and expectations, SARIMA Conference, 29-31 May 2018.

Databases/Websites

- 1 online platform 'CAMPUS' accessed via dedicated website contains courses with the necessary tools, course modules, literature and document repository.

↑ Outcomes

- Participating HEIs have the capacity to develop and implement online distance learning courses and online platforms.
- HEIs have capacities in developing curricula and conduct research and teaching on food security and agriculture
- Staff and students have knowledge of key concepts, theories and methods in food security and agriculture.

🎯 Impacts

Usage

- The project forged a solid network between the academic staff of the 3 HEIs in southern Africa.

Policy implications

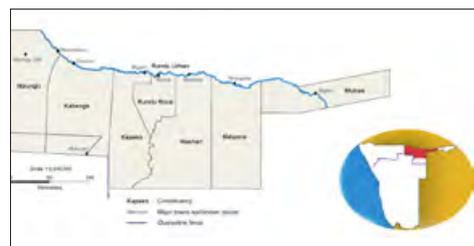
- The gender reports can inform evidence-based policy-making frameworks (gender, food security and education) in the 3 countries.

Sustainability

- The eLearning platforms will preserve and allow continuation of the course and generate scientific and general publications.



Online modules.



Kavango-study-area.



WITS Siyakhana Initiative.

TESTIMONIAL



Limson Kaluzi,
Lilongwe University of
Agriculture and Natural
Resources, Extension
Department, Malawi

“The course offers good background to topics and contextualises the issues. I now have a broader understanding of these issues and how narrowly current policy handles food security by only focusing on food availability and ignoring utilisation and diversity. It has

enabled me to understand the gaps in the local food systems such as food safety and resilience to climate change.”

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Financed by the European Union

HEI's cooperation contributing to rural development in Mozambique

SUMMARY OF RESULTS

Models for sustainable community development were introduced into the courses offered by OWU with 6 specific thematic units and materials. The teaching materials were improved and adapted to local contexts. The teaching capacity of OWU was improved with the training of teachers in new technologies for sustainable renewable energy resources and small-scale conservation farming. The university has also increased its capacity to design and carry out research activities. The physical and virtual Knowledge Resource Centre was established and a sound co-operation formed among the HEIs in Mozambique, Portugal and South Africa.

BACKGROUND

The majority of the population in Mozambique depends on small-scale conservation farming and lives below the poverty line. The environment and agricultural production are increasingly subject to adverse effects of climate change including flooding and drought. The project aimed at developing methods in training, and interventions by students and graduates to secure sustainable agricultural methods, food security and sustainable living conditions for rural communities.

The project strengthened both academic and community capacities by developing and enhancing the relevance of the existing course in Community Development based on practical actions. The goal was to improve production and livelihoods in rural communities through developing thematic units and teaching materials, alongside teacher training in delivering research and techniques on small-scale renewable energy and agricultural systems.

The goal also included the establishment of a virtual and physical Knowledge Resource Centre. This was complemented by increased collaboration between the partner Higher Education Institutions (HEIs) on the use of evidence-based solutions for sustainable development in improving the training of community developers.

ISET/OWU offers two specialisation courses: Community development and Pedagogy. ISET/OWU is supported by a Research and Knowledge Center that develops tailor-made solutions for the particular challenges faced by the local communities in the Changalane. ISET/OWU has an annual enrolment rate of 250 students and has 30 teachers and administrative staff.

METHODOLOGY

Improved curriculum

Improved curriculum of the partner HEIs to test and adapt to different local circumstances for sustainable community development.

Techno-socio-economic feasibility studies

Renewable energy solutions for solar water pumping and purification and for supporting agricultural systems.

Improved teaching materials

Analysis of methods to introduce new technologies to small-scale conservation farmers and increase the value and commercialisation of food and cash-crops. Produce teaching modules on sustainable technologies.

Improved teaching capacity

Training seminars for teachers in technologies for sustainable RES and small-scale conservation farming as well as human resource organisation.

Creating a network

Creation of a network of HEIs in Mozambique, South Africa and Portugal involved in sustainable technologies.

Increasing capacity of HEIs to conduct research

Teacher training on implementation of techno-socio-economic feasibility studies on renewable energy resources (RES) solutions. Course development on different approaches for organising and leading farmers and simplified feasibility studies.

Physical and virtual knowledge resource centre

Creation of the centre and development of a detailed establishment and activity plan.



Researcher from ISA Portugal training students in sustainable agriculture methods.

PROJECT IMPLEMENTATION PERIOD

November 2013 – January 2017

CONSORTIUM

- Instituto Superior de Educação e Tecnologia - One World University (ISET/OWU), Mozambique
- Stellenbosch University, South Africa
- Instituto Superior de Agronomia (ISA), Universidade Técnica de Lisboa, Portugal

PROJECT CONTACT

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PROJECT WEBSITE

<http://www.adpp-mozambique.org/>

RESULTS

→ Outputs

Capacity building

- 6 teachers and 90 students trained in technologies for sustainable RES and small-scale conservation farming.
- 6 teaching modules on sustainable technologies.
- Teaching materials on subjects such as food security, sustainable technologies and environmental conservation introduced into subjects of Agriculture and Technology and Production.

Documents

- Manuals:
 - Sustainable agriculture.
 - Simplified feasibility studies.
 - Energy and water management.
 - Solar photovoltaic charging station.
- Feasibility studies:
 - Renewable energy.
 - Sustainable technologies.

Networking

- The physical and virtual Knowledge Resource Centre used to provide technical support, training and promotion of renewable and sustainable technologies

for the community.

- 10,350 men and women reached via activities of the students in local communities in Changalane.
- Links with national universities and research centres.

Visibility

- ISET/OWU and ADPP (*Ajuda de Desenvolvimento de Povo para Povo*) websites (www.adpp-mozambique.org).
- Posters, pamphlets about conservation farming, climate change, etc.

↑ Outcomes

- ISET/OWU has capacity in developing local sustainable development solutions.
- ISET/OWU has capacity to deliver teaching and conduct research in sustainable community development.
- Knowledge Resource Centre has cemented international co-operation for resource use in research and teaching.

🎯 Impacts

Usage

- The training materials produced and the education modules introduced into ISET/OWU's curricula will sustain a more ambitious and pragmatic knowledge creation, management and application at the university level.

Policy implications

- Renewable energy and food security are high on the agenda of the government of Mozambique, but policy and implementation need further development. ISET/OWU is in a position to influence

policy and practice via its new capacities in research and producing professionals.

Sustainability

- With the potential to increase the number of professionals, government authorities have been supportive of the intervention including the Ministry of Science and Technology which has pledged funds and ongoing support in order to promote science, technology and innovation in rural development.



Students studying theoretical studies.



Students in a local community meeting.

TESTIMONIAL



Acacio Chelene,
community development
worker, Changalane
village, Mozambique

“I have been trained by teachers from universities in Portugal and South Africa to work directly with communities. My work covers implementation and teaching about renewable energy and solutions. People now understand the importance of conservation farming, renewable energy and strategies to mitigate climate change. This kind of training is very important as it provides methods that people are able to develop by themselves.”

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PARTICIPIA – Participatory Integrated Assessment of Energy Systems to Promote Energy Access and Efficiency



Participatory mapping in Mokolodi village, Botswana.

PROJECT IMPLEMENTATION PERIOD

October 2013 – December 2016

CONSORTIUM

- Universitat Autònoma de Barcelona, Spain
- University of Bergen, Norway
- University of Stellenbosch, South Africa
- University of Botswana, Botswana
- Namibia University of Science and Technology, Namibia

Associated partners:

- Alianza 4 Universidades (A-4U), Spain
- Universidad Autónoma de Madrid, Spain
- Universidad Carlos III de Madrid, Spain
- Universitat Pompeu Fabra, Spain
- Food and Agriculture Organization of the United Nations
- Energy Division, New Partnership for Africa Development, NEPAD

PROJECT CONTACT

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PROJECT WEBSITE

<http://participia.net/>

SUMMARY OF RESULTS

The University of Botswana developed a novel Master's Programme in Participatory Integrated Analysis of Energy Systems (MPIES). The Namibia University of Science and Technology approved a new Master's programme in Sustainable Energy Systems (MSES) combining the outcome of several EDULINK projects, including three PARTICIPIA modules. Stellenbosch University (SU) accredited two of the PARTICIPIA modules for integration within existing programmes. A massive open online course (MOOC) was developed and launched to support teaching.

BACKGROUND

Energy systems in the Southern African Development Community (SADC) region are still predominantly based on conventional non-renewable energy resources. In dealing with current and future challenges, scientists and policy makers must address multiple, overlapping and global challenges in: energy access, food and water security, climate change, environmental degradation, poverty, and population growth. In particular, the nexus between energy, food and water supply is one of the most pressing sustainability challenges for research and education.

Therefore, the aim was to equip graduates with the necessary skills required by the energy sector at local, regional and national levels via the development of innovative teaching and teaching materials, whilst adhering to the national and international quality assurance standards.

Expertise that dealt with complex system theory, participatory processes of governance and decision making, integrated assessment, and alternative energy systems, was mobilised in order to develop and incorporate these new courses.

One of the main anticipated challenges was to engage traditional schools of engineering in the novel interdisciplinary approach.

METHODOLOGY

Development of curriculum

A transdisciplinary curriculum was built around an integrated set of 8 master modules relevant to socio-economic contexts in the SADC region.

Case studies

3 cross-modular case studies were carried out involving consultations with local actors: urban slum electrification (South Africa), participatory rural approaches to energy systems (Botswana), and national energy metabolism and policies (Namibia). Case studies served to (i) maintain coherence among modules; (ii) create locally-relevant teaching material; (iii) engage local staff (capacity building), and (iv) support accreditation (needs assessment) through demonstration of local policy relevance.

Training of personnel

Interactive workshops and a summer school were organised to train local lecturers and test teaching material.

Development of online teaching support

A MOOC consisting of 8 modules, each composed of 3 classes of 30 min each, was developed with the dual purpose to train local staff and to create support material for mixed classroom models.

Promotion and dissemination

A promotional video was developed and shown at local events in support of accreditation. Master programme design and case studies were disseminated at local and international conferences.

RESULTS

→ Outputs

Capacity building

- 14 local academic staff trained in teaching novel interdisciplinary master modules.
- MOOC (Coursera): Sustainability of Social-Ecological Systems: the Nexus between Water, Energy and Food (over 2,000 learners since 03 July 2017).
- 4 online video lectures on vimeo on public participation, post-normal science, and science for policy.

Publications

- Kiravu C, *et al.*, 2018. Proposing a master's programme on participatory integrated

assessment of energy systems to promote energy access and energy efficiency in Southern Africa. *Int. Journal of Sustainability in Higher Education*, 19: 622-41.

- Kovacic Z. & Giampietro M., 2017. Between theory and quantification: An integrated analysis of metabolic patterns of informal urban settlements. *Energy Policy*, 100: 377–86.
- Smit S. *et al.*, 2017. Conceptualising slum in an urban African context. *Cities*, 62: 107–19.
- Kovacic Z, *et al.*, 2016. Probing uncertainty

levels of electrification in informal urban settlements: A case from South Africa. *Habitat International*, 56: 212-21.

- Three case studies documented in Proceedings of the 2nd SASEI-IREC Conference, 25-28 October 2016, Gaborone (ISBN: 978-99968-541-7).

Visibility

- Promotional video 'PARTICIPIA Master's Programmes'.

↑ Outcomes

- Accreditation of MSES Master Programme in Namibia and 2 master modules accredited in South Africa.

- MPIES Programme in accredited process in Botswana.

- Local academic staff trained to develop and deliver innovative and interdisciplinary programmes.

🎯 Impacts

Usage

- The introduction of modules on participatory integrated assessment of energy systems and policies enhances the academic excellence of the partner institutions and stimulates student enrolment at postgraduate level.
- A transformation of attitudes has resulted in the local engineering schools with respect to interdisciplinary approaches and new research lines.

will translate into more effective policies. These policies will facilitate access to alternative energy technologies and their efficient utilisation in different local socio-economic and geographical contexts.

Sustainability

- The sustainability of the new Master's programme and modules is guaranteed by the commitment of the University Councils and the endorsement received from peer international universities and relevant state authorities, such as the Engineering Council of Namibia.

Policy implications

- The interdisciplinary method of producing scientific input for use in decision-making by the new generation of energy planners



Survey on electrification in the Enkanini slum, South Africa.

TESTIMONIAL



Naledi Monnagosi
(Mmokolodi, Botswana),
chairperson of Mmokolodi
Village Development
Committee and member
of the Ramakutlo develop-
ment/conservation trust

“I expect that the entire country will benefit from this project. Energy planners will understand community energy needs. I also expect that eventually village institutions and Village Development Houses will have access to energy/electricity. On a personal level, I

have realised that solar energy can be used to provide power. I'm now planning to use solar energy for my borehole and the house. Some of our energy needs in the village can be met through clean alternative energy.”

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ACADIA – African Center for Applicative Development & Innovation in Agribusiness

SUMMARY OF RESULTS

Capacity building was provided in the field of higher education and contributed to create an efficient, highly productive, sustainable and job-creating agribusiness sector in Kenya, Uganda and in other East African countries. Two complete facilities, in Kenya and Uganda, for e-learning content production and teaching have been equipped, each consisting of a classroom with 25 laptops and one multimedia recording room.

BACKGROUND

One of the main problems of the agribusiness sector in Kenya and Uganda is low productivity, due to inadequate agricultural practices and technologies and an outdated agro-industry. Although the necessary basic conditions for agricultural production are available, the skilled labour, capital and technology are inadequate. There is an urgent need to address the inadequacies in skilled labour and technology in the region.

The project aimed to act upon inadequate and outdated curricula content. The most valuable mobilised resources were the sources of local data and talent from UPCT and the European industry.

METHODOLOGY

The project focused on: agro-industry market orientation curricula, accessibility of education (distance learning), agricultural productivity, fostering entrepreneurship and cooperative work on the agro-industry sector. For this purpose, the elaboration of the four reports that reflect the needs of the industry, its opportunities, the strategic plan for the Agribusiness Center, and the analysis of the educational structure, were based on primary sources. Primary sources included meetings, interviews and surveys at Chuka University and Gulu University, which were also complemented by secondary sources of information, duly searched and extracted.

The design of the Agribusiness curricula of ACADIA was based on the four reports and modern industry knowledge from the most advanced economies. The content is available in the created e-learning platform. Two complete facilities for e-learning content production and teaching have been equipped - one at each partner and each consisting of a classroom with 25 laptops and one multimedia recording room.



Reports.



Acadia Training Programme.

Training courses

- e-Learning platform, Moodle and use of Multi-media rooms.
- Digital content management training course Moodle ACADIA.



E-learning Platform training sessions.

PROJECT IMPLEMENTATION PERIOD

October 2013 – November 2016

CONSORTIUM

- Universidad Politécnica de Cartagena (UPCT), Spain
- Chuka University, Kenya
- Gulu University, Uganda

PROJECT CONTACT

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PROJECT WEBSITE

www.acadiaproject.org/

RESULTS

→ Outputs

Capacity building

- Networks between industry and the universities in Kenya and Uganda.

Documents (reports)

- Analysis of market needs.
- Opportunities for agribusiness in Kenya and Uganda.
- Report on Agribusiness Education.
- Strategic plan for agribusiness centre in Kenya and Uganda.
- Support to the definition of e-learning platform specifications (for procurement).
- Training needs and methodology.

Publications

- *Innovación docente: ¿una rápida evolución?* Inaugural lesson of the 2016-2017 aca-

demie year at the Public Universities of the Region of Murcia, Spain.

Tools

- The teaching structure of ACADIA has been established on credits (32 ECTS) and on different modules which allow segmentation of the content and offer learning at different levels and in different formats, on the principle that every ECTS requires 25 hours of work.
- Training materials:
 - 24 pdf documents.
 - 10 training activities (exercises, case studies analysis and resolution, alternative proposals, etc.).
 - 8 Power Point Presentations.
 - 2 challenges (games) to measure what

they have learned.

- 16 videos.
- 8 learning objects (SCORM).
- 30 documents and links with complementary information.

Networking

- Acadia workshop: Development and opportunities through agribusiness in African Countries.

Visibility

- Video Acadia: <https://vimeo.com/187165237/502491ffa5>
- Web inscription: <http://acadia.upct.es/>
- Website: www.acadiaproject.org/
- Platform e-learning: <http://acadiaupct.azurewebsites.net/>

↑ Outcomes

- The partner Higher Education Institutions (HEIs) have capacity to deliver Agribusiness curricula and training.
- The HEIs have the capacity and resources to manage and deliver digital online academic content.
- Linkages with agricultural sector actors established.

🎯 Impacts

Usage

- Both universities are collaborating on the dissemination of the e-learning centre at different events organised. They continue to develop and maintain links with industry and other stakeholders to ensure quality of teaching and the utilisation of the e-learning centre as a source of information to identify Research & Development players, to disseminate their news in current agribusiness technologies and products.
- A new curriculum in agribusiness education named BSc in Agri-entrepreneurship

and Communication Management was accredited and launched in 2016/2017 in Gulu.

Policy implications

- Chuka University established a new directorate of e-learning and distance learning in to spur the continuous development of the current agri-business curriculum.
- Gulu University is now developing infrastructure to support e-learning. This includes broadband internet connectivity

and the MOODLE learning platform (<https://elearning.gu.ac.ug/>).

Sustainability

- Chuka University is commitment to a well-supported directorate of distance learning and e-learning.
- Gulu University has full-time staff committed to management of the e-learning platform and running the new agribusiness programme.

TESTIMONIAL



Prof. Dolores de Miguel Gómez, Department of Business Economics, Higher Technical School of Agronomic Engineering, Universidad Politécnica de Cartagena, Spain

“The project aims to improve the technical capacity of teaching staff. The main outcome has fulfilled the goal of enhancing and strengthening the curricula of the two partnering universities. It also provides knowledge of new teaching methodologies (e-learning tool

created). Furthermore, the provision of two units - polymedia rooms - for the production of contents in Chuka and Gulu universities, ensures a great deal of sustainability in the future.”

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PASUFONS – Partnerships to Strengthen University Food and Nutrition Sciences Training and Research in Eastern and Southern Africa

SUMMARY OF RESULTS

The curricula for 6 food and nutrition science related programmes were reviewed, and input from stakeholders and recommendations for university-industry engagement were developed and disseminated. The reviewed curricula incorporated activities aimed at developing enhanced research and practical skills among graduates. A total of 16 academic and 16 technical staff were trained to enhance their capacity to instil practical and research skills. Joint training, supervision and examination of graduate students enabled the partner universities to leverage human resources in the network. Joint teaching was further supported by installation of telematics teaching equipment and through use of an e-teaching platform. Furthermore, the strengthened collaboration among academics at the partner universities resulted in 2 joint research projects and joint publications.

BACKGROUND

The food production sector in eastern and southern Africa is faced with high post-harvest losses, poor quality of supply, limited value addition, limited diversity and low farm gate prices. Agricultural communities require interventions that provide improved post-harvest systems and value addition. High levels of malnutrition, specifically deficiencies of specific micronutrients are also prevalent and are exacerbated amongst vulnerable groups.

Universities can address the challenges through relevant research and knowledge transfer. The potential, however, has not yet been adequately exploited. Indications are that graduates lack the required skills and research does not result in application. Strengthening interactions with the food and nutrition sector will focus training and research to enhance capacities to contribute to improved food and nutrition security. By strengthening the capacity of the 3 participating Higher Education Institutions (HEIs) to provide practical training and research in food and nutrition sciences, graduates will be better prepared to engage with these sector challenges. Acting in isolation, however, universities will lack the critical training and research infrastructure. PASUFONS sought to promote collaboration between the participating HEIs and strengthen the links with the private sector and public institutions to facilitate exchange of information and the sharing of training and research resources

METHODOLOGY

Participatory implementation

Consultations amongst the partners and stakeholders informed the desire to improve service delivery. Postgraduate curricula were reviewed to identify opportunities for enhancing practical and research skills. The review also considered curricula of other HEIs and recommendations by professional organisations.

Curriculum development committee

A committee consisting of representatives of the food science departments revised curricula to be reviewed by peers and external experts. Recommendations were submitted for reconsideration and approval to the relevant hierarchies and accreditation bodies. Curricula delivery followed institutional arrangements, including mechanisms for obtaining credits at partner universities.

Skills development training

Training needs were determined and training programmes designed. Academic staff training included tailor-made and existing courses in andragogy, research methods and supervision of research students. Skills development included staff apprenticeships with senior colleagues. Technicians' training covered analytical methods, laboratory management and practical teaching methods.

Networking platform and virtual learning and communication

A collaborative research and training platform is used to exchange information and engage in activities, including joint supervision, teaching and joint publication development. Utilisation of virtual learning platforms including telematic and e-learning facilities can help ensure collaborative use of available expertise and resources in participating institutions.



Dr. Julia Kigozi (Makerere University) with texture analysis equipment at Stellenbosch University, South Africa,

PROJECT IMPLEMENTATION PERIOD

November 2013 – November 2017

CONSORTIUM

- Makerere University, Uganda
- Stellenbosch University, South Africa
- Jomo Kenyatta University of Agriculture and Technology, Kenya

Associated partners:

- Regional Forum for Capacity Building in Agriculture (RUFORUM), Uganda
- South African Association for Food Science and Technology (SAAFoST), South Africa

PROJECT CONTACT

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PROJECT WEBSITE

www.pasufons.org

RESULTS

→ Outputs

Capacity building

- Academic programmes reviewed and updated in consultation with 167 stakeholders. The programmes have so far been piloted on 27 students.
- Institutional framework for identifying and responding to stakeholders' research and training needs established within the 3 partner universities with at least 230 stakeholders involved in its development.
- 16 technicians and 16 academic staff trained in specialised laboratory analysis techniques, research methods and statistics, and specialised food processing techniques.

Platforms

- A platform for research and training collaboration for HEIs in Eastern and Southern Africa.

Collaborative research projects

- Adaptation and promotion of refractance window drying technology for production of high quality bioproducts (BioInnovate Africa Call 2017) funded by Sida.
- INSBIZ: INSect-based agriBIZiness for sustainable grasshopper and cricket production and processing for food in Kenya and Uganda (2017-2020). SIDA/Bioinnovate Africa, Phase II.

Publications

- Muyonga J.H. *et al.*, 2018. Nutritional and Nutraceutical Properties of Traditional African Foods. In Public Health, Disease and Development in Africa (Eds. Kalipeni E. *et al.*), CRC Press.
- Muyonga J.H. *et al.*, 2017. Traditional African foods and their potential to contribute to health and nutrition. In Exploring the Nutrition and Health Benefits of Functional Foods. (Eds. Shekhar, H.U., Howlander, Z.H. & Kabir, Y.). Medical Information Science Reference, Hershey, PA. Chapter 15.

↑ Outcomes

- HEIs have the capacity to deliver practical training and research in food and nutrition sciences.
- HEIs and non-university food science and nutrition stakeholders are co-operating in training and research.
- Academic and research staff are collaborating in order to improve quality and relevance of HEIs' training and services.

🎯 Impacts

Usage

- The revised curricula have placed more emphasis on practical and research skills so as to contribute towards the improved employability and productivity of graduates.

Policy implications

- Dissemination of the project results, including the publication of 2 book chapters, a policy brief and 3 general media articles have contributed to the awareness of and potential adoption of collaborative activities including joint research by other universities.

Sustainability

- The new skills acquired by the technicians and staff are being utilised in the development of research that attracts funding to the universities. 2 examples include the following industry related projects approved for funding:
 - Non-destructive evaluation of bubble structure of dough and bread produced from roasted wheat flour.
 - Non-destructive evaluation of micro-structural changes in whole barley kernels during malting.

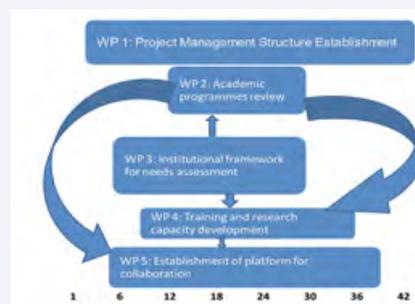


Illustration of methodology.



Project leader Prof. Muyonga with Uganda's Minister of Finance Hon. Matia Kasaija and the Executive Secretary of RUFORUM Prof. Adipala Ekwamu.

TESTIMONIAL



Meeme Hadijah,
Second year student
following MSc Food
Science and Technology
Makerere University
Uganda

“PASUFONS has greatly contributed to the enhancement of graduate students' knowledge and research capacity through the joint teaching exchange programs. Discussion of research ideas with experienced academic staff from partner universities has enabled students to produce better quality research that can be published and shared with other scientists internationally.”

ACP-EU Co-Operation Programmes in the fields of Higher Education and Science, Technology and Research

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Financed by the European Union

Food Security: from University to Territory. Strengthening the University Management for Learning and Practice in the Field of Food Security

SUMMARY OF RESULTS

A Master's Degree in Sustainable Development and Climate Change has been developed and accredited by the Ministry of Higher Education, Science and Technology. Knowledge was gained in food security and climate change subjects. Links were created with the agricultural sector, especially with local development agencies, to develop the specialisation modules in 'Agro-environmental project management for sustainable social development'. Laboratories have been equipped to support work and research in food security throughout the Caribbean region.

BACKGROUND

The Dominican Republic is primarily dependent on agricultural exports based on primary and derivative products. However, courses and programmes for agronomy and for technicians are very limited, as is the student demand for agronomy related careers. Low demand is due to the low profitability of the agricultural sector. The lack of professionals has greatly contributed to the poor situation of the rural and agricultural sectors.

The government has identified the agricultural sector as an area for urgent reform and the Ministry of Higher Education, Science and Technology recognises that Higher Education Institutions (HEIs) are central to the reform and must themselves adapt to the new social and economic needs of the country.

As a response, teachers and existing professionals have been targeted for skills development. A course has been developed to enhance careers in agronomy and the HEIs were strengthened to deliver these courses and establish links with the rural and private sectors.

METHODOLOGY

Formation of School of Agronomy within UCE

The school was established within the existing School of Engineering Sciences and Natural Resources.

Curricula development

Review and update of study plans involving ministries and comparisons of curricula. Establishing political relationships and exchanges with universities and other schools of Agronomy (agreements with universities). Acquisition of texts, subscription to journals, databases and specialised collections in agronomy and food security.

Capacity development

Training of teaching staff in food security and complementary topics, such as the management of food systems, policy and programming, ensuring food quality and marketing of products. Exchange of teachers and students, including co-operation agreements between universities for joint thesis and master research. Transfer of knowledge and good practices to local producers. Establishment of links between universities and teachers with local community agricultural markets, producers and consumers. Geo-referencing of production data and identifying problems and resources related to the local supply of food.

Networking

Promotion, dissemination and demonstration of results. Identifying and conducting SWOT analysis of food value chains and local economic development agencies. Establishing relationship with the Ministry of Agriculture to incorporate policy changes and support agricultural extension services.



Dr. Leopoldo Hidalgo, training passion fruit producer, Seibo, Dominican Republic.

PROJECT IMPLEMENTATION PERIOD

February 2014 – August 2017

CONSORTIUM

- Universidad Central del Este (UCE), Dominican Republic
- Politecnico di Milano (POLIMI), Italy
- Centro Nacional de Sanidad Agropecuaria (CENSA), Cuba

Associated partners:

- Red de Agencias de Desarrollo Económico Local de la República Dominicana / Red ADELDOM, Dominican Republic
- Réseau International 'Urban-Rural Network: Generating new forms of Exchange between Citizens' (URGENCEI), France

PROJECT CONTACT

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Dr. Gilberto Vazquez
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Dominican Republic
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PROJECT WEBSITE

www.uce.edu.do/investigacion/Food_Security



RESULTS

→ Outputs

Capacity building

- 19 teachers trained in agronomy and subjects related to food security.
- School of agronomy established.
- Master's Degree in Sustainable Development and Climate Change.
- 28 students enrolled in the specialisation in Agro-environmental project management for sustainable social development.
- 1 agricultural science laboratory constructed.
- 2 collaboration agreements between HEIs for exchange of staff and students, and for research and student theses exchange.

Documents

- Manual.

Publications

- 16 articles to be published based on student theses.
- Territorial analysis and value chain mappings of the Seibo province.

Visibility

- Public exhibitions of students' theses.
- Exhibitions to disseminate information on value chains and local markets.
- RADIO-UCE broadcasts used to inform on project activities and the activities carried out for the general public.

Databases/platforms/websites

- https://sp.uce.edu.do/investigacion/Food_Security/SitePages/Inicio.aspx
- <https://produrreterritorio.wordpress.com/category/progetti/edulink-ii/>
- EBSCO hosted research database to provide student access to their different subject investigations. The database also served as a supportive platform for students who studied the specialty in the management of agro-environmental projects for sustainable local development.

↑ Outcomes

- Teachers specialised in the fields of agronomy and food security.
- Integration of UCE and partner universities with government structures and civil society within the domain of food security.
- UCE and partner HEIs able to deliver quality educational courses, research and outreach related to food security.

🎯 Impacts

Usage

- Students studying the specialty in agro-environment project management for sustainable social development had the opportunity to implement knowledge in their territories through exchanges on agricultural development, planning and development of local and sustainable projects in the territorial contexts. This culminated with their final research that was then presented in their respective theses.

Policy implications

- The number of qualified professionals with an enhanced understanding of food security and sustainability of production has increased. These individuals may be future policy makers and implementers who will influence food security and sustainable practices.

Sustainability

- The Master's Degree in Sustainable Development and Climate Change has been approved by the Ministry of Higher Education, Science and Technology of the Dominican Republic and the first group to start the master's course is being registered.
- The developed courses are sustainable over time in the capacity of food security and the increase in the number of qualified professionals will contribute to improving food security in the region.

TESTIMONIAL



Franklin Garcia,
Project liaison officer,
Universidad Central del
Este, Dominican Republic

“Without any doubt, the most tangible impact of the project has been the new production techniques introduced to smallholders as well as the capacity building offered to staff. The modules developed and offered in the 6 targeted territories will contribute to local development, as well as the strengthening of the local development agencies' capacities in the field of food security.”



Tania Rivas from CENSA talking with cacao producer, Cuba.

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Deploying Interactive On-line Networking Platform for Improving Quality and Relevance of African University Graduates to Labour Markets



D. Pillot, AGRINATURA Science Days Vienna, Austria (May 2014).

PROJECT IMPLEMENTATION PERIOD

February 2014 - December 2017

CONSORTIUM

- Egerton University Kenya
- Makerere University, Uganda
- Jomo Kenyatta University of Agriculture and Technology (JKUAT), Kenya

Associated partners:

- Regional University Forum for Capacity Building in Agriculture (RUFORUM), Uganda,
- FUTURISTIC, Kenya
- African Biodiversity Conservation and innovations Centre (ABCIC), Kenya

PROJECT CONTACT

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PROJECT WEBSITE

www.onnetgraduate.net

SUMMARY OF RESULTS

An interactive platform (i-OGMSS) has been developed which allows postgraduates and supervisors to register and track student education programmes within a specified Road To Completion (RTC) and considering specific universities' requirements. The platform monitors interactions among graduate students, supervisors and alumni. The platform can also send alerts to graduate students, supervisors and the graduate school in case some of the activities specified in the RTC are not accomplished within the time specified. At the end of graduate studies, the platform automatically registers graduates in the alumni portal and links them with industries and the labour market.

BACKGROUND

The Interactive Online Graduate Mentoring and Supervision System (i-OGMSS) is a platform that facilitates interaction between various stakeholders involved in graduate mentorship and supervision. The system records the registration of various stakeholders (graduate student, prospective employers and supervisors), and supports and facilitates their interactions in the mentoring and supervision process.

The project aimed to enhance the capacity of African universities to produce high quality graduates who are responsive to the demands for innovation in the agricultural sector. This is in response to the deteriorating quality of graduates for the agricultural labour market which is increasingly expressing low confidence in the graduates and demanding fit-for purpose graduates. The impact of this situation is diminishing graduate employability and limiting their much needed contribution to the agricultural innovation process, which is necessary to revitalise agriculture, boost economic recovery, and achieve the 6% annual growth target stipulated by the comprehensive African development programme.

METHODOLOGY

The graduate networking platform was designed and developed. The online technology platform was established after determining stakeholders' requirements

and conducting a gap analysis and scoping. During the development, user assessments needs were conducted and variations between university requirements and regulations were considered, and the system fine-tuned to accommodate the different needs of the partner Higher Education Institutions (HEIs).

The first phase of the network platform covered automation of admission, enhancement of completion rates via efficient supervision and mentoring of graduate students, thesis evaluation, and publication of research findings.

The second phase covered automatic registration of graduated students in the alumni portal and linkage of graduate students with alumni and stakeholders.

A community was established in order to recruit, mobilise and facilitate graduate students, university staff, research experts and professionals from agricultural labour market alumni, and European experts.

An institutional framework and mechanism was established to embed graduate supervision and mentorship into the platform.

The dissemination of the platform was initiated via newsletters, workshops and conferences hosted by RUFORUM in order to capture their 66 member universities from Africa.

RESULTS

→ Outputs

Platform

- Integrated Open Graduate Supervision and Mentorship System (IOGMSS – www.onnetgraduate.net):
 - www.onnetgraduate.net/iogmss
 - www.onnetgraduate.net/iogmss/studentportal
 - www.onnetgraduate.net/iogmss/supervisorportal
 - www.onnetgraduate.net/iogmss/industryexperts
 - www.onnetgraduate.net/iogmss/alumniportal
- Institutional framework and mechanisms for deploying open graduate supervision and mentorship.
- Database of graduate students and experts.
- Training and research addressing mentor-

ship and supervision needs of graduate students.

Capacity building

- Egerton University, Faculty of Agriculture, 13 PhD curricula were reviewed:
 - Departments of Crops Horticulture and Soil Science (7), Animal Science (3), Agriculture Economics and Agribusiness Management (2), Dairy Food Science and Technology (1).
- Makerere University:
 - Postgraduate Diploma and Masters of Science in Computer Science.
 - Postgraduate Diploma and Masters of Information Technology.

- Postgraduate Diploma, PhD and Masters of Information Systems.
- Postgraduate Diploma and Masters of Data Communications and Software Engineering.
- JKUAT:
 - BSc Horticulture.
 - BSc Environmental science and landscaping technology.
 - Various courses in the Department of Agricultural and Resource economics.

Visibility

- Website.
- 2 conference publications, newsletter and policy brief.

↑ Outcomes

- Improved perception and acceptance, from both graduate students and supervisors, of introduced methods and tools in student mentoring and supervision.
- Opportunities for universities and industry to collaborate in research, standardisation and enhance physical research infrastructure.
- Economies of scale and optimal use of available resources in providing efficient services to universities for mentoring and supervision of postgraduate students.

🎯 Impacts

Usage

- Exchange of external examiners and supervisors and the sharing of peer reviews is possible due to the platform.
- Graduate students are able to acquire research publications and use them in preparing their own research.

of PhD programmes across the east African region.

Sustainability

- The partnership has committed resources to the platform and is committed to expanding the platform to other institutions. Engagement with the community of Open Source Software Developers will ensure continuous improvement of the platform.

Policy

- Due to the success of the platform and a high demand from other universities, the platform has the potential to harmonise HEI policy regarding the organisation



Partners attending the End of Project meeting held at Corat Africa, Nairobi, Kenya.

TESTIMONIALS



Mr. Felix Akatch, Egerton University graduate alumni, Kenya

“I benefited from career mentorship talks by labour market actors. I was inspired to develop a business idea and now run a consultancy in the livestock industry.”



Dr. James O. Owuoché, Department of Crop Horticulture and Soil Science, Egerton University, Kenya

“As supervisor, mentor and board member of the graduate school, I participated in reform initiatives in graduate student supervision and mentorship.”

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*Programme de Coopération ACP-UE
pour la Science et la Technologie (S&T II)*





ACP Science
and Technology II Programme

WIKWIO – Weed identification and knowledge in the Western Indian Ocean

SUMMARY OF RESULTS

A collaborative web platform on tropical weed flora was created. *Socially*, a network of 780 actors interested in tropical weeds (researchers, teachers, students, technicians and farmers) was established. Individual and institutional capacity was built: 10 technician jobs created, 13 students supervised and 71 training sessions held in eight countries. *Technologically*, new tools for collaborative work (web portal, IDAO 'IDentification Assistée par Ordinateur' identification system, mobile applications for data collection and identification) were developed that respond with great efficiency to stakeholders' needs. *Technically*, knowledge on 420 tropical weed species was assembled and c.10,000 field observations collected. *Conceptually*, a new approach of collaborative work and knowledge sharing in the field of agricultural science was demonstrated. A growing interest in other regions of the world was raised which will lead to the extension of the portal in other tropical areas.



Trainees collecting and identifying weeds in a banana plantation, Ivembeni farm, Comoros (October 2015).

PROJECT IMPLEMENTATION PERIOD

November 2013 - February 2017

CONSORTIUM

- CIRAD - Centre de coopération Internationale en Recherche Agronomique pour le Développement, France
- Institut Français de Pondichéry (IFP), India
- Mauritius Sugarcane Industry Research Institute (MCIA/MSIRI), Mauritius
- Centre National pour le Développement Rural (FOFIFA), Madagascar
- Centre National de Documentation et de Recherche Scientifique (CNDRS), Comoros

Associated partners:

- Center for the Coordination of Agricultural Research and Development in Southern Africa (CCARDESA), Botswana
- Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), Uganda

PROJECT CONTACT

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thomas.le_bourgeois@cirad.fr
www.cirad.fr

PROJECT WEBSITE

www.wikwio.org
http://portal.wikwio.org

BACKGROUND

Weeds are considered one of the main constraints in tropical agriculture. They cause between 20-80% of yield loss and their management represents about 50% of farmers' time. Different stakeholders are concerned by this problem: farmers who have to appropriately manage weeds to increase their production, extension staff who must be able to help farmers resolve weed management problems, students and lecturers learning and teaching weed science, and researchers – of which there are too few in tropical areas – to be able to study the full spectrum of weed issues (identification, ecology, biology, control...).

The research hypothesis was: there is no single complete source or authority on weed management, but the complete knowledge (empirical, technical and scientific) is spread amongst different stakeholders. If this knowledge and/or the problems are shared with other stakeholders, through a dedicated and efficient knowledge platform, all stakeholders will benefit from comprehensive information to improve weed management practices and obtain better yields. Information on weeds and weed management to elaborate optimal weed management practices is quite scarce, dispersed and not easy to obtain, particularly from African institutions (scientific, academic or technical) and grey literature. Hence, can the project elaborate

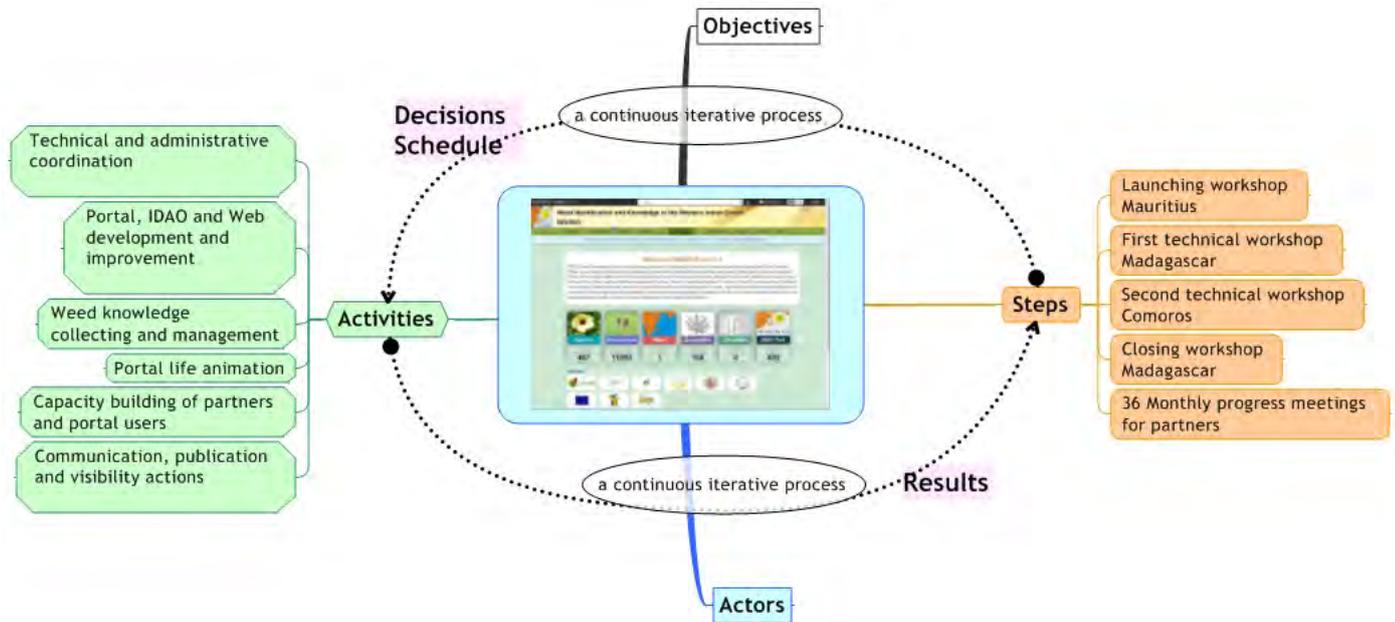
a Web collaborative system where all this information can be stored, synthesised and made immediately and publicly accessible? Can it also provide tools which allow any actor to contribute to this knowledge-sharing process by posting information, documents, observations of (un)known species and discuss problems / solutions with other actors of the network?

Two already tested ICT technologies were combined. The collaborative Web portal of the Indian Biodiversity Portal was adapted to weed management and integrated with the IDAO (*IDentification Assistée par Ordinateur*) species identification system. Furthermore, the IDAO identification module was made available to multisystem applications (PC on- and offline, mobile for Android and iPhone operating system iOS) and in English and French.

The participating institutions have extensive experience in weed science and management to collect and compile weed data, as well as long-term background in computer development for collaborative portals and IDAO (CIRAD patent) to develop and improve the tools. They also have regional outreach potential to support agricultural development in the Western Indian Ocean area as well as in continental Eastern and Southern Africa.



METHODOLOGY



The workshops were the highlights of the project during which the partners presented the project progress and tools and trained local and regional actors in their use.

Web portal and IDAO development

The Wikwio portal and associated mobile tools were set up and continually improved. The platform of the portal is built on a Linux Ubuntu operating system with PostGRES, PostGIS, database, Apache tomcat application server, and grails framework. Any information on the portal is under the Creative Commons license framework. Mobile applications were developed in Java language. All data, knowledge, pictures and documents are stored in the portal's database and are publicly accessible.

The portal and mobile applications (Wikwio CS - Citizen Science - for the collection of observations and Wikwio IDAO for identification) were upgraded to a bilingual version (French/English) integrating taxonomic management and species traits management and a Wikwio IDAO multiplatform for on-, offline and mobile use. Feedback from users was collected to evaluate the efficiency of the identification system and improve the portal and mobile applications.

Web portal feeding and animation

With an initial list of 200 weed species from the South West Indian Ocean region the portal was extended to 420 species found in the region's cropping systems. Nearly 10,000 field observations on c.1,000 species were posted. 11 working groups produced weeding recommendations and a bibliography of 100 documents was shared in the documents module.

Weed pictures and specimens were collected during weed surveys in different agro-eco-



Students from the Ravelojaona Politics Studies Institute, Antananarivo, Madagascar, during a training using the Wikwio weed identification tools (April 2017).

logical zones of Madagascar, Comoros and Mauritius. Large amounts of data obtained from previous weed surveys in tropical zones were also entered in the portal's database. Guidelines for taking pictures of weeds and for collecting and preparing herbarium specimen were established. The animation work of the portal included the feeding of the species pages, the identification of observations, the follow-up of discussions and the feeding of the working groups.

With the contribution of nearly 900 members, the portal has been fed on a regular basis, making a very large amount of information on regional tropical weeds available to the general public.

Capacity building

Trainings in the use of tools (portal, IDAO, mobile apps) were carried out in Mauritius, Madagascar and Comoros for farmers, extension staff, lecturers, students and scientists, but also in other African countries (Zambia, Malawi, South Africa, Senegal, Côte d'Ivoire, Reunion Island, Mayotte) in close collaboration with national institutions. In the annual

workshops, weed scientists and technicians from other countries in the region (Ethiopia, Tanzania, South Africa, Rwanda, Swaziland, Zimbabwe, and Reunion Island) were trained in the use of the tools which they practiced later on in their own countries. Technicians of the participating institutions in Mauritius, Madagascar and the Comoros were strengthened in their skills in weed science, while 14 students from various universities were supervised during their internship (technician, BSc, Master and PhD).

Communication and publication

The Wikwio project informed the general public, stakeholders and institutions of its objectives and results, and took into account stakeholders' feedback and knowledge on weeds (from users of the tools who became collaborating members on the portal). Information was disseminated to: citizens through general media (TV, radio, newspapers and Netnews); institutions through institutional Websites and newsletters; the extension community in technical journals; and the scientific community at conferences and through scientific papers.



Attendees of the final workshop identifying weeds with the mobile app Wikwio IDAO on the Ivato farm, Madagascar (October 2016).

→ Outputs

Toolkits

- 1 Wikwio collaborative website (English, French).
- 1 Wikwio portal user guide (English, French).
- 1 Wikwio participatory portal (English, French).
- 1 database for 420 species pages (English, French).
- 1 matrix of species characters for IDAO identification system (420 species / 253 characters).
- 1 IDAO app for PC offline: 500 USB Keys and downloadable.
- 1 Wikwio Citizen Science (CS) mobile app for Android (available on Google Play).
- 1 Wikwio Citizen Science mobile app for iOS (available on Apple Store).
- 1 Wikwio IDAO mobile app for Android (available on Google Play).
- 1 Wikwio IDAO mobile app for iOS (available on Apple Store).
- 2 technical guidelines: taking photos, preparing herbarium specimen (English, French).
- 8 guidelines for weed management (English, French) on: annual and perennial grasses, sedges and broadleaf plants; parasitic plants; aquatic plants of lowland rice fields.
- 22 PowerPoint files on the project, the portal, the mobile apps and the IDAO identification system.

Capacity building

- 862 students, farmers, advisory staff, extension staff, researchers and public servants (32% female) trained in the use of the portal and associate mobile tools in 12 countries: 4 training sessions during regional workshops in Comoros, Madagascar and Mauritius; 71 training sessions for local stakeholders in France, Zambia, Malawi, South Africa, India, Côte d'Ivoire, Senegal, Mozambique and India.

Visibility

- 780 registered members on the WIKWIO weed knowledge portal; 12,156 users from 156 countries.
- 3,500 project leaflets (English, French).
- 11 interviews in local press (TV and radio).
- 24 articles in newspapers and Netnews (Comoros, Madagascar, Mauritius).
- 1 video documentary on YouTube.
- 3 interviews on YouTube.
- 6 presentations in 6 universities.
- 7 presentations at international conferences and national congresses.
- 2 articles in technical journals.
- 1 scientific book chapter.
- 8 ministers or representatives and several

directors of agricultural research institutes attended the technical workshops.

- 13 articles in institutional websites.
- 9 articles in institutional and scientific societies' newsletters.

Publications

- Vattakaven T. *et al.*, 2018. Traits: Structuring species information for discoverability, navigation and identification. Multimedia tools and applications for environmental & biodiversity informatics. Joly A., Bonnet P., Vrochidis S., Karatzas K. and Karppinen A., Springer Verlag ed.: 89-108.
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- Prabhakar R. *et al.*, 2016. An open participatory species traits infrastructure to organize and discover species information. TDWG 2016 Annual Conference. Santa Clara de San Carlos, Costa Rica.



WIKWIO portal (<http://portal.wikwio.org>).



Identifying weeds with the mobile app.

RESULTS



Outcomes

- The Wikwio portal has brought together agriculture stakeholders around an open data, knowledge-sharing platform, strengthening their weed management capacities across the wider tropics. Registered members are sharing knowledge and retrieving information.
- The Wikwio portal and tools are popular in Mauritius, Comoros, Madagascar, South Africa and Réunion Island as they are considered as essential knowledge tools on weeds and their management due to the increasing use of smart-phones and Internet.
- Researchers and weed scientists acquainted in retrieving information on weed species and posting new observations on already known or unidentified species.
- New weed management practices developed by weed scientists and farmers.



Impacts

Usage

- Lecturers from agricultural universities are using the Wikwio tools to teach plant identification and tropical weed science.
- Students in agronomy or weed management are using the Wikwio portal to identify weed species, get information on weeds, consult literature on tropical weed science, post observations from their studies and contribute to species pages by comments from their study results.
- Extension staff is mostly consulting information on weed behaviour and management in order to help farmers. They also occasionally post observations, specifically for unidentified species found in fields for which they require identification assistance.
- Farmers are mostly consulting the species pages as a classical web page, just to get information on weed behaviour and management recommendations. Few of them are posting observations for unidentified weeds.
- Wikwio will play an important role for the smart agriculture of tomorrow in the

Western Indian Ocean and other tropical areas.

- Since the end of the project, 8,446 new users have visited the portal.
- The portal's use among agricultural stakeholders is increasing continuously. People from other tropical areas are interested in this portal and weed identification approach, and wish to expand the portal to their area and related weed flora.

Policy implications

- Currently there is no regulatory text specifically addressing crop weed management in the region. However, Réunion Island and Mayotte (French overseas departments) are concerned by the regulation of the Ecophyto 2025 plan for the 50% reduction of pesticides by 2025. Countries like Mauritius are also reducing their use of agricultural pesticides, particularly through initiatives like smart agriculture implemented by their Chamber of Agriculture. The WIKWIO portal

contributes to these strategies by facilitating the dissemination of knowledge and information on an effective and reasoned management of crop weeds.

Sustainability

- CIRAD has started to include data and new weed species for pastures in New Caledonia. Further expansion is expected for West and Central Africa, French Guyana, West Indies, South East Asia, Pacific Ocean...
- The Wikwio portal is expected to evolve into a WIKTROP portal (Weed identification and knowledge in the tropics).
- Discussions are on-going in the Mediterranean area and temperate French areas to develop a similar set of tools (portal and mobile apps) dedicated to Mediterranean and temperate weeds and cropping systems.
- Project partners will continue work in the South West Indian Ocean region, and are looking to expand to other tropical regions and seek further funding.

TESTIMONIALS



Jean-Jo Esther, weed management technician, eRcane, Réunion Island

“As a regular user of Advenrun software, it was natural to turn to Wikwio after receiving training on the use of this platform. I mainly use three modules: the ‘Species’ module to verify the identity of species using the very detailed descriptive sheets; the ‘Observations’ module allows me to appeal to the community for the identification of species for which I have little information and mostly only photos; and the ‘IDAO’ tool when I bring back a sample that I want to identify. In my contacts with technicians and farmers, I mention Wikwio as the most complete tool currently available for the recognition of weeds in sugar cane fields in Réunion which can be easily installed on a mobile phone and taken to the field.”



Pierrot Serge Randrianaritiana, Permanent Secretary, Ministry of Agriculture and Livestock, Madagascar

“Agricultural policy not only concerns the increase of food productivity, the improvement of seeds, the use of new techniques, and the production of fertilisers, but also the various ways to eradicate weeds. The use of new ICTs is the solution proposed by the Ministry to facilitate the detection and control of weeds in our agricultural fields.”

ACP-EU Co-Operation Programmes in the fields of Higher Education and Science, Technology and Research

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SATTIFS – Strengthening innovation and technology dissemination for sustainable development in cereals, cocoa and coffee value chains in Western and Eastern Africa

SUMMARY OF RESULTS

The participating universities have strengthened their capacity to tackle food security and economic development issues in the agricultural sector at local level. Three Centres for Innovation and Technology Dissemination (CITED) were created with staff interacting with, and laboratories providing mycotoxins and food analyses for, researchers, farmers, public administrators and suppliers.

Trainers-of-trainers, farmers, researchers and consultants were trained in the management and organisation of sustainable crop farming. Artisans were trained to accurately respond to the specific needs of clients in the production of agricultural equipment (ploughs, seeders, dryers). Manuals for the application of appropriate technologies (use of oxen for sowing, cultivation associations, packaging for grain storage and drying plants...), as well as guidelines on correct supply chain management of cocoa, coffee and cereals were developed and widely distributed to farmers.



Field inspection before sowing maize at a farmer's field, Techiman, Ghana (August 2014).

PROJECT IMPLEMENTATION PERIOD

January 2014 - June 2017

CONSORTIUM

- Università degli Studi del Molise (UNIMOL), Italy
- Agenzia Regionale per la Protezione Ambientale del Molise (ARPA Molise), Italy
- Gulu University, Uganda
- Bioeconomy Africa, Ethiopia
- University of Energy and Natural Resources (UENR), Ghana

PROJECT CONTACT

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PROJECT WEBSITE

<http://www.sattifs.unimol.it/index.php/en/>

BACKGROUND

Poor production and post-harvest and processing practices in many African countries are resulting in low quality agricultural products. For instance, mycotoxin contamination in crops is an issue for African exporter countries as these crops do not meet the quality standards defined for imports in the European and global markets.

The African absorptive capacity for new (appropriate) technologies (ATs) is low: when new technologies are introduced, often in an attempt to leapfrog existing technologies, they are often adopted incompletely, inefficiently used or later abandoned. Low adoption and use of ATs can be attributed to poor linkages between key actors in the knowledge or innovation systems (research community, public research organisations, universities, industries and farmers). In addition, there is also a weak framework for technology and innovation dissemination. For these purposes, the creation of Centres for Innovation and Technology Dissemination (CITED) implied, among others, identifying the profiles of CITED staff that represent a bridge between farmer associations, farmers and final beneficiaries of initiatives. The stakeholders of various agri-food sectors (maize, rice, cocoa, and coffee) of Ethiopia,

Uganda and Ghana were approached for identifying the real needs of the different actors in these sectors and for fine-tuning the project's innovation and dissemination activities.

The involved stakeholders were: district agricultural extension departments, public and private research institutions, universities, civil society organisations, private entrepreneurs and farmers' associations (sector-specific according to the commodity). They collected baseline information on the existing technologies in the three African countries in the different production value chains, disseminated project findings and selected the technologies for dissemination to farmers to increase the productivity of the crops as well as to facilitate joint learning and knowledge sharing among participants at demonstrations and farmer field schools.

The project beneficiaries were: university professors; researchers; post-graduate students; coffee, cocoa, maize and rice farmers; agricultural extension agents; agricultural consultants; and other stakeholders in agro-food chain sectors (Ethiopia: grains and coffee; Ghana: maize and cocoa; Uganda: maize and rice).



METHODOLOGY



Centres for innovation and technology dissemination (CITED)

In the universities where the CITEDs would be located, an **infrastructure survey** was carried out to establish the laboratories and equipment available for chemical-physical and microbiological analyses of agricultural products. This survey allowed for the construction of an inventory that served to effectively equip the laboratories to carry out mycotoxin analyses.

Three **CITEDs were created** and integrated into each participating university and represent a useful counter for farmers and other interested stakeholders. Specialised staff was selected for the CITEDs to promote sustainable agricultural production and food security, among others by appropriate technologies (ATs) like mycotoxin analysis, skills and knowledge. Office equipment and kits for mycotoxin analysis were procured.

CITED staff were trained, as well as farmer trainers and artisans, in sustainable crop management including organic treatments, drying and packaging.

A continuous exchange of information with stakeholders has been activated by CITED and the universities to check existing and potentially exploitable knowledge and technologies. Several workshops have been organised by CITED, in conjunction with field trials and

the adoption and effectiveness of new technologies, to disseminate the results obtained and discuss critical issues.

Dissemination and promotion of successfully proven appropriate technologies (ATs)

'Demonstration farms' were established for three main purposes. Firstly, to demonstrate the best locally available technologies in different crop production techniques to farmers, secondly to interact with the target farmers, and finally to select suitable farmers who could go on to apply the new technologies. At these model farms local farmers were trained in the effective use of appropriate technologies in the maize, rice, cocoa and coffee value chains. Researchers and technicians of the agricultural sector were trained to disseminate good sustainable agricultural practices and post-harvest in a practical way. The emphasis was on the correct application of production inputs that would sustain the environment as well as maximise crop production, such as ensuring seed varieties, plant population, soil tillage and fertilisation, weed control, insect and disease control, and post-harvest management practices.

One of the most acceptable means of technology dissemination is at **'farmer field schools'** where farmers receive hands-on field training. In Uganda, for instance, the primary technology disseminated was the animal drawn rice

and maize planter. The problem of weeding, after sowing, was then tackled. Thus, weeders were also delivered to farmer groups. The rationale for this was that once the farmers become familiar with the planting technology, weeding should become much easier. Other field trial activities involved collection of crop samples for analysing aflatoxin prevalence.

Training-of-trainers on the use of proven ATs was customised to the desired topics of the participating countries (cocoa crops, cultivation of new maize varieties, and drying and coffee bean treatments). Training and facilitation of artisans, mechanics and blacksmiths took place with a particular focus on the construction and maintenance of ploughs and seeders, drying plants (for cocoa) and wetting plants (for coffee).

Preparation of manuals on selected ATs. A manual on the animal-drawn rice planter was produced both in English and a local dialect. It was distributed to local Ugandan farmers with the purpose of planting different rice seed varieties at the right depth, one seed per hole and plant spacing at the required seed rates. Another manual on conservation agriculture for boosting productivity and contributing to reducing land degradation was written and distributed in the Robe district in Oromia region, Ethiopia. Finally, a manual for maize production was produced for local farmers in Ghana.

→ Outputs

Capacity building

- Training for 15 CITED staff (12 male, 3 female) and 75 trainers-of-trainers (43 male, 32 female; including farmers, researchers and consultants) on:
 - Integrated pest management in cacao, coffee and cereals production.
 - Principles of sustainable agriculture.
 - Food safety and quality assurance.
 - Analysis of food products.
 - Post-harvest processing.
 - The economics of sustainable farming.
- Ghana: 2 Farmer Field Schools on the use of appropriate technologies in maize production: 59 farmers (25 male, 34 female) trained by CITED and public agricultural extension staff. They also monitored over 100 farmers on the state of their maize after storage in hermetic bags for 3-6 months.
- Ghana: Aflatoxin training workshop for 34 participants (23 male, 11 female): maize farmers, food processors, food vendors, agricultural extension staff, food regulators, public health practitioners, students and the media.
- Uganda: 6 Farmer Field Schools on animal-drawn rice and maize planters for 200 farmers (148 male, 52 female).
- Ethiopia: 1 stakeholder workshop on coffee cultivation and processing for 60 farmers (48 male, 12 female).



Laboratory for food analyses at CITED in Gulu University, Uganda (September 2014).

Appropriate technologies

- A transportable grain dryer to serve the villages close to Gulu (Uganda).
- 'Domestic' packs (about 60 kg capacity) with a high barrier against oxygen and humidity to keep healthy dried maize at farms from season to season (Ghana).
- A transportable coffee grain wetting plant to serve the cooperatives of Delo Mena villages near Harenna Forest (Ethiopia).
- ELISA (Enzyme-Linked-Immuno-Sorbent-Assay) method introduced in the 3 CITEDs at the service of farmers and grain transformers for the analysis of mycotoxins.



Transportable prototype of grain dryer before shipping to Gulu (Uganda), Naples, Italy (September 2016).

Documents

- 65 baseline reports on the existing production and processing technologies in the value chains of cocoa, coffee and cereals in Ghana, Uganda and Ethiopia.
- 193 manuals on selected Appropriate Technologies (distributed to farmers, agricultural extension officers, local offices for agricultural development, local administrations, regional universities and training centres, other stakeholders, and participants at promotional events).

Visibility

- Project website.
- 586 brochures, 162 leaflets and 634 posters (distributed to farmers, local institutions, regional universities and training centres, participants at promotional events).
- 340 project stickers (attached to project instruments).

Publications

- Opare P., Adjei-Ohemeng J., Lartey M., Obeng-Ofori D., Panfli G., Cinquanta L., 2015. Enhancing maize production by resource-poor farmers in Ghana through effective technology dissemination systems. Proceedings of the International Conference ICC/AISTEC 'Grains for feedings the world'. Milan, Italy.
- Cinquanta L., Manoni R., Nyeko M., Obeng-Ofori D., Panfli G., 2015. Strengthening innovation and technology dissemination for sustainable development in cereals, cocoa and coffee value chains in Western and Eastern Africa, SATTIFS. Proceedings of the International Conference ICC/AISTEC 'Grains for feedings the world'.
- Cinquanta L., Fratianni A., Panfli G., Albanese D., Malvano F., Di Matteo M., 2015. Comparison and perspective among analytical methods for determination of ochratoxin A (OTA) in cocoa. Proceedings of the 3rd International Congress on Cocoa Coffee and Tea (CoCoTea - Aveiro Portugal).
- Cinquanta L., Salvatori G., Di Cesare C., Manoni R., Piano A., Roberti P., 2015. Mineral essential elements for nutrition in different chocolate products. Proceedings of the 3rd International Congress on Cocoa Coffee and Tea (CoCoTea - Aveiro Portugal).
- Cinquanta L., Manoni R., Nyeko M., Obeng-Ofori D., Panfli G., Zampino S., 2016. Food science and technology dissemination in Africa: the case of the SATTIFS cooperation project. Proceeding 4th International ISEKI_Food Conference, Vienna, Austria.
- Cinquanta L., Di Cesare C., Manoni R., Piano A., Roberti P., Salvatori G., 2016. Mineral essential elements for nutrition in different chocolate products. International Journal of Food Sciences and Nutrition. 67(7):773-8.

Crops

- 5,000 cocoa seedlings distributed to farmers.

Facilities

- 3 Centres for Innovation and Technology Dissemination (CITED) at Gulu University (Uganda), Bioeconomy Africa (Ethiopia) and University of Energy and Natural Resources (Ghana) equipped with a laboratory for the determination of mycotoxins in plant products (cereals, cocoa and coffee).



Laboratory for mycotoxin analyses at CITED in Madda Walabu University, Robe, Ethiopia (October 2015).

RESULTS

Outcomes

- The CITEDs have strengthened the capacities of participants to manage food security and economic development issues in the agricultural sector at local level.
- The CITEDs have improved the linkages between agricultural stakeholders and universities.
- CITED staff are able to meet the needs that weather conditions or crop epidemic attacks can cause.
- Farmers have been exposed to innovative crop farming with environmentally sustainable techniques, in particular basic and practical knowledge on a good storage environment, including a proper storage facility and pre-storage activities, such as harvesting, drying, threshing or cleaning, to maintain the quality and quantity of stored grains and seeds.
- Teachers, researchers and students of the participating universities have expanded their skills in post-harvest management and control of safe raw materials (i.e. mycotoxins).

Impacts

Usage

- The control of mycotoxins has encouraged the development of technologies and innovations in the various production phases of maize, coffee and cocoa: from cultivation to consumption, emphasising sustainable development and food safety.
- The quality control (analysis of mycotoxins) of coffee and cocoa will become an instrument to correct any errors during the production and conservation of plant products, resulting in increased export to the EU and USA.
- The control of the quality of the raw material can substantially increase the profitability of small farms.

Policy implications

- The transportable drying and wetting plants will spread these processing technologies throughout the different villages near the universities where the CITEDs are located.
- The formulation and implementation of new policies are expected to provide useful information and support to farmers to cooperate and produce food in a sustainable and safe way.

Sustainability

- Some modules of university courses are being developed (plant pathology, chemical analysis of food, microbiology, post-harvest) in collaboration with UNIMOL to improve university training and dissemination of research findings.
- Specific research on mycotoxin contamination in local production systems is foreseen, in particular on cocoa (Ghana), maize (Uganda) and coffee (Ethiopia), to manage food safety and provide useful information to both producers and processors to reduce contamination.

TESTIMONIALS



Ellen Antwiwaa, cocoa farmer in Goaso, Ghana

“I never previously thought about the local technologies that I can use to improve my yield. For example the selection of fertilisers and the period to apply them are critical, the knowledge of different cocoa diseases, and so on. The training on the different steps of cocoa production, from nursery preparation to harvest, is a great experience, which has to be repeated at least once a year, because it helps us to learn about new technologies that can be used in cocoa production to improve the yield.”



Okya Peter, rice farmer in Gulu, Uganda

“The introduction of ox-drawn rice planters and ox-drawn rice weeders will allow me to increase the cultivated area because it will decrease the operational costs. I also think that the collaboration with the university is important because it will allow us to have news about local new technologies and improve our incomes.”



Nicolas Miwomunyuie, student at UENR, Sunyani, Ghana

“I never learnt about mycotoxins in food, but through training on the ELISA method, I have gained some knowledge and this is amazing. I hope to deepen this research during my university career, because I want to investigate mycotoxins in African food.”

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ACP Science
and Technology II Programme

GMASSURE – Assuring agricultural and food safety of genetically modified organisms (GMOs) in Southern Africa

SUMMARY OF RESULTS

Capacity-building events provided stakeholders with objective information, enabling them to be active, informed participants in the debate about genetically modified organisms (GMOs). After an awareness-raising symposium, several training events were held on biosafety, food safety and science communication. These were followed up by workshops on cultural and religious issues related to agriculture and biotechnology, topics around GMOs in agriculture, and the impacts of new biotechnologies in agriculture in the Southern African Development Community (SADC) region. Resource booklets for extension officers were produced on new technology developments, reflecting current opinion and providing an informed view on the status of GMOs in the participating countries. Videos have been produced on risk assessments for genetically modified crop traits, risk-benefit assessments, the identification and labelling of genetically modified products, and regulatory systems in different countries.



Regular and golden rice, the latter bio-fortified with vitamin A precursor beta-carotene through genetic modification technology. Bio-fortified rice can benefit millions of poor people, but regulations and fear of genetically modified organisms (GMOs) prohibit the widespread uptake of the technology.

PROJECT IMPLEMENTATION PERIOD

January 2014 - June 2017

CONSORTIUM

- University of Pretoria (UP), South Africa
- Agricultural Research Council (ARC), South Africa
- Council for Scientific and Industrial Research (CSIR), South Africa
- University of Namibia (UNAM), Namibia
- University of Johannesburg (UJ), South Africa
- University of Zimbabwe (UZ), Zimbabwe
- Technical University of Denmark (DTU), Denmark

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PROJECT WEBSITE

www.gmassure.org

BACKGROUND

Agricultural production in the SADC region is currently at a crossroads. Only South Africa has invested heavily in agricultural biotechnology and particularly in the application of genetically modified crops. Even within South Africa there remains considerable debate around genetically modified organisms (GMOs), with conflicting viewpoints and legislation emanating from different government departments.

The major staple food in the SADC region is maize. However, 2011 estimates show that only South Africa, Zambia and Malawi produced surpluses of this crop, with South Africa being a major supplier to the rest of the region. The development of a SADC regional agricultural policy is in process. It is not yet known how or if such a policy will incorporate aspects of agricultural biotechnology. Policy coordination on pertinent issues such as the production and sale of genetically modified grains is limited.

In the Southern African environment, policy makers and regulatory authorities are heavily reliant on expertise within universities and research institutions to advise them as to the safety of GMOs and their derived products. Yet, despite many training courses in biosafety, the general level of expertise amongst both government officials and scientists remains low, and there is a lack

of confidence in terms of decision taking. There is also a lack of hands-on experience in biotechnology techniques and much knowledge remains theoretical. Staff turnover is an on-going problem in many institutions, so that training of single individuals does not sufficiently embed the knowledge in the organisation.

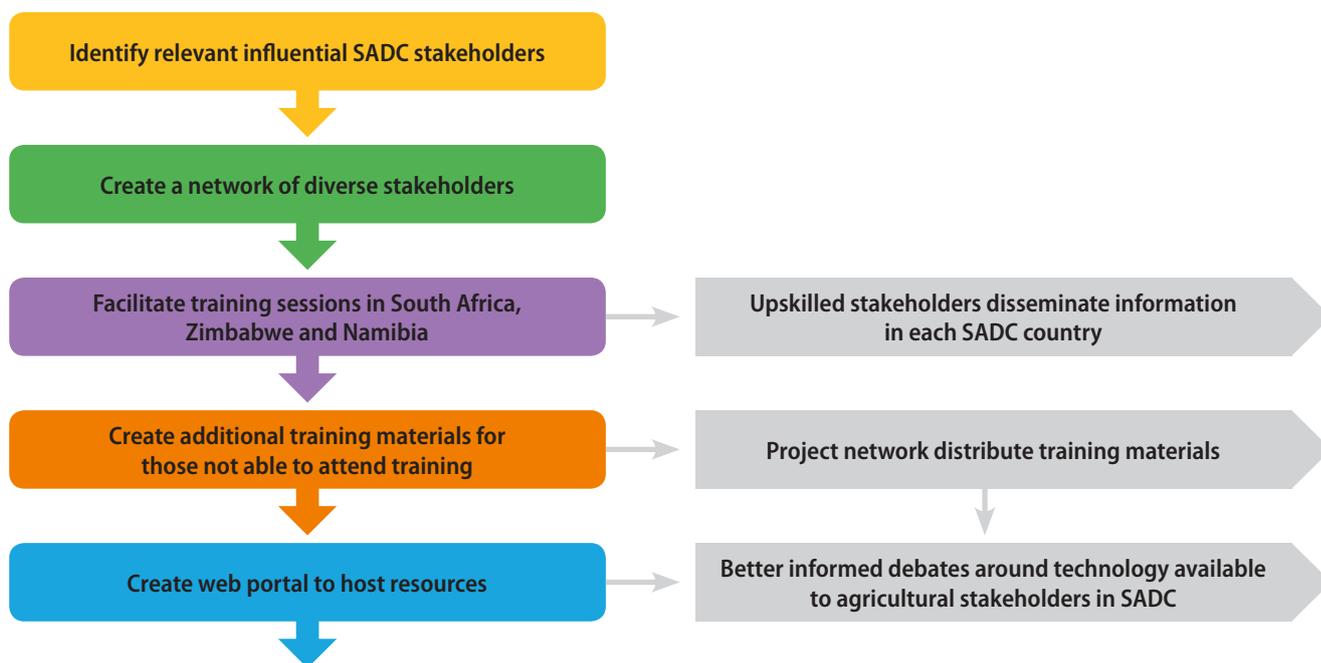
The project, therefore, targeted scientists and government officials in Southern Africa, complemented by outreach to farmers, consumers and other stakeholder groups. Scientists would be provided with the knowledge and expertise to embed training programmes on biotechnology and biosafety in their institutions, to ensure sustainability, as well as to provide information and advice to policy and decision makers, farmer organisations, agro-processors, consumer organisations and others in the agricultural value chain.

The project beneficiaries were: government officials and policy-makers responsible for handling GMO regulatory issues; the general public who require reassurance that GMOs are safe; farmers and others in the agriculture and food value chain who need to take decisions regarding the adoption of new technologies; and scientists and students who will benefit from having better information regarding GMO safety.



Danmarks Tekniske Universitet

METHODOLOGY



Identification of stakeholders

Relevant stakeholders, who would be able to influence the debate on agricultural biotechnology in their home countries, were identified in each SADC country.

Creation of stakeholder network

Events where stakeholders were trained served as networking platforms. These were supplemented by interactive workshops in each country, which helped to further solidify relationships between the different actors. An initial symposium was organised with key decision makers in the SADC region to highlight the importance of GMO biosafety for agriculture and food security and to ensure that the relevant people attended training courses. By bringing scientists and government officials from different countries in the region together for short courses and workshops, they had opportunities to share experiences and build a community of practice. This should stand them in good stead when they are faced with issues regarding GMOs in their own countries, since they will have a network of colleagues to support them.

Training sessions

The 'train-the-trainer' approach was applied, providing scientists and government officials and their colleagues with the materials to enable them to embed the information in their own institutions and to further disseminate these. This was supplemented through the online biosafety modules, which are availa-

ble as training materials on the project's web portal.

The inclusion of a course in the '-omics' techniques was regarded as an important step towards building additional skills in the region that are relevant for biosafety. While it is recognised that many of the scientists will have limited ability to use these techniques in their home institutions due to lack of equipment and expertise, nevertheless they gained new skills and are able to share the information at a theoretical level.

The following training courses and workshops were held in South Africa, Zimbabwe and Namibia:

- Biosafety risk analysis.
- Science communication to effectively disseminate information to farmers, extension officers and others in the agriculture value chains.
- Awareness raising of new biotechnology developments and their possible regulatory implications.
- Cultural and religious issues related to agriculture and biotechnology.
- The role of new '-omics' techniques (transcriptomics – gene expression profiling, 'next generation' sequencing; proteomics - protein profiling; and metabolomics - metabolomic analyses of food products) in assuring biosafety was demonstrated to scientists from research institutions. A workshop was held to discuss regulatory

implications of new biotechnology techniques beyond current GMOs.

- Impacts of new biotechnologies in agriculture in the SADC region.

Training materials

Accurate and appropriate information on GMOs was produced and disseminated: newsletters and brochures, the creation of an online biotechnology and biosafety panel to which questions and comments can be submitted, and interactive workshops with cultural and religious leaders in the region.

Web portal

All training and information materials were made available online, ensuring that the materials are also available to new employees of key organisations, countering some of the effects of high staff turnover and attrition. Linkages were also provided to other existing training resources.

Dissemination

Outputs were all directed towards the achievement of a common position on GMOs in the SADC region, through sharing of information and the provision of a cadre of trained and networked scientific personnel and government officials, with linkages to farmer organisations and other actors in the agriculture and food value chain. The interlinked activities address a variety of needs in the area of agricultural biosafety that are not dealt with through any existing programmes.

RESULTS

→ Outputs

Capacity building

- 12 training workshops and short courses for SADC stakeholders in South Africa, Namibia and Zimbabwe:
 - General biosafety (2).
 - Food safety with particular application to GMOs.
 - Addressing cultural and religious issues (3).
 - Interactive workshops (3).
 - Application of ‘-omics’ to biosafety.
 - Impacts of new biotechnologies.
 - Science communication.

Toolkits

- 13 online training videos on various agricultural biotechnology issues:
 - Risk assessment of Bt maize for food and feed use.
 - Risk assessment of Bt maize for general release and cultivation.
 - Risk assessment of herbicide-tolerant maize for food and feed use.
 - Risk assessment of herbicide-tolerant maize for general release and cultivation.
 - Risk assessment of Bt cotton for general release and cultivation.
 - Managing resistance to Bt.
 - Risk assessment of nutritionally enhanced crops.

- Risk benefit assessment method.
- Labelling and identification of GMOs.
- Risk assessment of crops with wild relatives in the region.
- Risk assessment of RNAi modified crops.
- Requirements for contained use facilities.
- Regulatory systems around the world and implications for new breeding techniques.

Networks

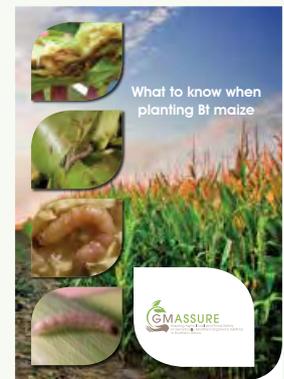
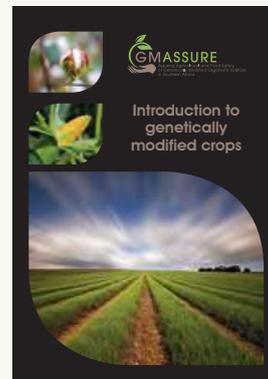
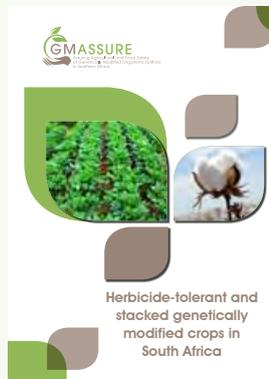
- Network of SADC agricultural biotechnology stakeholders.

Visibility

- Project website.
- 18 e-newsletters.
- Brochures.

Publications

- 3 resource booklets for extension officers:
 - What to know when planting Bt maize.
 - Herbicide-tolerant and stacked GM crops in South Africa.
 - Introduction to genetically modified crops.



SADC scientists and government officials going through the practical steps of analysing control and genetically modified crops at the level of transcript, protein and metabolite at the whole genome level. These sensitive techniques can distinguish minute differences between GMOs and their untransformed counterparts. Training conducted in Pretoria and Johannesburg, South Africa (October 2015).



Workshop on cultural and religious concerns surrounding agricultural biotechnology with different cultural and religious stakeholders.

RESULTS



Outcomes

- Cadre of SADC stakeholders (scientists and government officials) trained in GMOs and biosafety issues.
- Established network of SADC country representatives in agricultural biotechnology.



Impacts

Usage

- Cadre of SADC stakeholders (scientists and government officials) ready to participate in agricultural biotechnology debates in the region.
- Web portal as a reference for those actively participating in GMO debates.

Policy implications

- Informed decision-makers best empowered to accept or reject agricultural technologies in their respective countries.

- Policy developments in SADC are extremely slow, not only for the agricultural biotechnology field. However, Namibia launched a national GMO testing, training and research laboratory on 29 January 2018.
- SADC looks to Europe and the USA for policy guidance: however, different approaches to regulation of biotechnology crops followed in each of these regions leads to further confusion and delays in

African acceptance of agricultural biotechnologies.

Sustainability

- Information is readily available and debate should be advanced in SADC countries, especially as the severity level of droughts and pests may require intervention with new technologies.
- Stakeholders to sustain information dissemination efforts in each SADC country.



Women tending maize crops in Africa. It has been demonstrated that planting biotechnology crops such as maize could lead to labour-saving- where less spraying of herbicide and less weeding is required. This could free up vital time, especially for women, to attend to other activities.

TESTIMONIAL



Zama Ngungumbane
Mkwananzi, Mberengwa,
Midlands province,
Zimbabwe

“There was a lot of mistrust and suspicion among scientists, the government and the public when it comes to the controversial issue of GMOs with respect to technical, cultural

and religious issues. A lack of information had stalled a progressive debate about the potential benefits of genetically modified crops in the country.”

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ACP Science
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OPTIONS – Optimisation of pesticidal-plants: technology innovation, outreach & networks



Lead farmers show other farmers how to propagate pesticidal plants in homemade screen house, Moshi, Tanzania (October 2016).

SUMMARY OF RESULTS

Scientific, technological and application capacity of agricultural stakeholders to exploit pesticidal plants and optimise their use for smallholders was strengthened. Protocols and methodologies were designed and used for testing plants against target pest organisms in laboratory and field trials and for the propagation of eight key pesticidal plant species to guarantee supply. Thousands of trees and pesticidal shrubs have been planted in communities in Kenya and Tanzania. In Eastern and Southern Africa, existing partnerships with various stakeholders were consolidated, and commercial ventures established on small and large scale. Commercial opportunities for pesticidal plants, particularly Pyrethrum, have been established with major producers and policy makers in Kenya, and are being further developed in light of their environmental and economic benefits.

PROJECT IMPLEMENTATION PERIOD

January 2014 - June 2017

CONSORTIUM

- Natural Resources Institute (NRI) - University of Greenwich, UK
- Royal Botanic Gardens, UK
- University of Zimbabwe, Zimbabwe
- Mzuzu University, Malawi
- Sokoine University of Agriculture, Tanzania
- World Agroforestry Centre (ICRAF), Kenya
- Sustainable Global Gardens, UK
- National Museums of Kenya, Kenya

Associated partners:

- Centre For International Forestry Research (CIFOR), Indonesia
- Ministry of Agriculture, Irrigation and Water Development, Malawi
- Egerton University, Kenya
- Community Initiatives For Rural Development, Kenya
- Community Sustainable Development Empowerment Programme (COSDEP), Kenya
- Kenya Organic Agriculture Network, Kenya
- Indigenous Knowledge Centre (IKC), Malawi
- Environment Africa, Zimbabwe
- Pyrethrum Growers Association, Kenya

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PROJECT WEBSITE

<http://projects.nri.org/options>

BACKGROUND

The expected world population of 9 billion by 2050 and associated food demands places increasing pressure on global food production. Demand for land area to produce adequate food sustainably while reducing inputs is high and pest damage to crops is a major challenge to food and nutritional security and disproportionately affects poor farmers and low-input agriculture. Africa experiences this acutely due to 80% of food being produced by smallholders who farm marginal and degraded land areas of <2 ha, with little mechanisation or effective inputs (Sibhatu et al., 2015). Pest control is often overlooked because of the prohibitive financial outlay among many smallholders, but higher production rates are dependent on pest management. Current practices are reliant on agrochemical inputs, which have negative impacts on the health of both users and consumers, as well as on ecosystem services such as pollinators and natural pest regulation.

While food production and storage are limited by numerous constraints, insect pests are a manageable challenge for even the poorest of farmers who can exert control with low cost interventions. Furthermore, if left unmanaged, insects will invariably cause further, often severe damage. Pesticidal

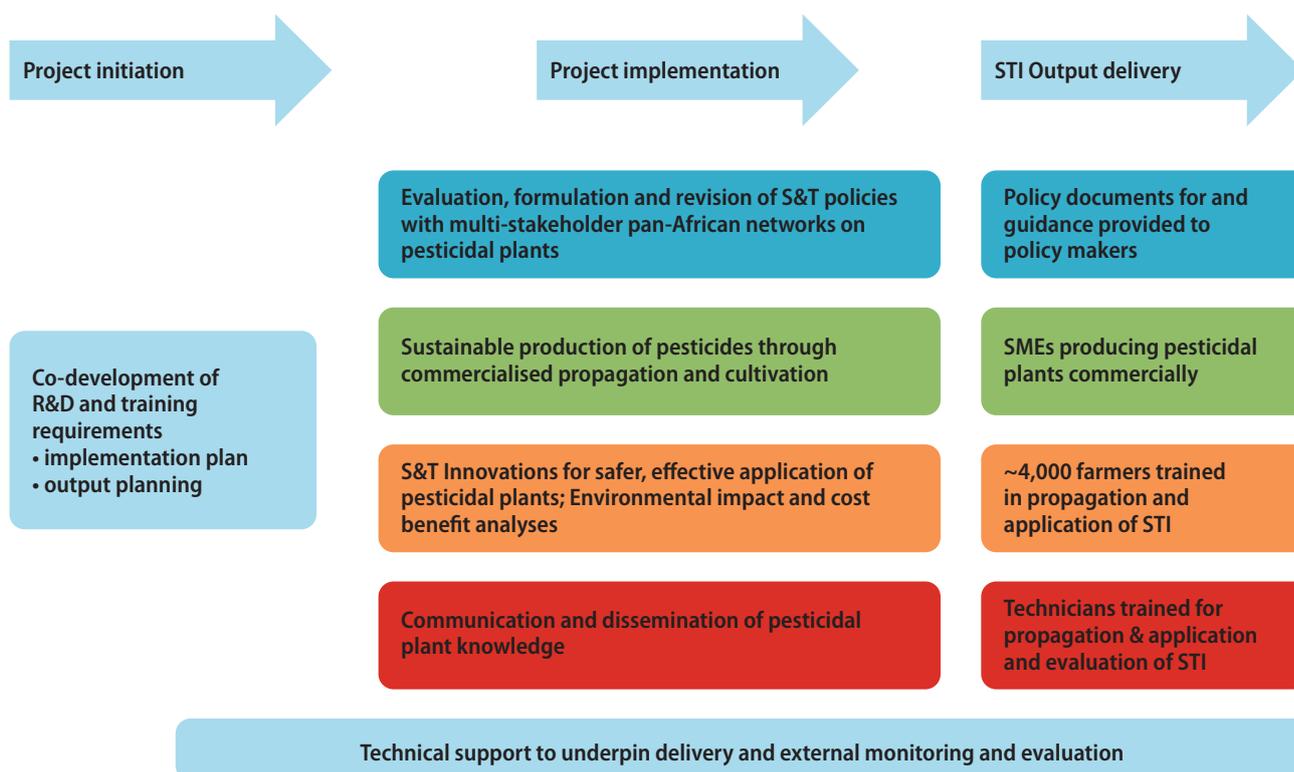
plants are a viable alternative approach to pest control and are widely used. However, greater knowledge is required about the optimisation of this organic intervention to enable farmers to benefit from their natural and more environmentally benign pest control properties.

The main problem addressed by the project was to maximise the opportunities for smallholders to use pesticidal plants to control pests in an economically viable, environmentally benign and effective way that improved crop production sustainably. The project also provided knowledge and tools to improve plant propagation permitting farmers to produce their own materials and potentially develop towards self-sufficiency and commercial production.

The main users of the outcomes were farmers, nursery growers, small enterprises commercialising indigenous plants for pest control, and government and non-government agricultural extension staff. Other beneficiaries included researchers from universities and the National Agricultural Research System (NARS) who learned new approaches to addressing scientific problems and conducting robust publishable scientific research.



METHODOLOGY



Evaluation, formulation and revision of Science and Technology policies with multi-stakeholder pan-African networks on pesticidal plants.

Engagement with policy makers took place to draw on their support for existing and new initiatives and to promote the use of plants as environmentally benign pesticides. The policy environment and current status of the pesticidal plants sector were assessed for their suitability for commercial production and documented in policy papers outlining opportunities and hurdles to up-scaling the use of pesticidal plant technologies for crop pests and livestock ectoparasites. Work has continued with policy makers at the highest level in East Africa, including the Governor of Nyandarua and Deputy Governor of Nakuru in Kenya, to support the revival of the botanicals sector.

Sustainable production of pesticides through commercialised propagation and cultivation.

>50 scientists / nursery growers per country - in three countries - were trained in propagation or innovative application protocols of at least four indigenous pesticidal trees and shrubs per country. A total of 10 local training workshops and one national training workshop per country were held. 40,000 trees were planted by 4,000 farmers located across three countries enabling a participatory approach to learning and upscaling. Harvesting protocols and optimised preparations for at least



Laboratory training for technicians and agricultural scientists working on pesticidal plants in Nairobi, Kenya, June 2015.

eight pesticidal plant species were developed through chemical and biological studies. Project partners and trainees were informed about the UN's Convention on Biological Diversity and intellectual property issues relating to indigenous materials to ensure appropriate access and benefit sharing.

Science and Technology Innovations for safer and more effective application of pesticidal plants along with environmental impact and cost benefit analyses.

STIs were developed and promoted to farmers. Elite pesticidal plant materials were identified for 10 species through chemical analysis and biological study in laboratory and field

trials. Application technologies for four plant species for control of cattle ticks on livestock were developed and promoted to farmers. Safe handling methodologies and improved application protocols were developed for use of pesticidal plants on stored food products and knowledge transferred to farmers. Parameter profiles for four pesticidal plant species were determined to understand climate sensitive variables.

Communication and dissemination platform for pesticidal plant knowledge.

The OPTIONS network was established for communication among partners and to the wider community of stakeholders through stakeholder appropriate outputs, a website and public speaking and training events. Scientific research papers describing results and outcomes were published in high impact international refereed journals. An international conference was hosted to consolidate the African pesticidal plants network and provide a dissemination platform for new knowledge to the wider stakeholder community.

Using pesticidal plants means farmers need not invest in costly and environmentally harmful synthetic pesticides. Cost-benefit analyses proved their economic value even when harvesting and preparation time was factored in. This economic assessment was published in two peer reviewed scientific papers (Blankson et al., 2014 *Crop Protection* and Mkenda et al., 2015 *PLoS One*).

RESULTS

→ Outputs

Capacity building

- >20 local training workshops in Kenya, Tanzania, Malawi and Zimbabwe.
- Hundreds of farmers trained in optimised use of pesticidal plants (~40% female, especially for legume cropping systems).
- >90 scientists and nursery growers (~30% female) trained on the propagation of 4 indigenous species; additional training and knowledge transfer about other effective species including *Tephrosia*.
- >90 graduate students and scientists trained in scientific techniques about validation of biological activity and in the propagation and use of pesticidal plants.

Plant material

- Elite pesticidal plant materials identified for 10 species.
- Application technologies for 4 plant species for control of cattle ticks on livestock.

Technologies

- Simple methods to maximise the efficacy of pesticidal plants using, e.g., liquid soaps to maximise extraction efficiency and novel approaches to propagate the plant species most at risk of overuse such as *Securidaca* and *Bobgunnia* (important and indigenous tree species).

Training material

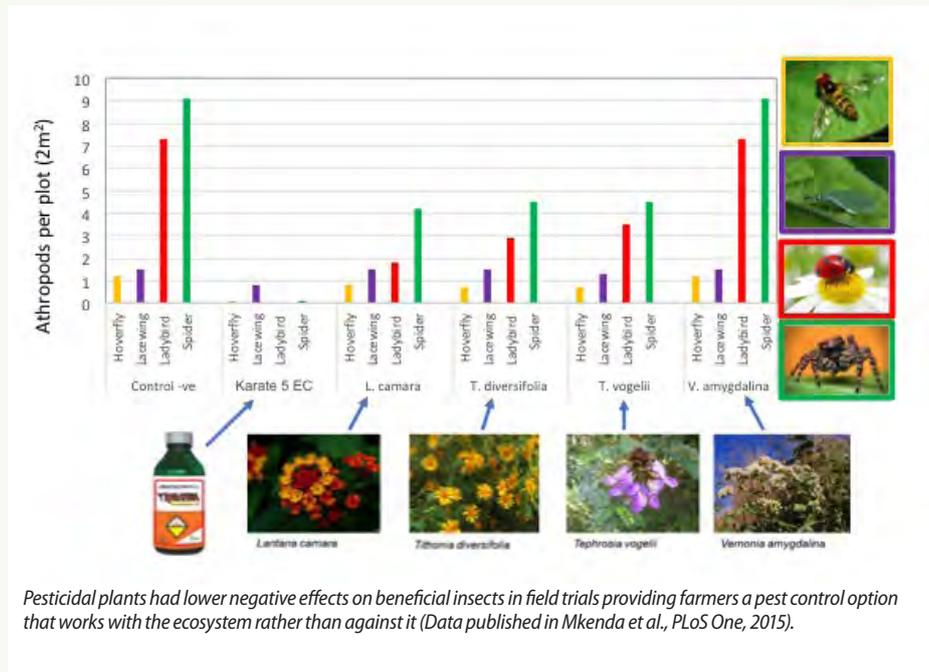
- Handbook on 'Pesticidal Plants' (English and French).
- Leaflet on the propagation of *Securidaca longepedunculata*.
- Proceedings of a training workshop on Optimisation of Pesticidal plants: Technology Innovation, Outreach & Networks (OPTIONs).
- 12 pesticidal plant information sheets (in English, French and Kiswahili): *Aloe ferox*, *Chenopodium* (syn. *Dysphania*) *ambrosioides*, *Euphorbia tirucalli*, *Lippia javanica*, *Securidaca longepedunculata*, *Solanum incanum*, *Strychnos spinosa*, *Tagetes minuta*, *Tephrosia vogelii*, *Tithonia diversifolia*, *Vernonia amygdalina*, and *Zanthoxylum holtzianum*.
- Guidelines for the 'Sustainable harvesting of traditional medicinal plants'.

Facilities

- Analytical chemical facility established at Mzuzu University to provide technical support for further research in pesticidal plants.

Policy papers

- 3 policy papers published as reports in an internationally reviewed journal (*Food Security*) and a widely read magazine.



Visibility

- Project website.
- International conference held with 80 abstracts / presentations and >120 scientists participating.
- >5 public media narratives including TV and radio.
- Leaflets.

Publications

- Stevenson P.C. et al., 2016. Pesticidal plants in African agriculture: Local uses and global perspectives. *Outlooks on Pest Management*. 27(5): 226-230.
- Arnold S.E.J. et al., 2016. Shades of yellow: interactive effects of visual and odour cues in a pest beetle. *PeerJ*. 4:e2219.
- Stevenson P.C. et al., 2016. Nor-Hopanes explain pest control activity of *Zanha africana* root bark. *Phytochemistry*, 123, 25-32.
- Nyahangare E.T. et al., 2016. Acute oral mammalian toxicity and effect of solvents on efficacy of *Maerna edulis* (Gilg & Ben.) De Wolf against *Rhipicephalus* (Boophilus) *decoloratus* Koch, 1844 (Acarina: Ixodidae), Tick Larvae. *BioMed Research International*. 8.
- Mkenda P. et al., 2015. Extracts from field margin weeds provide economically viable and environmentally benign pest control compared to synthetic pesticides. *Plos ONE*. 10(11), e0143530.
- Arnold S.E.J. et al., 2015. Responses to colour and host odour cues in three cereal pest species, in the context of ecology and control. *Bulletin of Entomological Research*, 1-9.
- Mkenda P.A. et al., 2015. Contact and

fumigant toxicity of five pesticidal plants against *Callosobruchus maculatus* (Coleoptera: Chrysomelidae) in stored cowpea (*Vigna unguiculata*). *International Journal of Tropical Insect Science*. 35(4): 172-184.

- Sola P. et al., 2014. Botanical pesticide production, trade and regulatory mechanisms in sub-Saharan Africa: making a case for plant-based pesticidal products. *Food Security*. 6(3): 369-384.
- Tembo Y. et al., 2018. Pesticidal plant extracts improve yield and reduce insect pests on legume crops without harming beneficial arthropods. *Frontiers in Plant Science*, 10, 01425.
- Stevenson P.C. et al., 2014. Pesticidal plants for stored product pests on small-holder farms in Africa. In: *Advances in Plant Biopesticides* (ed. Dwijendra Singh), Springer India, pp. 149-172.
- Grzywacz D. et al., 2014. The use of indigenous ecological resources for pest control in Africa. *Food Security*, 6 (1). pp. 71-86.
- Amoabeng B.W. et al., 2014. Cost-benefit analysis of botanical insecticide use in cabbage: implications for smallholder farmers in developing countries. *Crop Protection*. 57, 71-76.
- Anjarwalla P. et al., 2016. Handbook on Pesticidal Plants. World Agroforestry Centre (ICRAF), Nairobi, Kenya.
- Anjarwalla P. et al., 2013. Proceedings of a training workshop on sustainable production, harvesting and conservation of botanical pesticides. World Agroforestry Centre (ICRAF), Nairobi, Kenya. 61pp.

RESULTS

Outcomes

- New knowledge on harvesting and usage of pesticidal plants to control pests and improve yields
- Awareness of pesticidal plants as economic and environmentally benign alternatives to synthetic pesticides for use in field and storage.
- Small and medium sized enterprises engaged to commercialise pesticidal plant products.
- Pesticidal plants had lower negative impacts on beneficial insects in the fields such as pollinators and natural predators.
- Farmers in West Kenya stimulated to propagate and sell their own pesticidal plants.
- Policy makers in Zimbabwe, Malawi and Kenya aware of scope for more effective and sustainable pest management in field crops and stored products using plant-based pesticides.
- Capacity of scientists enhanced to conduct research more effectively using robust methodologies and statistical analysis to ensure scientifically sound evidence.

Impacts

Usage

- c.4,000 farmers in Kenya, Tanzania, Malawi and Zimbabwe are propagating trees, and >40,000 trees have been planted.
- A manufacturer in Kenya is setting up commercial production of pesticidal plants, specifically Pyrethrum, for export to reinvigorate this Kenyan manufacturing sector. Further support is being sought, for instance with direct contacts with County Governors, and predictions indicate that the African botanical insecticides sector will redevelop into a major industry on both domestic and international markets.
- Farmers generating new income streams by growing and selling pesticidal plants in local fora and for local uses will develop the outreach and uptake of these plants through a desire to increase their own wealth; and the benefits of these technologies will underpin commercial success and further adoption.

Policy implications

- It was determined that the use of pesticidal plants by smallholder farmers also supported agro-ecological intensification. These studies provide strong evidence to inform policy that pesticidal plants are a sustainable alternative to synthetic pesticides.
- Policy environment has been informed through policy assessments and policy papers, and policy briefs were published and distributed widely. Policy documents published in the scientific literature have been cited frequently by other scientists.

Sustainability

- Through the McKnight Foundation network that supports a variety of research activities on legume production systems in Southern and Eastern Africa, our botanicals research has supplemented R&D projects because they suffered from pest issues and have since used pesticidal plants

to resolve the problem effectively and thus promoted a wider uptake in their use.

- Further research funding was obtained through: the McKnight Foundation Farmer Research Network to evaluate sustainable agro-ecological crop protection using pesticidal plants; and the Darwin Initiative to look at wider benefits of pesticidal plants in supporting beneficial insects in natural landscapes adjacent to farm land.
- Contributions were made to a new project funded through the UK's Global Challenges Research Fund to understand how field margin diversity supports both beneficial insects and botanical insecticides and underpins recovery of beneficial populations.
- The regional research capacity through the analytical chemistry facility in Mzuzu University and expertise in conducting field and laboratory studies on the bioactivity of plant materials will be further exploited.

TESTIMONIALS



Emmanuel T. Nyahangare, University of Zimbabwe, Zimbabwe

“The project provided an excellent opportunity to grow both as a researcher and PhD scholar. This has helped me carve a small niche in the research and development of acaricidal plants that can be used against ticks in developing countries like Zimbabwe.

I enjoyed setting up both in vitro and in vivo efficacy experiments while the network of other senior scientists working around the same area gave invaluable advice on the development of protocols and other soft and hard skills. I now have internationally peer-reviewed publications and presented the project work at various conferences.”



Dr. John F. Kamanula, Mzuzu University, Malawi

“The project has made a significant contribution to our Department of Chemistry, through capacity building in analytical and natural products chemistry, bioassays, proposal and manuscript writing, but also with a high performance liquid chromatograph (HPLC) for the characterisation of bioactive compounds in pesticidal plants. The equipment is still being widely used for teaching and research. Furthermore, smallholder farmers who use pesticidal plants in northern Malawi benefitted from the project through training in processing, application and sustainable harvesting of pesticidal plants.”

ACP-EU Co-Operation Programmes in the fields of Higher Education and Science, Technology and Research

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ACP Science
and Technology II Programme

IFCIC – International Fine Cocoa Innovation Centre

SUMMARY OF RESULTS

An International Fine Cocoa Innovation Centre has been established showcasing a multi-pronged approach to the development of a sustainable cocoa industry. A 6-acre model cocoa orchard has been established to deliver training to cocoa producers. Information and technology services for farmers (DNA fingerprinting, quality certification, traceability, branding services), basic and advanced chocolate making training (>250 trainees), and technology and business incubation to support value addition have been operationalised. Chocolate making equipment was purchased to supply intermediate raw material to chocolatiers resulting in 59 new start-ups and micro, small and medium-sized enterprises, and a business cluster around the cocoa farming sector. Enterprises were exposed to public and regional markets through four World Cocoa and Chocolate Day Expos and other trade expos and fairs to assist in building their markets. The development of a cocoa breeding programme in Jamaica was also supported.



One of the 2018 graduating classes of the 'Introductory Chocolate Making Course' at the Cocoa Research Centre, Trinidad.

PROJECT IMPLEMENTATION PERIOD

March 2014 - August 2018

CONSORTIUM

- Cocoa Research Centre (CRC), The University of the West Indies (UWI), Trinidad and Tobago
- Caribbean Fine Cocoa Forum (CFCF), Trinidad and Tobago
- Jamaica Agricultural Commodities Regulatory Authority (JACRA, formally called Cocoa Industry Board, Jamaica)
- Newer Worlds, United Kingdom

PROJECT CONTACT

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PROJECT WEBSITE

www.facebook.com/cocoacentre

BACKGROUND

The cocoa sector in Trinidad and Tobago and the Caribbean has been in decline due to:

- lack of innovation in breeding, production, processing and the marketing system;
- lack of a technology transfer system to transfer information and new technologies from laboratory-to-farm-to-table;
- poor quality management systems among processors resulting in variable quality;
- aging farms and farmers, low productivity of farms, high production costs and labour shortages resulting in unviable business models;
- convoluted and long value chain resulting in farmers receiving disproportionately low proportions of the value chain (5%);
- inability of farmers to access the lucrative ultra-niche markets in the metropolises due to lack of branding, certification, traceability systems; and
- low levels of value addition and lack of a business sector around the cocoa farming sector.

and private sector investment to support industry development, thus becoming a technology transfer interface.

- Research and development will allow more nuanced approaches to cocoa orchard management and smallholder mechanisation resulting in improved yields and quality, and higher profitability.
- Branding, quality management, certification and traceability systems will allow farmers to directly access lucrative boutique markets ensuring farmers at least 30% of the market share.
- Master classes in value addition along with technology and business incubation supported by their exposure to markets through trade expos and fairs will allow start-ups and micro, small and medium-sized enterprises (MSMEs) to become successful businesses and export their produce to the lucrative tourism markets.

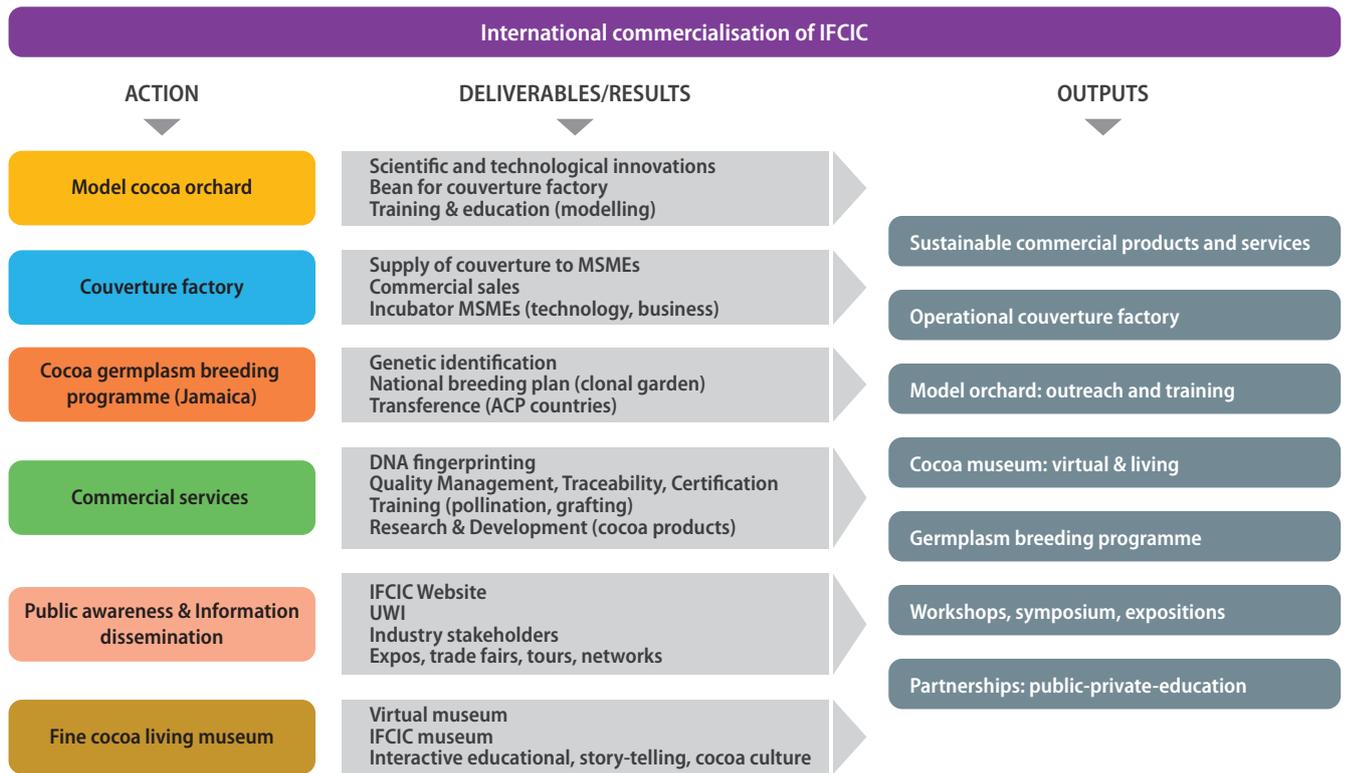
The project applied the following hypotheses:

- The IFCIC facility established on a triple helix model (university-public-private partnership) will be able to develop smallholder innovations along the value chain, showcase them, provide training and technology services, support the development of policy and attract public

The project beneficiaries were: cocoa producers (farmers, farmers groups, private investors in the local and regional cocoa sector); cocoa value chain actors (cocoa processors, chocolatiers, bakers, chefs); public sector (ministries, committees, special purpose business companies); networks (Caribbean Cocoa Industry Network 'CocoaNext', Caribbean Fine Flavour Forum, Chocolate Guild); general public and consumers; academia.



METHODOLOGY



Model cocoa orchard

After a comprehensive literature review of best practices in existing model farms in Brazil, Australia, and Ecuador, a model cocoa orchard was constructed to demonstrate irrigation techniques, innovations in tree management, mechanised harvesting, pest and weed control, and post-harvest processing innovations.

Couverture factory

A fully-functioning fine chocolate factory producing couverture and other intermediate processed products as input feed for resident micro-, small- and medium-sized enterprises (MSMEs) chocolatiers will be functional in 2019. There have been workshops, seminars, and master classes based around chocolate making and other cocoa derivatives using innovative techniques and these will continue. Chocolatiers have also been trained through technical courses in quality along the Cocoa Value Chain, Introduction and Advanced Chocolate Making and Sensory Evaluation.

Cocoa germplasm breeding programme

In Jamaica, over 800 mother trees were identified and DNA fingerprinted to select a limited number for yield trials and clonal gardens. Staff from the Ministry of Agriculture and the College of Agriculture Science and Education (CASE), as well as several technicians from the Caribbean region were trained on conventional and modern breeding methods (DNA fingerprinting and molecular marker technology). Following the unintended introduction of the Frosty Pod Rot disease in Jamaica in 2016, new varieties with tolerance to this

disease were sourced from the International Cocoa Quarantine Centre at the University of Reading (UK) and supplied to Jamaica.

Commercial services

- Superior mother trees from Jamaica and Trinidad and Tobago were identified with a Fluidigm DNA fingerprinting system.
- Branding of cocoa growing areas through Geographical Indication designation, as well as a farm-based branding (tree-to-bar) were applied.
- A quality certification service has been developed that allows sustainability, farm and quality certifications.
- Using genome-wide association studies (GWAS), molecular markers for important agronomical traits have been established, and once validated will allow for a global innovative molecular marker service.
- With a Near Infra-Red Reflectance Spectrometry (NIRS) service, a start has been made to develop a database of spectral fingerprints for cocoa from various parts

of the world.

- A digital traceability service was developed to track cocoa beans throughout the production process, from the farm up to the manufacturer.

Public awareness & Information dissemination

The IFCIC website, in addition to cocoa specific information, contains technical bulletins, stories of cocoa estates, online training courses, audio visual promotional materials, the e-journal, and conference and symposia proceedings.

Fine cocoa living museum

An electronic museum has been set up, and will be developed into a physical facility showcasing the story of cocoa in Trinidad and Tobago. The physical facility will also serve as a tourist attraction. IFCIC will feature a visitor centre that will allow bean-to-bar tours for the public as well as a hub for other cocoa-based agrotourism facilities.



CocoaTown representation of bean-to-bar process.

→ Outputs

Stakeholders involved

- 800 farmers / cocoa producers.
- 10 private investors in the local and regional cocoa sector, government controlled / managed cocoa farms.
- 10 processors with fermentation and drying facilities.
- 260 chocolatiers, chocolate based cuisine chefs.
- 70 start-ups and MSMEs involved in cocoa-based value added products.
- 12 public sector organisations: local and international cocoa industry boards, government ministries, special purpose public sector boards, bureau of standards, financial entities, export import agencies, cocoa industry networks - CocoaNext and Caribbean Fine Cocoa Forum, Cocoa Research Centre Chocolate Guild, Partners in Conservation.

Capacity building

- Short courses (theory and practical): Agronomy (13), Chocolate making (36), Sensory analysis (6), Post-harvest (6), Molecular marker technology (4).
- Support to 59 start-ups in facility design, purchase of equipment, product development, food safety assessment and Standard Operating Practices (SOP) for laboratories, quality management systems and certification.
- People trained: Chocolate making trainees (239), Agronomy technicians (287), Sensory laboratory technicians (78), Post-harvest technicians (120), Molecular laboratory technicians and supervisors (36), Farmers (56), Cocoa value add producers (116), Start-up technologists (68).
- 2 online courses: Rehabilitation of cocoa fields; Risk analysis and mitigation.

Toolkits

- 9 databases: Agro-ecological zones, Risk and constraints, Base survey of cocoa industry in Trinidad Tobago 2017, Cadmium contamination of soils and beans, Soil fertility of cocoa soils, Flavour map of Trinidad and Tobago, DNA fingerprint, NIRS spectral fingerprint, Cost of production.
- 1 digital traceability platform.
- 8 videos: Cocoa Research Centre and IFCIC, Post-harvest processing, Bean-to-bar production, Quality Control and certification, DNA fingerprinting, Cocoa pollination, Climate change and cocoa yields, Genebank.
- 7 bulletins: IFCIC; Cadmium contamination and mitigation; Disease identification and management; Cocoa propagation,

pruning and shade management; Quality management; Value addition; Post-harvest processing.

- 9 guidelines: Geographical indication based branding, Traceability of cocoa, SOP for quality laboratories, Quality certification of cocoa, SOP for DNA fingerprinting, Fidelity testing, Determination of ancestry of cocoa clones; Determining an effective population size for conservation; Determination of cadmium in cocoa beans and leaves.
- 3 protocols: DNA isolation for DNA fingerprinting, DNA fingerprinting using FLUIDIGM, NIRS analysis of cocoa samples.
- 2 manuals: Quality certification, Branding.
- 15 brand stories for farms.

Facilities

- 2 technology, 6 business and 1 cuisine incubators.
- Refurbished laboratory in compliance with certification standards.
- Refurbished greenhouses to support propagation.
- Chocolate factory (to be built in 2019).
- Model cocoa orchard to showcase innovations in propagation and tree management.

Crops

- Superior cocoa varieties identified in Jamaica through comprehensive DNA fingerprinting.

Technology services

- Global DNA fingerprinting.
- Branding support.
- Quality certification.
- Traceability.
- Molecular marker.

Documents

- 6 policy briefs: Labour policy brief, Cocoa Industry Research and development needs, National cocoa strategic plan and action plan, International cocoa flavour and quality standards, National and regional standards for cocoa quality, National and regional standards for cocoa products.

Visibility

- IFCIC website: <https://ifcic.center/>
- International conference papers.
- Annual World Cocoa and Chocolate Day Expos.

Publications

- Umaharan P. (ed), 2018. Achieving sustainable cultivation of cocoa. Burleigh Dodds

Series in Agricultural Science. Cambridge, UK.

- Krähmer A. *et al.*, 2015. Fast and neat – Determination of biochemical quality parameters in cocoa using Near Infrared Spectroscopy. Elsevier Food Chemistry 181:152-159.
- Sukha D.A. (*in press*). Grading and quality of dried cocoa beans. Chapter 5 in ‘Drying and Roasting of Cocoa and Coffee’ (Eds. Ching Lik Hii and Flavio Meira Borem) CRC Press Series: Advances in Drying Science and Technology. [ISBN pending. Publication date - Spring 2019].
- International Symposium on Cocoa Research, Lima, Peru. 13-17 November 2017:
 - Ali N.A. *et al.*, 2018. Profiling fermentation progression and quality attributes of Trinitario and Refractario Cacao (*Theobroma cacao* L.) hybrid populations at the International Cocoa Genebank Trinidad (ICGT) – Opportunities for genetic branding.
 - Sukha D.A. *et al.*, 2018. Evidence for applying the concept of ‘Terroir’ in cocoa (*Theobroma cacao* L.) flavour and quality attributes.
 - Mahabir A. *et al.*, 2018. Identification of a core SNP panel for cacao identity and population analyses.
 - Lewis C. *et al.*, 2018. The genetic variation of cadmium (Cd) uptake and bioaccumulation in *Theobroma cacao* L.
 - Umaharan P. *et al.*, 2018. Supporting entrepreneurship and development within the fine/flavour sector using science technology and innovation – Case of the International Fine Cocoa Innovation Centre.
- Sukha D.A. *et al.*, 2017. The impact of pollen donor on flavor in cocoa. Journal of the American Society for Horticultural Science 142 (1):13-19.
- Sukha D.A. and Seguire E.S., 2015. Protocols for the preparation and flavour evaluation of samples and small-scale fermentation techniques. Chapter in ‘Cocoa Beans: Chocolate and Cocoa Industry Quality Requirements’, p. 71-92. Edited by M.J. End and R. Dand. CAOBISCO/ECA/FCC, Brussels, Belgium.
- David Gopaulchan D. *et al.*, 2019. Morphological and genetic diversity of cacao (*Theobroma cacao* L.) in Uganda. Physiol Mol Biol Plants.
- Motilal L.A. *et al.*, 2016. Association mapping of seed and disease resistance traits in *Theobroma cacao* L. Planta 244(6): 1265-1276.

RESULTS



Outcomes

- International interest for participation in the cocoa training courses at IFCIC.
- IFCIC able to showcase innovations in cocoa farming systems.
- IFCIC able to provide value addition support.
- IFCIC able to provide 5 technology services: DNA fingerprinting and molecular marker, Branding support, Certification of farm and product quality, NIRS spectral analysis, Digital traceability.
- IFCIC received the Vice-Chancellors Award for Excellence of the UWI's globally most impactful project.
- Strengthened fine cocoa sector (stakeholder networks and technology services).



Impacts

Usage

- IFCIC's public-private-university partnership model will be capable of enticing public and private investments.
- Commercial production of intermediary products for sale to MSMEs.
- IFCIC's factory outlet contains own branded chocolates and other value added products, and chocolates from start-ups.
- The IFCIC web portal transfers information to stakeholders and offers training programmes.
- The IFCIC facility will become a hub of public-private-university partnership activities, as well as a tourist attraction.
- Young farmers are increasingly interested in working in the cocoa sector and existing farmers report sustainable incomes.
- Private and public sector cocoa stakeholders are interested in CRC's services and research.
- Continued engagement with cocoa value chain stakeholders.

Policy implications

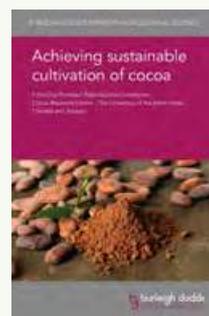
- Trinidad and Tobago is proposing IFCIC as one of five innovation centres to improve the economic diversification of the country with an expected rehabilitation of the cocoa industry.
- Jamaica is developing a Plan of Action for the control of Frosty Pod Rot.
- Adoption of the IFCIC Clonal Garden for replication across Jamaica depends on the Ministry's implementation of a wider national plan.

Sustainability

- CRC participates in the Australia-Caribbean Cocoa Knowledge-Sharing Symposium with the adaptability of the IFCIC Model Orchard practices.
- IFCIC will provide high quality intermediate cocoa products to farmers through the couverture factory.
- IFCIC will work with an international working group for standards to provide

international training in sensory analysis and quality management.

- There is a worldwide interest in the global DNA fingerprinting service.
- IFCIC is developing a range of molecular markers to support breeders.
- IFCIC will offer commercial services (farming innovations, branding, certification, traceability, value addition) to improve farm yields and the cocoa value chain.



TESTIMONIALS



Mr. Clarence Rambharat,
Minister of Agriculture,
Land and Fisheries,
Trinidad and Tobago

“Farmers should be fortunate to have some of the best minds in the industry at the Cocoa Research Centre of UWI. The Centre addresses many important issues to advance the industry and bring resources to our farmers, not to mention our cocoa knowledge bank. Examples are: improving cocoa production through the adoption of best practices, management of cocoa diseases, post-harvest processing and quality management and the critical importance of value added cocoa products.”



Ms. Nikita Nath,
Operations Manager,
and **Mr. Russell Nath,**
co-owner, **Ortinola Great House (Ortinola),**
Trinidad

“Our estate has increased in productivity, quality and refinement. Having participated in the chocolate making courses and as incubatees, the estate launched its own chocolate brand and other value-added products: cocoa nibs, cocoa powder and 75% dark chocolate offerings, including the flavoured dark chocolate line. The Cocoa Research Centre was instrumental in getting us started. We look forward to continue working together to further develop our wonderful estate.”



Mr. Christopher Paul,
Chairman, **Montserrat Cocoa Farmers Co-operative Society Limited,**
Gran Couva, Caroni, Trinidad

“Thanks to the CRC and IFCIC project our co-operative has attained a Geographic Indicator, Rain Forest Alliance Certification and direct export marketing of the area's fine flavour beans. The CRC innovated and provided a quality certification that assisted us to link with a buyer from Switzerland, which resulted in a 2.5 fold increase in price per tonne. These accomplishments led to our innovations being awarded as one of the top 10 smallholder innovations by FAO in 2018.”

ACP-EU Co-Operation Programmes in the fields of Higher Education and Science, Technology and Research

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ACP Science
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In situ conservation and use of crop wild relatives in three ACP countries of the SADC region

SUMMARY OF RESULTS

Over 50 scientific staff from 14 countries of the Southern African Development Community (SADC) were trained on *in situ* conservation methodologies, predictive characterisation and pre-breeding of crop wild relatives to better conserve and use these resources. A toolkit on conservation planning of crop wild relatives, templates and tools for preparing National Strategic Action Plans for the conservation and use of crop wild relatives as well as National Strategic Action Plans for Mauritius, South Africa and Zambia were developed. The diversity of crop wild relatives was documented and assessed, priority species for conservation and areas for *in situ* conservation were identified, and concrete and strategic actions for their conservation and use delineated. Together with farmers in Zambia, incentive mechanisms for their conservation were developed and conservation costs determined. A concept for a regional *in situ* crop wild relatives conservation strategy was developed for the SADC region.



Wild relative of coffee (*Coffea mauritiana*) in full bloom in Black River Gorges National Park, Mauritius. © M.E. Dullo

PROJECT IMPLEMENTATION PERIOD

January 2014 - December 2016

CONSORTIUM

- International Plant Genetic Resource Institute (IPGRI, operating under the name of Bioversity International), Italy
- University of Birmingham, United Kingdom
- University of Mauritius, Mauritius
- Department of Agriculture, Forestry and Fisheries, South Africa
- Ministry of Agriculture and Livestock, Zambia

PROJECT CONTACT

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www.bioversityinternational.org

PROJECT WEBSITE

<http://www.cropwildrelatives.org/sadc-cwr-project/>

BACKGROUND

Climate change is having a severe impact on farming systems and farmers' livelihoods because of heavy dependence on local crop varieties which are not adapted to the changing environment. Climate change-induced loss of local landraces and crop wild relatives (CWR) is also fast occurring, leading to the loss of genetic diversity and traits useful for climate change adaptation. CWR species are often neglected due to ignorance of their value to agriculture by public policy, decision makers and wild habitat (including non-protected areas) managers. There is a lack of coordination between agriculture and environment sectors for an effective conservation and use of CWR. There is also little capacity among national-level scientists to effectively conserve and make use of CWR due to lack of tools to assess occurrences of CWR and to identify potential novel traits, new uses and market options.

The project was set up to enhance the scientific capacities in the SADC region to conserve CWR and identify potential traits for use to adapt to climate change, and develop National Strategic Action Plans (NSAPs) for conservation and use of CWR. The key problem addressed was the capacity of national programmes to be conserving CWR diversity *in situ* as a mitigation measure for adapting to climate change.

The research questions to be answered were:

- What capacities exist in the participating countries on the conservation and use of CWR?
- What tools do these countries have to effectively conserve and use their CWR?
- How many CWR exist in these countries and how are they distributed? What are their status in the wild? Which are priority CWR for the countries?
- What do policy makers and decision makers know about the importance of CWR and why should they be taking measures to conserve them and promote their use?

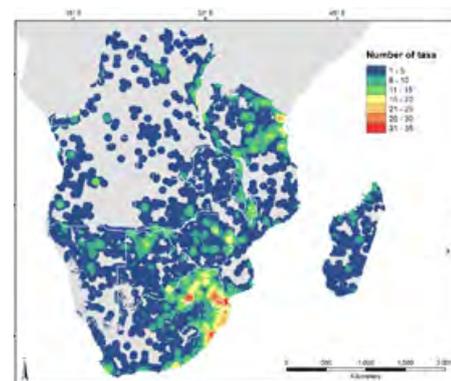
The stakeholders included: *Small-scale farmers* who face the effects of climate change and need access to new, adapted seeds and planting materials for sustainable, cost-effective agricultural production; *National agricultural and environment scientists*, including breeders, who are responsible for implementing (research) activities related to conservation and use of agricultural biodiversity; and *Public policy and decision makers* who develop policies relating to agricultural development and natural resource management and who are responsible for translating policies relating to food security and environmental protection into actions.



METHODOLOGY



Project staff engaging with local communities on *in situ* conservation incentives in Chiawa Camp, Lower Zambezi National Park, Zambia (April 2016). © Warwick Wainwright



CWR richness in the Southern African Development Community (SADC) region.



Field collecting of crop wild relatives in Burgesford, South Africa (March 2016). © Mahlatse Mogale

Baseline information on CWR diversity

The first step in conservation planning of CWR is to assess the diversity of CWR species present in each country (Mauritius, South Africa and Zambia) by making a checklist of all the CWR that exist in these countries. This is done by crossing the identified crop genera with the genera of the national flora checklist. Not all CWR can be conserved and thus CWR were prioritised according to a set of country specific criteria (e.g. potential of the wild relative in crop improvement, socio-economic value of the related crop, threat status). For each priority species the following was gathered: detailed taxonomic data, general distribution, genetic relationship to the crop(s), socio-economic value of the related crop, threat status and existing conservation actions. Using this a full inventory of CWRs was prepared.

CWR hotspots and priority sites for conservation

Occurrence data of the priority CWR was compiled and analysed using Geographic Information System (GIS) and spatial modelling tools. The tools were used to determine CWR distribution and specifically identify high concentration and complementary areas where active *in situ* conservation could be implemented.

Identification of traits from CWR

The identification of useful traits from drought-tolerant CWR of both *Vigna* (cowpea) and *Sorghum* was done in South Africa using predictive characterisation techniques.

The CAPFITOGEN (Capacity building programme in support of national plant genetic resources programmes of FAO's International Treaty on Plant Genetic Resources for Food and Agriculture) tool was used to identify CWR populations with useful traits.

National Strategic Action Plans (NSAPs)

Once the CWR conservation planning was finalised, NSAPs were developed in collaboration with all stakeholders. Two national workshops were organised, the first to discuss the outline of the NSAP and the second to validate the final drafts.

Five tools were developed to guide and facilitate countries in national CWR conservation planning as well as in the development of their NSAP. The tools are as follows: 'Interactive toolkit for CWR conservation planning', 'Template for the preparation of a NSAP for the conservation and sustainable use of CWR', 'Template for the preparation of a technical background document for a NSAP for the conservation and sustainable use of CWR', 'CWR checklist and inventory data template', and 'Occurrence data collation template'. All these tools were made available on the project website and the 'SADC Crop Wild Relatives Project Dataverse' website, and are readily accessible for use in conservation planning of CWR and development of a NSAP.

Awareness raising

Awareness of the importance of CWR and their contributions to food security and the promotion of their *in situ* conservation was

raised at policy and decision makers' level in the ministries of agriculture, environment and forestry. Each country organised national committees to bring together key stakeholders, including national policy makers, needed to ensure proper implementation of the project in their respective countries.

Awareness of the importance of CWR was also raised through TV broadcasts, posters, leaflets, and policy briefs. Presentations were given at major conferences of the FAO such as the Commission on Genetic Resources and the Governing body of the International Treaty on Plant Genetic Resources for Food and Agriculture. Project results were presented at the first Agrobiodiversity International Conference in New Delhi (India) in 2016.

→ Outputs

Stakeholders involved

- 307 scientists (101 female, 206 male).
- 14 breeders (2 female, 12 male).
- 191 decision/policy makers (59 female, 132 male).
- 98 farmers (35 female, 63 male).

Tools

- Interactive toolkit for CWR conservation planning.
- 4 templates on CWR collection and NSAP preparation.

Policy documents

- National Strategic Action Plans developed for Mauritius, South Africa and Zambia (of which those of South Africa and Zambia have been endorsed by their respective governments).

Capacity building

- 2 training workshops: *In situ* conservation of CWR and diversity assessment techniques; Predictive characterisation and pre-breeding.
- 41 national scientists (18 female, 23 male) from 14 SADC countries on conservation and use of CWR.

Visibility

- Project website.
- SADC CWR Dataverse website (https://dataverse.harvard.edu/dataverse/SADC_CWR_Project).
- 14 presentations, 2 papers and 3 posters at 19 national and international meetings and conferences.
- 4 TV broadcasts.
- 2 news articles.
- 1 video.
- 1 blog.

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Oryza longistaminata, a crop wild relative of rice, Uningi Pans, Mbala district, Zambia.



Solanum lichtensteinii, a crop wild relative of eggplant, South Africa. © Livhuwani Auldren Nkuna

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Ipomoea bathycolpos plants wild relative of sweet potato, Barberton, Mpumalanga province, South Africa. © Livhu - SANBI

- Special issue on CWR in Journal Plant Genetic Resources Characterisation and Utilization (in press):
 - Allen E. *et al.*, 2018. A crop wild relative inventory for southern Africa: A first step in linking conservation and use of valuable wild populations for enhancing food security.
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RESULTS

Outcomes

- Improved knowledge of CWR diversity in the SADC region.
- Increased awareness about the value and importance of *in situ* conservation of CWR in scientific and political communities.
- Enriched capacity of scientists and breeders to apply new innovative tools (conservation planning, diversity analysis and CAPFITOGEN) allowing for identification of both hotspot areas for *in situ* conservation of CWR and desired traits found in CWR for breeding.

Impacts

Usage

- There is a lot of interest in the application of the various project resources. E.g., the CWR and NSAP templates are being downloaded from the *SADC CWR Diverse website*. The online interactive toolkit for CWR conservation planning is useful for both the public and private sector.
- One of the training workshop attendees is doing a PhD in the UK on developing a CWR conservation strategy for Malawi with national stakeholder involvement.
- It is expected that in 5-10 years farmers will see the positive contributions that CWR can make to their crops, provided there are CWR of their crops in the vicinity and the environment is conducive to allow gene flow between the wild population and cultivated crops. Indicators of success would be the existence of better adapted crop varieties.
- The involvement of local communities in Zambia about the economic impacts of *in situ* CWR conservation resulted in perceiving how much Zambian farmer communities are willing to conserve CWR on-farm, specifically in field margins.

Policy implications

- *In situ* conservation of CWR is being considered in government policies in many SADC countries, e.g. endorsed National Strategic Action Plans (Mauritius, South Africa and Zambia), National Bioersity Strategy and Action Plan (Mauritius), Protected Areas Network Expansion Strategy (Mauritius and South Africa), National Agricultural Policy (Zambia), the National Plan for the Conservation and Sustainable Use of Plant Genetic Resources for Food and Agriculture (PGRFA, South Africa), and South Africa strategy for implementing Target 9 of the Global Strategy for Plant Conservation.
- The SADC Plant Genetic Resources Centre (SPGRC) is using the results of the baseline survey to develop a regional strategy on CWR for the entire SADC region.
- The *in situ* conservation of CWR is a long-term process and will take years before CWR genetic reserves can be formally established. It would require interventions by policy makers and other national organisations to implement the recommendations established in the NSAPs.

Sustainability

- Project results can be sustained through the implementation of the NSAPs. Each NSAP contains an Action Plan with concrete activities, a proposed collaborative partnership, and clearly identified roles and responsibilities of the different stakeholders involved.
- The training materials can be used to scale up to other regions. Bioersity and the University of Birmingham plan to organise similar courses in different regions of Africa, Latin America and Asia to further develop capacities and create greater awareness of the importance of CWR.
- A network of stakeholders in the SADC region has been invited to join the International Union for Conservation of Nature (IUCN) Species Survival Commission's (SSC) CWR Specialist Group.

TESTIMONIALS



Chike Mba, Plant Production and Protection Division, FAO, Italy

“As Chairperson of the project Steering Committee I observed first-hand the impressive outputs of the multi-stakeholder endeavour. The project engendered a unique community of practice (COP) which developed and validated innovative tools.

These tools enabled the mapping of CWR locations in resource-challenged countries that are home to these irreplaceable germplasm that are veritable repositories of novel traits for crop improvement. The trained scientists can now harness these traits for breeding resilient crop varieties to enhance crop production systems, as well as improving the nutritional qualities of staple crops. The COP also serves as a model to create a global network that could facilitate the conservation and sustainable use of CWR.”



Dr. Julian Jaftha, Chief Director of Plant Production and Health, Department of Agriculture, Forestry and Fisheries (DAFF), South Africa

“As part of the project, South Africa hosted three consultative workshops, namely: the national stakeholder workshop, pre-breeding and predictive characterisation workshop and final dissemination workshop. DAFF, the South African Biodiversity Institute (SANBI) and the Agricultural Research Council developed a National Strategic Action Plan for conservation and sustainable use which was approved and endorsed by DAFF, key departments and relevant stakeholders. DAFF also incorporated CWR into their national plan for conservation and sustainable use of plant genetic resources for food and agriculture. The project assisted DAFF and its stakeholders to bring a national focus to the conservation of CWR.”

ACP-EU Co-Operation Programmes in the fields of Higher Education and Science, Technology and Research

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ACP Science
and Technology II Programme

IPICA – Empowering knowledge transfer in the Caribbean through effective IPR & KT regimes

SUMMARY OF RESULTS

Areas for improvement in the intellectual project rights and knowledge transfer (IPR & KT) regimes in Caribbean countries were identified and awareness raising activities targeted at policy makers on good practices in innovation processes took place. Macro and micro level studies were conducted, their recommendations reviewed by national and regional multi-stakeholder forums, and policy recommendations made for filling gaps in national innovation systems. A policy white paper on IPR & KT good practices was produced. Innovation capacities of organisation leaders and policy makers of research organisations, energy sector technology transfer practitioners and inventors and social entrepreneurs were enhanced. Winners of the 'E(nergy)-efficiency ideas competition' were awarded with a full-scale mentoring programme providing expert input and support from experienced entrepreneurs and professionals with market knowledge, networks and intellectual project management expertise.

BACKGROUND

There is a general lack of policy actions in the Caribbean region to stimulate intellectual property rights (IPR), and even more so in the area of science, technology and innovation (STI). By using intellectual property (IP) tools more strategically (in education, research and business), Caribbean societies could benefit significantly, for example through identifying and transferring existing technologies, as well as creating value for local products through branding.

The establishment of a stakeholders' forum to evaluate whether the design of the current IP system is fit for a new innovation landscape, and how best to cope with growing demand to protect and trade ideas is needed. Good management of intellectual assets is important for the competitiveness of most organisations, private or public, and for their attractiveness to investors. Well-defined regulations on IP ownership and IP and knowledge transfer (KT) policies, as well as the participation of researchers in technology transfer to society, need to be addressed.

Generating impact on knowledge and technology transfer policies was one of the main goals of the IPICA project. IPICA focused

on the analysis of the IP and KT frameworks of the Caribbean region. Feedback was collected from a wide range of stakeholders.

Relevant stakeholders from policy level (IP offices, ministries), research organisations, Higher Education Institutions (HEIs), individuals involved in research and enterprise (researchers, KT practitioners, entrepreneurs) and international organisations in the national innovation systems were engaged, including at the highest level of government. Awareness was increased about intellectual property and its importance in the innovation process and a set of policy recommendations was produced reflecting the stakeholder views. The national stakeholders' forums and the replication workshops in particular have secured the commitment and collaboration of stakeholders to upgrade the IPR and KT regime in Caribbean countries as a critical part of applying STI to development.

The project focused on analysing IPR & KT regimes in the Caribbean countries to identify areas for improvement and raise awareness with policy makers about good practice KT & IPR frameworks.



Innovation Summer Camp in Santo Domingo, Dominican Republic (July 2016).

PROJECT IMPLEMENTATION PERIOD
January 2014 - December 2016

CONSORTIUM

- Universidad de Alicante (UA), Spain
- FH JOANNEUM Gesellschaft mbH, Austria
- University of Technology (UTech), Jamaica
- Instituto Tecnológico de Santo Domingo (INTEC), Dominican Republic
- The University of the West Indies (UWI), Trinidad and Tobago
- Jamaica Intellectual Property Office (JIPO), Jamaica
- Oficina Nacional de la Propiedad Industrial (ONAPI), Dominican Republic
- Ministry of Science, Technology, Energy and Mining (MSTEM), Jamaica

Associated partners:

- Intellectual Property Office, Ministry of the Attorney General and Legal Affairs (IPO), Trinidad and Tobago
- Oficina Española de Patentes y Marcas (OEPM), Spain
- World Intellectual Property Organisation (WIPO), Switzerland
- Oficina de Propiedad Intelectual de la Unión Europea (EUIPO), Spain
- Caribbean Community Secretariat (CARICOM), Guyana

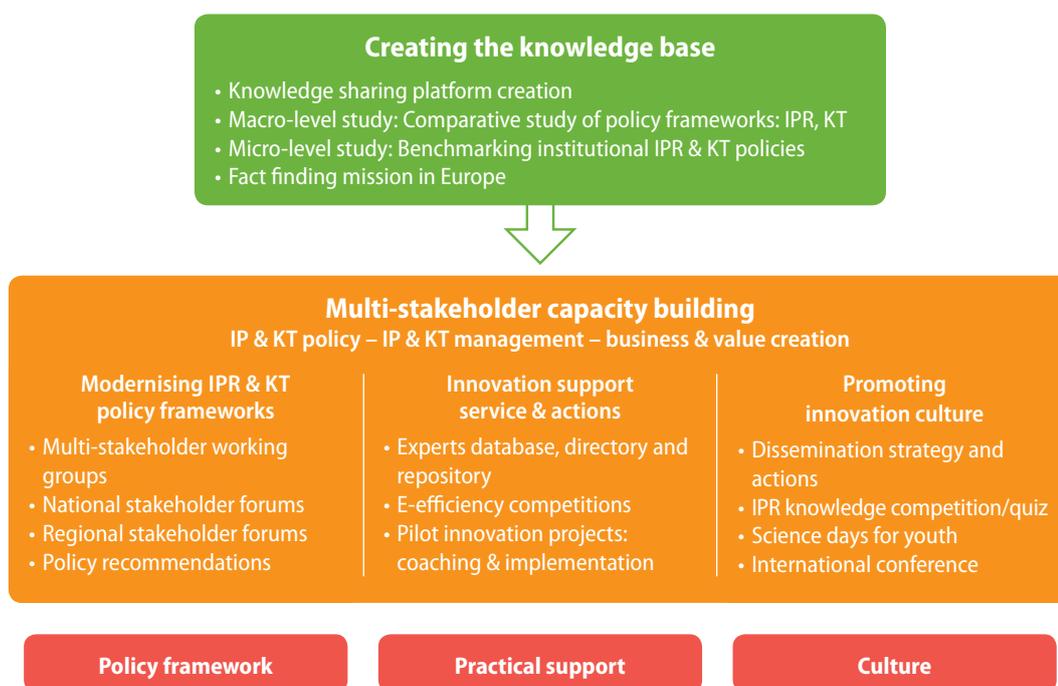
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PROJECT WEBSITE

<http://www.ipica-project.eu/>





Knowledge base

The micro-level study ‘Benchmarking IPR & KT regulations and practices in higher education and research organisations’ determined the knowledge base of HEIs and research organisations and IPR & KT issues in Caribbean countries. The macro and micro level studies were shared with participants at national multi-stakeholder forums which made policy recommendations for filling gaps in national IP/KT systems. Based on these recommendations and the findings and feedback gathered from regional multi-stakeholder forums, the policy white paper ‘Encouraging IPR & KT good practices in the Caribbean region’ was produced. This document includes a brief description of the innovation systems of the Dominican Republic, Jamaica and Trinidad and Tobago; a mapping of actors, gaps and challenges in the IPR & KT regimes, and national policy recommendations. The paper also identifies relevant good practices in local institutions, mainly related to IP policies, innovation practices, IPR management and KT methodologies and procedures.

Capacity building

IPR & KT policy frameworks: Three training workshops on how to promote innovation and knowledge transfer on strategic and practical levels involved different stakeholders: organisation leaders and policy makers of research organisations, energy sector technology transfer practitioners and inventors and social entrepreneurs. Practical know-how and opportunities to exchange with peers on international good practices in regulation, management and evaluation of STI activities was



After a successful business idea competition, the winners of the IPICA idea challenge experienced an intense 3-day entrepreneurship boot camp. Business models were improved together with experts from Europe, Barbados, Jamaica, Trinidad and the Dominican Republic. The University of the West Indies, St Augustine Campus in Trinidad (January 2016).

provided. Technology transfer managers and researchers that attended the training workshop for ‘Energy sector technology transfer practitioners’ organised five replication workshops in their respective countries (two in Jamaica, two in the Dominican Republic and one in Trinidad and Tobago) to reinforce the sustainability of the learning outcomes.

Two regional multi-stakeholder forums took place (Dominican Republic and Trinidad and Tobago). The first was combined with the 3rd international conference of the PILA Network (*Red de Propiedad Intelectual e Industrial en Latinoamérica*) ‘Generating value from knowledge transfer’, and the second with the final EDULINK CAP4INNO project conference. Country specific working groups conducted two national multi-stakeholder forums in each country.

Policy recommendations at regional level were produced on the following issues: innovation

systems policies, legal frameworks, awareness policies, capacity building, promoting research and innovation and exploitation of IPRs.

Innovation support: Six outstanding ideas were selected as winners of the ‘E(nergy)-efficiency ideas competition’. The winners were awarded with a full-scale mentoring programme on their pilot innovation projects and received expert input and support from experienced entrepreneurs and professionals with market knowledge, networks and IP management expertise. All projects reached some progress throughout the mentoring process, although in some cases, progress meant the abandonment of the idea as the validation and market potential analysis did not deliver the expected results.

Innovation culture: To stimulate IPR awareness, an IPR knowledge competition was organised. An IP quiz held in each country reflected limited knowledge about the different types of IP and related strategies. A noticeable need was perceived for greater efforts to build capacity and increase awareness about IP and the consequences and lost opportunities that may result from not following the established procedures to protect and exploit IP. For young student communities, national science days were organised to showcase success stories and achievements in science and technology areas. A research symposium was held, as well as an international conference on STI in collaboration with the Scientific Research Council of Jamaica and the EDULINK project CAP4INNO.

→ Outputs

Capacity building

- 226 KT managers, organisation leaders and policy makers of research organisations, energy sector technology transfer practitioners and social entrepreneurs trained at 8 training workshops on: Innovation & KT promotion, Intellectual property policies and strategies, and Business modelling.
- 6 pilot innovation projects for energy efficiency implemented under a mentoring scheme have unearthed regional talent.

Toolkits

- e-learning repository:
 - Tutorial for the proper use of patent databases.
 - State of the art bulletin on renewable energy, 2012.
 - Guide for the registration of patents and utility model, 2014.
 - Guide for the registration of industrial designs, 2014.
 - State of the art bulletin on dairy industry, 2014.
 - The secret lies in the brand: Guide for trademarks.
 - Attraction through form: Guide for industrial design.
 - Inventing the future: Guide for patents.
 - Collective marks: An intangible value that increases revenues.
 - IPICA Workshop I: Training for knowledge transfer managers and practitioners.
 - IPICA Workshop II: Training for STI organisation leaders and policy makers.
 - IPICA Workshop III: Training for inventors & social entrepreneurs.

Documents

- Map of innovation systems in the Caribbean region.
- Policy recommendations for the improvement of 3 national IPR & KT regimes (Dominican Republic, Jamaica, Trinidad and Tobago).
- Policy recommendations at regional level on: innovation systems policies, legal frameworks, awareness policies, capacity building, promoting research and innovation, and exploitation of IPRs.

Network

- Platform for Innovation support services and expert database.

Visibility

- Project website.
- Leaflets.
- 1 poster.
- Presentations at national and regional multi-stakeholder forums.
- 'Research Technology & Innovation Day' (10 March 2016; at UTech, Jamaica)
- 'Day of Science for young people' (19 July 2016) during the Innovation Summer Camp: 50 high school juniors from public and private schools between the ages of 15-18 performed science, technology, engineering and mathematics experiments.
- Research symposium 'Sustainable Development' (7-8 April 2016; at UWI, Trinidad).
- 1 international conference: The 4th Biennial National Science, Technology and Innovation Conference & Exposition under the theme 'Science, Technology

and Innovation: Stimuli for Health Wealth and Wellness' in Kingston, Jamaica (14-15 November 2016)

Publications

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- Sporer D., Friedl C., Macek A., Vuckovic M., 2016. Barriers in the knowledge transfer chain & research to market process in the Caribbean.



Participants at the last IPICA coordination meeting held during the 4th Biennial National Science, Technology and Innovation Conference & Exposition in Kingston, Jamaica (November 2016).

RESULTS



Outcomes

- Increased awareness on the importance of STI, IPR & KT mechanisms and strategies among national innovation system stakeholders in the Caribbean region: from policy level (IP offices, ministries), research organisations, HEIs, individuals involved in research and enterprise (researchers, KT practitioners, entrepreneurs) and international organisations.
- Increased dialogue and cooperation between HEIs, IP offices and relevant stakeholders in the Caribbean region for the development of 'National science, technology and innovation policies' in the Dominican Republic, Jamaica and Trinidad and Tobago.
- Increased regional cooperation among innovation system stakeholders in the Caribbean region.
- Enhanced capacities of policy makers, KT managers, entrepreneurs and professionals on knowledge transfer as a key driver for innovation, and how to promote innovation and knowledge transfer on strategic and practical levels.



Impacts

Usage

- The UWI (St. Augustine, Trinidad and Tobago) is actively pursuing the commercialisation of its research results and is developing closer working relationships with relevant national stakeholders (IP offices, ministries and legislators).

Policy implications

- The commitment and collaboration of stakeholders in Jamaica (IP offices, ministries and legislators) to upgrade the IPR and KT regime in the Caribbean region in order to apply STI for development,

recognised in the 'Vision 2030 Jamaica - National Development Plan'.

- The policy white paper, circulated to both the political and public administration sides of government, has anchored comprehensive recommendations at regional level on the following issues: innovation systems policies, legal frameworks, awareness policies, capacity building, promoting research and innovation and exploitation of IPR, for strengthening the IPR and KT regime in the Dominican Republic, Jamaica and Trinidad and Tobago. The information

obtained will assist in the development of their 'National science, technology and innovation policies'.

Sustainability

- JIPO has initiated activities with stakeholders and has used the project's training materials to assist individual innovators. It has recognised the mentoring of innovators as part of its regular work plan and will continue.

TESTIMONIALS



Dr. Georgiana Marie Gordon-Strachan,
The University of the West Indies, Jamaica

"The 'lean approach' to technology commercialisation which was introduced to the university in the January 2016 Workshop for Inventors and Social Entrepreneurs is now being more widely utilised in the university. Information provided by the lead partner on its spin-out company policy and experience is being used by UWI as it develops its own spin-out policy. UWI St. Augustine and the Technology Transfer and Intellectual Property Office (TTIPO) of Trinidad and Tobago continue to collaborate on other projects such as the IDB-funded Regional Entrepreneurial Asset Commercialisation Hub (REACH). The two organisations are also working together on the development of an Intellectual Property Academy for Trinidad and Tobago."



Mr. Martin Henry,
University of Technology, Jamaica

"The national stakeholders' forums and the replication workshops in particular have secured the commitment and collaboration of stakeholders to upgrade the IPR and KT regime in the country as a critical part of applying science, technology and innovation to development as recognised in the Vision 2030 National Development plan and in a new STI policy. The international conference allowed close collaboration with the Scientific Research Council of Jamaica, the National Commission on Science & Technology, the Jamaica Intellectual Property Office, and the Ministry of Science Energy & Technology on IPR and KT matters. The white paper, circulated to key players in the innovation system on both the political and public administration sides of government, has anchored comprehensive recommendations for strengthening the IPR and KT regime in the country."



Mrs. Kaydian Smith,
Ministry of Science, Technology, Energy and Mining (MSTEM), Jamaica

"The reports produced on Intellectual Property Rights and Innovation and Knowledge Transfer Systems will assist in the development of the National Science, Technology and Innovation Policy, in particular the policy positions on the protection and promotion of scientific innovations."

ACP-EU Co-Operation Programmes in the fields of Higher Education and Science, Technology and Research

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ACP Science
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GeosAf – Geomatic technology transferred to animal health services in southern Africa

SUMMARY OF RESULTS

Through the application of geomatics technologies, epidemiological knowledge of national veterinary services has been strengthened, updated, adapted to local contexts and allowed for development of vector-borne diseases' control strategies for improved livestock production. 15 key-persons from public veterinary services from Zimbabwe, Botswana and Mozambique were trained in recent geomatics (mapping) technologies and improved their knowledge on the distribution of ticks and tsetse flies. Equipped geomatics units were established within national veterinary services to assist in the collection and analysis of field data for the production of vector distribution and disease risk maps. The link between the scientific community and technical services has been strengthened. The geomatics products were disseminated through multi-stakeholder meetings and scientific publications, and results transferred to animal health actors in order to adapt control strategies for vector-borne diseases.



Epsilon traps set-up in the savannah of Rekometchi Station, Mid Zambezi Valley, Zimbabwe, during tsetse fly capture (February 2015).

PROJECT IMPLEMENTATION PERIOD

February 2014 - November 2017

CONSORTIUM

- CIRAD - Centre de coopération Internationale en Recherche Agronomique pour le Développement, France
- Ministry of Agriculture, Mechanisation and Irrigation Development, Zimbabwe
- Ministry of Agriculture, Botswana
- Ministério da Agricultura e Segurança Alimentar, Mozambique
- University of Zimbabwe, Zimbabwe
- University Eduardo Mondlane (UEM), Mozambique.

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www.rp-pcp.org/projects/on-going/geosaf

BACKGROUND

Livestock production is dependent on environmental factors such as climatic conditions (e.g. drought) and disease incidence and relies on technical expertise and knowledge in animal production and health. Infectious vector-borne diseases are one of the major contributors to the global burden of livestock diseases. In sub-Saharan Africa, small-scale farmers suffer from livestock production losses (morbidity and mortality) and the lagging behind of technical veterinary expertise (availability, capacity, capability and use of the latest technologies to respond to specific demands of livestock producers).

As science, technology and innovation have not yet percolated from research to national institutions and local stakeholders, the project addressed the scientific and technological gaps in animal health capacity with regard to the surveillance of African animal trypanosomiasis (AAT) and tick-borne disease (TBD) like Theileriosis and Heartwater, the most important vector-borne diseases in Botswana, Mozambique and Zimbabwe. By (re-)articulating the transfer of geomatics and related technologies between research institutions and governmental veterinary services, epidemiological knowledge was improved, updated and adapted to local contexts. The increased knowledge in vector-borne diseases' control strategies will

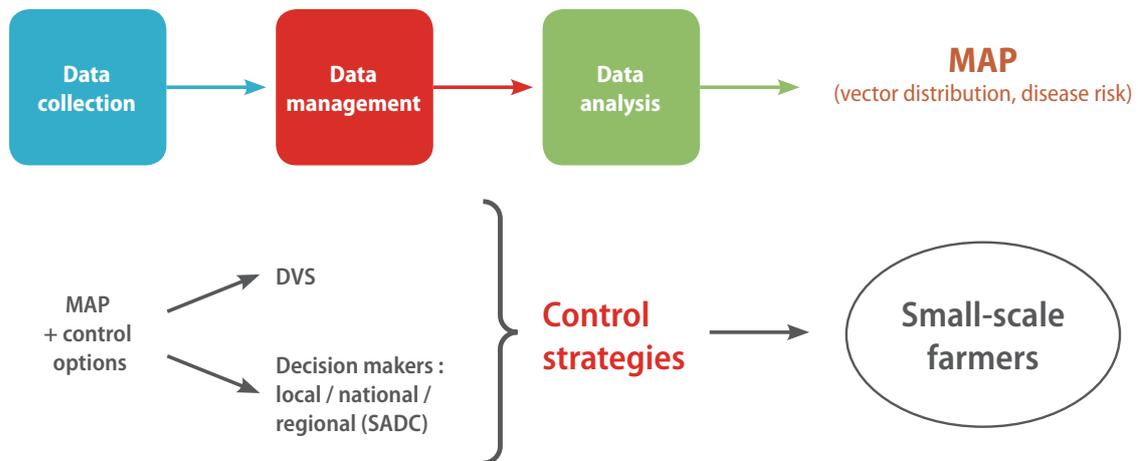
enable veterinary services to improve surveillance and control of vector-borne diseases and as such to contribute to improved livestock production at farm level.

The research platform 'Production and Conservation in Partnership' (RP-PCP) provided an excellent framework for supervision and communication on geomatics technologies between scientific and technical experts, and students. By improving livestock health, notably in semi-arid areas of southern Africa where rural communities often share their space with protected areas, the project contributed to global ecosystem and wildlife health.

The outputs of the geomatics technologies were disseminated to provincial and district veterinary services, communal farmers and agricultural workers in order to ensure that new control strategies are properly accepted. The stakeholders involved in the project were: Divisions of Veterinary Services (DVS) in Botswana, Mozambique and Zimbabwe and other Southern African Development Community (SADC) countries; researchers from universities and agricultural research centres in the field of vector-borne diseases; communal farmers, livestock producers and traders; and decision makers and strategy planners in animal health at national level.



METHODOLOGY



The project was set up to support the adoption of geomatics technologies by central and local veterinary services to improve vector-borne disease management at the local, national and SADC level. Through the creation of functional geomatics units within the Divisions of Veterinary Services (DVS) at the ministries of agriculture, staff were trained in related geomatics technologies. These included remote sensing, GIS, statistics, data collection, data management and data analysis, to produce vector distribution and disease maps and improve knowledge on the epidemiology of TBD and AAT. These maps and proposed control strategies were communicated to the DVSs and relevant decision makers at local, national and regional level.

Data collection – Identification of transfer needs for geomatics technologies

The current knowledge and needs in geomatics technologies, data and information gathering and production tools within the DVS of Botswana, Mozambique and Zimbabwe were identified and reviewed, enabling the set-up of training sessions.

Data management – Training in geomatics-related technologies

Trainings in statistics, remote sensing, GIS, collection, identification and dissection of tsetse flies and ticks, population genetics and molecular diagnostics were open to students and researchers from the participating organisations and from organisations of other SADC countries. These included: Lupane University, Tobacco Research board, Zimbabwe Forestry Commission, Agronomy crop productivity services division from Zimbabwe; and veterinary officers from Botswana.

The three DVSs identified ‘surveillance and control of vector-borne diseases’ as a priority to control their major livestock diseases. Of the 15 veterinary officers involved in the project, 6 were involved in post-graduate studies that executed priority research proposals on ticks and tsetse flies.

Data analysis – Implementation of geomatics technologies

In each country study sites were identified based on the disease context and priorities, and field data collection, processing and analysis were carried out. The application of Geographic information System (GIS) and remote sensing allowed for mapping of tsetse and tick distribution and establishing a strong planning tool for vector monitoring and control.

The participants involved in postgraduate studies have strengthened the links between science and governmental services and demonstrated the importance of applied research on spatial epidemiology to design better adapted control strategies.

Map production – Dissemination of project outputs

The research findings, and disease and risk maps, were disseminated at national and international level. Dissemination occurred via various scientific fora, conferences, meetings, scientific publications, and to local communities and farmers at the study sites. Two technical guides on the dissection of tsetse flies, and on attracting and trapping insect vectors were distributed to animal health actors in the three countries.



Epsilon traps setup in the savannah during vector capture, Rekomechi area, Zimbabwe (February 2015).

→ Outputs

Capacity building

- 15 veterinary officers (7 female, 8 male) from the Divisions of Veterinary Services (DVS) of Zimbabwe, Botswana and Mozambique trained in geomatics technologies: statistics; remote sensing; GIS; collection, identification and dissection of tsetse flies and ticks; population genetics; and molecular diagnostics.
- 16 students and researchers (7 female, 9 male) from Lupane University, Tobacco Research board, Zimbabwe Forestry Commission, Agronomy crop productivity services division (from Zimbabwe); students from University Eduardo Mondlane (Mozambique); and veterinary officers from Botswana trained in GIS and spatial analysis, vegetation mapping, data management, statistical analysis, vector collection and population genetics.
- 6 veterinary officers (all male) were involved in post-graduate studies (2 obtained a MSc degree).

Guides

- Technical guide on the dissection of tsetse flies.
- Technical guide on attracting and trapping insect vectors.

Infrastructure

- 3 functional geomatics units in the DVS in Botswana, Mozambique and Zimbabwe fully equipped with computer hardware and GIS and remote sensing software to increase their efficiency in analysing surveillance data.

Visibility

- Webpage on the website 'Research Platform - Production and Conservation in Partnership (RP-PCP)'.
- Leaflets, poster.
- Presentations at international key conferences: 2 SADC Livestock Technical Committees with representatives of 11 SADC countries, the 13th meeting of PATTEC (Pan African Tsetse and Trypanosomosis Eradication Campaign) with representatives from Trypanosomosis and Tsetse affected countries, the 2nd Research Platform 'Production and Conservation in Partnership' (RP-PCP) Regional conference 'Coexisting (with) in TFCA, local perspectives' with c.200 researchers, the 37th International Symposium on Remote Sensing of Environment (ISRSE-37) in South Africa.
- Meetings were organised to disseminate the research findings with livestock farmers, agricultural extension workers, local

councillors, village heads, tsetse control managers, veterinary field staff and secondary agricultural students.

Publications

- Chikowore G., Dicko A.H., Chinwada P., Zimba M., Shereni W., Roger F., Bouyer J. and Guerrini L., 2017. A pilot study to delimitate tsetse target populations in Zimbabwe. *Plos Neglected Tropical Diseases*.



Small cage used to collect insects during a training on dissection, identification of tsetse flies, Rekomechi area, Zimbabwe (February 2015).



Acaricide foot bath treatment implemented with amitraz at the Chirobhi diptank, Mazowe district, Zimbabwe (February 2015).



Cattle caught and immobilized on the ground for the tick collection at the Chirobhi diptank, Mazowe district, Zimbabwe (February 2015).

RESULTS



Outcomes

- 15 veterinary professionals (national, provincial and district level veterinary officers (7 female, 8 male) capable of applying geomatics technologies, spatial analysis and relevant field data collection and management.
- Veterinary services able to improve vector-borne disease surveillance and control for the benefit of communal farmers, livestock producers and traders.
- Decision makers and strategy planners in animal health at the DVS provided with relevant data and insights to design eradication and surveillance strategies and take informed decisions.
- Decision makers at the DVS better informed of the spatial situation of animal vector-borne diseases through the production of maps of vector distribution and disease risk, and able to guide the management and control of TBDs and AAT.
- The importance of the geomatics tools to improve the control and surveillance of vectors and diseases they transmit is fully absorbed by the DVS.
- Improved understanding by the DVS of the distribution and determinants of vectors and vector-borne diseases, and the relationships between prevalence of target diseases and environmental characteristics.



Impacts

Usage

- With the knowledge on geomatics technologies and the distribution of ticks and tsetse flies in the field, the DVS have capacity to design vector-borne diseases' control strategies - in the eradication programme of tsetse flies - and significantly improve livestock production.
- One of the Mozambican veterinary officers is pursuing a PhD at the University of Pretoria on tick distribution and diseases.

Policy implications

- The DVS of the 3 countries are transferring information to national policy makers.

Sustainability

- The project results allow national policy makers to guide strategies against vectors and thus contribute to reducing rural poverty by improving livestock production.
- Trained veterinary officers will assist their countries in the drafting of elaborate vector control and survey plans.
- The knowledge on distribution and determinants of vectors and vector-borne diseases, and the relationships between prevalence of target diseases and environmental characteristics will guide the animal health actors in their choice of appropriate control strategies.

- The operationalisation of 3 functional and equipped GIS units at the DVSs will continue with the analysis of vector and disease surveillance data.
- One training workshop attendee is now in charge of the GIS unit at the Botswana DVS.
- The DVS in Zimbabwe is integrating the International Atomic Energy Agency's (IAEA) tsetse flies eradication programme in Zimbabwe.

TESTIMONIALS



Silence Chiota, student, University of Zimbabwe, Zimbabwe

“The project was educational and taught me a lot about GIS. It was interesting to mix with and learn from other people from different countries. I really enjoyed and benefited from the training courses.”



Dr. P.V. Makaya, Head of Veterinary Laboratory Diagnostics and Research, Department of Veterinary Services, Zimbabwe

“I am very excited to inform you that the Division of Veterinary Services now has a pool of trained officers capable of carrying out different geomatics applications including disease and vector distribution maps. Our trained officers were instrumental in refining the national tick distribution maps as well as TBD distribution maps for the Nkayi and Lupane districts. The same geomatics tools are currently being used to map out the distribution of the current Theileriosis outbreak in more than 7 districts in 4 provinces.”

ACP-EU Co-Operation Programmes in the fields of Higher Education and Science, Technology and Research

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ACP Science
and Technology II Programme

One Health, One Caribbean, One Love

SUMMARY OF RESULTS

The 'One Health' approach has been promoted and rolled out across the Caribbean region. A Caribbean One Health policy was written and then approved by the Caribbean Community (CARICOM). In parallel, a six-year One Health strategic framework mapping out the implementation of the One Health policy was written and distributed to Caribbean countries and international organisations. 29 inter-sectoral One Health leaders from 12 countries were trained in all areas of One Health. They created national One Health networks and developed and conducted a community-based One Health national project. Using a train-the-trainer philosophy, over 500 field veterinarians and 'first responders' were trained in the recognition and response to key exotic, endemic and zoonotic diseases. Laboratory capacity and capability was also strengthened in veterinary diagnostic laboratories across the region through Quality Assurance & Biosafety training, proficiency testing and the introduction of novel molecular diagnostic techniques into laboratories.



Children in Dominica growing iron-rich vegetables to combat iron-deficiency anaemia (September 2016).

PROJECT IMPLEMENTATION PERIOD

March 2014 - June 2017

CONSORTIUM

- The University of the West Indies (UWI), Trinidad and Tobago
- Pan American Health Organization (PAHO), USA
- CIRAD - Centre de Coopération Internationale en Recherche Agronomique pour le Développement, France
- Ministry of Agriculture, Guyana
- Ministry of Agriculture, Marine Resources and Cooperatives, St. Kitts and Nevis
- Ministry of Agriculture, Forestry and Fisheries, Grenada

Associated partners:

- Food and Agriculture Organisation (FAO), Italy

PROJECT CONTACT

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PROJECT WEBSITE

<http://www.onehealthcaribbean.org>

BACKGROUND

The Caribbean nations are connected by shared waters, culture and climates, yet the distance, diversity and various approaches to governance between nations complicates efforts to promote an integrated, holistic approach to problems at the interface between human, animal and environmental health. Overcoming this challenge is urgent because of the many significant problems related to 'One Health' in the region. These include more frequent and severe tropical storms and hurricanes, water shortages, rises in sea levels, losses of fisheries, increases in mosquito-borne diseases and chronic non-communicable diseases linked to poor nutrition, poverty and environmental pollution.

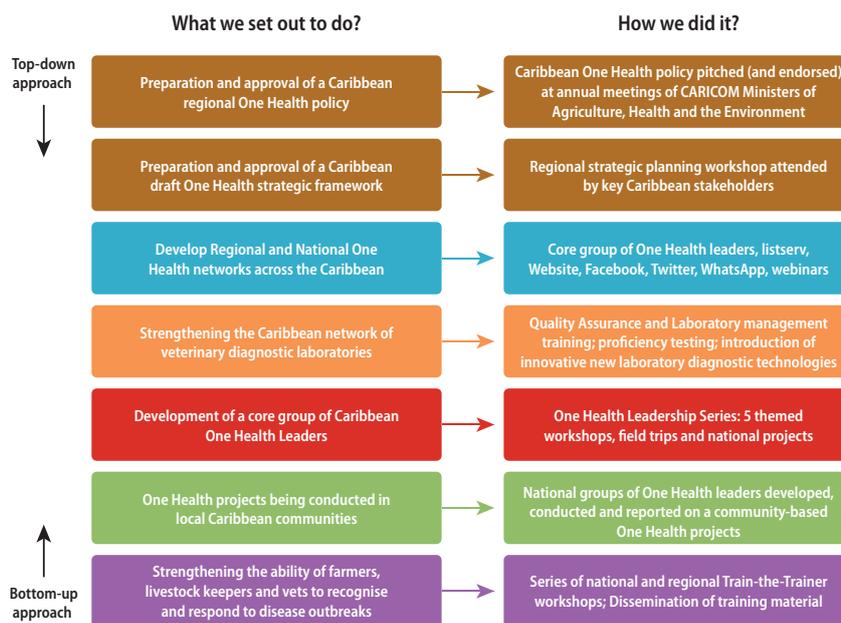
The low internal capacity, limited resources and high burden of human and animal infectious and non-communicable diseases in the Caribbean clearly point towards the relevance of pursuing a One Health approach involving close collaboration and sharing of resources between human, animal, agricultural and environmental health sectors both within and between Caribbean island states. The many advantages of following a One Health approach include: increased awareness of health issues, fewer unintended consequences from health related problems,

reduced vulnerability and increased resilience to major health threats / disease outbreaks and higher levels of efficiency in dealing with health threats, resulting in reduced human / animal health care costs.

The majority of Caribbean countries are unable to recognise and diagnose animal and zoonotic infectious diseases. This makes the animal and human populations, as well as the tourist-reliant Caribbean economies, extremely vulnerable. With the recent emergence of new and emerging animal and zoonotic diseases both globally and across the Caribbean, as well as the effects that climate change is having on incidence and rates of transmission, it has become imperative to be able to rapidly, efficiently and accurately recognise, diagnose and then respond to these diseases locally.

The direct beneficiaries from the One Health project include: Caribbean Ministries of Health, Agriculture, Environment, Finance and Planning; the Caribbean Community (CARICOM); the trained One Health leaders from 12 Caribbean countries; the Caribbean public, livestock producers and farmers, veterinary surgeons and diagnostic laboratories, animal technicians, first responders, medical doctors, nurses and environmental scientists.





Preparation of a Caribbean regional One Health policy and a strategic framework

A regional Caribbean One Health policy was prepared and then approved by the Caribbean Community (CARICOM) Ministers of Agriculture, Health and Environment. At a regional strategic planning workshop with 60 representatives (from 10 countries) from key CARICOM organisations, a draft six-year Caribbean One Health strategic framework was developed to implement the One Health policy.

Development of a core group of Caribbean One Health Leaders

A core group of One Health leaders across 12 Caribbean countries was created, coming from multiple sectors (public, non-governmental and academic). Participants were carefully selected based on their leadership capacity, passion for One Health, and professional references.

A One Health Leadership series was conducted to develop a cadre of inter-sectoral, One Health leaders. A multi-prong approach was used, combining themed training workshops (five in total), field trips, project formulation / management and reporting, and mentoring to foster leadership skills in the selected professionals. The workshops included technical training on One Health approaches, using concrete examples of successful One Health projects. The workshops also built leadership capacity by setting personal goals and exploring leadership qualities,



Farmers in Haiti learning about the safe use of pesticides as part of the Haitian One Health leaders' national project (June 2016).

personality types, individual core values, and developing communication capacity. Team building exercises were conducted in order to establish the Caribbean One Health Leadership team.

One Health projects

Each country participant team prepared a proposal for a simple One Health project. These proposals addressed priority health issues in their home countries, and had goals and objectives aligned with those of the One Health One Caribbean One Love project. Participants were encouraged to leverage additional funding. At the final Leadership workshop, each participant gave a presentation on their project, including lessons learned. This activity allowed participants to practice project formulation and management, including reporting, as well as gain practical experience in developing and testing One Health approaches.

Information and communication on One Health and the establishment of a Caribbean One Health regional network with national working groups

Information and communication was facilitated through the project website, as well as through other social media platforms (Facebook, Twitter, WhatsApp). The One Health leaders developed national working groups in their home countries. A listserv of all Caribbean stakeholders who attended the workshops held throughout the project was developed, which has formed the basis of a Caribbean One Health regional network.

Strengthening the ability of field veterinarians and 'first-responders' to recognise key exotic animal / zoonotic diseases

A series of regional and national 'train-the-trainer' workshops / training courses were held for field veterinarians, farmers and livestock keepers to accurately recognise, diagnose and respond to the threats of animal and zoonotic infectious diseases.

Strengthening the Caribbean network of veterinary diagnostic laboratories

The ability of Caribbean diagnostic laboratories to accurately diagnose priority infectious diseases was strengthened through training in Quality Assurance (QA) and laboratory management (biosafety), the organisation of proficiency testing (comparative testing) and the introduction of innovative new diagnostic technologies into selected laboratories.

→ Outputs

Policy

- Approval and endorsement of a CARICOM One Health regional policy by representations of Chief Medical Officers, Chief Veterinary Officers and the CARICOM Ministers of Agriculture, Health and Environment.
- A draft regional One Health strategic framework.

Network

- 29 One Health Leaders from 12 Caribbean countries.

Data

- A list of priority animal and zoonotic diseases by country for the Caribbean region.
- 12 small scale One Health country projects:
 - **Antigua and Barbuda:** reducing the impact of the Giant African land snail on farmers.
 - **Barbados:** antibiotic residues in locally produced meat, poultry, milk and eggs.
 - **Belize:** rabies outreach and prevention.
 - **Dominica:** reducing the prevalence of iron deficiency anaemia.
 - **Grenada:** reducing obesity in preschool children.
 - **Guyana:** improving solid waste management through collaboration.
 - **Haiti:** knowledge and practices for the safe use of pesticides.
 - **Jamaica:** improving farming practices on the river's edge.
 - **St. Lucia:** reducing childhood obesity, vector-borne diseases and solid waste.
 - **St. Vincent and the Grenadines:** mitigating the effects of lionfish on marine ecosystems.
 - **Suriname:** use of aquaponics to provide heavy metal free and safer food.
 - **Trinidad and Tobago:** risk assessment for the consumption of shark meat.
- Resource material, including 20 training videos on priority diseases, factsheets and PowerPoint presentations, to identify and respond to endemic and zoonotic animal diseases (disseminated to trainers across the Caribbean region, available on the project website).

Technologies

- Novel diagnostic technology (molecular Polymerase Chain Reaction, PCR) validated within the Caribbean region and rolled out into 3 national veterinary diagnostic laboratories (Trinidad and Tobago, Suriname and Guyana).



Promotion of rabies vaccination in small ruminants in Northern Belize as part of the Belizean One Health leaders' national project (January 2017).

Infrastructure

- 2 Caribbean diagnostic laboratories with quality accredited tests in place (Cuba and Jamaica).

Capacity building

- 29 One Health leaders from different health sectors (animal, human and environment) trained in One Health issues.
- 32 veterinary personnel from 14 Caribbean countries trained as trainers in the recognition and response to foreign and endemic animal diseases.
- 5 national workshops on the identification and response to endemic and zoonotic animal diseases (Dominican Republic, Guyana, Jamaica, St. Lucia and Trinidad and Tobago) for 500 veterinary personnel and first responders (approx. 50:50 male / female).
- 11 laboratory technicians trained in Quality Assurance (QA) and Biosafety.
- 7 veterinary diagnostic laboratory technicians from Guyana, Suriname and Trinidad and Tobago trained in real-time molecular PCR technology.
- 7 national diagnostic laboratories participated in a proficiency testing exercise.

Visibility

- Project website.
- 3 social media accounts (Facebook, Twitter, WhatsApp).
- YouTube channel (training courses, presentations, news...).
- 1 One Health celebrity patron 'Bay-C', bass vocalist from platinum-selling dancehall / reggae quartet T.O.K. (Listenmi News presentation: https://www.youtube.com/watch?v=0mL29J_J_bk).
- 8 promotional and 20 training videos.
- 2 One Health webinars.
- 21 presentations at national, international and regional conferences and events.
- 20 press releases and interviews (TV and

radio), regionally and nationally.

- 300 hard copies of book 'Caribbean resilience and prosperity through One-Health' distributed to key Caribbean One Health stakeholders.

Publications

- Oura C., Mahase-Gibson A. and Stephen C., 2017. Caribbean resilience and prosperity through One Health. www.onehealth-caribbean.org
- Oura C.A.L., 2014. A One Health approach to the control of zoonotic vector-borne pathogens. *Veterinary Record*, 2014 Apr 19; 174 (16):398-402. doi: 10.1136/vr.g2539.



One Health leaders being trained in leadership and One Health in Jamaica (June 2015).



Laboratory technicians from Trinidad and Tobago, Suriname and Guyana learning to perform molecular diagnostics in Trinidad (January 2017).

RESULTS



Outcomes

- Increased capacity for veterinary personnel to identify and respond to endemic and zoonotic animal diseases.
- Increased laboratory capacity for laboratory technicians to diagnose foreign and endemic animal diseases.
- Veterinary diagnostic laboratories in Guyana, Suriname and Trinidad and Tobago able to rapidly detect priority animal and zoonotic disease-causing pathogens using molecular techniques.
- One Health Leaders across the Caribbean sensitised on the importance of following a collaborative One Health approach when addressing priority health issues at the interface between human, animal and environmental health.



Impacts

Usage

- 32 veterinary personnel from 14 Caribbean countries are training national 'first responders' in their home countries to recognise and respond to priority animal / zoonotic diseases. Over 500 people trained to date.
- Efficient and accurate recognition and diagnosis of priority animal and zoonotic diseases will lead to faster and more efficient interventions.
- Relevant and easily accessible training material is available through the project website to carry out national training courses.
- Multiple stakeholders from various ministries, NGOs, universities and the private sector across the Caribbean region can now recognise the connections between well-being, prosperity and healthy environments, and also the advantages of working together by sharing resources and expertise to find better and more urgent solutions to priority health issues.

Policy implications

- With a ratified CARICOM One Health policy, the Caribbean is the first region in the world to have such a regional policy in place.
- Caribbean countries are using a One Health approach to solve priority health issues nationally and regionally. For example, antimicrobial resistance action plans are being developed across the region.
- Many agencies in the region are tackling the root causes of priority health issues using a One Health approach. They are also building resilience by examining the shared health factors that link people, animals and the environment. CARICOM's action plans for combating obesity and other chronic diseases stipulate that food, nutrition and health goals cannot be decoupled from agricultural systems, thus ensuring food security is central in regional health policy.

- Government employees and workers from multiple sectors are regularly emphasising the importance of using a One Health approach in their policies and practices and the need for inter-sectorial and inter-governmental collaboration.
- PAHO is currently working to secure funding to implement plans from the Strategic framework and get approval from CARICOM organisations.

Sustainability

- Multiple stakeholders from various ministries, NGOs, universities and the private sector across the Caribbean are now promoting One Health in their work.
- The One Health Leadership series is considered to be the first of its kind worldwide. It has attracted global interest and requests for replicability around the globe.

TESTIMONIALS



**Rennard Overton, lecturer,
University of Guyana,
Guyana**

"Being part of this project did a lot for me. I learned a lot over the two years and have grown as a result. I have been pushing the One Health concept as much as I can in lectures, in the Ministry of Public Health and wherever possible."



**Kerry-Ann Hamilton, social
scientist, St. Vincent and
the Grenadines**

"The One Health journey has been an enriching experience. The benefits are evident in my practice and the way I regard crisis intervention and educational campaigns in the psychosocial field. It has widened the lens through which I view psychological and social issues allowing me a larger canvas to plan and implement more effective interventions. I'm looking forward to facilitating the One Health movement across the region and beyond."



**Joann M. Lindenmayer,
Chair, Board of Directors,
One Health Commission,
USA**

"This book [Caribbean resilience and prosperity through One Health] is outstanding! I am so pleased that it covers such a wide range of topics. It's truly one of the best One Health publications I've ever seen. It's critically important that the world views One Health through a broad lens and applies it in every aspect of health and well-being for people, animals, plants and the environment. Only by doing so, as you have in the Caribbean, will we be able to restore health and well-being to our planet and its inhabitants."

ACP-EU Co-Operation Programmes in the fields of Higher Education and Science, Technology and Research

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ACP Science
and Technology II Programme

INVOCAB – Improving Innovation Capacities in the Caribbean

SUMMARY OF RESULTS

An average 12% increase in the passes for external science examinations was achieved for Mathematics, Agricultural Science, Integrated Science and Information Technology at the eight participating secondary schools in Jamaica and Trinidad and Tobago. Teaching strategies and classroom delivery methodologies in both the primary and secondary schools were improved, for instance on the integration of practical activities (simplifying the types of cell division, observing density and polarity, and identifying real life application of vectors). The schools were also provided with laboratory equipment, scientific charts, reagents and models of major human internal systems and organs. The establishment of two 'Science centres' in Jamaica at the Mico University College and the Church Teachers' College facilitated the access to resources not available in all schools. The resource manuals which were produced for teachers will be used in both countries island wide.



Judges listen to students during the Innovation competition at the Mico University College, Kingston, Jamaica (July 2017).

PROJECT IMPLEMENTATION PERIOD

January 2014 – March 2018

CONSORTIUM

- Scientific Research Council (SRC), Jamaica
- National Institute of Higher Education, Research, Science and Technology (NIHERST), Trinidad and Tobago
- University of Technology (UTECH), Jamaica
- The Mico University College, Jamaica

Associated partners:

- Technische Universität Dresden (TUD), Germany
- Ministry of Education (MOE), Jamaica
- Ministry of Science, Technology, Energy and Mining (MSTEM), Jamaica
- Church Teachers' College Mandeville, Jamaica

PROJECT CONTACT

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PROJECT WEBSITE

www.invocab.org

BACKGROUND

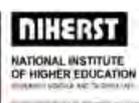
The Caribbean region can be recognised as consumers rather than producers of innovation due to inadequate incorporation of science, technology and innovation activities in the education system. As a result, students are prepared for employment rather than being taught skills for problem solving and innovation. Hence, the need for inclusion of creativity in the education system has been the focus of the INVOCAB project. The project stimulated an interest in science, technology and innovation, and improved the teaching and learning of science in both traditional and non-traditional settings. The research questions to be answered during the project were:

- Will the provision of laboratory and other equipment result in changes to teaching strategies in schools and student test scores at examinations?
- Will the establishment of 'Science centres' facilitate shared knowledge and experiences for schools?
- Will teacher training workshops and summer camps impact how science is viewed by students and taught by teachers?

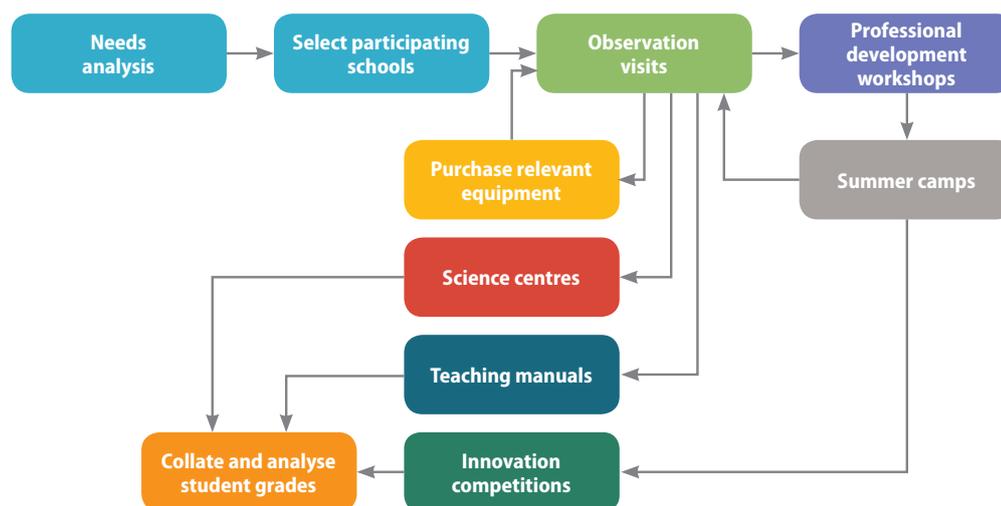
The target groups of the project were students and teachers of Grades 4-6 (primary level), and Grades 9-11 (secondary level) from 8 primary schools, 8 secondary schools,

and 2 teacher colleges. Both the primary and secondary schools generally exhibited low performance in 2012/2013 external examinations. At the primary level, this examination is the Secondary Entry Assessment (SEA, Trinidad and Tobago) and the Grade Six Achievement Test (GSAT, Jamaica). At the secondary level, both countries sit the external examinations, namely the Caribbean Secondary Education Certificate (CSEC) and Caribbean Advanced Proficiency Examination (CAPE). The schools often have insufficient teaching resources, low teacher motivation, inadequate or non-existing laboratory spaces and average to poor student literacy. The teacher colleges (in Jamaica) exhibited better pre-project conditions. They were already being accessed by schools in the surrounding communities as a resource centre and offer degree programmes in science education at the primary and secondary levels.

The users of the project results are: the Ministries of Education, school teachers and principals, students, and the Ministries of Science and Technology. The project impacts are intended to guide policy for future implementation of education programmes as executed by the Ministry of Education in both countries. Currently such programmes have restricted hands-on activities.



METHODOLOGY



Baseline survey

An infrastructural and competency needs analysis was conducted at 46 schools: 30 in Jamaica and 16 in Trinidad and Tobago. The gathered information was used to determine the schools most in need of intervention, with the Principals' interest being a critical factor.

Observation visits

In the 16 selected schools, teachers of science subjects were observed in the classroom (averaging 1 hour in length) and the 'Danielson Rubric' was used as a framework for teaching evaluation. Outcomes were used to prepare other project activities.

Professional development workshops

Subject-appropriate material was developed for the teacher development workshops. Two-day workshops were conducted, separately for the primary and secondary school levels with joint sessions for topics such as classroom management and effective lesson planning. The form of knowledge transferred ranged from practical / engaging / age-appropriate activities to be conducted in the classroom, the design of effective programmes and activities for 'Science centres', to the sharing of 'Education programmes' designed to impact both teachers and students simultaneously.

Provision of laboratory equipment

The baseline surveys and physical visits to existing laboratory spaces determined what equipment was needed for the schools. The various items were purchased in such a way that all secondary schools within a country got identical resources and all primary schools too.

Summer camps

Three annual one-week summer camps facilitated student learning outside of the classroom and also included field trips, sports competitions and a 'Design challenge'. Teachers were exposed to new methods of conducting lessons.

Science centres

In Jamaica, two teacher colleges were outfitted with laboratory and electronic equipment and established as 'Science centres', primarily to facilitate the inclusion of other (non-participating) schools in hands-on and age-appropriate learning. Student teachers are now able to improve their teaching strategies as they have access to the centre's resources and the college lecturers are able to supplement their lectures with practical activities.

Teaching manuals

Teaching manuals on selected science subjects (mathematics and science at both primary and secondary levels; chemistry, physics, agricultural science, information technology and biology at secondary level) were produced which facilitated the improvement and effectiveness of teaching strategies. Difficult topics highlighted during the collection of baseline data are presented in a simplified manner, as well as lists of alternate teaching activities and human anatomical models, field trip options, and relevant integration into real life applications.

Innovation competition

With guidance from teachers, students from the schools' 'science clubs' developed practical projects for solving or mitigating food security and energy efficiency issues in their schools and communities, which are critical areas to small island developing states.

Statistical analysis of student grades

The 'Statistical Programme for Social Scientists (SPSS)' was used to analyse the students' grades obtained in order to determine a correlation between the project activities and the grades obtained hereafter. Improvement in students' performance was determined by assessing their passes in external examinations: SEA (Secondary Entrance Assessment) in Trinidad and Tobago and GSAT (Grade Six

Achievement Test) in Jamaica. Both islands do CSEC (Caribbean Secondary Education Certificate) and CAPE (Caribbean Advanced Proficiency Examination) at secondary level. A comparison was done to determine the percentage pass for the schools before and after the project. The majority of schools obtained a 10% increase in passes, when compared to the baseline year of the 2012/2013 examinations.



Teachers at a training workshop, Kingston, Jamaica (April 2016).



Opening of the Science Centre at the Mico University College, Jamaica (May 2017).



A student of Carron Hall High discusses how the laboratory equipment has helped her complete her practical assignments, St. Mary, Jamaica (March 2017).

→ Outputs

Capacity building

- 18 two-day professional development training workshops for >200 teachers (~30 male, ~170 female) in delivery methodologies on 'difficult to teach' topics.
- 6 one-week summer camps for students and teachers. Each island had 3 annual summer camps (>400 teachers and students).



Students display their project at the 2017 Innovation Competition, Port of Spain, Trinidad (October 2017).

Infrastructure

- 2 science centres outfitted with laboratory and demonstration equipment (microscopes, fixed slides of biological structures, models of the brain / heart / ear...).
- 16 schools outfitted with office, laboratory and field equipment (light microscopes, meter rules, conical flasks, balances, desk top computers, digital cameras...).
- At 4 schools, the security of spaces air-marked for science converted into a functional experimental space.

Toolkits

- 9 curriculum support manuals (under review by the Ministry of Education, Jamaica):
 - for secondary schools: Mathematics, Chemistry, Integrated Science, Agricultural Science, Biology, Information Technology and Physics.
 - for primary schools: Science and Mathematics.

Visibility

- Project website.
- FaceBook account.
- >50 press productions (newspaper articles, television interviews, radio interviews, and online posts). Examples:
 - Highlights of INVOCAB activities. <http://www.niherst.gov.tt/projects/invocab.html>
 - The Jamaica Observer Online Thursday, February 26, 2015. http://www.jamaicaobserver.com/news/EU-donates-science-equipment-to-local-schools_18469665
 - Ministry of Science & Technology online. <https://www.mset.gov.jm/educators-laud-science-education-project>
 - Sunday Express, August 23, 2015 "Kids enjoy a Summer of Science at NIHERST" (Trinidad).
 - The Jamaica Observer Online: Sunday September 24, 2017. <http://www.jamaicaobserver.com/career-education/>

horace-clarke-high-and-bull-bay-all-age-win-src-science-competition-honours-111711?profile=1286&template=MobileArticle

- 2 education symposia.

Publications

- 5 academic papers (under preparation):
 - The role of science centres in enhancing science education outside the classroom.
 - Scientific concepts, theories and principles: Key areas addressed by Science Centres.
 - Do summer camps support student learning? The INVOCAB experience.
 - Summer camps as a tool to enhance student learning.
 - Strategies towards improving science performance in Jamaica.



Jamaican teachers review draft manuals during summer camp 2017 at the Mico University College, Kingston, Jamaica.

↑ Outcomes

- Improved teaching skills and knowledge in science subjects by primary and secondary level teachers (>200).
- Increased interest in science subjects by primary and secondary level students (>10,000).
- Science is no longer perceived as difficult, but as a subject that requires observation and enquiry.
- Students actively involved in the development of solutions for agriculture and energy-based problems within their schools and communities.
- Improved teaching practices in the classroom with the aid of relevant resource materials.
- Improved execution of School Based Assessment (SBA) exercises, as required by the Caribbean Examination Council (CXC) due to the availability of measuring instruments, models, reagents, charts, and microscopes.

- Improved pass rates of primary and secondary school students in external examinations in science-related subjects.

External examination assessment (2014-2016)

- 1 of the 8 participating secondary schools had a 22% increase in pass rates for the CSEC examination compared to previous years.
- Biology external examination pass rates improved by over 10% in Jamaican secondary schools.
- 1 of the 8 participating primary schools had a 12% increase in pass rates for mathematics compared to previous years.
- GSAT students who participated in the summer camps scored significantly higher grades than those that did not participate.
- Primary level mathematics (Jamaica) pass rates improved from an average of 35% to 45%.

- Agricultural science (Jamaica) pass rates improved from 87% at baseline to 96%.
- Secondary level mathematics (Trinidad) pass rates improved from 37% to 45%.

Internal examination assessment

- Overall secondary level female students in both Jamaica and Trinidad and Tobago showed improvements in performance exceeding 10% compared to previous years.
- The examination pass rates for mathematics, information technology and chemistry improved more than 10% in Jamaican secondary schools compared to previous years.
- Primary and secondary level students have improved grades in internal school examinations, especially for students having participated in the summer camps.

RESULTS

Impacts

Usage

- Through the 15 projects submitted for the Innovation Competition, there have been improvements in farming and energy conservation practices that were implemented in some of the schools. It is expected that, with additional support, the most impactful projects will be implemented on a wider scale in schools and communities across Jamaica and Trinidad and Tobago.
- Teachers exposed to new methods of conducting lessons intend to utilise these methods in their individual schools.
- The improvement in teaching methodologies means that students can be more engaged in the learning of topics perceived to be difficult. Coupled with the science manuals and additional learning resources, the performance of schools would be constantly improved.
- The usage of electronic equipment (computers, surge protectors and cameras) enables the schools in data collection, analysis and research for their various projects.

Policy implication

- Recommendations for the adoption of a multi-pronged approach to science education (camps, workshops, equipment, science centres...) have been made to the relevant Ministries, but the actual conversion into policy requires time and will- ingness of current and new governments. Post-project follow-up by NIHERST and SRC will be required.

Sustainability

- Some aspects of the project activities will continue via the existing programmes of NIHERST and SRC. Their science-based education programmes will now include the schools that participated in the project. As such, monitoring of the schools' performance in external examinations can continue. The aspects of the project that will continue are the innovation competitions amongst schools, as well as the professional development workshops for teachers.

- The schools that participated in the project can take part in activities such as those routinely hosted by the Science centres in Trinidad and Tobago, the essay and oratory competitions (SRC), science fairs, school tours and science-based school societies in Jamaica.
- The sustainability of the results will also be affected by the movement of teachers trained in the project to other schools: participating schools may experience a regression in performance; non-participating schools (that the trained teachers migrate to) may see an improvement in performance. It is expected that teachers who participated in the project will retain and improve on the skills obtained. In the event that those impacted by the project move to other schools, it is expected that they will implement what they have been taught and practiced in their new environment.

TESTIMONIALS



**Mr. Alex Brown, teacher,
Carron Hall High, Jamaica**

"I loved camp! It provided a great means of interacting with my students one-to-one, which is difficult to do during the regular class sessions. This INVOCAB project is fantastic. As a rural school we don't often get outside help with resources and training. Being a part of the teacher training workshops was good for me as I learned new approaches to lesson planning and developing critical thinking skills in my students. I enjoyed the mathematics sessions done using music to help remember formulae. Thank you for this opportunity."



**Mr. Dominique Joseph,
teacher, Barataria Boys'
R.C. Primary School,
Trinidad and Tobago**

"INVOCAB has given me the perspective that 'learning can be fun'. It sounds cliché, but I was able to see first-hand that this is possible. INVOCAB provided the opportunity to teach mathematical and scientific concepts using activities that are fun; it also gave the student the chance to think critically. Children love to have fun and the best part is they are also learning something. One of my main observations was that resources and materials were inexpensive, accessible and available right here in Trinidad and Tobago. At the camps, there was no shortage of resources and materials. Each student had their own to work with, even while working in groups. Overall, I learned new methods of teaching some difficult concepts, especially in mathematics. A lot of these methods helped students and their confidence in the classroom increased, as so did mine."



**Ms. Raquel Kalloo, teacher,
St. Augustine Secondary
School, Trinidad and
Tobago**

"There was merit for the INVOCAB project. It opened up my mind to new ways to introduce topics in the classroom. The facilitators were knowledgeable and I was able to receive more training and exposure to creative teaching methods. What was particularly noteworthy for me were the 'Professional Development Workshops'. I appreciated being able to interact with colleagues from other secondary schools and to have the opportunity to exchange ideas and classroom experiences. As a teacher, you often feel as though you are teaching in a vacuum and it is refreshing to learn that other teachers experience the same challenges. These workshops offered us the forum to share ideas and teaching strategies."

ACP-EU Co-Operation Programmes in the fields of Higher Education and Science, Technology and Research

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ACP Science
and Technology II Programme

AFRHINET – An ACP-EU technology-transfer network on rainwater harvesting irrigation management for sustainable dryland agriculture, food security and poverty alleviation in sub-Saharan Africa

SUMMARY OF RESULTS

A technology-transfer and market-oriented framework strategy focusing on rainwater harvesting and its use in agriculture was produced. In addition, a transnational 'ACP-EU network on rainwater harvesting irrigation (RWHI) for improved food security and poverty alleviation (AFRHINET)' for sub-Saharan Africa was established. This network facilitates the exchange and transfer of efficient and innovative know-how and technologies in the field of RWHI. A set of Research and Technology Transfer Centres were established at universities in Ethiopia, Kenya, Mozambique and Zimbabwe which act as knowledge hubs and focal points for bridging institutional, administrative and policy-making levels as well as bringing the issue of rainwater harvesting close to local businesses, NGOs and the civil society as an effective tool for poverty alleviation and income generation in rural communities.

BACKGROUND

Water shortages pose a serious limitation to agriculture in Africa and there is a limitation as to the options available to cope with this problem. In addition, there is little capacity among African countries to capitalise from the use of water sources, such as rainwater, for irrigation purposes. AFRHINET used a participatory approach including all relevant stakeholders: Higher Education Institutions (HEI), national / international research institutions, NGOs, businesses / micro-enterprises and local authorities, as well as local rural dryland communities, especially farmers, women and youth groups, and small entrepreneurs. Consultations with these stakeholders showed a keen interest in fostering sustainable access and efficient use of rainwater harvesting irrigation (RWHI).

The research question to be answered was: How can rainwater harvesting help to pave the way to sustainable economic growth and equitable socio-economic development in sub-Saharan Africa?

RWHI is a multi- and inter-disciplinary approach combining know-how and technologies from multivariate disciplines, such

as engineering, agronomy, political and social sciences. AFRHINET used available existing innovative knowledge in the field of RWHI for its capacity building, technology transfer and networking activities. It favoured the application of indigenous knowledge and learning processes, boosting the development and use of rainwater harvesting as supplemental irrigation technology.

The project tested and implemented various simple, yet effective low-cost technologies which are highly suitable for sub-Saharan Africa, because they can be applied in any rural arid or semi-arid area. Its activities include national and regional multi-stakeholder workshops in the participating countries; national and regional comprehensive baseline studies; the revision of policies in the field of RWHI; and the drafting of a research technology transfer and market-oriented framework strategy.

The project has had a great importance in benefitting poor and marginalised rural communities in sub-Saharan Africa suffering from water shortages. The experiences gathered and the lessons learned suggest that it may be replicable in other ACP regions.



Gathering of rainwater is a community-based collection area, Kenya (July 2016).

PROJECT IMPLEMENTATION PERIOD

March 2014 - May 2017

CONSORTIUM

- Hamburg University of Applied Sciences (HAW), Germany
- Addis Ababa University, Ethiopia
- University of Nairobi, Kenya
- Eduardo Mondlane University, Mozambique
- University of Zimbabwe, Zimbabwe

Associated partners:

- International Crops Research Institute for Semi-Arid Tropics (ICRISAT), India
- Southern and Eastern Africa Rainwater Network, International Centre for Research in Agroforestry (SearNet/ICRAF), Kenya
- WaterAid, United Kingdom

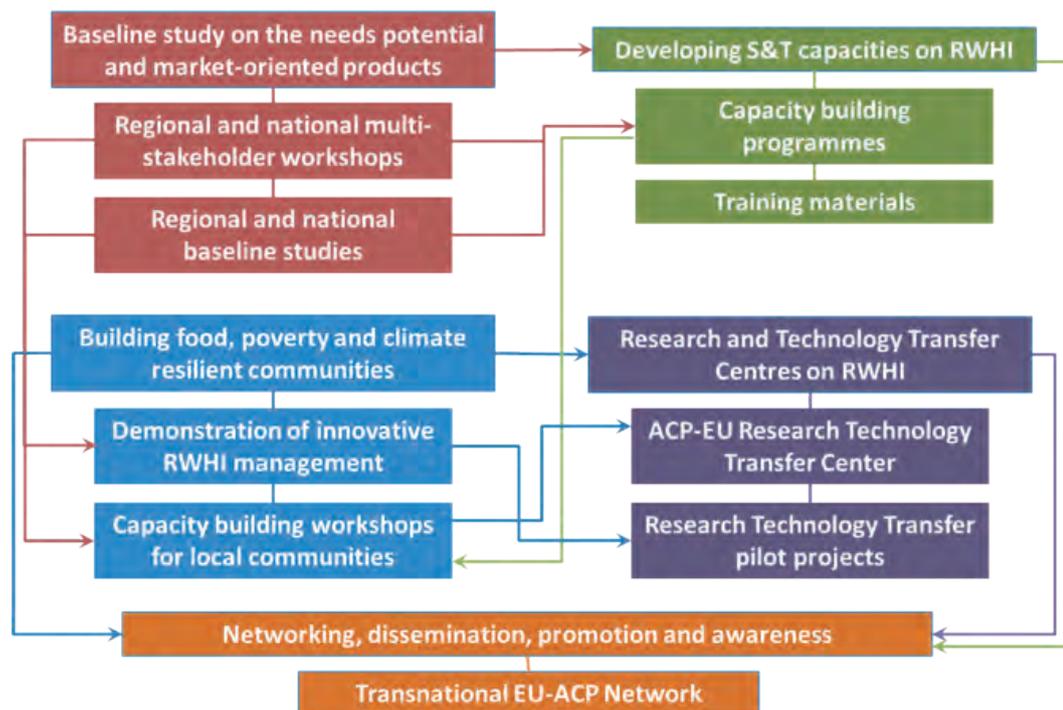
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PROJECT WEBSITE

<http://afrhinet.eu>





Baseline study

Regional and national multi-stakeholder workshops and baseline studies were conducted to learn about capacities, needs and potential of RWHI management, its market development and stimulation of local entrepreneurship in dryland areas of sub-Saharan Africa. Policies to be pursued by governments at national and regional levels in the field of RWHI were also revised.

Developing Science and Technology (S&T) capacities on RWHI

Advanced capacity building and train-the-trainer workshops focused on the scientific and theoretical dimension of RWHI, project management and funding, and the technical capacity to practically implement RWHI for multipliers (S&T communities, businesses / micro-enterprises, and other private, non-governmental and public institutions). A series of publications were produced for internationally recognised journals. Further advanced training materials on RWHI were developed for usage at national and regional levels.

Research and Technology Transfer Centres on RWHI

A better capitalisation and dissemination of research results was facilitated through the establishment of ‘Research and Technology Transfer Centres’ at each participating university. These centres act as knowledge hubs and focal points for bridging institutional, administrative and policy-making levels, as well as linking S&T with local businesses, NGO’s and civil society.

Four ‘Technology Transfer Pilot Projects’ were implemented to promote specific technologies, such as low-cost drip irrigation, ultraviolet radiation pond lining, upgraded manual pumping and drip irrigation linked to a sand storage system.

Regional and national RWHI research and technology transfer strategies were developed. RWHI policy guidelines and recommendations were produced, as well as a market-oriented framework and a transnational report with recommendations for upscaling and replication of RWHI technologies.

Building food, poverty and climate resilient communities

The gap between theoretical approaches and practical use was bridged by means of feasibility studies of viable RWHI projects, national / regional dialogue, demonstration projects and specific training of multipliers from local communities.

Regional and national round tables involving representatives from farmers’ organisations, extension workers and some farmers themselves, were organised to identify and disseminate viable low-cost technological solutions such as those based on solar pumping or the use of gravity to bring rainwater to agriculture fields.

By means of specialist events focusing on the technical aspects of rainwater harvesting with local stakeholders (representatives from farmers’ organisations, extension workers and

some farmers themselves), efforts were made to boost their capacity to develop participatory policies and approaches to foster S&T innovation and developments in the field of RWHI, based on local needs.

Networking, dissemination and promotion

A new transnational ‘ACP-EU network on RWHI for improved food security and poverty alleviation (AFRHINET)’ was established to facilitate the exchange and transfer of efficient and innovative know-how and technologies in the field of RWHI such as: low-cost drip irrigation linked to an improved farm pond system, ultraviolet radiation pond lining linked to an improved farm pond system, low-cost drip irrigation linked to an earth dam system, low-cost drip irrigation linked to a roof water harvesting system, solar powered pumping linked to a rock catchment system, and upgraded manual pumping and drip irrigation linked to a sand storage system.

The project network was also expanded with other international and regional networks. Relations with all relevant stakeholders were established to make sure that RWHI solutions can be replicated at national and regional level, specifically within academia and scientific institutions, private, public and non-governmental actors, and civil society and local community groups.

In addition, an international seminar on RWHI was carried out to disseminate the project outputs.

→ Outputs

Network

- A transnational ACP-EU network on RWHI for improved food security and poverty alleviation (AFRHINET) with 370 members from 68 countries, and linkages with 8 relevant international networks.
- Memoranda of understanding on cooperation on fostering rainwater harvesting between Addis Ababa University, WaterAid and the Federal Ministry of Water and Irrigation of Ethiopia; and between University of Nairobi, Greater Horn of Africa Rainwater Partnership, Jomo Kenyatta University of Agriculture Technology and the Ministry of Environment, Water and Natural Resources of Kenya.

Toolkits

- 3 sets of capacity-building and train-the-trainer materials on how to use rainwater in different contexts.
- Compilation of best RWHI practice compilation and 4 technical sheets.
- Manual water pumping with treadle pumps and gravitational irrigation with drip and hand watering (Ethiopia).
- Low-cost drip irrigation linked to an improved farm pond system (Kenya).
- Low-cost drip irrigation linked to an earth dam system (Mozambique).
- Solar powered pumping linked to a rock catchment system (Zimbabwe).

Facilities

- AFRHINET Research and Technology Transfer Centres (RTTCs), a network of centres with offices at the University of Nairobi (Kenya), University of Zimbabwe (Zimbabwe), Eduardo Mondlane University (Mozambique) and University of Addis Ababa (Ethiopia).
- Several rainwater storage facilities, consisting of underground water dams, small ponds and roof-top collection.

Policy documents

- National Research Technology Transfer strategies published to serve a basis for future policies.
- 1 sub-Saharan Africa-ACP Regional Research Technology Transfer strategy.
- 1 transnational recommendation report on RWHI for sub-Saharan Africa.

Capacity building

- 4 advanced capacity-building and train-the-trainer courses for multipliers (e.g. workers at extension offices) focusing on theoretical and practical know-how of RWHI technologies and practices, with 150 delegates from 4 countries (59 male,



Surface run-off harvesting, Kenya (June 2015).

- 91 female).
- 4 capacity-building and train-the-trainer courses for local communities on RWHI technologies and practices, for over 200 participants (136 male, 64 female).
- 3 sets of capacity-building and train-the-trainer materials.

Visibility

- Project website.
- 3 regional round-table and information events in Kenya.
- 8 demonstration trials of cost-efficient RWHI technologies and practices.
- 1 international scientific seminar.
- Presentations at various symposia in Kenya, Ethiopia, Zimbabwe and Mozambique.
- 2 brochures, 1 poster, 1 banner.
- 6 newsletters.
- 322 USB sticks and 1,000 pens.

Publications

- Ogugu N. *et al.*, 2017. National feasibility report on rainwater harvesting in Kenya. Project AFRHINET, HAW Hamburg, Germany, 2017. 28.03.2016 (1st edition) 20.05.2017 (2nd edition).
- Simane B. *et al.*, 2017. National feasibility report on rainwater harvesting in Ethiopia. Project AFRHINET, HAW Hamburg, Germany, 2017. 28.03.2016 (1st edition) 20.05.2017 (2nd edition).
- Famba S. *et al.*, 2017. National feasibility report on rainwater harvesting in Mozambique. Project AFRHINET, HAW Hamburg, Germany, 2017. 28.03.2016 (1st edition) 20.05.2017 (2nd edition).
- Wuta M. *et al.*, 2017. National feasibility report on rainwater harvesting in Zimbabwe. Project AFRHINET, HAW Hamburg, Germany, 2017. 28.03.2016 (1st edition) 20.05.2017 (2nd edition).

- Leal Filho W. and de Trinchiera Gomez J. (Eds), 2018. Rainwater-smart agriculture in arid and semi-arid areas. Fostering the use of rainwater for food security, poverty alleviation, landscape restoration and climate resilience. Springer, Berlin:
 - Trinchiera Gomez J. *et al.* Using Rainwater for off-season small-scale irrigation in arid and semi-arid areas of Sub-Saharan Africa: Key working principles and best practices.
 - Woldearegay K. *et al.* Fostering food security and climate resilience through integrated landscape restoration practices and rainwater harvesting/management in arid and semi-arid areas of Ethiopia.
 - Simane B. *et al.* Fostering the use of rainwater for off-season small-scale irrigation in arid and semi-arid areas of Ethiopia.
 - Ogugu N. *et al.* Fostering the use of rainwater for off-season small-scale irrigation in arid and semi-arid areas of Kenya.
 - Wuta M. *et al.* Rainwater harvesting options to support off-season small-scale irrigation in arid and semi-arid areas of Zimbabwe.



Recharging pit, Zimbabwe (October 2015).

RESULTS

Outcomes

- Small-scale farmers aware of the application and benefits of RWHI technologies as supplemental irrigation technology and to enhance food security, alleviate poverty and increase local communities' resilience towards external shocks.

Impacts

Usage

- Hundreds of small-scale farmers across Ethiopia, Kenya, Mozambique and Zimbabwe are applying RWHI technologies, such as underground water dams, roof-top irrigation and overflowing mounds.
- The usefulness and effectiveness of rain-water harvesting methods, and their high replicability potential, will allow the generation of income for small-scale farmers on short, medium and long-term level.

Policy implications

- Technical details on the use of RWHI as a tool for agricultural development and

growth will support the implementation of: the Ethiopian Agricultural Sector Policy (2010-2020); Kenya's development agenda Vision 2030 to meet the UN's Sustainable Development Goals (SDGs); the National Agricultural Policy and Strategic Plan of Mozambique; and the Agricultural Policy Framework 1995-2020 in Zimbabwe.

Sustainability

- The AFRHINET Research and Technology Transfer Centres (RTTCs) have exerted significant efforts (fundraising) to establish links with relevant government

departments and donor agencies to be able to tap into any available economic resources, and also to continue establishing both formal and informal collaborations and partnerships with an extensive range of private and public organisations, and civil society and community groups to secure the constant sharing of relevant information on innovative RWHI management.

- A greater access to, and efficiency in the use of natural water resources for irrigation purposes will enable local communities to become more climate resilient.



Run-off irrigation, Zimbabwe (May 2015).



Crops irrigated by rainwater, Mozambique (December 2015).



Run-off irrigation, Ethiopia (February 2015).

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ACP Science
and Technology II Programme

Boosting coffee productivity in Kenya and Malawi through better access to and use of modern technologies and innovations

SUMMARY OF RESULTS

Two tissue culture laboratories were modernised and operationalised in Kenya and Malawi. Standard laboratory operating protocols for the 'temporary immersion system' were formulated. The laboratories produced 103,000 coffee plantlets. Three nurseries for weaning of tissue culture plantlets were established in Kenya and 75 farmer-owned nurseries in Malawi. Fertility status of coffee soils in Central and Northern Malawi were determined and the information as well as fertiliser advice made available to coffee stakeholders. Soil scientists have been enabled to undertake chemical analysis of coffee soils and draft fertiliser recommendations. Similarly, coffee extension staff and farmers are now able to undertake soil and leaf sampling for chemical analysis. Four Farmer Field Schools in Malawi facilitated farmer capacity building on good agronomic practices. A public private partnership between the research institutions and commercial nurseries was created allowing the nurseries to directly access coffee plantlets produced through tissue culture.



Laboratory assistant selecting rooted coffee hybrid variety Ruiru 11 plantlets from RITA units for acclimatisation at the Coffee Research Institute laboratory, Ruiru, Kenya (November 2018).

PROJECT IMPLEMENTATION PERIOD

March 2013 - August 2018

CONSORTIUM

- CAB International (CABI), United Kingdom
- Luyangwa Agriculture Research Services, Ministry of Agriculture (LARS), Malawi
- Coffee Research Institute, Kenya Agricultural and Livestock Research Organization (KALRO), Kenya

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BACKGROUND

Smallholder coffee production in Africa remains unprofitable due to low productivity, losses due to pests and high input costs. Both Kenya and Malawi, where smallholder farmers command 60% of Arabica coffee production, have developed varieties resistant to the main coffee diseases Coffee Berry Disease and Coffee Leaf Rust. However, farmer access to such varieties is constrained by lack of seedlings. The supply of hybrid coffee varieties relies on conventional propagation methods involving hand cross pollination and rooted cuttings. These methods are cumbersome, inefficient and costly, making the coffee seed systems in the two countries non-competitive and unable to meet the farmers' demand for seedlings of the improved hybrids. This limits the adoption rate of improved coffee varieties thereby making coffee production rely mainly on obsolete varieties with low productivity and high production costs.

The project addressed the coffee seedling supply problem by increasing the rate of hybrid seedling production through tissue culture methods. The capacities of coffee research institutions in Kenya and Malawi were strengthened in propagating seedlings of improved coffee varieties in quantities that match farmers' demand. This was achieved by modernising tissue culture

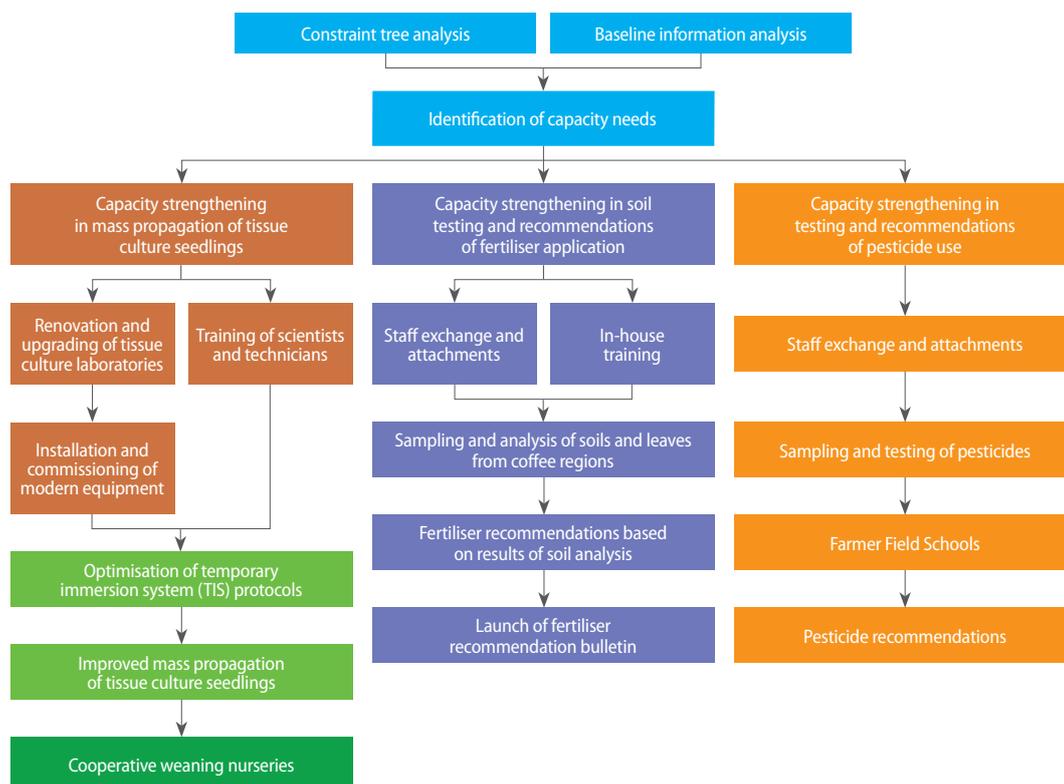
laboratories through installing and using the 'temporary immersion system' (TIS) of tissue culture based on RITA[®] technology. Scientists and laboratory technicians were trained in TIS and a procedural manual for the modernised system was developed. To facilitate uptake of the improved coffee varieties, a public private partnership arrangement was made between the participating research organisations and the cooperative coffee nurseries.

Furthermore, the system of fertiliser recommendation for coffee production used in Malawi was based on blanket application and not guided by the level of nutritional deficiency in the soil. A soil and leaf testing system was put in place to guide fertiliser recommendations for coffee farmers. Pesticide application was also not judicious with a high risk of using adulterated or banned pesticides. With 'integrated pest and disease management' approaches, the project contributed to the development or updating of the national policy on testing and recommendations of pesticides for use in coffee and associated crops.

The direct beneficiaries of the project were the coffee research organisations, smallholder coffee farmers and their primary cooperatives in Kenya and Malawi.



METHODOLOGY



Baseline information

The key problems impeding the sustainability and profitability of the smallholder coffee farming systems in Kenya and Malawi were identified. Existing technologies for mass propagation of coffee using tissue culture such as a Temporary Immersion Bioreactor based on RITA[®], Disposable Bioreactors and Box-in-Bag Bioreactors were evaluated. The RITA[®] system was selected as the most adaptable to the Kenyan and Malawian conditions. Technical capacity needs of the participating research institutions and the collaborating primary cooperatives with respect to the ‘temporary immersion tissue culture system’ (TIS), soil and leaf analysis, and agrochemical testing were determined and appropriate training curricula developed.

Capacity building in mass propagation of coffee through tissue culture

Two tissue culture laboratories were renovated to house the identified modern equipment for mass propagation of coffee. Scientists and technicians were subsequently trained on the use and maintenance of the installed equipment. To facilitate successful adaptation of the TIS tissue culture system, a laboratory procedural manual and health and safety protocol were developed to guide daily operations of the laboratories.

Protocols for the optimisation of the TIS system

were developed to maximise callus proliferation and seedling throughput. This involved setting up experiments to identify the combination of plant growth regulators which

enable optimum production of coffee plants under TIS whilst also reducing required production time.

Establishment of weaning nurseries

Available statistics on the main coffee regions and cooperatives in Kenya and Malawi were studied and coupled with on-site evaluation of the cooperatives using key informant interviews. Target nurseries were then identified by matching the results of the interviews and the developed criteria to determine the suitability of nurseries. The criteria included the current and projected demand for seedlings of improved varieties, accessibility of the nursery, access to water, availability of land for coffee expansion in the regions, and willingness of the target cooperative to participate in the project. Facilities for weaning the tissue culture seedlings were then established in each of the selected nurseries.

Soil and leaf analysis

Soil samples were collected in key coffee growing areas in Central and Northern Malawi, and then processed and analysed for major nutrients including available phosphorus, exchangeable potassium, calcium and magnesium, % carbon, % organic matter and potentially mineralisable nitrogen (% N). The samples were also analysed for soil acidity (pH_w) and electrical conductivity (EC) for soluble salts. The results of the analysis were used to determine the appropriate fertiliser combinations for the coffee regions. Fertiliser recommendations were then formulated based on the results and compiled into a fertiliser recommendation bulletin. This was supported

with provision of training on sampling and analysis of coffee leaves for nutrient deficiency.

Farmer Field Schools

Four Farmer Field Schools (FFS) were established in Malawi to facilitate farmer training and dissemination of information. Demonstration plots were established to showcase appropriate use of fertiliser and pesticides, and to undertake training on other good agronomic practices including weed control, crop canopy management, harvesting and Integrated Pest and Disease Management (IPDM).



Mr. Paul Chemiati of Mayekwe Farmers' Cooperative Society gives his view on the uniformity and early maturity of tissue culture seedlings of hybrid Ruiru 11 during a field visit in Bungoma, Kenya (July 2018).



Nursery attendant undertaking routine check of coffee mother plants for use at the Lunyangwa tissue culture laboratory, Mzuzu, Malawi (March 2016).

→ Outputs

Infrastructure

- 2 tissue culture laboratories modernised: at the Coffee Research Institute (CRI), Ruiru, Kenya, and at Lunyangwa Agricultural Research Centre, Mzuzu, Malawi.
- RITA® tissue culture bioreactors at CRI (900) and Lunyangwa (280).
- 1 laminar flow hood at Lunyangwa.
- 1 standby electricity generator at Lunyangwa.
- 3 weaning nurseries in Kenya and 3 other nurseries transformed in Kenya to wean tissue culture pre-germinated seedlings.

Toolkits

- Temporary Immersion System (TIS) protocol for tissue culture.
- Manual for TIS-based tissue culture laboratory.
- Weaning techniques for tissue culture plantlets at smallholder coffee nursery level.
- Farmer Field School approach to coffee extension in Malawi.

Data

- Soil health status for 16 coffee growing regions extension planning areas in Malawi (Misuku and Mphompha – North, and Ntchisi – Central).
- Cost-benefit information and break-even points for tissue culture seedling production.

Capacity building

- 20 scientists and technicians trained in Kenya (13 female, 7 male) on improved tissue culture techniques.
- 3 scientists (1 female, 2 male) and 6 technicians (1 female, 5 male) trained on *in vitro* TIS for mass propagation of coffee tissue culture in Malawi.
- 1 MSc student trained in *in vitro* techniques and protocol development for TIS.
- 1 technician from Lunyangwa trained in soil testing protocols.
- 45 extension staff (Agricultural Extension Development Officers) and 90 farmers' representatives (30% female) trained in soil and leaf sampling techniques.

- 4 Farmer Field Schools in Malawi (Misuku, Mphompha and Ntchisi) on Integrated Pest and Disease Management.
- 6 nursery attendants trained on nursery management techniques and weaning of pre-germinated tissue culture seedlings.

Visibility

- Project web page.
- 1 article in 'CABI in AFRICA Newsletter'.
- Participation in Open Day in Malawi on 24 April 2015 under the theme 'Improved access to agricultural technologies and services for enhanced farmer livelihoods'.

Publications

- Wanjiku M.I. *et al.*, 2018. Effects of auxins and cytokinins on callus induction in leaf cultures of *Coffea arabica* F1 Hybrid. Proceedings of the 13th JKUAT Scientific, Technological and Industrialisation Conference and exhibition (*in press*).



Assessing the performance of tissue culture coffee trees at Mayekwe Farmers' Cooperative Society demonstration plot, Bungoma, Kenya (August 2018).



Scientists discussing progress with embryogenesis of *Coffea arabica* in a RITA® temporary immersion system at the Coffee Research Institute, Ruiru, Kenya (June 2016).



Laboratory technician working within a tissue culture laboratory equipped with RITA® Temporary Immersion Bioreactors at the Coffee Research Institute, Ruiru, Kenya (December 2018).



Nursery assistant at West Pokot, Kenya, attending to the tissue culture seedlings of Arabica coffee hybrid Ruiru 11 (December 2015).



Tissue culture plantlets developing within a RITA® temporary immersion system at the Coffee research Institute in Ruiru, Kenya (June 2016).

RESULTS



Outcomes

- Improved TIS skills and knowledge of coffee researchers in Kenya and Malawi.
- Primary coffee cooperatives in Kenya able to produce seedlings from pre-germinated tissue culture plantlets.
- Improved skills and knowledge of scientists and technicians from LARS on soil and leaf analysis, and fertiliser recommendations.
- Improved knowledge by coffee industry managers in Malawi of the nutritional status of soils.
- Improved access and use of research results by primary coffee cooperatives in Kenya and Malawi.



Impacts

Usage

- The TIS protocols are expected to be adopted by private sector operators and scientists in various research institutions and universities in Malawi, Ethiopia, Tanzania and Uganda.
- Mass propagation of hybrid coffee in Kenya has shifted to the use of TIS which is more efficient compared to the previously used solid media methods.
- LARS is providing advice on appropriate fertiliser use on coffee.
- Smallholder coffee farmers in Malawi are adopting integrated pest management approaches.
- Efficiency of seedling production using tissue culture significantly increased in Kenya by reducing the production cycle by 21 weeks per year and increasing throughput by up to four times.
- Significant increase in coffee cherry production and improved payments to farmers.
- Significant increase in farmer participation in cooperative activities.
- Coffee farms in the project area are being renovated using good agronomic practices including rehabilitation of abandoned farms.
- Scaling up of weaning procedures for tissue culture plantlets by primary coffee cooperatives expected in 2-3 years given that more cooperatives want to be included in the programme of weaning tissue culture plantlets.
- The plantations using tissue culture seedlings have high uniformity, mature earlier and are prolific giving rise to better yields and higher returns.
- With improved productivity at reduced cost of production, smallholders will obtain increased incomes. Wide scale benefits expected in 5-10 years given the long juvenile period and perennial nature of coffee.
- Once greater areas of coffee farms are planted with improved and disease resistant seedlings, in 3-5 years, there will be a reduction or elimination of fungicide use.

Policy implications

- Soil and leaf analysis in Malawi is helping advise policy on efficient use of fertilisers and soil amendment products, which are expected to be incorporated into national fertiliser policy.

Sustainability

- Establishment of laboratories using TIS culture systems has enhanced the capabilities of Kenya and Malawi to take part in higher level research on *in vitro* propagation of perennial and woody crops.
- The tissue culture laboratory in Kenya has attained commercial level of production and should be able to sustain its operations through sale of seedlings at break-even prices. It is also able to propagate other high value crops, such as bananas, *Aloe vera*, passion fruit, orange fleshed sweet potatoes and pineapples, which could be sold at higher returns and the accrued profits re-invested to undertake further innovation. The same is expected of the laboratory in Malawi which is already being used to facilitate large-scale propagation of clean planting materials of bananas.
- The cooperative nurseries are making profits from the sale of superior seedlings. The accrued profits could be re-invested into the nursery operations.

TESTIMONIALS



Mr. Wambura Omoga, Secretary Manager, Gitungi Farmers' Co-operative Society, Migori county, Kenya

“Farmers who received the tissue cultured coffee seedlings are having better coffee yields. They are delivering more coffee cherry to the cooperative, enabling the cooperative to process and sell more coffee. With the increased income, the cooperative

has reduced the proportion levied on coffee income by the cooperative to finance its operations from the 20% mandated by law to 15% currently. The farmers now enjoy better prices for the delivered cherries. If the current payment to farmers continues at the same rate or improves for the next five years, then we foresee significant reduction in poverty among our cooperative members.”



Mr. Paul Chemiati, Secretary Manager, Mayekwe Farmers' Co-operative Society, Bungoma county-Kenya

“This project has contributed immensely to me personally as a farmer and to our co-operative. The coffee supply to the cooperative grew steadily over the past three years, moving from 107,506 kg in 2015/2016 to 264,548 kg in 2017/2018. We have also seen improvement in the quality of coffee beans supplied to the cooperative. Prices paid to the farmers have improved mainly due to improved profitability of the society. The excellent performance of the tissue culture plants observed in the demonstration plot has generated farmer interest in trainings at the cooperative. We have registered an increase of 150 to 510 farmers attending trainings on good coffee production practices.”

ACP-EU Co-Operation Programmes in the fields of Higher Education and Science, Technology and Research

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ACP Science
and Technology II Programme

NEED – Network of excellence in renewable energy technologies for development

SUMMARY OF RESULTS

NEED has interlinked initiatives, research institutions, small and medium-sized enterprises, national and local public decision makers in the area of renewable energy technologies to contribute to a wider acceptance of renewable energy within Southern Africa. Research policies were formulated, a process for the alignment of industry standards in the region was initiated, involving the local industry, the national and Southern African Development Community (SADC) standardisation bodies. Furthermore, higher education and vocational training institutions, and national training authorities were interlinked and an undergraduate dual-study programme in renewable energy technology was developed to serve as a blueprint for the region. Energy concepts and transition roadmaps, i.e. a community-based methodology for the transition from fossil to renewable energies for two model regions (fossil-free wetlands and renewable mini-grid drylands) were developed. Scientists involved in renewable energy technologies have been enabled to ensure increased supply of secure energy in the region.

BACKGROUND

Supply of and access to sustainable and secure energy is lagging behind in many Southern African countries, in particular in remote areas. Despite existing ambitious plans and policies to prioritise the use of renewable energy resources, the lack of professional know-how and a skilled workforce in the field of renewable energy technologies (RET) still undermines their development and economic use. To date, mainly small-scale research and demonstration projects have been initiated, but a comprehensive, integrated approach and good practices to establish RET on a broad scale for the supply of energy are still lacking. Weak links among research and education institutions and the private sector, as well as slow governmental decision-making processes hinder the widespread deployment of RET in Southern Africa.

The project established a SADC-wide network of public, private and higher education stakeholders to unite and boost local capacities and roll out RET on national and local level that have previously been out of scope. The research results are of use for policy

makers, scientists and technical staff in the area of RET, and feed into the development of future energy and research policies of the relevant national ministries (e.g. of higher education, research and energy) of the SADC region and the EU. The private sector can improve the planning and implementation of RET projects.

Botswana, Namibia and Zambia have a comparable state of the introduction of RET with respect to their policy background and presence of significant renewable energy potential. The majority of their populations depend on firewood and charcoal for cooking and hot water supply, which poses serious threats to the environment, health and economy because local resources are used unsustainably, generating the risk of deterioration of valuable soil necessary for food production. Simultaneously, because of the favourable climatic conditions, the use of solar-based RET in these countries has enormous potential. The availability of sustainable and affordable energy is considered vital for development.



Visit to the Biomass Test Facility at Thomro Biofuels, Lusaka, Zambia (April 2014).

PROJECT IMPLEMENTATION PERIOD

March 2014 - August 2017

CONSORTIUM

- Technische Hochschule Ingolstadt (THI), Germany
- Botswana International University of Science and Technology (BIUST), Botswana
- Okavango Research Institute (ORI) - University of Botswana, Botswana
- Namibia University of Science and Technology (NUST), Namibia
- University of Zambia (UNZA), Zambia

Associated partners:

- Botswana: Ministries of Infrastructure, Science and Technology, Education and Skills Development, Minerals, Energy and Water Resources; Botswana Power Corporation
- Namibia: Ministry of Education, Arts and Culture; Desert Research Foundation of Namibia
- Zambia: Zambia Electricity Supply Corporation; Copperbelt Energy Corporation; Centre for Energy, Environment and Engineering Zambia; Muhanya Solar; National Technology Business Centre
- Germany: Deutsche Gesellschaft für Internationale Zusammenarbeit; Bundesverband Solarwirtschaft; Munich Advisors Group

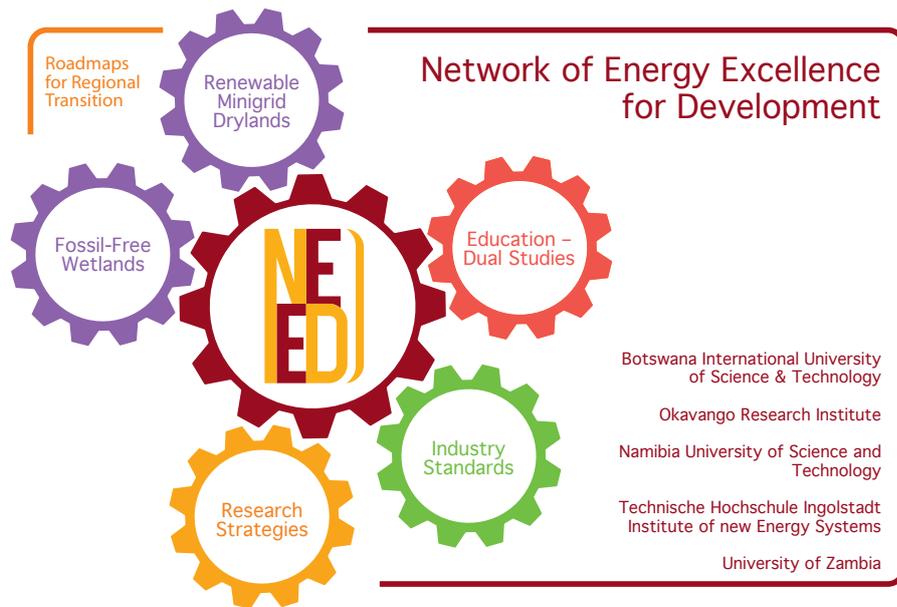
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PROJECT WEBSITE

<http://www.need-project.org>





Research strategies

In cooperation with relevant stakeholders (research and higher education institutions, NEED’s industry partners and respective ministries), research strategies were prepared to accelerate research in RET which are appropriate to endogenous energy resources. In this respect, the status of the technologies in the renewable energy sector was assessed, areas herein that required further investigation were identified, and a methodology for developing research strategies was created. National RET stakeholder mappings were also carried out in order to identify relevant actors for future research activities and to develop national research strategies.

Dual study programmes

Aimed at enhancing practical training in RET as part of an undergraduate study programme, a curriculum including compulsory vocational training components and industry internship was developed. A web-based survey was conducted to assess the specific training needs of

scientists, engineers and technologists focused on applied RET knowledge. Based upon this survey, a framework for courses at Higher Education Institutions (HEIs) in solar photovoltaic, solar-thermal and wind energies as well as the structure and curriculum of a RET dual study programme was developed. Within this process, two focus group meetings with officials of the National Training Authority (NTA) in Namibia were held in order to capture input related to national needs.

Industry standards

The requirements for RET standards and technical directives as well as the standardisation processes in the SADC region were assessed with respect to the alignment of RET industry standards. Certain standards exist, but are not compatible across national borders. A survey was conducted to obtain information from RET practitioners, as well as national and SADC standardisation bodies, in Botswana, Namibia and Zambia. An appro-

priate process for the SADC-wide alignment of industry standards was identified and the respective actors involved.

A workshop with RET stakeholders in Botswana resulted *inter alia* in the foundation of the Renewable Energy Association of Botswana (REAB) to support the development of cost-effective, sustainable renewable energy generation and consumption solutions.

Fossil-free wetlands and Renewable mini-grid drylands

In so-called ‘model-regions’, technical options of RET for two typical local environments were investigated: a small village in the desert (dryland area) and an accumulation of tourist lodges in a national park (wetland area). The principles that were developed for setting up an energy concept and its incorporation within local structures and policy frameworks created a model for the implementation of sustainable energy concepts in other typical rural regions.

Several case studies have been conducted, e.g. at the Chobe Game Lodge and the Guma Lagoon Lodge in Botswana, for the development of a simulation model of typical wetlands tourist facilities. These included collecting and evaluating local energy production and consumption data. A simulation-based case study with the Topnaar community in the Namibian desert was conducted in order to show the technical and economic options of village electrification based on a solar photovoltaic mini-grid. This included a local community workshop to explain all aspects of the operation of a mini-grid, such as the maintenance and management of the installations.



Non-electrified Topnaar settlement using a solar home system in the Erongo Region in Central Namibia where NEED conducted a survey to assess the sources and use of energy amongst the Topnaar community (March 2015).

→ Outputs

Stakeholders

- Parastatal and public institutions, public limited companies, state-owned enterprises, government agencies: Botswana (18), Namibia (14), Zambia (8).
- Universities and national research institutes: Botswana (2), Namibia (4), Zambia (6).
- HEIs, vocational and secondary schools, training institutes, national qualification authorities, curriculum development centres: Botswana (4), Namibia (9), Zambia (10).
- International and regional organisations, civil society and non-governmental organisations, major energy consumers: Botswana (40), Namibia (8), Zambia (4).
- Topnaar region (Namibia) and the Okavango Delta (Botswana): 102 lodges, 615 individuals.

Capacity building

- 2 workshops on the use of RET with tourist service operators in Botswana.
- 3 short courses in solar and wind energy for students at NUST to serve as a blueprint for other HEIs in the region.
- Demonstration of the use of RET kits in photovoltaics (PV), solar thermal and wind energies at the National Commission on Research Science and Technology (NCRST) Science Festival in Ongwediva and the Topnaar community focus group meetings near Gobabeb in Namibia.

Networks

- 1 local government-university-industry forum in Zambia.
- Renewable Energy Association Botswana (REAB).
- The registration of the 'Network of Energy Excellence for Development (NEED Ltd.)' as a non-profit organisation in Zambia.

Toolkits

- 1 methodology for developing RET research roadmaps.
- 3 national and 1 regional RET research roadmaps.
- Recommendations on teaching methodology in RET.
- RET kits in PV, solar-thermal and wind energies for use in schools.
- 1 report on sourcing of funds for summer camps.
- 1 funding strategy to promote a culture of science.

Documents

- 1 report on the development of RET standards within the region and their harmonisation process through the SADC Cooperation in Standards (SADCSTAN).
- 1 comparative table on the RET standards in Botswana, Namibia and Zambia.
- 1 comprehensive report on energy production and consumption.
- 1 regional energy concept for the Okavango Delta in Botswana.
- 1 roadmap for regional transition in sustainable energy production and consumption with the vision of 'Fossil-free wetlands' in the Okavango Delta.
- Recommendations on capacity building in RET.

Visibility

- Project website.
- 2 scientific fairs; 12 presentations at international conferences; 1 final project conference; 1 half-day summit on RET as part of the International Conference on Development and Investment in Infrastructure Strategies for Africa (DII-2016) in Livingstone, Zambia.
- 5 newsletters (2,500 copies each).
- 3 policy briefs.
- 1 RET-related science quiz competition, 1 RET-related science fair.
- 1 broadcast on Namibian TV, 3 journal articles, 1 press release.
- 1 flyer (10,000 copies), 1 conference flyer, 1 brochure (60 pg.; 1,000 copies).
- 150 bags, 1 banner, 160 caps, 100 folders, 60 mugs, 250 notepads, 1,350 pens, 200 USB keys.

Publications

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 - Kelebopile L. *et al.*, 2016. Development and harmonization of renewable energy technology (RET) standards in the SADC sub-region.

- Mbaiwa J.E. *et al.*, 2016. Perceptions of tourism operators towards renewable energy use in accommodation facilities in the Okavango Delta.
- Chisale P. *et al.*, 2016. Sustainable renewable energy mini-grids for energy access: economic and social benefits of mini-grid systems.
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- Junker F. *et al.*, 2016. The NEED project: Strengthen the implementation of renewable energy resources in the Southern African Region. International conference on solar technologies hybrid mini grids to improve energy access, Bad Hersfeld, Germany, 21-23.09.2016.
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- Motsholapheko M.R. *et al.*, 2017. Access to grid electricity in Botswana: Implications for energy transition in the Okavango Delta.
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RESULTS



Outcomes

- Knowledge and skills of project partners strengthened in collaborating with national and international stakeholders in the area of RET research leading to two subsequent research projects and numerous joint project proposals.
- Linkages between academia, RET industry and policy makers strengthened and frequent exchange fostered in the SADC region.
- Awareness raised on curriculum of dual study programme at undergraduate level, and local and higher education institutes and authorities encouraged to introduce practice-oriented higher education in RET in the SADC region.
- Methodology for developing national strategies for research in RET enabling local stakeholders to implement and execute research activities in RET in the SADC region.
- Process and actors at national and international level identified for the harmonisation of RET industry standards enabling the acceleration of industry standard development and alignment in the SADC region.
- Energy concepts for the two model regions used to involve relevant stakeholders, such as the Okavango Wilderness Safaris (OWS) in Botswana and the Topnaar community in Namibia, and to raise awareness about using RET.



Impacts

Usage

- The developed framework and curriculum for dual study programmes serves as basis for the introduction of practice-oriented undergraduate RET study programmes at respective universities in the region.
- Industry actors active in the area of RET benefit from the established network and initiate close cooperation with NEED universities at technical level.
- Government institutions benefit from the established international network and involve NEED universities in decision making related to the use of RET.
- of RET policies for the SADC region.
- Research institutions benefit from greater government institution awareness of RET and consequently growing public support for the renewable energy sector and innovations.
- The research roadmap and industry standards for RETs can serve as best practice examples which can be adapted to other countries' needs (multiplier effects).
- The regulatory and institutional frameworks for the implementation of renewable energies may be improved through appropriate RET research policies and aligned industry standards.

Policy implications

- The results from the investigation on industry standards, and the needs assessment in the area of dual study programmes serve as a sound basis for the development

Sustainability

- The non-profit network 'NEED Ltd' will ensure the continuation of technology and

knowledge transfer between its members (academia, industry, civil society and government institutions).

- NEED contributed to ensuring the security of energy supply in the SADC region by the promotion of endogenous sources of energy.
- The reduction of fossil fuel consumption, especially in the model regions (in both the short and medium term, through institutionalised transition processes) can promote the wider use of sustainable energy technologies and contribute to a reduction of climate change impacts.
- The methodology on the development of research strategies will support the development of RET research strategies on national and regional level in Southern Africa.

TESTIMONIALS



Kudakwashe Ndhlukula, Executive Director, SADC Centre for Renewable Energy and Energy Efficiency (SACREEE), Windhoek, Namibia

“NEED addresses the demand for localised information in the RET sector in Southern Africa. As SACREEE, we depend on and work with the academia and industry to provide our stakeholders with relevant information on the local context and suitable solutions. Capacity is still a big issue in Africa's renewable energy sector. We need to build this capacity at both individual and institutional level.”



Dr. Ackim Zulu, Senior Lecturer, Department of Electrical and Electronic Engineering, University of Zambia, Zambia

“When we started this project, there were only loose or poor relationships among renewable energy stakeholders on national and regional level. Through the NEED project, we established strong links between stakeholders and target groups in the Southern African region. In addition, the interest in RET from national governments has increased. Governments now participate in RET sector discussions and are interested in the newest developments and innovations. Moreover, the local industry is coming on board to work more closely with higher education and research institutions.”

ACP-EU Co-Operation Programmes in the fields of Higher Education and Science, Technology and Research

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ACP Science
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StopRats – Sustainable technology to overcome pest rodents in Africa through science



Field school students learning how to set and place different kinds of rodent traps, Ambohitantly, Madagascar (October 2014).

SUMMARY OF RESULTS

Groups of researchers, knowledge disseminators, policy makers, public and private sector service providers and end users in several African countries discussed rodent pest issues and why rodents continue to be a severe pest problem for the great majority of African families. These discussions have resulted in a number of high-impact publications aimed at informing policy, raising awareness and generating new knowledge about the constraints and opportunities to improve rodent pest control in Africa. For example, the role and impact of avian and mammalian predators in controlling rodent pests, currently lacks evidence. As such, this has led to many anecdotal accounts and a lack of appreciation by smallholder farmers on the need to conserve habitats for wild carnivores. Clear communication bottlenecks between farming communities and extension services were identified. The project team members have improved their empirically-based assessment skills, ensuring future research will address key problems of new technology innovation and rodent impact assessment.

PROJECT IMPLEMENTATION PERIOD

January 2014 - December 2016

CONSORTIUM

- Natural Resources Institute (NRI) - University of Greenwich, UK
- University of Namibia, Namibia
- Association Vahatra, Madagascar
- Concern Worldwide, Sierra Leone
- Agricultural Research Council – Plant Protection Research Institute, South Africa
- University of Venda, South Africa
- University of Swaziland, Swaziland
- Sokoine University of Agriculture, Tanzania

Associated partners:

- International Rice Research Institute (IRRI), Philippines
- University of Antwerp, Belgium
- Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia

PROJECT CONTACT

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PROJECT WEBSITE

<http://projects.nri.org/stoprats>

BACKGROUND

Rats and mice are arguably one of the most neglected pests the world over. Rodents attack and damage crops grown in the field, but also damage stored crops in homes, warehouses and factories. Hence, their damage and contamination of food is problematic across the value chain. Despite this, accurate valuations of loss due to rodents in both pre- and post-harvest agriculture are difficult to obtain for most sub-Saharan countries. Rodents also cause problems in cities, where they feed on refuse, damage sewage and drainage systems, undermine foundations, and damage both electrical wires and gas supplies. The economic and social costs of such damage occasionally make the news when hospital equipment fails or buildings burn down due to damaged wires, but such damage is rarely systematically quantified. Zoonotic diseases such as Lassa fever and Bubonic plague are endemic problems in rural Africa, which sometimes lead to human-to-human disease outbreaks. More often than not, rodent-borne diseases are not recognised or diagnosed and poorly treated, with many thousands of poor rural people dying from rodent-borne diseases across Africa each year. With rodents transmitting more than 60 diseases to people and domestic animals, damaging food production systems, and exacerbating sanitation problems, few

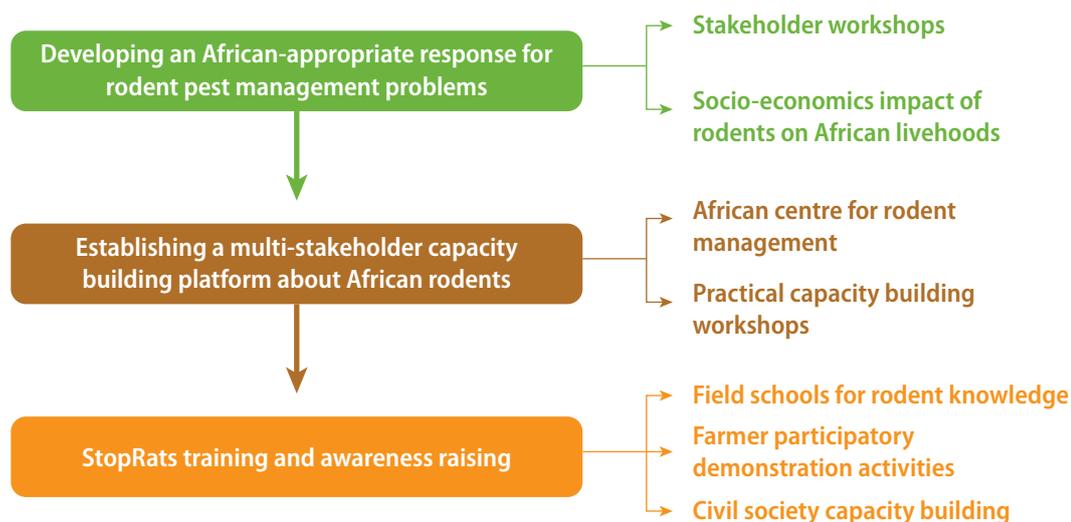
would argue that society's rat problems have been solved. Despite this, research on rodent pest management is entirely absent in many African countries.

The StopRats project worked with all stakeholder groups involved in rodent management, research and service delivery as well as those suffering from rodent pest problems in Sierra Leone, Tanzania, Namibia, South Africa, Madagascar and Swaziland. They worked alongside smallholder farming communities to clarify issues such as ownership of different rodent pest problems and to understand the constraints and opportunities for improving the delivery of rodent pest control services.

The direct beneficiaries of the project were: smallholder farmers and end users of knowledge and technology for the sustainable management of rodent pests; agricultural research institutions involved in developing new knowledge and innovating novel technologies for rodent management; and public and private rodent management service providers involved in knowledge dissemination, supply of technology inputs and other packaged services to end users and smallholder farming communities (NGOs, government extension, businesses and regulatory authorities).



METHODOLOGY



Developing an African-appropriate response for rodent pest management problems

Organisation of a series of stakeholder workshops on people's perceptions about rodent damage and impact, the effectiveness of existing control strategies and availability of different knowledge and tool input suppliers. The workshops brought together the different institutions involved in rodent research and the delivery of rodent knowledge and technology to end users, including public and private sectors and farmers.

Understanding the socio-economic impact of rodents on African livelihoods and particularly how these problems are being met by the research community. This involved searching through literature following meta-analytical guidelines and developing comparative tools to understand the impact of rodents according to different crops, crop stages and rodent species causing damage. Results were published as a meta-analytical paper in *PLoS One*.

Establishing a multi-stakeholder capacity building platform about African rodents

Creation of an African centre for rodent management. A database of researchers and pest control service providers was developed. This was shared with government officials and through a centre website aiming to help connect knowledge providers with those seeking knowledge. This networking of researchers enabled further funding from the World Bank (6 million USD) and the African Union (1 million USD) to establish the 'African Centre of Excellence for Innovative Rodent Pest Management and Biosensor Technology Development'. This centre, located at Sokoine University of Agriculture, Tanzania, aims to be the leading post-graduate training centre on rodent research. The African Union funded



Field school where students learn how to collect and process blood samples from rodents to screen for infectious disease pathogens in Kangari Hills, Sierra Leone (August 2016).

project 'Ecologically based rodent management for sustainable agriculture and food security in Africa' brings together researchers from the Centre of Excellence with many of the researchers involved in the StopRats project to carry out research on rodents in the context of sustainable agriculture and provisioning of ecosystem services.

Organisation of practical capacity building workshops for academic and extension staff on how to write grant proposals and peer-reviewed publications, how to deliver scientific presentations, and how to build stronger networks between researcher, end users and private sector rodent pest management service providers.

StopRats training and awareness raising

Field schools for rodent knowledge where students and university staff, NGO and government extension staff learned about the tools and techniques of field biology in a rodent context. This included learning how to trap rodents and sample collection for taxonomic and disease screening, with a view to raising the profile of rodent research and career opportunities for early career researchers in Africa.

A range of demonstration activities with smallholder farming communities about the tools and technologies that can be used to manage rodent pests as well as to increase end user understanding about rodent pests to build their capacity. These farmer participatory activities involved trials on the use of hermetic bags to protect stored grain from rodents, the value and impact of domestic and wild predators in rodent control, the potential use of fertility control instead of mortality control, trapping and trap barrier systems to control rodents without the use of poisons and farming practices.

Civil society capacity building. Communities and knowledge providers were directly involved in the management and decision making processes of carrying out action research and demonstration trials. This has particularly helped to empower communities and to build both their capacity and awareness. Work has also focused on developing an understanding that many rodent pest issues cannot be solved

alone and requires communities to work together.



Rodent damage to farm-stored sacks of maize grain, Stinkwater, South Africa (October 2015).



Community demonstration of rat trapping in Tonkolili, Sierra Leone (April 2014).

→ Outputs

Data

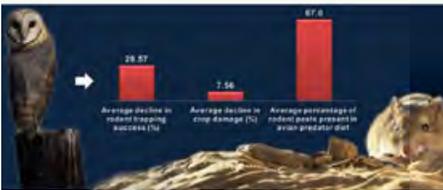
- Meta-analysis database of research on the agricultural impact of rodents in Africa and historical research across sub-Saharan Africa.

Toolkits

- Videos on 'How to control rodents' (English, French, Kiswahili).

Documents

- 4 policy discussion papers on controlling rodent pests.



Impact of avian predators on rodents.



Village information board in Ranomafana, Madagascar (May 2015).

Capacity building

- 5 field schools for students and early career researchers (73 male, 26 female) in core skills related to wildlife research, conservation and management.
- 38 students (30 male, 8 female) graduated (Madagascar: 1 PhD, 2 MSc, 11 Licence degrees; Namibia: 1 PhD, 3 MSc, 6 BSc; South Africa: 4 MSc, 5 BSc; Swaziland: 5 BSc).
- c.2,450 farmers and rural community members participated in training events: 700 (Sierra Leone); 300 (Namibia); 500 (Tanzania); 250 (Madagascar); 400 (South Africa); 300 (Swaziland), with approximately equal gender balance.

Visibility

- Project website.
- 3 radio interviews; 1 TV interview.
- 2 podcasts.
- 4 newsletter articles.
- 30+ articles in popular press.
- 1 press release.
- 1 leaflet; 4 posters.
- 14 conference presentations.

Publications

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- McCauley D.J. *et al*, 2015. Effects of land use on plague (*Yersinia pestis*) activity in rodents in Tanzania. *American Journal of Tropical Medicine and Hygiene* 92 (4): 776-783.
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Impact of small carnivores on rodents.

RESULTS

Outcomes

- Improved knowledge of farmers and service providers on biological control organisms' roles in regulating rodent pests.
- Improved knowledge of farmers, service providers and researchers on the suitability of non-chemical rodent control (economically and agro-ecologically viable).
- End users and development organisations have realised that practical methods for rodent control do exist and do work in practice under smallholder farming conditions.
- The quality of research carried out can be directly measured in terms of publication impact factors, international co-authorship, citation rates and h-indices of staff involved in the research.
- African researchers are now much more integrated into international networks with other experts and embedded into broader inter-disciplinary networks in their own countries, enabling them to leverage further funding from various donors.
- African-based research on rodents is now arguably superior to research carried out in industrialised countries, most notably reflected in the creation of a Centre of Excellence on rodents.

Impacts

Usage

- Existing and workable practical methods for rodent control under smallholder farming conditions could reach more farming communities through awareness raising campaigns and practical demonstration.
- Concern Worldwide is considering using community-based rodent management to help empower community action.
- Rodent fertility control is widely accepted to be more ecologically sustainable, humane and cost-beneficial, Fertility control clearly works for a range of larger mammal species, but is still being developed for rodents. Project results will help further efforts aimed at commercialising rodent fertility control.
- Post-harvest damage and contamination to stored grain is a major problem where insects, fungi and rodents can cross-exacerbate stored food loss and waste issues. The hermetic bag technology may be highly appropriate to prevent rodent damage.
- Knowledge on the role of small carnivores, predatory birds and domestic cats/dogs on rodent pest regulation are useful for understanding the role of biodiversity in provision of ecosystem services.
- The increased understanding of the economic impact of rodents through a meta-analysis of research is expected to provide the basis for a more systematic approach for future rodent impact analyses across Africa.

Policy implications

- Policy discussion documents and further networking are increasing rodent management discussions with some prospects for change in the short to medium term:
 - The Tanzanian government is discussing national registration and regulations around selling a contraceptive bait to reduce rodent fertility. The completion of the licensing requirements for a fertility

- control product is expected shortly.
- There is increased discussion in South Africa about banning illegally traded products used as rat poisons, because of abuse and extreme danger to people.
- The Madagascan government is discussing changing recommendations for preventive rodent control in the context of more effectively managing Bubonic plague outbreaks. This involves accepting the need to kill rodents through intensive trapping and the supply of such technology to communities.

Sustainability

- African researchers have been enabled to seek funding for research projects.
- The next generation of rodent researchers is being created through engaging with post-graduate students and highlighting opportunities for careers in rodent research with global relevance.

TESTIMONIALS



John R. Turay, resident of Rosint, teacher of the Tonkilili District Council Primary School, Sierra Leone

“Rodents were widespread in the community destroying our crops in the field and in grain stores. Rat infestation has greatly reduced: people now get enough sleep at night, post-harvest loss has greatly decreased and there has been an increase in household income.”



Chauke Wilson, farmer, Vyeboom, South Africa

“The project has helped me better understand different small mammals I didn't even know that they existed. I was informed of the extent of the impact that the rodents have on different things that I plant on the farm. I was also told that rodents start eating corn from the field and not only after harvest which is what I originally thought.”



Ngobeni Brown, farmer, Ka-Ndengeza, South Africa

“There are animals that I thought ate chickens, little did I know that those animals could help me by eating rodents. I was informed on different ways of doing away with rodents without affecting other parts of the environment. Some animals that I thought were dangerous only are dangerous when threatened.”

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ACP Science
and Technology II Programme

WABEF – Western Africa bio-wastes for energy and fertiliser

SUMMARY OF RESULTS

Anaerobic digestion has been promoted to decision makers and practitioners interested in installing a biogas plant in West Africa as a way to recycle bio-wastes for energy and fertiliser use, and thus closing the organic matter loop. An operational tool has been developed for each step of the biogas value chain: availability of bio-wastes; supply needs for different anaerobic digestion systems; use of biogas and agronomic management of bioslurries; viability for the whole value chain business; and ready-to-use knowledge (theoretical and practical) for decision makers and practitioners. A policy brief has been published on the integrated development of the biogas sector in West Africa describing and illustrating why the usage of bio-wastes for the production of biogas should be promoted, how it should be produced, and what policy and financial incentives are needed to promote a wider use of biogas.



Songhai green rural city model: a sustainable socio-economic settlement for the millennium. Sign displayed at Songhai Regional Centre in Porto-Novo, Benin (July 2017). © M. Kamaté

PROJECT IMPLEMENTATION PERIOD

February 2014 - July 2017

CONSORTIUM

- CIRAD - Centre de coopération Internationale en Recherche Agronomique pour le Développement, France
- Université Cheikh Anta Diop (UCAD), Senegal
- Institut Africain de Gestion Urbaine (IAGU), Senegal
- Association d'Entraide pour le Développement Rural – Teriya Bugu (AEDR), Mali
- Songhai Regional Centre, Benin
- International Network of Resource Centres on Urban Agriculture and Food Security (RUAF Foundation), The Netherlands

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PROJECT WEBSITE

wabef.cirad.fr

BACKGROUND

Population growth and urbanisation, along with changes in lifestyle and consumption, lead to large quantities of solid and liquid organic waste from agricultural, agro-industrial and urban activities. In the absence of an adequate waste management system, these can affect human health and the environment. Biogas technologies are unique among renewable energy forms in that they address environmental, health, agricultural and energy issues in sub-Saharan Africa in an integrated manner.

Within the framework of a (decentralised) mix of renewable energy, the production of biogas contributes to a reduction in (negative impacts of) the use of wood and fossil fuels. Better management of organic waste sources and pollution, as well as the implementation of clean cooking methods, contribute to improved sanitation, hygiene and health. In addition, the recycling of bioslurries or digestates contributes to improved agricultural performance, and biogas production creates new businesses along the service value chain, contributing to increased employment and improved livelihoods.

The adoption of renewable energies in developing economies is growing rapidly. In 2005,

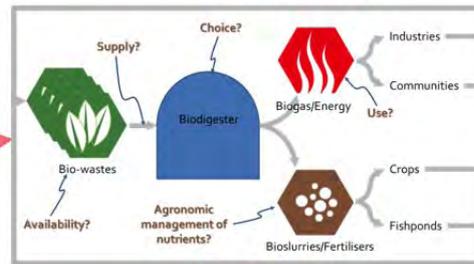
the Biogas Africa initiative was launched and since then, many actors have participated in various initiatives to support the development of anaerobic digestion. However, the dissemination of biogas in sub-Saharan Africa encounters obstacles, such as constraints to mobilise organic residues, high initial investment (construction) costs, incomplete national biogas programmes, and technical, institutional and socio-cultural barriers. Innovative approaches to disseminate information and build capacities are needed to support the private sector, governments and civil society to enable wider adoption and use of biogas as part of a further increase in the proportion of renewable energy in Africa.

To develop a critical mass of specialists in biogas and related topics for biogas development and dissemination, the target groups from the WABEF project were: public decision makers, researchers and lecturers, non-governmental organisations (NGOs), and technical staff from municipalities and agro-industries. The final beneficiaries were: communities, students and young entrepreneurs, industrial parks and agro-industries' managers, and farmers.

Analysis and removal of constraints related to the development of biogas in West Africa



Tools for assessing biogas usage and setting up a viable business plan



Involvement of local actors; Training



Analysis of biogas experiences in Europe and Africa

To remove the constraints related to the development of anaerobic digestion in West Africa, relevant and viable anaerobic digestion technologies in the Sudano-Sahelian context were identified. 14 visits to anaerobic digestion sites in Europe and 20 in Africa showed technological and managerial successes and failures, but also political and regulatory incentives and disincentives. The technical indicator relating to the nature of the bio-waste intake and the annual quantity processed in the biogas unit and the electric power generated were used as key indicators. Challenges to overcome for the development and appropriation of biogas as a solution for the management of bio-wastes in West Africa require a favourable political climate and strong government support that includes proper financial support for businesses and households investment. An integrated approach must also enable appropriate management of the information, the adapted technology chain, the bio-waste resources

(where, when, how much, with which energy and agronomic potential, competition, etc.) and the recycling of bioslurries. The results of the analysis were presented in a compendium that guides practitioners (contractors, biogas plant operators, entrepreneurs, farmers) interested in implementing a biogas plant, project promoters and policy makers into these constraints and challenges and towards the appropriate assessment tool which has been designed or adapted for each step of the biogas value chain.

WABEF, a toolkit to support the design of biogas value chains

Tools (database, dynamic simulation and calculator) were developed allowing the provision of answers to the following questions: What is the availability of bio-wastes? Which biogas system can be opted for? What possibilities are there for biogas use? When to use bioslurry or digestate? Is the whole biogas value chain feasible? What knowledge and know-how are needed for decision makers and practitioners? Most of these tools are designed with the MS Excel® spreadsheet.



Interview of the operator of an industrial biogas plant treating palm oil mill effluent in Kwae, Ghana (February 2016). © J.-M. Médou

Two existing demonstration plants (in Mali and Benin) were upgraded with extra materials (biogas engine, tarpaulin and monitoring devices) to complete the biogas value chain in order to show operational and sustainable biogas and bioslurry production technologies in local context. These were very useful to define the conditions for a feasible business model and to promote the integrated development of biogas.

Dissemination of knowledge in West Africa

Several multi-stakeholder events were held to ensure that the main results of WABEF were communicated to the relevant target groups and to engage them in the development of biogas in West Africa. A regional summer

school was organised at Songhai (Benin) to train high-level actors from international organisations, ministries, national agencies of renewable energy, NGOs, research institutions and universities from Benin, Cape Verde, Mali and Senegal in the use of the WABEF toolkit and further uptake and dissemination. A policy brief on integrated development of biogas in Africa for advocacy to policy makers, national and local institutional executives and financiers has also been produced. A lesson plan for courses on the WABEF approach and tools was developed to be included, among others, in a graduate curriculum in Senegal for students, technicians, engineers, practitioners and decision makers from the agriculture, agro-industry and urban sectors.



Bio-wastes sample collection (here: cattle manure) in Kaffrine, Senegal, to assess their agronomic and energetic values (February 2016). © J. A. Sambou



Wabef Songhai Energy 'Nenuphar' tarpaulin for biogas production at Songhai Regional Center in Porto Novo, Benin (July 2017). © M. Kamaté

→ Outputs

Capacity building

- 1 regional summer school with high-level actors (bioenergy senior officer from the ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE), programme officer from the West and Central African Council for Agricultural Research and Development (WECARD), directors of energy departments from ministries, researchers, technical advisors of national agencies of renewable energy, programme officers from NGOs, and university staff) from Benin, Cape Verde, Mali, Senegal and Niger (3 female, 20 male) trained in the use and dissemination of the WABEF assessment approach and toolkit.
- 4 multi-stakeholder events in Benin (1), Mali (2) and Senegal (1) for engagement and outreach to entrepreneurs and operational directors, project officers and coordinators from NGOs and public programmes, technicians from local institutions and NGOs, and university staff.
- 1 lesson plan for courses in specific masters' programmes in West Africa to train students, technicians, engineers, practitioners and decision makers from the agriculture, agro-industry and urban sectors on 'Integrated biogas development to contribute to the agro-ecological transition in sub-Saharan Africa' (*Méthanisation intégrée pour contribuer au développement de l'agro-écologie en Afrique Subsaharienne*).
- >1,000 high school and university students informed on the biogas value chain during educational visits to the demonstration sites in Teriya Bugu (Mali) and Songhai (Benin).
- 150 MSc students trained on the environmental and agronomic impacts of bio-waste use and on integrated biogas development to contribute to the agro-ecological transition in sub-Saharan Africa.

Tools

- For each step of the biogas value chain, WABEF adapted or designed an operational toolkit with 7 decision-making support tools:
- A methodology to identify, quantify and evaluate the potential availability of bio-wastes in terms of biogas production and fertiliser use of digestates, making use of 3 databases (MS Excel[®]) to estimate the wastes from agricultural (crops and livestock), municipal (bio-waste, faecal sludge and sewage sludge) and agro-industrial activities.
 - 2 simulation models (Approzut and UPU-TUC) adaptable to the West African context for the evaluation of bio-waste supply strategies for a collective biogas unit.



Automatic Methane Potential Test System to assess the biochemical methane potential of bio-wastes, located at the ISRA/IRD research centre of Dakar, Senegal (September 2015). © J.-M. Médoc

- Adapted technical economic model 'Methasim[®]', a web software to simulate on-farm biogas production.
- A MS Excel[®] spreadsheet to help local fertiliser providers, farming communities and farmers implementing an appropriate soil fertility system with organic residues based on bioslurry applications.
- A MS Excel[®] spreadsheet to assess the use of biogas for direct use (heating, cooking) or electricity generation.
- A set of 3 business model templates to assess the feasibility of a new biogas value chain (implementation of new biogas plant) and the viability of an existing biogas plant.

Manuals

- Biogas handbook (French, English) on the establishment and operation of a biogas production unit at domestic or small rural community scale.
- 1 compendium of technologies to promote the anaerobic digestion of agricultural, agro-industrial and municipal organic residues in West Africa.

Infrastructure

- Laboratory, biogas measurement and safety equipment at AEDR-Teriyá Bugu (Mali) and Songhai Regional Centre (Benin).
- A Nenuphar (i.e. water lily) tarpaulin and a biogas engine of 25 kW at Songhai Regional Center (Benin).

Visibility

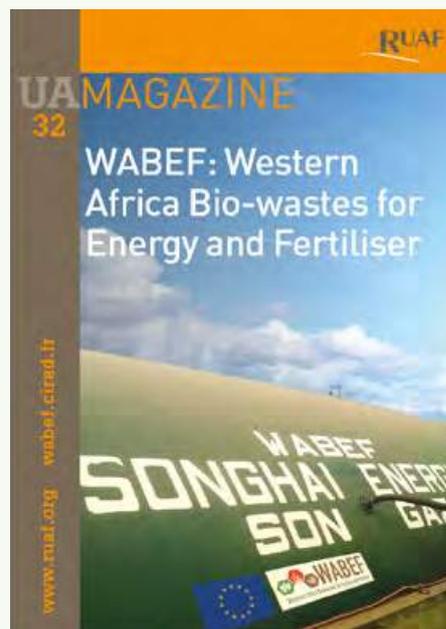
- Project website.
- >700 flyers, >200 posters, 5 banners, 200 USB sticks, 500 pens, 200 notebooks.
- 1 video on production and use of biogas.
- 3 radio and 2 Web TV interviews.
- 1 policy brief on integrated development of biogas in Africa for advocacy to public decision makers, national and local institutional executives, and financiers (350 leaflets

in English / French).

- 4 articles in a popular magazine (500 copies in English / French).
- 2 national newspaper articles (Benin and Senegal).
- 1 Web article.
- 1 WhatsApp group.
- 7 presentations at scientific and technical seminars.

Publications

- Médoc J.-M. and van Veenhuizen R., 2017. WABEF: Western Africa bio-wastes for energy and fertilisers. *Urban Agriculture Magazine* (32): 11-17.
- Kamaté M. and Médoc J.-M., 2017. Teriya Bugu in Mali. *Urban Agriculture Magazine* (32): 18-20.
- Lekoto J. and Médoc J.-M., 2017. Centre Songhai: Integrated development of renewable energy in Benin. *Urban Agriculture Magazine* (32): 20-23.
- Ba M. and Médoc J.-M., 2017. WABEF Support to renewable energy development in Senegal. *Urban Agriculture Magazine* (32): 24-25.
- van Veenhuizen R. *et al.*, 2017. Integrated development of biogas in West Africa. Leusden: Ruaf, 4 p. (RUAF Policy brief).
- Médoc J.-M. *et al.*, 2017. WABEF: une boîte à outils pour promouvoir la méthanisation des résidus organiques en Afrique de l'Ouest. In: Recueil des résumés JRI 2017. Club Biogaz ATEE, UniLaSalle. Beauvais: Club Biogaz ATEE-UniLaSalle, Résumé, 50.



Cover of the Urban Agriculture Magazine #32 highlighting the article on WABEF.

RESULTS

Outcomes

- Awareness raised among decision makers, institutional executives of public institutions (ministries, agencies, municipalities), researchers, university staff and engineers of sharing data, particularly on bio-waste deposits and the necessary implementation of their quantification and qualification in terms of agronomic and energy potentials.
- Key players from ministries' directorates, local institutions, technical and outreach institutions (chambers of agriculture, professional organisations and farming co-operatives), and chambers of commerce and industry identified for the collection and management of bio-waste data.
- Bioslurries as a new bio-waste managed

in terms of quality assessment (for which national and regional standards on fertilising material need to be updated to include bioslurries) to qualify them in term of agronomic values and correct usage as fertiliser in agriculture.

Impacts

Usage

- A first identification campaign on data collection of bio-waste deposits carried out in Senegal in the Peanut Basin by the Institut Sénégalais de Recherches Agricoles (ISRA) and the Biogas National Programme of Senegal (BNP-SN) identified agricultural bio-wastes suitable for anaerobic digestion.
- 2 students trained in the project implemented the methodology to identify and qualify available bio-wastes in the vicinity of Kaolack and Zinguinchor (Senegal) to promote the construction of biodigesters in their villages.
- The identification of bio-waste deposits induces an important leverage effect for research projects dealing with the urban food-waste-energy nexus.
- The agricultural interest of bioslurries issued from individual and industrial biodigesters has a significant market value. Thecogas and the BNP-SN are engaged in a standardisation process for bioslurry to provide farmers with a satisfactory cost-effectiveness ratio of its usage as fertiliser. ISRA and CIRAD are assisting by assessing the agronomic value of current bioslurries produced in fixed dome biodigesters and of new bioslurries produced at laboratory and field level.

- >10 entrepreneurs (from Senegal, Congo and France) are using the WABEF business model templates to convert bio-wastes into energy and fertilisers to assess the viability of their business ideas.
- 3 companies have approached CIRAD to support the development of a biogas value chain in Ivory Coast and Senegal.

Policy implications

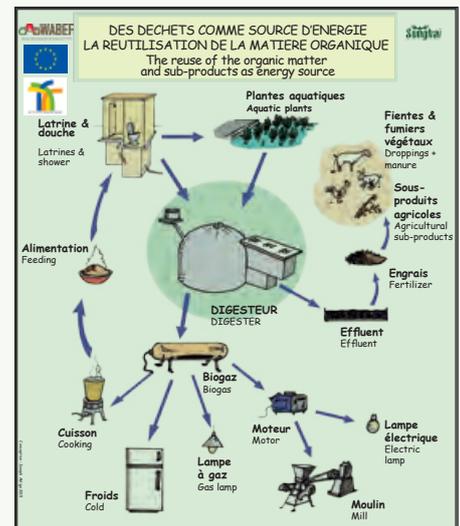
- In Mali, the National Agency for the Development of Biofuels (ANADEB) is introducing the development of a national programme on biogas with the following objectives: Research and management of various waste materials for biogas; Distribution of 7,000 biogas digesters (2017-2021); Operationalisation of a bio-energy quality control laboratory.

Sustainability

- CIRAD with the BNP-SN and ISRA will continue their collaboration on bio-waste research.
- CIRAD in partnership with Senegalese and Ethiopian research and academic institutions are engaged in the project 'OR4FOOD' – Organic Residual Products

for biofortified Food for Africa (funded by the African Union).

- The Malian Biogas National Programme and the demonstration plants at Songhai in Benin and Teriya Bugu in Mali remain operational.



Poster explaining the re-use of bio-waste (i.e. organic matter) as inputs in a biogas plant to produce energy and fertiliser.



Visit to 4 biodigesters in parallel digesting the wastewater and faecal sludge from the Rubaga Hospital, Kampala, Uganda (November 2014). © J.-M. Médoc



Visit to the industrial lagoon biogas plant treating palm oil mill effluent in Kwae, Ghana (May 2016). © M. Ba



Visit to the Safisana grid connected biogas plant (in construction) in Aischaman slum near Accra, Ghana (May 2016). © M. Ba

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ACP Science
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Strengthening the capacities for fostering innovation along potato value chains in East Africa



Practical field observation tour on best planting, weeding and crop protection practices during an 'Innovation and stakeholder engagement session on seed, production and post-harvest management of potatoes', Kenya Agricultural and Livestock Research Organisation (KALRO), Tigoni, Kenya (December 2015).

SUMMARY OF RESULTS

Setting up the 'East Africa potato research and knowledge exchange forum' – a research cluster made up of 16 research entities – has facilitated the exchange of information, the creation of 4 topical multi-stakeholder research groups (dealing with varieties, cultivation, storage and seeds), and the establishment of a web-based 'East Africa potato value chain knowledge-sharing portal'. This portal promotes co-operation between research organisations (primarily from East Africa) to create, update and use innovative technologies and best practices to enhance the quality of the potato value chain in East Africa. It contains a repository of scientific articles, guidelines on innovative technologies and best practices in the agri-food domain (relevant to the potato sector), country-specific policy recommendations (Kenya, Rwanda, Tanzania, Uganda), a database on East African and European potato research communities, and also enables scientists to prepare project proposals.

BACKGROUND

Demand for potatoes (*Solanum tuberosum*) and derived fresh and processed products has increased significantly in recent decades, spurred by rapid urban population growth in East Africa. Mostly produced by small-scale farmers as a food and cash crop, the potato plays a critical role in reducing extreme hunger and poverty in the region. Thanks to local supply and demand mechanisms, potato prices are not heavily dependent on international markets. Consequently, strengthening the potato value chain by developing a strong production and processing sector should become a key strategy for countries to increase their productivity and reduce their dependency on imports of processed potato products. This would also have the added benefit of creating new jobs.

Potato value chains in East Africa are characterised by low productivity and insufficient product quality due to:

- limited co-operation and knowledge transfer between value chain actors;
- limited potato varieties suitable for commercial processing;
- limited appropriate post-harvest and commercialisation technologies;
- inadequate quality control and product traceability from seed to market;
- mismatch between the existing regulatory framework and the real needs of the potato sector;
- limited use of certified seed potatoes.

The value chain actors responsible for these limitations participated in the project, which strengthened their capacity to innovate and boost the quality of potato and derived products in the value chain by:

- Bringing the **potato research community** together in a virtual forum to improve knowledge sharing, collaboration and coordination of activities. Moreover, the creation of specific research groups focusing on different scientific topics will facilitate the generation of new ideas and the preparation of joint research proposals.
- Informing **private sector and civil society organisations (farmers, processing companies, traders, and non-governmental organisations)** on innovative potato production, post-harvest and processing technologies through innovation sessions, demonstration of best practices and the issuing of guidelines.
- Informing **policymakers and government authorities (national ministries of agriculture, standards bureaus, seed agencies, extension services and certification institutes)** about national and regional regulatory frameworks, both successful and unsuccessful, to help them adopt the policies, regulations and standards required to facilitate innovations along the potato value chain.

PROJECT IMPLEMENTATION PERIOD

January 2014 – December 2016

CONSORTIUM

- Inkoa Sistemas, S.L., Spain
- Agricultural Research Institute – Uyole (ARI-Uyole), Tanzania
- University of Rwanda, Rwanda
- Makerere University, Uganda
- University of Nairobi, Kenya
- Basque Institute for Agricultural Research and Development (NEIKER), Spain

PROJECT CONTACT

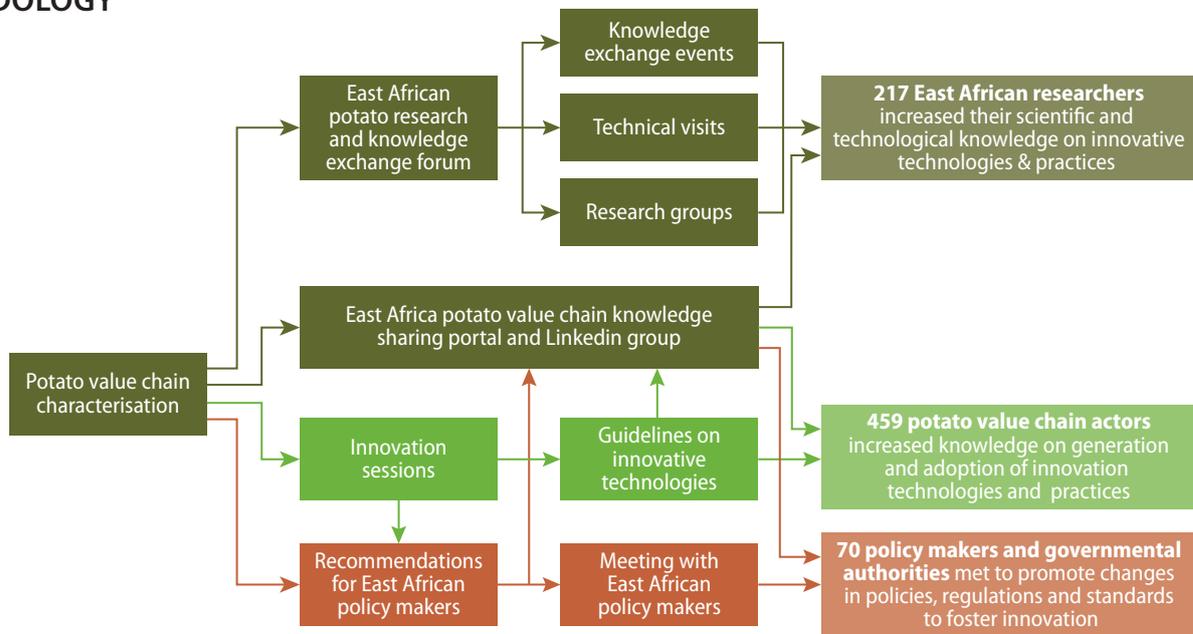
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PROJECT WEBSITE

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METHODOLOGY



Strengthening the scientific and technological knowledge of key East African research organisations on innovative technologies and practices

Potato value chain characterisation: Assessment of the state-of-the-art of research on innovative technologies and of best practices for enhanced potato quality in East Africa (literature review, questionnaires and interviews with c. 100 stakeholders from the research community, private sector and government authorities). The results were used to develop the supporting information and training materials (activities 1.2, 1.3, 2.1), and to draft policy recommendations (activity 3.1).

Release of a web-based **East Africa potato value chain knowledge-sharing portal** with registered members and filled with resources, news and events. The additional 'East Africa Potato Value Chain LinkedIn group' fosters networking between actors along various agri-food value chains (relevant to the potato sector): producers, processors, researchers...

Creation of the **East Africa potato research and knowledge exchange forum** to promote co-operation and information exchange between its members to strengthen their scientific and technological knowledge on quality issues along the potato value chain:

- **Knowledge exchange events** in Kenya, Uganda, Rwanda, Tanzania and Spain with researchers from a variety of research and higher education organisations enable knowledge- and experience-sharing in diverse areas of expertise, the setting up of partnerships, and the identification of research priorities.

- **Technical visits** to research institutions, farmers organisations and co-operatives, private companies, and government institutions

involved in potato breeding, production, processing and commercialisation. Topics covered included: quality management along the seed potato value chain; development of new potato varieties; production and post-harvest techniques; product quality, traceability and management of information; and processing techniques and technologies.

- Creation of **Research groups** to exchange information and draft research proposals.

Strengthening the capacities of key stakeholders for generating and adopting innovative technologies and practices

Innovation sessions with private sector actors and civil society organisations (smallholders, farmers associations, food processing companies, agricultural extension services...), government services and research entities in Uganda, Tanzania, Kenya and Rwanda to identify the main gaps in the adoption of innovations, to foster the adoption of innovative technologies and practices, and to identify possibilities for collaboration. Policy gaps identified have been used to draft guidelines (activity 2.2) and policy recommendations (activity 3.1).



Vegetable plantation

Production of a set of 4 **Guidelines on innovative technologies** and best practices on enhanced potato quality.

Promoting changes in policies, regulations and standards to foster the generation and implementation of innovations

Production of a set of **country-specific policy recommendations** for fostering the adoption of innovations along the potato value chain through modifications in existing policies, regulations and standards.

Face-to-face meetings with relevant authorities and policymakers of the Rwanda Parliament, MAAIF (Ministry of Agriculture Animal Industry and Fisheries, Uganda), AFA (Agricultural Food Authority, Kenya), MAL&F (Ministry of Agriculture, Livestock & Fisheries, Tanzania), KEBS (Kenya Bureau of Standards), UBS (Uganda Bureau of Standards), TOSCI (Tanzanian Official Seed Certification Institute), UNCST (Uganda National Council for Science and Technology) and KEPHIS (Kenya Plant Health Inspectorate Service) to share gaps and weaknesses identified in current policies and to foster the adoption of policy recommendations with respect to innovations in the potato sector.



Dehydrated potato storage facility

Technical visit to Njoro Canning Ltd. in Nakuru, Kenya (June 2016).

RESULTS

→ Outputs

Databases

- Database of the East African potato research community (universities, research institutes, national agricultural research organisations, government inspectorate services...) - 136 organisations, 217 researchers.
- Database of 535 members of private sector, civil society and government services.

Networking

- East Africa potato research and knowledge exchange forum - 16 research entities, 63 researchers (East Africa, Europe); 50% are female.
- East Africa potato value chain knowledge-sharing portal - <http://platform.spiritacp.com>: 447 registered members (335 from East Africa), 301 resources (scientific articles, training documents, regulation and standards, general documents); 127 news articles and 60 events published.
- East Africa potato value chain LinkedIn group - 81 members (scientists, lecturers, students, entrepreneurs).
- 4 topical research groups - 82 researchers who share publications, exchange ideas and explore funding opportunities:
 - Study on potato varieties for processing.
 - Strengthening farmers' knowledge and capacities on pest and disease control management, and soil management and disinfection.
 - Storage facilities and packaging methods and techniques.
 - Improved access to quality seed potato/certified seed and other inputs.
- 20 meetings with 70 East African government authorities.

Capacity building

- 6 knowledge exchange events - 108 stakeholders from the potato research community; 37% were female.
- 31 technical visits to national research centres, processing industries and farmers associations - 40 researchers informed on quality management of seeds, development of new potato varieties, innovative production, post-harvest and processing techniques and technologies, quality control, traceability and management of information throughout the potato value chain.
- 16 innovation sessions - 459 stakeholders from the private sector, civil society and government services trained in innovative technologies and best practices for: improving quality management and product quality, production and post-harvest

technologies and practices; and improving the management of information along the potato supply chain.

Research proposals

- 6 research proposals submitted, with the participation of 24 research organisations.

Documents

- 4 guidelines:
 - Innovative technologies and best practices for enhancing quality management along the seed potato value chain in East Africa.



- Production and post-harvest technologies and practices for improving potato quality in East Africa.
- Enhancing product quality in the potato industry processing sector in East Africa.
- Enhanced control of product quality and management of information along the potato value chain in East Africa.
- Country-specific brochures with policy proposals and recommendations to foster the adoption of innovations in the agricultural sector, in particular potato production and processing, in Kenya, Rwanda, Uganda and Tanzania, focusing on 7 main areas:
 1. Seed certification and standards.
 2. Food safety and quality regulations and standards, including traceability and information management.
 3. Financing and credit policies for the adoption of new and innovative technologies in processing industries.
 4. Fostering the adoption of Good Agricultural Practices (GAPs) among farmers at production and post-harvest level.
 5. Fostering the adoption of best manufacturing practices by processing industries.
 6. Establishment of extension support services that effectively connect researchers with farmers.

7. Policies for fostering product commercialisation.

- 1 report compiling the set of country-specific policy proposals developed for East African policymakers with modifications in existing policies, regulations and standards to foster the adoption of innovations along the potato value chain in Kenya, Rwanda, Uganda and Tanzania; distributed to 146 policymakers and government authorities.

Visibility

- 1 project brochure distributed by email; 4,650 copies distributed at knowledge

exchange events, innovation sessions, conferences and other events.

- 17 project newsletters.
- 3 newspaper articles.
- 1 press note - "SPIRIT: A project to promote innovation along the potato value chain in Africa" published in February 2016 in several electronic media (SPRI, Sustrai, Euskadi.eus, Finanzas.com, Argentinapapa.com...).
- 1,400 project flyers distributed at the knowledge exchange events, and at conferences and congresses in Africa and Europe.

Publications

- SPIRIT Project: "Strengthening agricultural innovations along the potato value chain in Uganda for enhanced product quality of potato sector" Project article published in the East African magazine The Nutritionist (No. 15. Feb. 2016).

RESULTS

Outcomes

- Increased knowledge of East African potato researchers on: potato production and processing (seed quality management and certification, new varieties development, new production and post-harvest techniques, potato quality control and traceability, processing technologies); the formulation of research projects.
- Increased knowledge of national agricultural ministries, national standards bureaus, national seed agencies and certification institutes from East Africa on: creating a business and legal environment that will allow East African potato value chains to flourish.
- Increased knowledge of private sector and civil society organisations from East Africa on: potato production and processing (innovative production and post-harvest practices, processing technologies, seed potato value chain and quality management).

Impacts

Usage

- The application of innovative technologies and best practices by potato producers is expected to reduce production and post-harvest losses, and to improve product quality. The resulting higher product prices and increased incomes will improve the welfare of their families, enhance their living conditions and generate employment opportunities. The adoption of sound phytosanitary and pesticide management practices will minimise associated environmental and health hazards.

Policy implications

- The project outcomes will facilitate the formulation and implementation of policies that are better able to unlock the full potential of the potato value chain in East Africa. These outcomes have already been mainstreamed in Kenya's National Potato Strategy 2016-2020, a final review of which was conducted by a team consisting of representatives from 10 Kenyan public institutions, which are also members of the East Africa Potato Research and Knowledge Exchange Forum.

Sustainability

- The improved capacity of the East African potato research community to formulate research projects and the enhanced co-operation between researchers is expected to contribute to the consolidation and generation of new potato research lines, as well as to increased participation in international research programmes.

TESTIMONIALS



Dr. Juliana Mwakasendo,
ARI-Uyole, Tanzania

“Knowledge exchange events and technical visits built the capacity of the participating scientists, especially regarding production/development and seed certification and standards, food safety and quality regulation and standards, potato production and post harvesting and handling, and potato processing techniques. ARI-Uyole has gained knowledge on how to prepare guidelines for seed potato production, potato production and post harvesting, potato processing and product quality control. The visibility of our institute has been increased and we have the opportunity to collaborate with other institutes working on research in Tanzania and other countries from East Africa and Europe.”



Dr. George Ooko Abong,
University of Nairobi,
Kenya

“The project has made a significant contribution in the East African potato value chain towards enhancing a body of knowledge by documenting the current status and innovations in value chains of 5 countries. Through innovation sessions, at least 100 Kenyan stakeholders were involved in information sharing and their capacities were built along the value chain, including segments of production and post-harvest management, handling and storage, processing and information exchange. Policy aspects along the value chain were reviewed and important aspects advocated for. Easy-to-use guidelines were developed to improve productivity, safety and quality of potato and potato products. A stakeholder reported during the innovation

sessions on production, ‘Why have you taken so long to hold such practical training? Please do more of these for us to be informed and have better yields and output.’”



Wachira Kaguongo, CEO of
the National Potato Council
of Kenya

“The potato industry in Kenya benefitted through the project. It provided a platform for information and innovation exchange to various stakeholders in the potato industry, including farmers, processors and policy makers. The various policies advocated include a strategy on how to transform and improve the seed potato value chain, regulations on implementation of a 50 kg standard bag and pricing by weight, among other policies geared towards the development of the potato sector.”

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ACP Science
and Technology II Programme

ENRICH – Enhancing energy accessibility & efficiency through establishing sustainable STI support national networks with a regional dimension in East Africa

SUMMARY OF RESULTS

National science, technology and innovation support networks with a specific focus on energy access and efficiency have been created in Kenya, Tanzania and Uganda. At regional level, the East Africa Energy Access and Efficiency Network 'EAENet' has been established, including an online platform and an expert database, facilitating regional dialogue and improving communication between academia, researchers, industries and policy makers. Over 300 managers and researchers have been trained in Research and Innovation Management resulting in increased capacities and quality of science, technology and innovation support. Recommendations for strengthening cooperation links in the energy sector in East Africa have been developed and dialogue with policy makers has been promoted. The project's final conference raised awareness of the real needs of science, technology and innovation related to energy access and efficiency, and fostered discussions on how the higher education system can contribute.

BACKGROUND

Energy deficit and poverty have become a major obstacle to growth and development in East Africa. East African countries underperform in energy access (around 27% average) compared with the sub-Saharan average of 30.5% (UN Economic Commission for Africa, 2014). One of the major energy issues is price volatility and energy security as East Africa suffers from high prices in the energy market and shrinking natural energy resources. The deficit in electricity supply and the lack of access to sustainable energy services hamper the satisfaction of basic human needs. It is estimated that 70% of the total inhabitants do not have access to sustainable energy sources. This leaves the region energy insecure and highly dependent on fossil fuels and high-carbon emission systems, which together with climate change is hampering the East African region from developing sustainably.

Efforts have been made to improve the energy accessibility in the region, but there are many areas where further engagement can be made, not only at the level of large investments, but also at the human and society level, with the intervention of Higher Education Institutions (HEIs). HEIs have well trained human resources, develop research, can collaborate with industry to further technological innovation, and provide

policy or technical advice to governments (local, national). They can also contribute in raising public awareness and be important actors in regional and international collaborations in research and development.

To find innovative solutions that will eventually alleviate energy poverty through enhanced energy accessibility and efficiency, ENRICH promoted quality Research and Innovation support services in Kenya, Tanzania and Uganda and strengthened co-operation links in the energy sector at national and regional level among academia, researchers, industries and policy makers via the establishment of the East Africa Energy Access and Efficiency Network 'EAENet', a regional platform with a database of experts. These activities were accompanied by a dissemination and awareness-raising strategy including network promotional events, workshops, round tables and international conferences.

A wide range of stakeholders in the energy sector were involved, ranging from academia, researchers, knowledge exchange and commercialisation practitioners, non-governmental organisations (NGOs), representatives of the industry and policy makers in order to encourage dialogue and strengthen cooperation links in the energy sector in East Africa.



Training workshop on 'Research support offices and policies & procedures, Kampala, Uganda (February 2015).

PROJECT IMPLEMENTATION PERIOD

February 2014 - April 2017

CONSORTIUM

- Universidad de Alicante (UA), Spain
- Glasgow Caledonian University, UK
- African Virtual University, Kenya
- Moi University, Kenya
- Mzumbe University, Tanzania
- Makerere University, Uganda
- Inter University Council for East Africa (IUCEA), Uganda
- Ministry of Education Science and Technology (MEST), Kenya
- Tanzania Commission for Science and Technology (COSTECH), Tanzania
- Uganda National Council for Science and Technology (UNCST), Uganda

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PROJECT WEBSITE

www.enrich-project.eu



METHODOLOGY



Comparative analysis

A **benchmarking survey** was conducted in Kenya, Tanzania and Uganda targeting key energy sector stakeholders including HEIs, government organisations, managers of enterprises and other organisations in the energy field. The innovation ecosystem in East Africa was studied: policies, initiatives and support services. The survey was conducted with the purpose of assessing the status of research and innovation activities and support mechanisms among public and private institutions with specific focus on energy access and efficiency. 80 Individuals were interviewed on the innovation ecosystem: 29 from HEIs and 51 from government organisations. The resulting three country reports and a consolidated comparative analysis were used to tailor the subsequent project activities.

During a **study visit** at the Glasgow Caledonian University (GCU), ENRICH partners learned about the innovation ecosystem within the university and got first-hand experience in daily Research and Innovation support service operation.

Training

Based on the results of the consolidated report and on the training needs identified in the country reports, three **capacity building workshops** for managers and researchers from HEIs who would be involved in the establishment of the East Africa Energy Access and Efficiency Network (EAENet) were held in Kenya, Tanzania and Uganda. The topics were: Research support offices and policies & procedures; Fundraising, proposal

drafting and project management; and Knowledge transfer and intellectual property management.

Networking

Three national support networks on energy access and efficiency were established in Kenya, Tanzania and Uganda to address the scientific, technological and innovation divide in energy access and efficiency among the East Africa Community (EAC) member states.

The **East Africa Energy Access Efficiency Network (EAENet)** was established with an online platform (<https://eaenet.org/>) and a database of experts in the field of energy access and energy efficiency and sustainability. This regional network aims to develop institutional capacity in the area of internationalisation to enable the creation, update and use of scientific knowledge on energy access and efficiency through the transfer of know-how, managerial capacities and actions to address institutional sustainability, planning procedures and networking. Each partner HEI also identified a manager and a researcher from amongst those who attended the workshops to be fully responsible for the platform as well as of the national support networks.

Two national round tables on energy were held in each country, as well as three national workshops and an international conference to promote cooperation with key stakeholders (academics, researchers, policy makers, businesses, professionals and NGOs in the energy sector) and enhance dialogue in energy access and efficiency. This culminated in a second international conference where a 'Blueprint for Cooperation in Energy Access and Efficiency in East Africa' was produced.



1st ENRICH international conference 'Energy accessibility & efficiency: the importance of science, technology and innovation support services', Dar es Salaam, Tanzania (October 2015).

→ Outputs

Capacity building

- 3 national training workshops: 300 managers and researchers from Kenya, Tanzania and Uganda trained in Research and Innovation Management (policies and processes, knowledge transfer, fundraising, proposal drafting, project and intellectual property management).

Networks

- 3 national support networks on energy access and efficiency (Kenya, Tanzania and Uganda).
- East Africa Energy Access and Efficiency Network (EAENet) with online platform and database of experts in the fields of energy access, energy efficiency and sustainability, knowledge transfer and general intellectual property management. <https://eaenet.org/>



EAENet

East Africa Energy Access and Efficiency Network

Publications

- Universidad de Alicante, 2017. Comparative analysis and recommendations to Higher Education Institutions top management and policy makers in East Africa. Final report: comparative analysis & recommendations, Alicante. ACP S&T programme.
- Beans C., López N. and Escarré R., 2017. Blueprint for cooperation in energy access and efficiency in East Africa – Recommendations from



the international conference 'Fostering cooperation in energy efficiency and accessibility in East Africa', ACP Edulink and S&T programmes.

Visibility

- Project website.
- EAENet website.
- 2 international conferences on Energy Accessibility and Efficiency.
- 6 national Energy round tables with energy stakeholders from academia, government, industry and society.



1st National round table on 'Energy accessibility and efficiency' in Morogoro, Tanzania (August 2016).

Documents

- 1st national round table forum on 'Energy accessibility and efficiency in Kenya', 3 May 2016.
- 2nd national round table forum on 'Energy accessibility and efficiency in Kenya', 10 March 2017.
- 1st national round table forum 'Energy accessibility and efficiency in Tanzania', 2 August 2016.
- 2nd Tanzania national round table forum 'Linking energy efficiency and stakeholders' daily activities', 29-30 March 2017.
- 1st national round table forum 'Energy accessibility and efficiency in Uganda', 30 June 2016.
- 2nd Ugandan national round table forum on 'Enhancing energy accessibility and efficiency in Uganda: what energy options should we prioritize?', 7 March 2017.



Final ENRICH international conference 'Fostering cooperation in energy efficiency and accessibility in East Africa', Zanzibar, Tanzania (March 2017).

RESULTS

Outcomes

- Increased awareness among stakeholders in the energy sector (academia, researchers, industries, policy makers, NGOs) of the importance of science, technology and innovation co-operation in East Africa to ensure energy access and efficiency.
- Enhanced knowledge and capacities of HEIs and public authorities in providing quality research and innovation support services to students, researchers and the private sector.
- HEIs and public authorities aware of the status of energy access and efficiency in East African countries.
- Strengthened co-operation links in the energy sector at national level in Kenya, Tanzania and Uganda among academia, researchers, industries and policy makers.

Impacts

Usage

- Regional and national stakeholders (ministries and agencies with responsibilities for the development and implementation of energy policies, local authorities, professional and corporate organisations in the energy sector) have established new relationships with universities, allowing them to identify potential collaborations in energy research and innovation.
- HEIs expect to conduct training on how to reinforce the awareness of research and innovation, particularly in the area of energy accessibility and sustainability.
- The 3 research and innovation national support networks in Kenya, Tanzania and Uganda will be reinforcing inter-university and university-industry co-operation links, providing an excellent meeting point and support for research and innovation.
- The pool of experts, mainly from the energy sector, at the EAENet portal will be extended. The areas of expertise are energy access, energy efficiency and sustainability, knowledge transfer and general intellectual property management.

Policy implications

- Ministries and agencies with responsibilities for the development and implementation of energy policies have been provided with recommendations for fostering cooperation in energy efficiency and accessibility in East Africa to enable policy reforms that improve energy access.
- Awareness of the real needs of science, technology and innovation related to energy access and efficiency was raised among policy makers to enable joint

innovative research among HEIs, research centres and industry at national and international level.

Sustainability

- The partnership will continue through the 'East African Energy Access and Efficiency Network (EAENet)' – once all the partners have signed the Memorandum of Understanding and Statutes – where they will work together to obtain new projects and collaborations to continue fostering regional dialogue among academia, researchers, industry and policy makers. The EAENet portal provides a good platform for research and innovation where energy experts keep in touch and engage in discussion forums.

TESTIMONIALS



Dr. Atieno Adala,
African Virtual University,
Nairobi, Kenya

“The topics covered at the ENRICH international conference ‘Fostering cooperation in energy efficiency and accessibility in East Africa’ were very helpful. I hope to use the resources I learnt about in my own work and to train others.”



Prof. Simiyu Sitati, Moi
University, Eldoret, Kenya

“The ENRICH international conference ‘Promoting partnerships between government, industry and Higher Education Institutions in energy access and efficiency within East Africa’ brought together stakeholders from academia, industry and government. This is key for policy formulation and uptake.”



Dr. Felichesmi Lyakurwa,
Mzumbe University,
Morogoro, Tanzania

“I am highly satisfied with the topics and discussions addressed during the ENRICH international conference ‘Fostering cooperation in energy efficiency and accessibility in East Africa’, because most of the critical issues were tackled, creating more awareness about renewable energy opportunities and challenges”

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ACP Science
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BIOCHAR PLUS – Energy, health, agricultural and environmental benefits from biochar use: building capacities in ACP Countries

SUMMARY OF RESULTS

Biochar knowledge and research findings were transferred into technology implementation, community development and policy advancement in Western, Eastern and Southern Africa. Existing biochar research and knowledge were analysed, structured and circulated during awareness raising and networking events to decision makers and the general public. Good practices and pilot activities on biochar, waste biomass recycling and ELSA improved clean cooking stoves resulted in the communities absorbing biochar technology due to endogenous learning and a participatory approach. The Africa Biochar Partnership was established as a continental platform for promoting and developing biochar and pyrolytic clean cooking systems: it serves as a hub for local, national, regional and continental institutions (municipalities, ministries, public development agencies, etc.), universities, research centres, foundations and the private sector for peer-to-peer exchange, learning, training, and coordination of biochar programmes.



ELSA cooking stove demonstration to researchers and women, Jimma, Ethiopia (June 2016).

PROJECT IMPLEMENTATION PERIOD

February 2014 – January 2017

CONSORTIUM

- Università degli Studi di Udine, Italy
- ECREEE - ECOWAS Centre for Renewable Energy and Energy Efficiency, Cape Verde
- STARTER - Studi Analisi e Ricerche Territoriali, Italy
- ASA Initiative, Ghana
- Université de Lomé, Togo
- CORD SL, Sierra Leone
- Jimma University, Ethiopia
- Bindura University of Science Education, Zimbabwe

Associated partners:

- African Union Commission (AUC), Ethiopia
- United Nations Industrial Development Organization (UNIDO), Austria
- Cornell University, USA

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PROJECT WEBSITE

<https://sites.google.com/site/biocharplusproject/home>

BACKGROUND

A large part of humanity still relies on wood for almost all of its energy needs. In sub-Saharan Africa the three-stone fire is a widely used system to generate energy for cooking using wood fuel. Such traditional stoves are very inefficient, harnessing only 5-15% of biomass energy. Furthermore, they require more fuel than necessary and result in a progressive environmental degradation, and increase of time required for collecting wood and of costs to buy it. The inefficient combustion system is the primary cause of indoor air pollution, a major global health hazard for the exposed persons, mostly women and children. In recent years, biochar produced through improved pyrolytic clean cooking stoves has been proposed as a winning strategy to address the above-mentioned issues. These ensure efficient combustion, minimise pollutant emissions, are suitable for the feedstocks available in the areas of use, are available at low cost and produce biochar, a carbon-rich compound which can increase soil fertility when added to the soil.

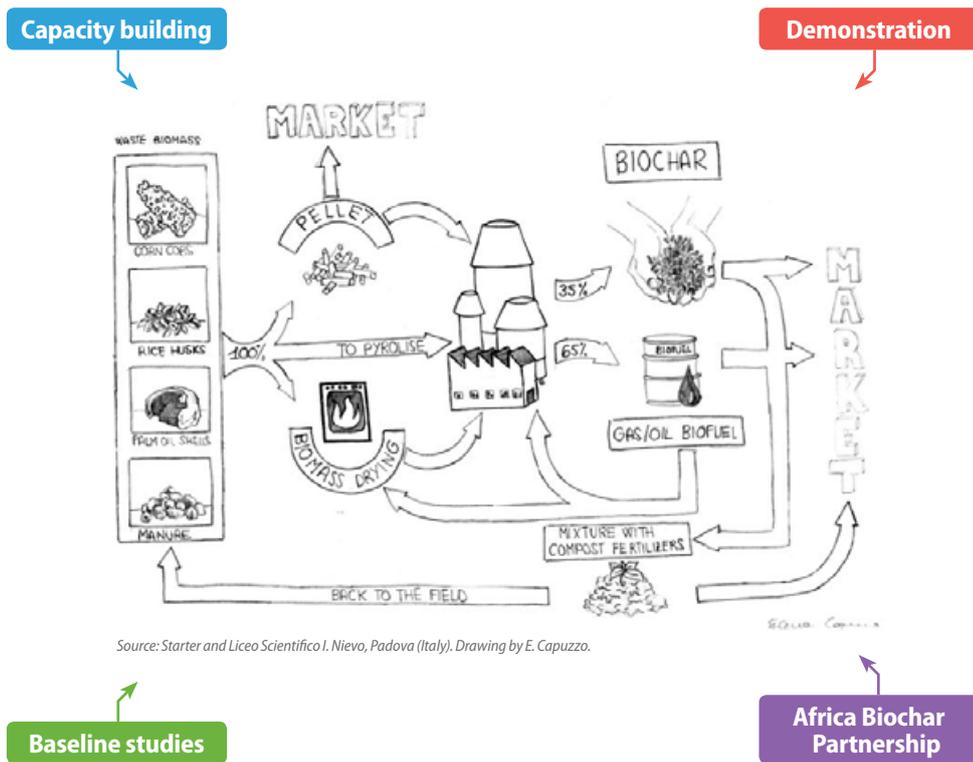
The project tackled the limited existing knowledge on biochar technology in sub-Saharan Africa. This environmentally friendly technology was introduced to different

stakeholders, from technology end users, mainly women and farmers, to researchers, policy makers and the private sector. They were exposed to this innovative technology, improved their knowledge and built capacities to use and exploit the benefits of biochar, such as: improved energy access; reduced diseases connected with current inefficient and hazardous cooking systems; enhanced soil fertility; reduced human pressure on the environment; and opportunities for socio-economic development. Adopting biochar can generate sustainable energy value chains through the introduction of pyrolytic clean cooking stoves and/or plants, the production and/or collection and distribution of fuel from waste biomass, and the collection and selling of biochar.

Multiple benefits from the adoption of the pyrolysis and biochar were achieved by local communities, including empowerment of the women. Women play an essential role in fuel collection and cooking. Due to the introduction of biochar and clean cooking systems, they now save time on cooking and improve cooking conditions. Saving time in firewood collection and reducing the physical burden placed on young girls and women allows them to enjoy a better quality of life.

Biochar^{Plus}





Source: Starter and Liceo Scientifico I. Nievo, Padova (Italy). Drawing by E. Capuzzo.

Local capacity of different society groups (educational institutions, farmers, women, entrepreneurs, etc.) on biochar usage was increased through training and awareness raising activities. Users could see and test biochar technology, understand its benefits and focus on organising a biochar system. The recognition of biochar and biochar systems was promoted to be included in regional and national strategies as an instrument to favour socio-economic development. Biochar systems have multiple benefits pertaining to energy, agriculture and food security, environment, sustainable forest management, health, and gender equality. For the introduction of a biochar system the three pillars of biochar technology were addressed: waste

biomass input, pyrolytic process, and energy and biochar outputs. This allowed proper management of all emerging issues posed by the introduction of such system and to better exploit biochar opportunities given the local conditions.

Capacity building

Biochar Plus informed and built capacities of research organisations, non-governmental organisations (NGOs), civil society actors and technology developers to enable them to scout implementation opportunities in their areas. The most recent biochar knowledge was channelled through informative and educative kits (produced in English and French) intended for policy and decision makers, as well as for researchers and those implementing biochar systems in the field.

Demonstration

As a clean cooking pyrolytic device, the ELSA concept offers multiple benefits, including the possibility to launch local start-ups producing and selling these stoves. During demonstrative sessions on stove construction and use throughout different countries in Western, Eastern and Southern Africa, agro wastes such as palm oil kernels and maize cobs were used as sustainable fuel. An assessment on the availability of residual and low value agro wastes was performed to avoid energy to food competition and possible trade-offs.

Baseline studies

Biochar technology includes the use of different scales of pyrolytic devices, ranging from pyrolytic stoves to industrial plants, suitable

for processing larger amounts of biomass and waste. In both cases, entrepreneurs and small and medium-sized enterprises (SMEs) could develop these activities and produce opportunities for socio-economic development. A baseline study and project pipeline, to be included in the National Renewable Energy Investment Plan of Guinea Bissau, was prepared for the Ministry of Energy and Industry, UNIDO and ECREEE including a preliminary feasibility study on macadamia nut shells. A baseline study and project pipeline on biomass electricity produced by sawdust and biochar, to be included in the National Renewable Energy Investment Plan of Zimbabwe, was also produced.

Africa Biochar Partnership

The introduction of biochar can simultaneously address some of the challenges Africa faces in terms of energy, health, food security, environmental protection, socio-economic development and climate change mitigation and adaptation. Existing initiatives and activities are scattered throughout the African continent. Biochar Plus stimulated the establishment of the Africa Biochar Partnership (ABP), a hub for continental and regional institutions, universities, research centres, foundations, NGOs and the private sector for peer-to-peer exchange, learning, training, and coordination of programmes to foster biochar development strategies and implementation of biochar systems in Africa. ABP focuses on promoting research and technology transfer, advocacy, policy development, stakeholders and end users engagement, networking and dissemination of best practices.



Pellets produced with waste biomass by the community, Cape Coast, Ghana (April 2016).

→ Outputs

Stoves

- >3,700 locally produced Elsa pyrolytic clean cooking stoves, adjusted to local users' needs, and distributed mainly to women: Ghana (3,609), Zimbabwe (38), Ethiopia (60), Sierra Leone (33).



Woman demonstrating Elsa stove use at exhibitions on clean cooking, Cape Coast, Ghana (April 2016).

Biochar

- 3,050 kg of biochar applied by 48 farmers on their fields in Ghana, Sierra Leone and Ethiopia.



Networking

- Africa Biochar Partnership (ABP). The first round of application to ABP took place in Nairobi during the international workshop 'Biochar Systems for Africa' held at ICRAF in March 2016, and involved 26 participants.

Capacity building

- 9 capacity building events in Lomé (Togo), Jimma (Ethiopia), Bindura (Zimbabwe), Banjul (The Gambia), Cape Coast, Kumasi and Akpafu-Mempeasem (Ghana), Milan (Italy), Nairobi (Kenya), involving around 750 people from research organisations, NGOs, civil society actors and technology developers and end users (women and farmers).
- 1 MSc thesis 'Methods and approaches to the application of biochar systems in Ghana, Sierra Leone, Zimbabwe Ethiopia and Cameroon', University of Padova, Italy.

Documentation

- Translations of latest available biochar knowledge into local languages (also dialects).
- 1 informative and 1 educative kit on biochar (English and French).
- Macro policy study of biochar systems potential in Ghana, African Center for Economic Transformation (ACET), 2016.
- 2 feasibility studies for industrial plants processing.



Informative and educative kits on biochar.

Visibility

- Project website.
- Facebook page.
- 1 video on how biochar can address deforestation issues and landscape restoration.
- 1 international conference in Nairobi, together with GEF6 Biochar for Sustainable Soil project.
- 3-day event at Expo 2015 in Milan <https://www.youtube.com/watch?v=LahwkNIVY0g>
- Scientific days and academic meetings in Kara and Lomé (Togo).
- 1 information event in Brussels, Belgium.
- Participation in a multi-stakeholder workshop (Cotonou, Benin).
- Participation in the European Development Days 2016 in Brussels, Belgium.
- Presentations at international events in Senegal, Benin, Ghana and Mali.

Publications

- Mengesha T.T., Venkata Ramayya A., 2015. Heat transfer validation and comparative evaluation of biochar yield from pyrolysis cook stove. Journal of Agricultural Science and Technology B 5: 389-400.
- Kibret H.A. *et al.*, 2016. Design, fabrication and sensitivity testing of an efficient bone pyrolysis kiln and biochar based indigenous fertilizer pelletizing machine for linking renewable energy with climate smart agriculture. Journal of Engineering and Applied Sciences, 11: 7951-7957.



Workshop on ELSA stove involving researchers in Bindura, Zimbabwe (December 2014).

RESULTS



Outcomes

- Awareness on biochar multiple benefits (energy access and efficiency, clean cooking uptake, soil fertility, environmental sustainability, and socio-economic development) raised among research and policy communities, civil society and private sector of Ghana, Togo, Sierra Leone, Ethiopia and Zimbabwe.
- Increased scientific knowledge on biochar at African research institutions.
- Socio-economic implications of possible biochar introduction identified, including: the effects that a biochar system has for socio-economic development, both in terms of social wellbeing and economic growth; under what conditions can these

benefits be realised to the maximum potential and which institutions should be engaged; how other sectors (e.g. waste management) can benefit from or be associated with the biochar system in order to drive biochar uptake and improve general wellbeing and economic progress.



Impacts

Usage

- It has been demonstrated that biochar systems improve households' as well as farmers' livelihood, support healthier households through clean cooking, and offer new business opportunities.
- 67 local communities and villages exposed to biochar technology in Zimbabwe, Ethiopia, Ghana, Cameroon and Sierra Leone.
- 36 farmers from Ethiopia, Ghana and Sierra Leone tested biochar to improve soil fertility and they observed an increase in crop growth.
- Local Biochar Plus partners in Ghana, Zimbabwe and Ethiopia started local production of the ELSA clean cooking device for research and business purposes.
- In Cape Coast (Ghana), pellet produced by multisource waste biomass is being produced and sold in the local market as cooking fuel.
- 24 scientific institutions around Africa improved their knowledge of biochar and can start training people on biochar.

Policy implications

- The project has identified: policies that can facilitate or limit the adoption of biochar systems in Ghana and in the continent; the state of current research / policy interface; how lessons learned from biochar-related initiatives in Africa can be capitalised; actors and their interaction; governance systems; crucial institutions for these governance systems and significance for policy advancements; possible dissemination channels on biochar.
- A discussion has been started with the African Union Commission on possible biochar technology incorporation into Energy and Rural Development, Health,

Public Private Partnerships (PPP) and Technical and Vocational Education and Training (TVET) policy areas.

- The World Bank and other donors demonstrated their interest in developing biochar related activities in other countries.

Sustainability

- A research proposal was submitted to the African Union.
- The Africa Biochar Partnership (ABP) is actively working on the topic of biochar technology in strong collaboration with the International Biochar Initiative (IBI). The World Bank has decided to follow up this project with a pilot programme in Burundi.
- The NGOs involved in the project are diffusing biochar technology and ELSA stoves among final users through microfinance support.

TESTIMONIAL



Mrs. Hannah Bangura,
farmer, Brama village,
Sierra Leone

"I used to buy expensive fertiliser, and one year after using it weeds took over my garden. Applying biochar has improved my livelihood. This technology improved my life by increasing my income level generated from the garden as a result of the use of biochar combined with compost and backyard manure. Now I can buy stationery for my children to go to school and I can afford medical bills when the family is sick, which was not possible before. I feel independent now, because I have my own resources. I will continue to propagate this technology to other communities."



ELSA system during cooking demonstration to women in Bindura, Zimbabwe (December 2014).

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ACP Science
and Technology II Programme

Strengthening capacities and informing policies for developing value chains of neglected and underutilised crops in Africa

SUMMARY OF RESULTS

Three National Action Plans for value chain upgrading of amaranth (*Amaranthus* spp.) and Bambara groundnut (*Vigna subterranea*) in Benin, Kenya and Zimbabwe were developed and promoted at national and regional levels. 70 young scientists upgraded their skills in designing interdisciplinary research projects on value chains of neglected and underutilised species, and 74 enhanced their capacity to communicate results to scientists and non-scientists. A curriculum guide on neglected and underutilised species was published and distributed to agricultural universities and technical colleges in sub-Saharan Africa. Three policy briefs were published on amaranth, Bambara groundnut and neglected and underutilised species education. Results were shared at three sub-regional workshops involving 23 African and three European countries, and at an international conference in Kenya. An expert meeting outlined the way forward for mainstreaming neglected and underutilised species in agricultural development in sub-Saharan Africa.



Bambara groundnut (*Vigna subterranea*), one of Africa's many neglected and underutilised species, is a priority crop for value chain development: a local market in Lomé, Togo.
© P. Rudebjer

PROJECT IMPLEMENTATION PERIOD

January 2014 - December 2016

CONSORTIUM

- International Plant Genetic Resource Institute (IPGRI, operating under the name of Bioversity International), Italy
- African Network for Agriculture, Agroforestry and Natural Resources Education (ANAPE), Kenya
- Africa University, Zimbabwe
- International Foundation for Science (IFS), Sweden
- Laboratoire d'Agrobiodiversité et Amélioration des Plantes Tropicales (LAAPT) - Université d'Abomey-Calavi, Benin
- University of Nairobi, Kenya

Associated partners:

- Excel Hort Consult Ltd (EHC), Uganda
- Global Horticulture Initiative (GlobalHort), Tanzania

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PROJECT WEBSITE

<http://www.nuscommunity.org/research/projects/acp-eu-value-chains/>

BACKGROUND

Since colonial times, agricultural research and development in Africa has focused on a few staple crops, particularly maize, wheat and rice, and commodities such as coffee, tea and tobacco. Some roots and tubers, bananas, legumes and pulses have also been a priority. Yet, hunger and malnutrition remain high in a rapidly growing population. Africa's rich diversity in neglected and underutilised species (NUS) is now being highlighted due to their nutritional properties and resilience to pests, diseases and climate change. However, weak capacity in research, extension and education, policy constraints, and low consumer awareness currently limit their wider use.

An earlier project under the ACP S&T I Programme showed, among others, that:

- Many young scientists in Africa work on NUS, but are constrained by weak individual and institutional capacity.
- Young scientists are unfamiliar with value chain or food systems approaches, so research projects often lack such perspectives.
- NUS scientists have limited contacts with the private sector during research design and implementation.
- Training in proposal writing, scientific writing, research design and communication in the context of NUS is in high demand.
- Better insights in the practical application of research results and how to communicate these are needed.

- NUS topics need to be introduced in higher education curricula.

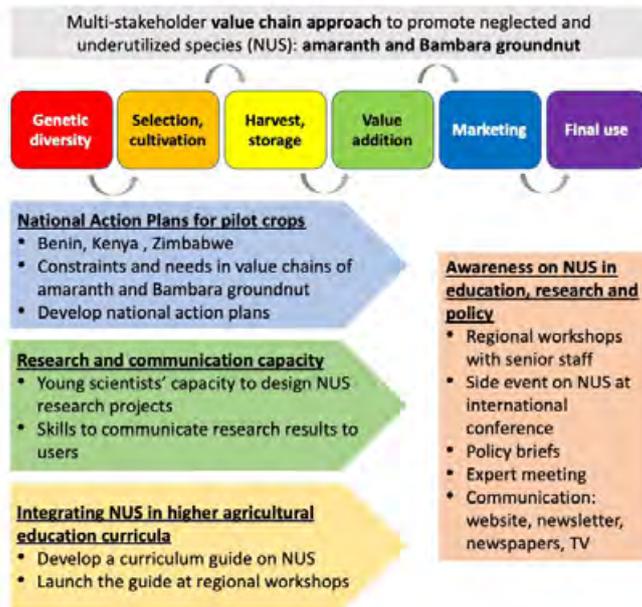
Based on these lessons, the project hypothesised that:

- Amaranth (*Amaranthus* spp.) and Bambara groundnut (*Vigna subterranea*) could serve as model crops for developing NUS value chains in Benin, Kenya and Zimbabwe, and lessons could be replicated for other species and countries.
- NUS scientists would increase their development impact if trained in project design and communication of research results.
- Universities and technical colleges in Africa are interested in teaching NUS, but lack a curriculum guide.
- Policy makers are receptive to information on the role of NUS in addressing malnutrition, adaptation to climate change, poverty and youth employment.

The direct beneficiaries of the project were: *Value chain stakeholders* in amaranth and Bambara groundnut value chains, including small-scale farmers, farmers' organisations, processors, traders and entrepreneurs; *Young scientists* who design and implement NUS research and publish results that need to be communicated; *Higher agriculture education institutions* interested in teaching NUS, and; *Policy actors* across Africa seeking options to meet the UN's Sustainable Development Goals.



METHODOLOGY



A national workshop in each country identified problems in value chains of amaranth and Bambara groundnut and prepared action plans for improving the situation, Cotonou, Benin (July 2014). © P. Rudebjer



Science communication training: school visit to create awareness on benefits of neglected and underutilised crops, Benin (October 2015). © P. Rudebjer

National action plans for pilot crops

A multi-stakeholder value chain approach was used for two pilot crops: amaranth, a pseudo-cereal and leafy vegetable; and Bambara groundnut, a protein-rich African legume grown in semi-arid regions. National workshops in Benin, Kenya and Zimbabwe analysed constraints in the value chains of these crops, identified opportunities for upgrading and agreed on priorities for action. National Action Plans (NAPs) were then developed covering six areas: Market access and consumer demand; Input supply; Agronomy; Technical and product development; Organisational management; Regulatory and policy environment; and Finance. The NAPs were promoted at exhibitions and agricultural fairs, in the press and on TV, and at agricultural conferences and meetings.

Research and communication capacity

Two training courses were offered in each of the three sub-regions to early career scientists from 19 countries who were involved in NUS research, in particular on amaranth and Bambara groundnut:

- Research proposal writing with a focus on upgrading value chains of NUS plants.
- Scientific communication with a focus on NUS plants.

Applicants' own research proposals or draft scientific papers – and their subsequent revisions – served as highly motivating key learning materials. Equally appreciated was the use of the trainees' own research results when practicing outreach of key scientific messages to different stakeholders.

Integrating NUS in higher agricultural education curricula

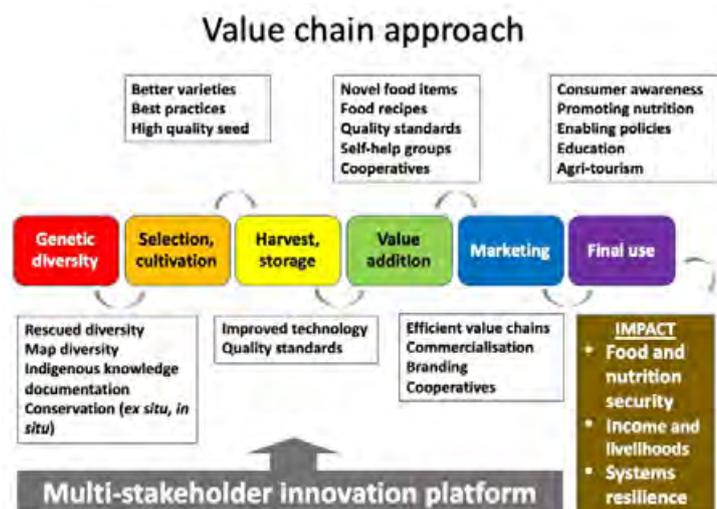
A regional workshop with participants from universities, research organisations, the pri-

ivate sector and international organisations assessed NUS training needs and developed a curriculum framework for NUS education. A NUS curriculum guide was produced with five modules: introduction; vegetables; fruits and nuts; edible insects; and rodents. The guide, in English and French, was widely distributed in sub-Saharan Africa and published online. It was launched at three sub-regional workshops.

Awareness on NUS in education, research and policy

At national level, project results were shared at agricultural fairs, and on the radio and TV. At sub-regional level, project experiences and products (policy briefs, NAPs, NUS curriculum guide) were shared at three workshops with mostly senior staff from research, higher education, policy/government and the private sector. The project reached out to a broader

African and international audience at a side event on NUS at the African Agri-Business Incubation Conference & Expo 2015 in Kenya. Policy briefs communicated key messages on amaranth, Bambara groundnut and NUS education. The end-of-project expert meeting shared project results with a group of influential stakeholders from African universities, national and international research institutes, NGOs and private businesses. The project website and those of project partners disseminated information on project activities and products.



The value chain approach for promoting neglected and underutilised crops was the focus for many project activities. Source: S. Padulosi, Bioversity International

→ Outputs

Stakeholders involved

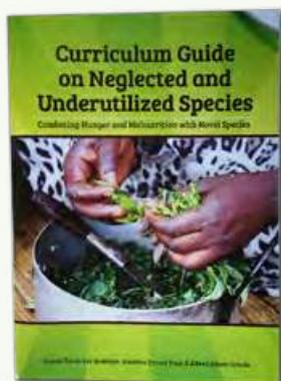
- 320 individuals in sub-regional/regional project activities (including 144 young scientists and 57 university staff).
- 225 value chain stakeholders in national workshops, consultations and events.

Capacity building

- 6 training courses:
 - 70 young scientists (40 male, 30 female) from 18 countries trained on NUS research proposal writing.
 - 74 young scientists (43 male, 31 female) from 14 countries trained in scientific writing and communication with a focus on NUS.
- 23 trainees applying for an individual IFS research grant benefitted from constructive feedback from and networking opportunities with IFS advisers.

Curriculum guides

- Curriculum guide on NUS for tertiary agricultural education.
- NUS curriculum for secondary schools in Benin.



Curriculum guide: a tool for NUS education in universities and technical colleges in Africa (ANAFE, Kenya).

Policy documents

- 3 National Action Plans (NAPs) on value chain upgrading of amaranth and Bambara groundnut in Benin, Kenya and Zimbabwe.
- National report on status and priorities for research and value chain upgrading of NUS in Zimbabwe.
- 3 policy briefs (English and French):
 - Upgrading grain amaranth value chains in Africa.
 - Bambara groundnut, a legume of choice for food security and industry.
 - Improving education on underutilised and neglected plant and animal species.
- Report of expert meeting 'The way forward' with 16 recommendations for following up project results.



144 young scientists from 18 countries were trained in NUS project design and science communication. © P. Rudebjer

Sub-regional work plans

- Work plan for NUS development in Southern Africa (short and long term).

Networks

- Informal sub-regional networks of young scientists working on NUS.

Research proposals

- 35 trainees submitted a proposal to IFS for an individual research grant, of which 12 were approved.
- Some trainees funded their research proposal from other sources.

Visibility

- Project website.
- 2 displays on NUS value-added products.
- 2 newsletters: ANAFE and NUS Community.
- 2 Facebook groups on science writing and communication.
- 2 webstories from side event on NUS in Kenya (28 September 2015):
 - <http://coastweek.com/3840-agriculture-03.htm>
 - <https://www.voanews.com/a/africa-agricultural-experts-promote-non-traditional-food/2986111.html>
- 1 webstory on Scientific Writing and Communication workshop.
- Newspaper articles in Zimbabwe, Kenya and Benin.
- TV coverage in Benin and Togo.

Publications

- Gbaguidi A.A. et al., 2015. Strategic action plan for the promotion of Amaranth and Bambara groundnut value chain in Benin. LAAPT/BIORAVE, FAST Dassa (University of Abomey-Calavi).
- Chemining'wa G.N., 2015. National action plan for the promotion of amaranth and bambara groundnut in Kenya. Department of Plant Science and Crop Protection University of Nairobi.

- Chiteka Z.A. et al., 2015. Strengthening capacities and informing policies for developing value chains of neglected and underutilized crops in Africa - Zimbabwe National Action Plan.
- Temu A. et al., 2016. Curriculum guide on neglected and underutilized species: Combating hunger and malnutrition with novel species.
- Chemining'wa G. et al., 2016. Upgrading grain amaranth value chains in Africa. Policy brief.
- Dansi A. et al., 2016. Bambara Groundnut, a legume of choice for food security and industry. Policy Brief.
- Yaye A. et al., 2016. Improving education on underutilized and neglected plant and animal species. Policy brief.
- Gbaguidi A.A. et al., 2016. Promotion de la chaîne des valeurs des espèces négligées et sous-utilisées au Bénin: cas du voandzou (*Vigna subterranea* L. Verdc.) International Journal of Neglected and Underutilized Species (2016) 2: 19-32. University of Abomey-Calavi, Benin.
- Agre A.P. et al., 2016. Plan d'actions stratégiques pour la promotion de la chaîne de valeur de l'Amarante (*Amaranthus* spp) au Bénin. International Journal of Neglected and Underutilized Species (2016) 2: 33-41. University of Abomey-Calavi, Benin.
- Hall R.A. and Rudebjer P. (eds.), 2016. 3rd International conference on neglected and underutilized species (NUS): for a food-secure Africa. Accra, Ghana, 25-27 September 2013. Proceedings. Bioversity International, Rome, Italy and International Foundation for Science, Stockholm, Sweden.
- Tiburce Odjo T. et al., 2015. Utilisation des plantes négligées et sous utilisées (NUS) dans les programmes d'enseignement des lycées et collèges du Bénin. LAAPT/BIORAVE, FAST Dassa (University of Abomey-Calavi).
- Hall R. et al., 2014. Upgrading value chains of Bambara groundnut and amaranth in Zimbabwe, Kenya and Benin. Conclusions and recommendations from three national innovation platform workshops, June-July 2014.
- Rudebjer P. and Kasolo W. (eds.), 2017. Report from expert meeting on NUS value chains in sub-Saharan Africa, 29-30 November 2016, IITA, Cotonou, Benin. Bioversity International, Rome, Italy.
- Proceedings of a sub-regional education and policy multi-stakeholder workshop on NUS 2016. ANAFE.

RESULTS

Outcomes

- The partners in Benin, Kenya and Zimbabwe play a key role in implementing the NAPs by linking them to national processes. They also strengthen the NUS profile in their own universities, in teaching, research and outreach.
- 5-6 additional countries in each sub-region were exposed to the project results. The scaling up of the results depends on the actions of the participants from these countries, the availability of funding and on 'NUS champions' to take the lead.
- 70 young scientists in 18 countries applied their new skills in the design of a NUS research project proposal, increasing their success rate. At least 12 alumni have funded new NUS research projects after the training.
- 74 young scientists in 14 countries have used their new skills in communicating research results. IFS reported that alumni had published 18 scientific papers of relevance to NUS.
- Trainees influence their home institutions as they inform colleagues on the training course results.
- ANAFE published a training manual on NUS in 2018, to be used by universities and technical colleges, along with the project's curriculum guide.

Impacts

Usage

- LAAPT (Benin) is leading a group of young scientists involved in value chain upgrading work and support to local entrepreneurs. In Kenya, the project linked up with the Kenya Agriculture and Livestock Research Organization (KALRO), involved in a national initiative on NUS. Both are mechanisms for implementing the NAPs.
- Universities and technical colleges in Africa have started to use the NUS curriculum guide to review and update courses and programmes.

Policy implications

- The project contributed to an on-going policy dialogue on the role of NUS in contributing to the Agenda 2030. For example, the Commission on World Food Security featured several talks on NUS in its 45th session on 15-19 October 2018, FAO, Rome, Italy. Experts stated: "We wish to see NUS at the centre of global efforts on nutrition, sustainability and climate change adaptation. We wish to see NUS

contributing to Agenda 2030. This vision should be reflected in the way we allocate funds, engage with donors, research value chains and develop capacity, for a transformative continuum."

Sustainability

- The sustainability of the capacity developed in 144 young scientists under the project will be reflected in their future actions to design new NUS projects and communicate results for development impacts.
- The sustainability of the project's educational activity is linked to efforts in universities and technical colleges to introduce NUS into courses and programmes, offer thesis research on NUS and link with

the private sector in promoting NUS value chains.

- Strong endorsement of the project's value chain approach by stakeholders in the three sub-regions was evident. Project results can be sustained by implementing the NAPs in Benin, Kenya and Zimbabwe, and other countries in the three sub-regions can follow.



The project's final expert meeting reflected on the results and developed a way forward for promoting NUS in sub-Saharan Africa, Cotonou, Benin (December 2016). © P. Rudebjer

TESTIMONIAL



Olusegun A. Yerokun,
former Vice Chancellor,
Zambia Open University,
Zambia

"Africa is blessed with rich biodiversity. Several plant species that have previously played a significant role in nutrition are now overlooked. They were relatively easy to access, affordable, nutritious, and hardy. However, the narrowing of diets with wide adoption of continental menus led to their neglect. The NUS project was beneficial to raise aware-

ness of these crops and the nutrition and economic roles they could play, especially when we are experiencing the harsh effects of climate change. I feel the project created a platform for specialists and practitioners to network. This will bring more attention to re-introducing NUS crops."

ACP-EU Co-Operation Programmes in the fields of Higher Education and Science, Technology and Research

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ACP Science
and Technology II Programme

iLINOVA – Strengthening capacity for participatory management of indigenous livestock to foster agricultural innovation in Eastern, Southern and Western Africa



Demonstration on how to perform artificial insemination of goats at Egerton University, Njoro, Kenya (February 2015).

SUMMARY OF RESULTS

Technical liaison desks were set up to facilitate and institutionalise university-industry-civil society links. A mobile application system to enhance information access on livestock production and management was developed. The multipurpose centre at Egerton University was renovated – renamed to Centre of Excellence for Livestock Innovation and Business, CoELIB – and hosts recording, meeting, laboratory and office spaces, as well as the African Academy of Dairy Sciences. The Centre acts as a think tank (for business information, technology, innovation, markets and entrepreneurship); provides links to access finances, business ideas, risk insurance, loans and markets; incubates business ideas and innovations; and provides business start-up advice, mentorship and guidance in the livestock value chain. A memorandum of understanding with the African Agribusiness Incubation Network enables CoELIB to be one of the region's incubation centres.

PROJECT IMPLEMENTATION PERIOD

January 2014 - June 2017

CONSORTIUM

- Egerton University, Kenya
- Lilongwe University of Agriculture and Natural Resources (LUANAR), Malawi
- Obafemi Awolowo University (OAU), Nigeria

Associated partners:

- Wageningen University and Research, the Netherlands
- Kenya Agricultural and Livestock Research Organisation (KALRO), Kenya
- Ministry of Agriculture, Livestock and Fisheries, Kenya
- International Livestock Research Institute (ILRI), Kenya
- Department of Agricultural Research Services, Malawi
- Department of Animal Health and Livestock Development, Malawi

PROJECT CONTACT

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PROJECT WEBSITE

www.ilinova.coelib.org

BACKGROUND

Use of indigenous livestock products is on the rise due to increased indigenous livestock population. Most of this livestock in Kenya, Malawi and Nigeria, however, are kept under low input systems and stakeholders along the livestock value chain remain food, nutrition and income insecure, and hence, perennially in poverty.

Policies developed in relation to management of indigenous livestock are not based on scientific evidence. The focus of academic programmes on science, technology and innovation has been so limited that young scientists trained in these programmes are not adequately equipped with qualifications and skills to promote innovation and develop appropriate technologies. Consequently, the capacity of scientists in Africa to successfully execute high through-put scientific technologies and innovations are limited and need to be enhanced through both training and development of institutional and structural capacities.

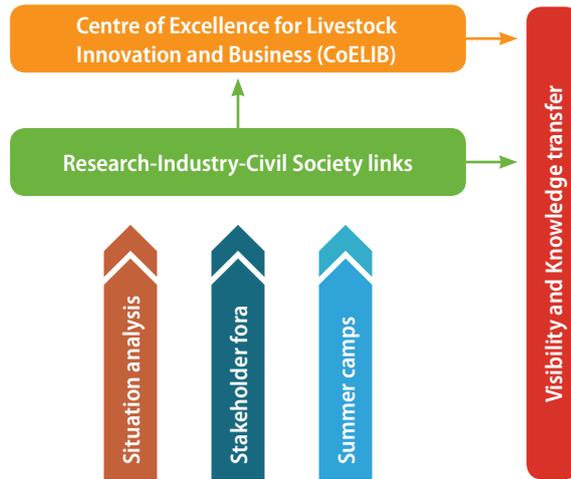
The general opinion among producers is that indigenous livestock have low performance. This perception is potentially hampering efficient utilisation of scientific technologies and innovation, and thus needs to be

altered and indigenous livestock potential appreciated. Indigenous livestock form an important repository of genetic diversity which could be improved using innovative technologies. Existing examples include the high producing beef breed 'Boran' which has been developed through efficient livestock management.

The project focussed on poverty reduction, food and nutrition security, growth and socio-economic development of stakeholders involved in indigenous livestock management (chicken, cattle, goats, rabbits, pigs, etc.) in Eastern, Southern and Western Africa. It enhanced the capacity of stakeholders along the livestock value chain to foster agricultural competitiveness and innovation in indigenous livestock production systems. These stakeholders include: scientific and teaching staff; undergraduate and postgraduate students; entrepreneurs and enterprises benefiting from knowledge on management of indigenous livestock; potential innovators; and other private and public actors in the agricultural sector benefiting from scientific technologies and innovations related to indigenous livestock management and policy recommendations.



METHODOLOGY



Situation analysis

Field surveys and interviews were held in Bunda (Malawi), Nyahururu and Njoro (Kenya) to determine the utilisation of existing scientific technologies (e.g., reproductive, feeding, breeding and animal health management technologies) by livestock industry players (farmers, producers, processors, business community) to manage their livestock, especially indigenous types. The extent to which they applied innovative features and entrepreneurship was assessed, as well as the gender roles in livestock management, product marketing, and other cross-cutting issues that influence livestock production.

Stakeholder fora

Local and international fora were held to exchange information between producers, producer groups, processors, lecturers and students from Higher Education Institutions (HEIs) and researchers on new developments in the livestock industry and emerging production challenges, as well as to share experiences and research outputs.

Summer camps

During summer camps both scientific (researchers, technologists, lecturers and post-graduate students) and producer communities (producers and producer groups' leaders) were trained in livestock production issues, e.g., genomic selection in livestock, livestock biodiversity conservation, hydroponics fodder production, livestock recording, and rabbit production. The training themes were based on the stakeholder needs determined in the situation analysis.

Research-industry-civil society links

Technical liaison desks were set up in the participating universities to link them with the livestock industry, stimulate industry actors



Training on artificial insemination of goats at Egerton University, Njoro, Kenya (February 2015).

to be mentors and offer internships, establish a database of industry players and mentors, and coordinate research projects and university-industry-civil society roundtable sessions. *Science and technology study projects* – action research projects – were carried out to enhance students' problem-solving skills, foster the use of science and technology in livestock management, and provide science-based recommendations to industry problems.

Science and technology internship programme enabled students to have hands-on experience in the firms / farms where various industry values were inculcated.

Mentorship programme, where students were assigned to mentors (industry technocrats, elite livestock producers and scientists), allowed discussions on general and specific issues, and hands-on experience.

Multipurpose centre

The multipurpose centre at Egerton University was renovated and renamed to Centre of Excellence for Livestock Innovation and Business, CoELIB. In Nigeria and Malawi, centres were established which served as branches of CoELIB in those countries. CoELIB offers the following products and services:

- *Incubation, business and market development:* Support to students, innovative entrepreneurs

and community members for establishing a new business, growing existing businesses, taking products to market and linking entrepreneurs with market opportunities.

- *Information, technical assistance and consulting:* Promotion of innovative technology, business and market development.
- *Research, development and commercialisation:* Application of knowledge derived from research to address the most pressing problems in society related to the livestock value chain.

CoELIB hosts the African Academy of Dairy Sciences (DairyAcademy) that is further strengthening the capacity of HEIs to deliver competent graduates for enhanced competitiveness in the dairy value chain. CoELIB is registered as a trademark in Kenya and is a member of the African Agribusiness Incubation Network (AAIN) enabling CoELIB to be one of the region's incubation centres.

Knowledge transfer

Newsletters, conference papers and scientific journal papers were produced. The project also took part in regional exhibitions where technologies and start-ups (established as part of the research-industry-civil society links and at CoELIB) were exhibited.



Improvised feeding trough, a cheap alternative for livestock keepers in a beef ranch in Laikipia, Kenya (April 2016).

→ Outputs

Stakeholders

- >900 stakeholders: lecturers and technical staff of the participating universities, researchers from the National Agricultural Research System (NARS; 103, 40% females), graduate students (141, 42% female), livestock producers (659, 23% female), policy makers, civil society organisations and advocacy groups, private and public firms.
- 7 innovation groups incubating their businesses at CoELIB.

Capacity building

- 10 MSc and 6 PhD students.
- 6 scientific community summer camps on: genomic selection of livestock, project cycle management and grant proposal writing.
- 6 stakeholder summer camps on: cooperative management, animal recording, feed ration formulation and dairy management.
- 1 mentorship workshop for community members on commercial rabbit management.
- Several technical trainings of students, university staff and community members on livestock technologies.
- 5 entrepreneurship trainings to business incubatees.

Networking

- 9 roundtable training sessions to foster university-industry-civil society links through partnerships and collaborations.

Facilities

- Centre of Excellence for Livestock Innovation and Business, CoELIB (www.coelib.org).
- 2 branches of CoELIB at LUANAR and OAU.
- 1 poultry unit renovated at OAU.
- 3 technical liaison desks in the participating universities.

Technologies

- Several audio and video programmes on technologies in the livestock industry available on YouTube (CoELIB-Egerton).
- A mobile application system that helps link researchers, farmers, input providers and the market.
- A protocol for the use of artificial vaginas for rabbits (OLIRAV).

Business start-ups (see: www.incubar.coelib.org)

- M-FUGO, a SMS-based marketing and information system for the different actors



Vaccination against foot and mouth disease in a pastoralist community in Mau Narok, Kenya (April 2016).

in the Indigenous Chicken Production Value Chain.

- Token, an online platform linking farmers to research organisations.
- Ukulima Frontline, a platform providing timely, relevant and reliable agricultural information by different actors along the agricultural value chain.
- Prima Gallus, a 3-point business model focusing on value addition in chicken products, and also a mentorship programme targeting young entrepreneurs.
- Mazao Miller, a producer of quality animal feeds such as layers mash, growers mash, chick mash and dairy meal among others for domesticated animals.

Visibility

- 6 newsletter issues.
- Flyers, brochures and leaflets.
- 1 regional conference on sustainable improvement of indigenous chicken productivity.
- 6 dissemination symposia (LUANAR, 3; OAU, 3).
- 1 international congress on livestock innovations and development.
- 1 radio programme on Egerton FM radio.
- CoELIB TV, an online TV station that produces and broadcasts agricultural programmes for farmers and other stakeholders.

Publications

25 papers in refereed journals; examples:

- Miyumo S. *et al.*, 2018. Genetic and phenotypic parameters for feed efficiency in indigenous chicken in Kenya. *Livestock Science* 207, 91-97.
- Popoola M.A. and Oseni S.O., 2018. Multifactorial discriminant analysis of cephalic morphology of indigenous breeds of rams in Nigeria. *Slovak Journal of Animal Science*, 51(2): 45-51.
- Adeyemi M. and Oseni S.O., 2018. Canonical discriminant analysis of biometric data

of Nigerian indigenous turkeys. *Archivos de Zootecnia*, 67(257): 7-12.

- Khobondo J.O. *et al.*, 2017. Genetic and non-genetic sources of variation in natural antibodies titre values among indigenous chicken. *American Journal of Research Communication*, 5(7), 31-45.
- Oseni S.O. *et al.*, 2017. *Nigerian West African Dwarf Goats*. In: Simões J., Gutiérrez C. (eds.), *Sustainable goat production in adverse environments: Volume II*. Springer, Cham, pp 91-110.
- Miyumo S. *et al.*, 2016. *Non-genetic sources of variation and temporal variability in growth and feed efficiency traits among phylogenetically distinct clusters of indigenous chicken in Kenya*. *Tropical Animal Health and Production*, 48 (8): 1569-1575.
- Khobondo J.O. *et al.*, 2016. *Variation and repeatability of natural antibodies against keyhole limpet hemocyanin of indigenous chicken of Kenya*. *Genomics and Applied Biology*, 7(4): 1-8,
- Mwangi S. *et al.*, 2016. Assessment of the genetic variability using pedigree analysis of the Sahiwal breed in Kenya. *Animal Genetic Resources* 59: 7-14.
- Gakige J.K. *et al.*, 2016. Performance of scavenging indigenous chicken ecotypes on targeted phase supplementary feeding. *Livestock Research for Rural Development*, 28, 4.
- Kahi, A.K. and Miyumo S., 2016. Hydroponic fodder technology – the potential and challenges. *Resilience Focus* 3, 46-49.
- Khobondo J.O. *et al.*, 2015. The effects of dietary probiotics on natural IgM antibody titres of Kenyan indigenous chicken. *Livestock Research for Rural Development*. Volume 27, Article #230.
- Makinde O.A. and Egbekun C.P., 2016. *Determination of optimum dietary energy and protein levels for confined early-stage Fulani Ecotype chickens*. *Livestock Research for Rural Development*. Volume 28, Article #164.



Nyama World employees sorting out dried meat to be packed in different weight sizes ready for the market in Lilongwe, Malawi (March 2017).

RESULTS



Outcomes

- Livestock producers interested in applying useful scientific technologies and innovations.
- University scientific staff are more equipped in participatory and action research methods and appreciate the interaction with the industry and resulting benefits.
- Researchers are able to produce scientific outputs that feed into the needs of the industry.
- Students have gained experience in the industry environment, i.e., the necessary skillsets required for them to enter industry without the need for retraining.
- Increased interest from stakeholders (livestock producers, extension agents, and the processing and manufacturing industry) in seeking information from the participating universities.
- Strengthened liaison offices at the participating universities that foster links and collaboration with other institutions across Africa.



Impacts

Usage

- Enterprises (smallholder farmers, processors, traders, cooperatives, extension services) have adopted scientific technologies (e.g., product value addition such as yoghurt making) and innovations (e.g. use of mobile applications in accessing extension and marketing information) along the livestock product value chains.
- Enhanced application of livestock production technologies on farms (e.g., pastured poultry farming, artificial insemination of chickens, animal recording, selective breeding, hydroponic pasture farming, and improved feed formulation techniques).
- Improved productivity on farms achieved through trained extension agents that are actively helping farmers adopt better methods and techniques (e.g., pastured poultry rearing), and helping them link with the local markets.
- Innovative ideas developed by producers, such as the Maggot House rearing maggots to be used as alternative protein sources during feed formulation.
- Training students and farmers on artificial insemination of chickens and other emerging approaches in effective livestock management.
- Increased engagement between the industry and researchers leading to more responsive research activities.
- Graduates acting as problem solvers to develop action-oriented research that solves farmers' challenges.
- More producers engaging in knowledge and technology-based livestock production and marketing.

Policy implications

- The participating universities have incorporated programmes such as industry links, mentorship and internship into their curricula.

Sustainability

- The livestock production efficiency has been enhanced, e.g., the producers' production and incomes are more predictable through utilisation of standardised procedures in the production of their livestock.

- The created networks and linkages between universities and industry continue with co-supervision of students and information sharing with industries, thus creating vibrant productive engagement that is resulting in responsive research and curricula offered at the universities.
- The enhanced environmental awareness of the actors in the livestock value chain is expected to reduce negative environmental impacts of their livestock production.
- The increased interest in the use of scientific technologies and innovations in livestock management has resulted in more industries seeking training in various aspects in livestock production.
- The registration of the multipurpose centre into a trademark 'CoELIB' with activities such as agri-journalism and agribusiness incubation has resulted in increased visibility of the institutions involved, allowed for youth participation in agriculture and stimulated interactions between industry and HEIs.

TESTIMONIALS



**Mr. A. Akinsola, CEO,
The Meats Republic,
Ile-Ife, Nigeria**

"The support and innovative ideas contributed through the project has led to better packaging and improvement in product sales. We were able to develop better packaging methods. We are now better able to offer better quality and safer meat to our consumers. Through these improvements in packaging and safety our sales increased and our customers were more satisfied with our products."



**Mr. Shaban, an inventor
that fabricates chicken egg
incubators from refrigerator
casings, Bunda, Malawi**

"At first we made our incubators with cartons, but we were unable to hatch anything or control temperatures which resulted in the chicks dying. With ILINOVA we developed an incubator made from fridge casings and hatching rates increased from 20% to 50%. We used to build 1 incubator per month and now we have orders of up to 15 incubators a month."



**Sophie Miyumo, MSc
student, Department of
Animal Sciences, Egerton
University, Kenya**

"ILINOVA has been key in shaping my academic and professional growth and development through its mentorship programme. Balancing supervision and independence has nurtured me into a confident, independent and valuable contributor to science and society. This programme also enabled me to network, connect and share experiences with scientists from other African countries."

ACP-EU Co-Operation Programmes in the fields of Higher Education and Science, Technology and Research

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ACP Science
and Technology II Programme

Promoting sustainable energy access through the use of geospatial technologies in West Africa



Wind resource map

PROJECT IMPLEMENTATION PERIOD

March 2014 - July 2016

CONSORTIUM

- ECOWAS Regional Centre for Renewable Energy and Energy Efficiency (ECREEE), Cape Verde
- The Energy Center, Kwame Nkrumah University of Science and Technology, Ghana
- Directorate of Energy, Cape Verde
- NOVELTIS S.A.S, France
- University of Geneva, Switzerland

PROJECT CONTACT

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<http://www.ecowrex.org/acp-eu>

SUMMARY OF RESULTS

The map framework of the web-based geographic information system (GIS) platform ECOWREX (ECOWAS Observatory for Renewable Energy and Energy Efficiency, a regional energy data hub) has been transformed into a complete spatial data infrastructure (SDI), compliant with international standards, including:

- new and enhanced datasets on solar and wind power potential with improved temporal and spatial resolutions;
- energy access maps and the most cost-effective technologies for increasing access to non-electrified communities using the improved energy access planning tool IntiGIS 2.0;
- maps of spatial distribution of power consumption and green power production potential.

ECOWREX – publicly accessible - provides policymakers in ECOWAS member states, project developers, investors and other stakeholders, with tailored information for evidence-based decision making, management and planning strategies. The standardisation and interoperability of spatial data on the platform enables end-users to easily explore, share and download data on renewable energy resources (solar, wind...) and energy access in West Africa.

BACKGROUND

In the ECOWAS (Economic Community of West African States) region, only 19% of the rural population has access to electricity. At least 60% of the ECOWAS electricity generation capacity runs on expensive diesel or heavy fuel and imposes significant pressure on national budgets, private households and the private sector. Despite vast renewable energy resources, the electricity systems are facing tremendous challenges as the gap between predicted demand, existing supply capacities and limited capital to invest continues to grow. The regional electricity demand for 2030 is projected to increase to 250 TWh with 7% rural, 48% urban and 45% industrial demand. The total grid-connected installed energy capacity in West Africa reached 10 gigawatts (GW) in 2010 and 39 megawatts (MW) in 2014 (excluding hydropower). The overall renewable energy-installed capacity is expected to reach 14.5 GW in 2020 and over 30 GW in 2030.

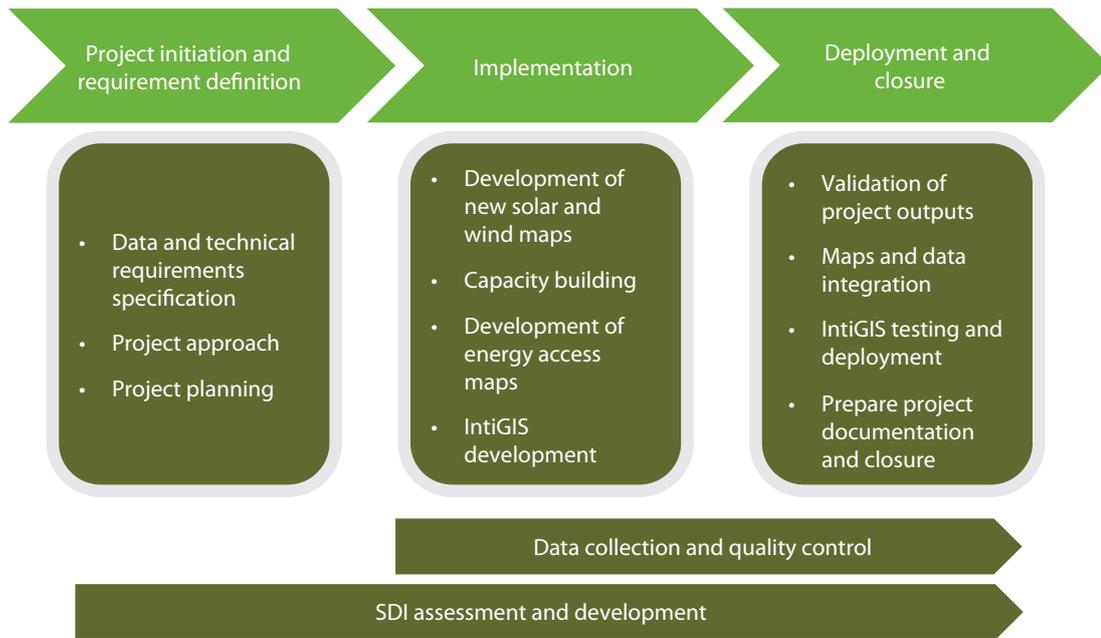
The lack of reliable and updated information on the energy systems poses a major constraint for development in the West African energy sector. Different systems and maps exist with various models (to depict size, terrain, points, lines...) and data sources, but information on energy resources and their potential is not readily available.

To help mitigate this problem, in 2012 ECREEE developed the web-based information platform ECOWREX to provide decision makers, project developers, investors, researchers and the general public, with tailored information about the energy sector. Among the flagship products of the platform is a GIS framework. The framework helps visually analyse the energy resources in combination with other human activities (grid network, protected lands, roads...), and plan where and when specific energy technologies (solar, wind, water...) can be deployed. However, the platform failed to meet some international standards defined by the Open Geospatial Consortium (OGC) and International Organization for Standardization (ISO) to optimise geospatial data discovery and access. The platform also lacked high-quality resource maps (solar and wind maps) and other relevant data on energy access, necessary to support development in the energy sector.

The project focused on geospatial technology for the energy sector in West Africa and related energy resource management capacities. It improved ECOWREX by developing new resource maps, enhancing existing potential renewable energy maps, and incorporating new technologies compliant with international standards to aid data interoperability, extraction, sharing and transfer of knowledge.



METHODOLOGY



During the **analytical stage**, the stakeholders' (planners, project developers, data managers ...) needs, technical assumptions (technological component performance, operation and maintenance, efficiency ...) and data requirements (energy resources, relevant infrastructure and their sources) were identified. Clear guidelines of these requirements, as well as standards for data format and metadata, were developed to support the data collection process. This was a very crucial stage as data exists in different formats, domains and types, and as such, a standard template for capturing and manipulating the data was required.

The **data collection process** started with a regional workshop of key experts from the energy research and planning departments in the ECOWAS member states. They were trained on data and metadata collection using guidelines based on Open Geospatial Consortium (OGC) standards. This was followed by field visits to the member states to provide support and collect the data required for the project. At the same time, the ECOWREX map framework was assessed to ascertain the technical and users' requirements needed for its restructuring into a Spatial Data Infrastructure (SDI).

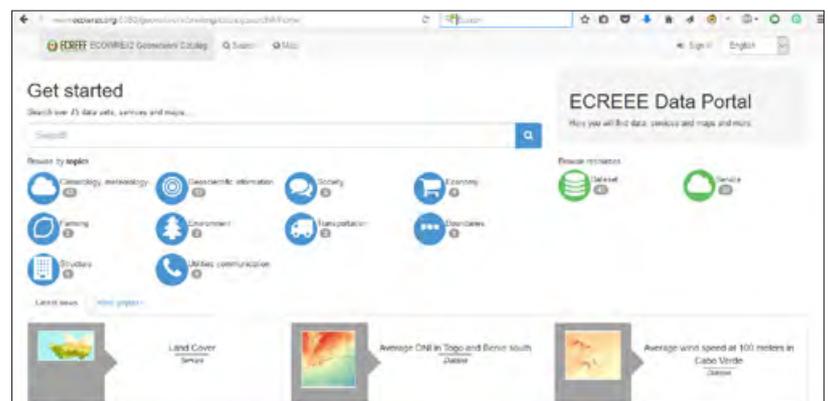
In the **development phase**, new resource (solar and wind) maps were produced, including a critical assessment of existing maps, comparison with *in situ* measurement stations in member states and production of hourly data for solar and wind sites, thereby increasing the temporal and spatial resolution.

Energy access maps for non-electrified communities were produced. Based on the adapted IntiGIS model (a GIS model for rural electrification with renewable energies), the most cost-effective technologies (e.g., home solar and wind systems; diesel, hybrid wind or photovoltaic (PV)-diesel mini-grids) for improving energy access in these communities were then identified. The IntiGIS software takes into consideration the Levelized Electricity Cost (LEC) for the various technologies, including: photovoltaic, diesel and wind energy home systems; central diesel mini-grids; and hybrid mini-grid systems (both wind-diesel and PV-diesel). The LEC is considered in combination with other parameters such as grid extension cost, operation and maintenance cost, diesel consumption, investment cost and other relevant spatial datasets. A combined map of power

consumption and green power potential was also produced.

After **assessing** the ECOWREX map framework, the restructuring of ECOWREX into a complete Spatial Data Infrastructure (SDI) was carried out. After completion, all the data and maps produced were integrated into the new ECOWREX platform.

Finally, a **project validation** meeting and training workshop on the use of ECOWREX, was conducted for experts from the data management and planning departments of the energy ministries in the member states. Throughout the project, constant dissemination of information on the project results and benefits were carried out, including e-newsletters and communication kits for distribution at events and other media channels.



ECREEE GeoNetwork Portal.

RESULTS

→ Outputs

Technical

- ECOWREX SDI fully compliant with OGC standards, based on Open Source software: www.ecowrex.org
- 60 new geospatial datasets: www.ecowrex.org/mapView
- ECOWREX metadata catalogue (Geonetwork v.3): www.ecowrex.org:8080/geonetwork
- Beta version for the software of the energy access planning tool 'IntiGIS 2.0'.
- The most cost-effective technologies for increasing access to some non-electrified communities in the region calculated.
- Enhanced solar and wind maps with improved temporal and spatial resolutions.
- Maps of energy access based on the IntiGIS model.
- Maps of power consumption and green power production potential.

Capacity building

- 2 regional workshops on standardisation of energy data and metadata collection and validation of project outputs.
- 80 national energy experts (71 male, 9

female) trained to use GIS and ECOWREX platform for energy planning:

- ECOWAS member states – the Energy Ministries, Rural Electrification Agencies, Energy Information Systems (SIE), Water Resources Directorates;
- Other ECOWAS institutions - ECOWAS Regional Electricity Regulatory Authority (ERERA) and West African Power Pool (WAPP).

Documents

- 9 reports describing the methodology for the evaluation and improvement of the solar and wind resources on ECOWREX geospatial data section (<http://www.ecowrex.org/page/maps>):
 - Solar comparative analysis
 - Wind comparative analysis
 - Wind critical analysis
 - Solar critical analysis
 - Solar resource study
 - Wind resource study
 - Wind Power Density at 60 meter high – Togo
 - Wind Power Density at 60 meter high

– Senegal

- Wind Power Density at 60 meter high – Sierra Leone
- 1 policy brief on the strategy for improving data collection and management for energy planning in the region.

Visibility

- 2 videos about ECOWREX and the project.
- Communication press kit: USB sticks (50), mouse pads (50), t-shirts (100), booklets (50) and pens (100).
- 2 press conferences.
- 2 news articles in West African journals.
- 2 TV news broadcasts.
- 4 electronic newsletters sent to ECOWREX stakeholders.
- 2 project banners.
- 200 ECOWREX flyers.

Publications

- Yushchenko A., de Bono A., Chatenoux B., Patel M.K., Ray N. GIS-based assessment of photovoltaic (PV) and concentrated solar power (CSP) generation potential in West Africa.



Electricity demand in rural areas.



PV suitability in the region.



Electricity production of grid-connected PV system.

RESULTS



Outcomes

- Strengthened knowledge of energy systems planners and developers and their increased use of geospatial technology (ECOWREX GIS framework) for data management and efficient energy planning in order to promote development in the energy sector in West Africa and to provide investors with reliable information.
- Policymakers have at their disposal the information needed for evidence-based decision making in the energy sector.
- The general public is aware of the energy resources and potential in West Africa.



Impacts

Usage

- With a publicly accessible ECOWREX platform, relevant knowledge and information is available to all stakeholders in the energy domain, acting as a catalyst for promoting sustainable energy development in the region, e.g., through transfer of GIS knowledge to support data management and planning in the energy sector.
- The ECOWREX Spatial Data Infrastructure will serve to disseminate information about other geospatial research and projects carried out in the region – including shapefiles, raster files, metadata files, maps, reports, etc. as these can easily be integrated into the platform.

Policy implications

- The developed renewable energy resource potential will support energy sector policy formulation and targets.
- The policy brief on the data collection strategy is expected to be transformed into a regional policy for ECOWAS member states.

Sustainability

- Institutional and financial sustainability: ECOWREX has become a major programme in ECREEE, through which it provides continued support to the ECOWAS member states and develops partnerships with financiers and data providers.
- Stakeholders' involvement will ensure that the platform is used effectively by the targeted audience and the data and applications developed are frequently updated and improved respectively.
- A continued skills development programme by ECREEE will adequately improve capacity in member states to use the platform, e.g., GIS expertise for the energy sector
- ECREEE is currently identifying experts from each member state to support the process of testing and improving the IntiGIS 2.0 software.
- Visibility of the ECOWREX platform is promoted at regional events, online, in newsletters and through collaboration with

REN21, IRENA, SE4ALL, REEEP and Open Data Inception.

Sustainability indicators to measure the achievement of the project benefits:

- Number of new data points, spatial datasets and information available on ECOWREX.
- Number of registered users and downloads from ECOWREX.
- Number of functionalities added to ECOWREX.
- Number of open data platforms utilising ECOWREX data.
- Number of stakeholders trained to use ECOWREX.
- Number of stakeholders using ECOWREX for energy planning.
- Number of publications from ECOWREX data.
- Number of applications and tools available to support energy planning and the number of users.

TESTIMONIALS



Mr. Coffi Able, GIS Manager, Directorate of Energy, Ministry of Energy, Benin

“This project will help us a lot with the collection and processing of data in the energy sector, and thus better plan in our country. As such, we expect a lot from this ECOWREX platform that has just been presented. Recalling that data collection is a

difficult process, now we have a platform that will help us process data and propose solutions to the authorities for better and quicker decision making, within the framework of the national energy planning process.”



Mr. Mahama Kappiah, Executive Director of ECREEE

“For us engineers, planners and policy makers in the energy sector, the problem has always been: how do we plan our systems? You cannot plan without information or without data. That data has never been readily available in our region, and in almost every country and sector there are gaps in the available data. These gaps and missing portions are caused by both a lack of collected data and inadequate accuracy levels of collected data. It is for this reason that the European Union decided to support ECREEE, to improve and update our ECOWREX data platform so that it can support member states in their planning processes and decision making.”

ACP-EU Co-Operation Programmes in the fields of Higher Education and Science, Technology and Research

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ACP Caribbean & Pacific Research Programme
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*Programme de recherche Caraïbes et Pacifique
pour le développement durable*



ACP Research for Sustainable Development (Caribbean and Pacific)

Enhanced food security through preservation and improvement of genetic diversity of sweet potato and aibika in Papua New Guinea and Solomon Islands



Screening putative sweet potato mutant population for drought tolerance, NARI Momase Regional Centre, Lae, Papua New Guinea in 2016.

SUMMARY OF RESULTS

The genetic research project involving two widely cultivated crops in Papua New Guinea and Solomon Islands - aibika (Pacific or slippery cabbage, *Abelmoschus manihot*) and sweet potato (*Ipomoea batatas*) - achieved the following:

- Research protocols for mutation breeding.
- Mutation breeding protocols for aibika seed and sweet potato cuttings, and putative mutants assessed for tolerance to abiotic stresses.
- New salinity-tolerant aibika and potentially frost-tolerant sweet potato genotypes identified.
- Increased laboratory and research capacity to conduct mutation breeding and basic DNA fingerprinting of sweet potato.
- Sweet potato and aibika germplasm collections.
- A herbarium to catalogue germplasm from aibika, sweet potato and other crops.

PROJECT IMPLEMENTATION PERIOD

August 2012 – July 2016

CONSORTIUM

- National Agricultural Research Institute (NARI), Papua New Guinea
- Ministry of Agriculture and Livestock (MAL), Solomon Islands

Associated partners:

- Papua New Guinea Women in Agriculture Development Foundation, Papua New Guinea
- Kastom Gaden Association, Solomon Islands
- RIKEN Nishina Center for Accelerator-Based Science, Japan

PROJECT CONTACT

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BACKGROUND

Papua New Guinea and Solomon Islands are increasingly vulnerable to the effects of global climate change, including longer and more severe periods of reduced rainfall and soil moisture deficits, and more frequent frosts in highland areas ('El Niño' events), as well as the threat of increased soil salinity in coastal and island environments due to rising sea levels. These effects require farming communities to adapt their traditional systems, for instance by introducing abiotic stress-resistant crop varieties.

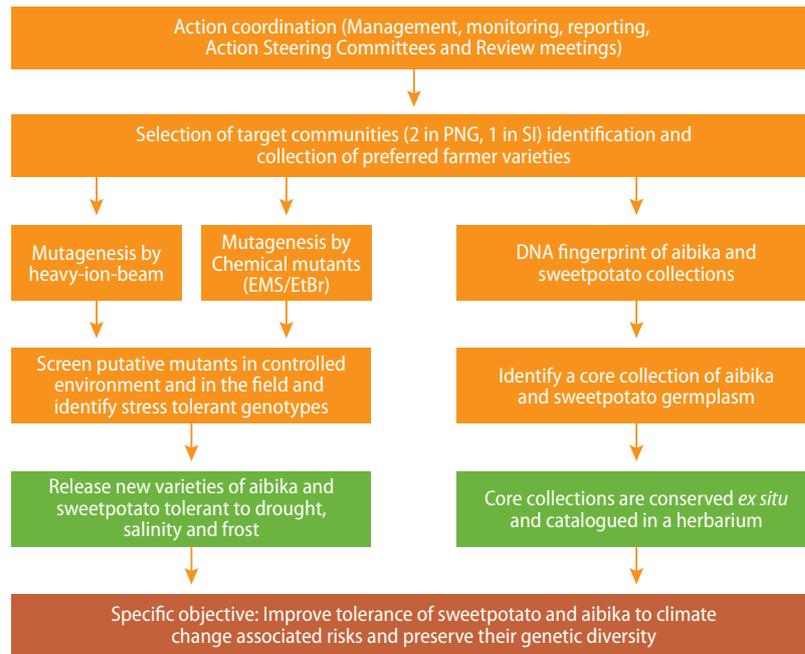
Aibika (Pacific or slippery cabbage, *Abelmoschus manihot*) and sweet potato (*Ipomoea batatas*) are among the most important vegetable and staple crops in Pacific island countries. They have a high nutritional value, but their productivity is limited by severe drought, frost and salinity. With a narrow genetic base for both crops, mutation breeding is one of the crop improvement approaches that can shorten breeding cycles and result in the development of stress-tolerant varieties. The new varieties could then be introduced to mainly subsistence farmers in both countries.

Communities located in areas known to have an increased risk of incidences of abiotic stress were selected to identify locally preferred varieties for the mutation breeding. In Papua New Guinea: Iomare Village (Central Province), a coastal village that has reported rising sea levels threatening their vegetable gardens and that is facing unusually long dry spells; and Yawer Village (Western Highland Province), located in an area prone to frost. In Solomon Islands: the Henderson area which is experiencing pronounced and increasingly prolonged dry seasons.

Research included the development of mutation breeding protocols, exposure of selected varieties to the mutant, *in vivo* evaluation of putative mutants and identification of promising genotypes. Research outputs were validated in the 3 communities using participatory approaches. Results were disseminated in technical publications and by the general media: newspapers, radio, newsletter, social media, the annual NARI Agricultural Innovations Show... Foundation planting materials of successful varieties were made available to farming communities.



METHODOLOGY



Baseline survey of target communities

In the three selected farming communities, focus group discussions with their representatives were held to identify:

- the importance of aibika and sweet potato for food security and income generation;
- the number of varieties grown;
- the most preferred varieties;
- the major constraints in production;
- the farmer-preferred varieties to be used for the mutation research; and
- the agronomic traits including tolerance to abiotic stresses to be improved on.

Mutagenesis of selected varieties

In each country, one variety each of sweet potato and aibika were mutagenised to develop genotypes showing tolerance to climate change associated stresses, such as drought, frost, and salinity. Originally two methods, viz., exposure to chemical mutant Ethyl methanesulfonate (EMS) and radiation through heavy-ion beam exposure were chosen. However, logistical difficulties in getting EMS to Solomon Island required a change of plans and instead Ethidium Bromide (EtBr) was used as the chemical mutant.

Papua New Guinea

- Aibika – chemical mutagenesis: 1,000 seeds exposed to EMS; physical mutagenesis: 1,000 seeds exposed to heavy-ion beam (radiation) at the research institute RIKEN in Japan.
- Sweet potato – chemical mutagenesis: cuttings/slips exposed to EMS treatment.

Solomon Islands

- Preliminary tests on chemical mutagenesis – 10 cuttings/slips each of aibika and sweet

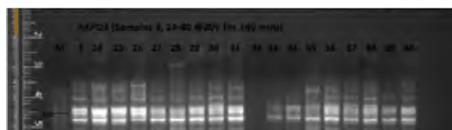
potato cuttings were exposed to EtBr as alternative chemical mutagen.

Screening of mutants

- Evaluation of sweet potato materials (exposed to mutagens) for drought stress in potting experiments in a screen house.
- Evaluation of sweet potato variety mutants for frost, drought and excessive soil moisture stress in field conditions.
- Evaluation of genotypes from aibika seed (exposed to mutagens) for salinity tolerance in a seedling potting trial.
- Agronomical evaluation of salt-tolerant aibika mutants and selected local aibika genotypes.
- Evaluation of different aibika mutants for drought tolerance in potting experiments in a screen house.

DNA fingerprinting

- DNA extraction from roots (aibika) and leaves (sweet potato) using Qiagen DNeasy® Plant Mini Kit for 40 accessions of the germplasm collection in Papua New Guinea.
- Assessment of genetic diversity using RAPD (random amplified polymorphic DNA) markers.
- Polymerase chain reaction (PCR) using a thermocycler and High Fidelity PCR EcoDry™ Premix or lyophilised PCR reagents.



RAPD banding patterns: 3 amplification results showing at least 5 polymorphic groups (A, B, C, D and E).

Germplasm collection

- Establishment of germplasm collections of sweet potato and aibika in Papua New Guinea and Solomon Islands.

Establishment of a herbarium

- Establishment of a sweet potato and aibika herbarium in Papua New Guinea.



Surviving putative mutants of the locally favoured sweet potato variety 'Korowest' at the Yawer farming community, Western Highland Province, Papua New Guinea, after exposure to a frost event (August 2015).



Putative mutant populations of aibika maintained at the NARI Momase Regional Centre, Lae, Papua New Guinea (November 2015).

→ Outputs

Capacity building

- 1 training workshop on the use of PCR (polymerase chain reaction) in Solomon Islands: 6 participants (2 female, 4 male) from MAL and Kastom Gaden Association.
- 1 training workshop on the use of molecular techniques in Papua New Guinea: 7 participants (4 female, 3 male) from NARI and 1 participant from Fresh Produce Development Agency (male).

Research

- Laboratory protocols for the generation of mutant populations from aibika seed.
- Screening protocols in a rain-out shelter to screen sweet potato and aibika for drought, excess moisture and salinity.

Crops

- New salt-tolerant lines of aibika (but with agronomic traits that are less desirable than their wild type line).
- Potentially frost-tolerant sweet potato lines.
- Identification of 4 putative sweet potato genotypes tolerant to soil moisture deficit, 2 genotypes tolerant to soil moisture excess and 4 salinity-tolerant aibika genotypes.

Facilities

- PGR (plant genetic resource) collections at NARI Momase Regional Centre, Lae, Papua New Guinea: c. 40 aibika accessions and 100 sweet potato accessions.
- PGR collection in Honiara, Solomon Islands: c. 50 aibika accessions and 30 sweet potato accessions.
- A herbarium (hortorium) in the NARI National Biotechnology Centre in Lae, Papua New Guinea, to conserve aibika and sweet potato germplasm as well as important accessions of other food crops.
- 2 screen houses for research on abiotic stress tolerance of crop varieties and other research protocols requiring screen house facilities, in Papua New Guinea and Solomon Islands.
- Solomon Islands' MAL biotechnology laboratory equipped with PCR instruments.

Documents (internal NARI reports)

- Technical report outlining new research protocols developed for mutation breeding in aibika and sweet potato seedling evaluation.
- Draft technical report on the development of a screening protocol for the assessment of aibika genotypes for soil moisture stress.



Assessment of salt tolerance of aibika seedlings in potting experiment at NARI Momase Regional Centre, Lae, Papua New Guinea, in 2015.

- Kawale G. et al. Sweet potato mutant line screening for drought and excess soil moisture tolerance (draft technical report).
- Pilon J. et al. Evaluation of salt-tolerant mutants and selected local Aibika (*Abelmoschus manihot* (L.) Medik) genotypes for yield under natural pest infestation conditions (draft technical report).
- Pilon J.L., 2015. Mutation induction and screening of M2 population of Aibika (*Abelmoschus manihot*) for salinity tolerance. NARI Cadet Project Report. PNG

National Agricultural Research Institute, Lae, Papua New Guinea.

Publications

- Rauka G.B. and Shigaki T., 2015. Occurrence and distribution of aibika (*Abelmoschus manihot* (L.) Medik.) collar rot and Fusarium rot in Morobe Province, Papua New Guinea. Fiji Agricultural Journal 55 (1): 4-10.



Sweet potato germplasm collection at Honiara, Solomon Islands, in 2015.

RESULTS

Outcomes

- Increased knowledge of researchers on new research techniques such as mutation breeding and using molecular tools to assess genetic diversity among crop accessions.
- Feasibility of DNA fingerprinting and mutation breeding for various crops.
- Increased awareness on the vulnerability of the Pacific island countries to global climate change impacts.
- Increased awareness on the importance of local herbaria to preserve and utilise the rich genetic diversity of agricultural crops in the Pacific region.

Impacts

Usage

- The mutation breeding protocols can be further expanded to include other aibika varieties or other crops of interest. These protocols can be further improved and used in research on developing crop varieties that are tolerant to moisture stress (deficit, excess) and salinity stress.

Policy implications

- Evaluations of putative mutants showing tolerance to target stresses are still at a very early assessment and evaluation stage. There is considerable additional research required before new improved varieties with target traits are available for dissemination to farming communities, with a timeframe of at least 3-5 years.

Sustainability

- The increased research capacity will enable NARI and MAL to address further agronomic challenges and develop improved crop varieties which eventually can be provided to farming communities. This includes developing sweet potato and aibika varieties with tolerance to drought, excess moisture and salinity.



Collection of passport information of sweet potato germplasm around Tambul, Western Highlands Province, Papua New Guinea, in 2013.

TESTIMONIALS



**Joel Pilon, Junior Scientist, NARI,
Papua New Guinea**

“While working on the project, I have benefited by learning enhanced crop improvement techniques, such as mutation breeding, and also DNA fingerprinting for conservation of genetic resources. This has strengthened my agricultural research capacity.”

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ACP Research for Sustainable
Development (Caribbean and Pacific)

WACOP – Changing waves and coasts in the Pacific

SUMMARY OF RESULTS

Wave climate reports for the Pacific region have been produced containing a summary of the main wind wave statistics of 200 locations and an online ocean wave atlas describing in detail the wave climate with over 400 maps and 40 graphs. Three technical reports describing the oceanography and geomorphology of two field sites, one technical report evaluating the cost of wave energy conversion in the Pacific and two journal articles examining the design of the forecast system for coastal inundation on fringing coral reefs and the transport of coral debris and their role in building beach berms, were also produced.

The improved knowledge on the wave climate and coastal hazards is being used by:

- SPC, SPREP (Secretariat of the Pacific Regional Environment Programme) and USP to train meteorological officers and marine science students on the impacts of climate change.
- Local engineering firms to design coastal infrastructures.
- SPC to design better forecasting tools for coastal inundation.
- SPC to undertake probabilistic inundation hazard assessments.



Deploying a pressure sensor on Fatato reef, Funafuti, Tuvalu. The data is analysed to extract short wave and infragravity wave information in order to gain insight on wave transformation on reef-fronted islands (April 2013).

PROJECT IMPLEMENTATION PERIOD

December 2012 – July 2016

CONSORTIUM

- Pacific Community (SPC), Fiji
- University of the South Pacific (USP), Fiji
- UNESCO-IHE Institute for Water Education, the Netherlands

Associated partners:

- University of Auckland, New Zealand
- The Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia

PROJECT CONTACT

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PROJECT WEBSITE

<http://wacop.gsd.spc.int/>

BACKGROUND

The coastal zone and coastal communities of Pacific Island Countries (PICs), especially low-lying atolls, will be particularly vulnerable to climate change and rising sea levels. Even more so since PICs are already facing a high threat level from coastal inundation hazards due to the co-occurrence of distant swell and high water levels, the passing of tropical cyclones or even tsunamis. The primary issues that coastal zones and communities face are land, food security and water security issues. This is due to climate change resulting in rising sea levels leading to permanent erosion of the shoreline and loss of land, permanent inundation of the lowest fringes, increased frequency, magnitude and extent of episodic inundations, salt water intrusion into ground water resources, as well as reduction or loss of coral reef biodiversity and productivity.

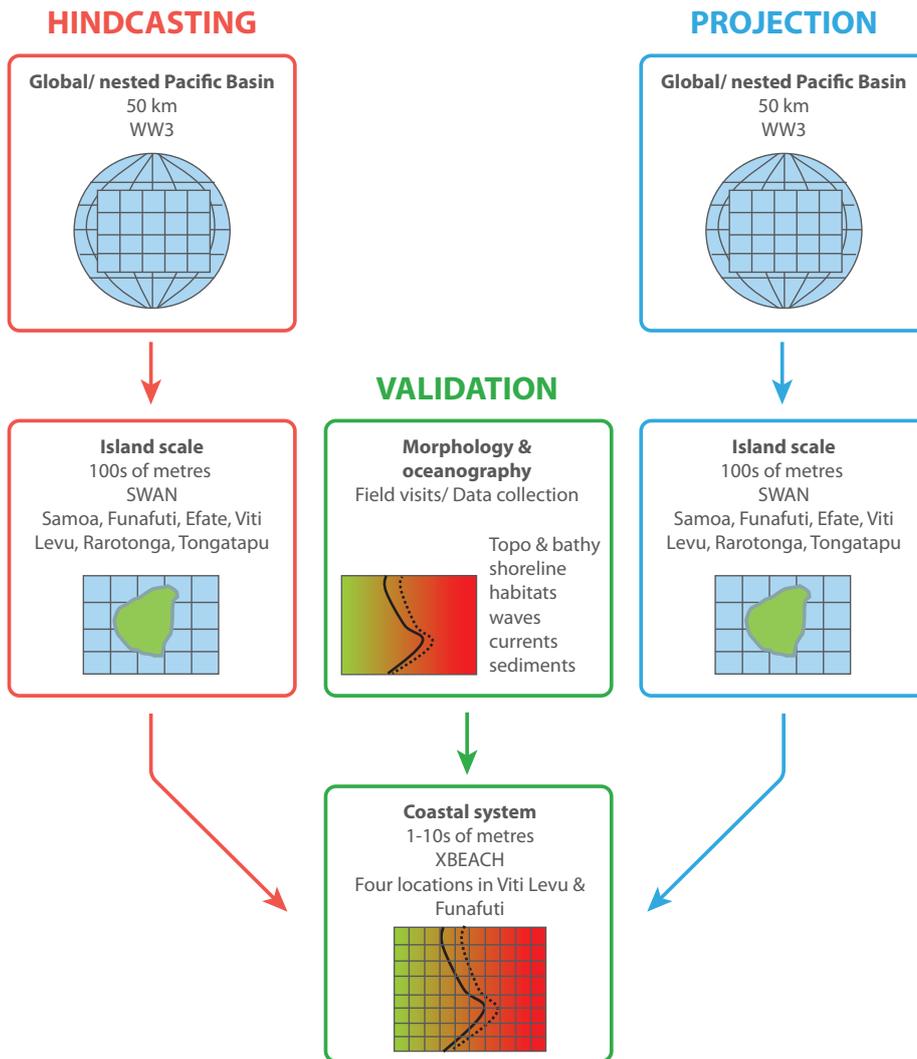
As coastal hazards are predicted to become more frequent and intense with climate change, it is critical to better understand the ocean wave climate (wind and swell waves) and how waves wear away land, remove beach sediments, and cause coastal flooding and habitat destruction during extreme events. With the projected reduction of corals, inducing lower reef friction, it is

also important to better understand wave transformation and wave energy dissipation across reef-fronted islands. This knowledge can be used to increase resilience of coastal communities by designing evacuation roads and finding suitable locations for evacuation centres, identifying vulnerable areas where infrastructure development should be limited or constrained by enforcing appropriate building codes, identifying critical habitats to be preserved (e.g. mangroves that protect the hinterland against erosion and dampen inundation), and designing coastal structures that better protect key island infrastructure such as fuel depots, fresh water reservoirs and power plants.

The project improved the understanding of regional ocean wave dynamics for small islands and of their influence on shoreline processes leading to coastal erosion and inundations. The project also assessed the potential for wave energy harvesting which provides a baseline for improved understanding of coastal vulnerability and adaptation responses in PICs. Data was processed and presented in a format accessible to public services, coastal communities and ocean users to make informed decisions based on sound scientific information.



METHODOLOGY



The methodology follows the coastal oceanography research standard of collecting field data in combination with numerical model interpretation.

| Hindcasting

The global wave hindcast data – from 1979 to 2012 with a 50km resolution – was modelled with the ‘Wave Watch 3 (WW3)’ open source model as part of the ‘Pacific-Australia Climate Change Science Adaptation Planning (PACCSAP)’ project. The WACOP project downscaled the 33 years of global wave hindcast data to a resolution of few hundreds of metres for 5 key capital islands using the open source model ‘Simulating Wave Nearshore (SWAN)’. From the analysis of the data, wave climate, extreme waves and wave energy resource information were compiled in a Pacific-wide wave atlas. This atlas includes broad regional wave climate information such as the mean wave height, the mean wave direction and period, the seasonal and inter-annual variability of wave height and the mean wave energy flux. Finally the nearshore wave hindcast data was fed into

the high resolution coupled hydrodynamic, wave and morphodynamic model ‘XBeach’ to investigate wave transformation on reef-fronted coastlines.

| Validation

Numerical modelling relies heavily on high quality baseline data. As such, bathymetry and topography data were collected in key locations in Viti Levu (Fiji) and Funafuti (Tuvalu). Bathymetry was collected using a single beam echosounder. Topographic data

was collected using a ‘Real Time Kinematic (RTK)’ GPS system. In order to gain confidence on the model results, oceanographic data were collected too. At each of the sites in Fiji and Tuvalu, 4 instruments collecting wave and water level data were deployed between the shoreline and the reef slope to measure wave, water level and currents. The oceanographic information was used to calibrate and validate the numerical models. Analysis of historical satellite imagery and oceanographic data combined with numerical simulation of sediment transport and wave climate, were used to assess how waves affect the shoreline morphology of each site.

| Projection

Climate models are used to improve the understanding on climate systems by simulating the historical period, the present and also the future climate which depends on greenhouse gas scenarios. They are also used to perform seasonal forecasts. There are a number of climate models available. For this study, 2 models (Mk3.5 and ECHAM5) were used under CMIP3 and 4 models under CMIP5 (CNRM-CM5, HadGEM2-ES, INMCM4 and ACCESS1.0). The latter 4 models were chosen due to the availability of relatively high spatial resolution and high (3 hrs) temporal resolution data. These were also the most up to date models.

The global wave projection computed under PACCSAP was fed into the island scale models. The data was averaged over 20-year time frames: historical (1986:2005), Mid 21st Century (MID21C, 2026:2045) and End 21st Century (END21C, 2081:2100). The ensemble average was calculated for each time frame. In order to obtain the projected changes, the difference between the projected and the historical scenarios were calculated for 3 variables: Significant Wave Height (H_s), Peak Wave Period (T_p) and Peak Wave Direction (D_p). Finally the projected nearshore wave climate could be used as a boundary condition into the XBeach model to investigate potential changes in coastal processes, with an emphasis on processes responsible for shoreline change and inundation.



Recovering instruments that collected waves and water level data in Maui Bay, Fiji. The data was used to better understand coastal inundation on fringing coral reef and to better design inundation prediction tools (2014).

→ Outputs

Models

- Wind wave models for Viti Levu (Fiji), Samoa, Tongatapu (Tonga), Rarotonga (Cook Islands) and Efate (Vanuatu). These models, based on open source solution (SWAN) can be used as a baseline to develop coastal inundation hazard assessments or wave forecast systems.
- A Formula Translation (Fortran) code for the XBeach model to allow the use of group resolving and shock capturing hydrodynamic algorithms with a flexible mesh and the ability to perform calculations on graphic cards.

Data

- Online Pacific-wide ocean wave atlas with more than 400 maps and 40 graphs relating to the wave climate in the Pacific, wave energy, coastal hazards and climate change (<http://wacop.gsd.spc.int/>).

Capacity building

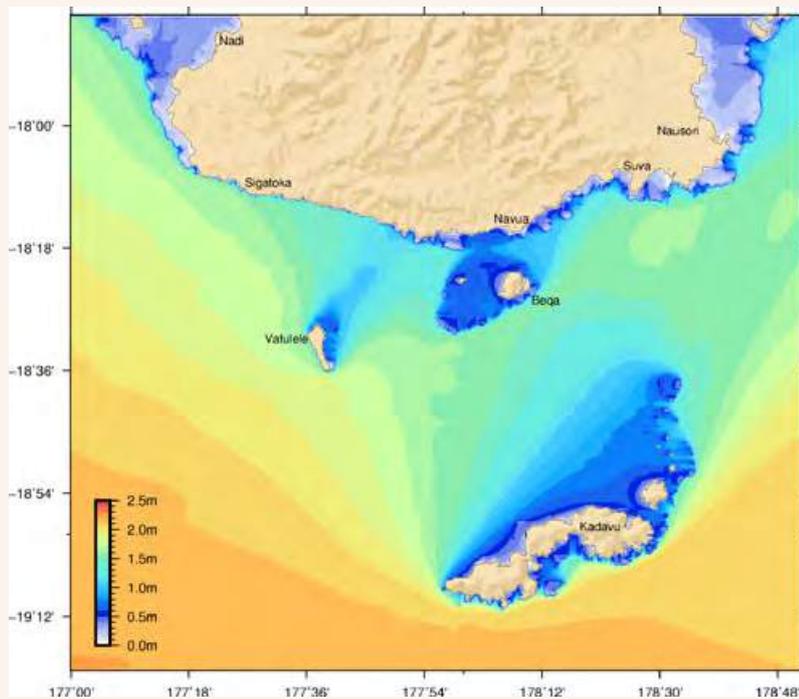
- 5 trainings on oceanography and coastal processes, the use of wave climate report, and wave driven inundation forecast for a total of 84 stakeholders from: meteorological services; disaster risk management offices; water, sanitation and hygiene services; and NGOs from 10 Pacific islands.
- Oceanography training material (discovery and application of wave climate information) for meteorological officers participating in the 'Climate and Oceans Support Program in the Pacific (COSPPac)', funded by the Australian government, which is supporting PICs to adapt to and mitigate the impacts of climate variability.
- Oceanography training material for Marine science courses at the University of the South Pacific (USP) in Fiji.

Documents

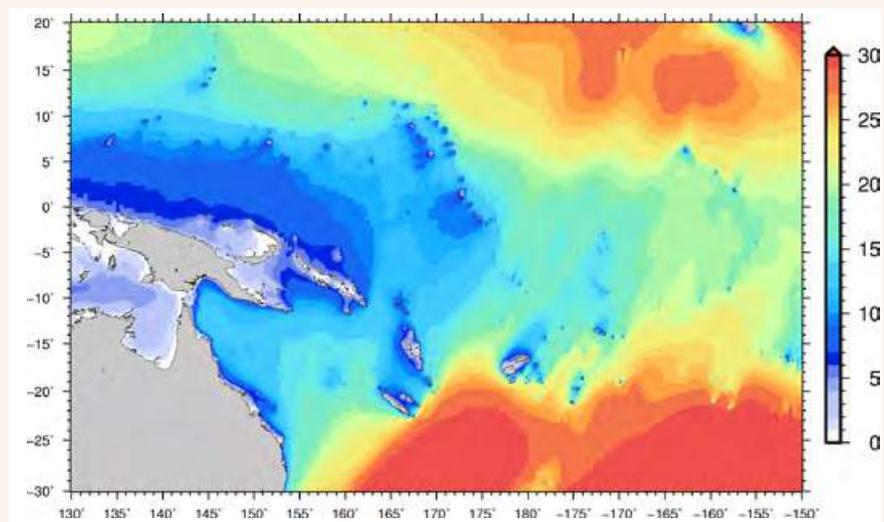
- 3 technical reports on the oceanography and geomorphology of Maui Bay (Fiji) and Fatato (Tuvalu).
- 1 technical report on the cost of wave energy in the Pacific addressing energy policy makers, development partners and energy companies.
- > 200 copies of reports on wave climate at specific locations in the Pacific.
- 2 peer-reviewed articles.
- 2 articles (draft).

Presentations

- 10 international conferences.
- 4 seminar / guest lectures.
- 5 regional stakeholder meetings.



Mean significant wave height south of Viti Levu Island (Fiji) computed from the WACOP downscaled wave model (based on wave hindcast data from 1979 to 2012).



Mean wave power (kW/m) around the Pacific region computed from a 30-year global wave model hindcast (based on wave hindcast data from 1979 to 2012).

Visibility

- Project website.
- 2 press communications.
- 1 poster.
- 2 banners.

Publications

- Online wave climate reports: <http://wacop.gsd.spc.int/WaveclimateReports.html>.
- Bosserelle C. et al., 2016. Waves and coasts in the Pacific: Maui Bay (Fiji) oceanography data collection.
- Bosserelle C. et al., 2016. Waves and coasts in the Pacific: Maui Bay (Fiji) topographic, bathymetric data collection report.
- Bosserelle C. et al., 2015. Waves and

coasts in the Pacific: Fatato (Tuvalu), oceanographic, topographic data collection.

- Bosserelle C., Reddy S., Kruger J., 2016. Waves and coasts in the Pacific: Cost analysis of wave energy in the Pacific.
- Kench P.S. et al., 2017. Coco G., Ryan E.J. Nearshore hydrodynamics, beachface cobble transport and morphodynamics on a Pacific atoll motu. *Marine Geology*, Volume 389, 1 July 2017, p. 7–31.
- Bosserelle, C., et al., 2015. 'Wave inundation on the coral coast of Fiji'. Paper presented at the Australasian Coasts & Ports Conference 2015, 15-18 September 2015, Auckland, New Zealand.

RESULTS

Outcomes

- National disaster and meteorological offices are informed on coastal hazards, wave energy and wave climate change.

Impacts

Usage

- Increased access of coastal communities to ocean information to promote safer ocean trips, optimise fishing time and enable more recreational use of the ocean.
- Coastal and civil engineers using the wave climate reports to – for example – determine jetty design for Savusavu Bay (Fiji), perform fatigue analysis for the detailed design of 1 MW demonstration plant for Kiribati, evaluate the potential coastal hazards in Penhryn Atoll (Cook Islands) and facilitate port operation (Papua New Guinea).
- The Kiribati Meteorological Service used the wave climate report for Kiritimati Island to prepare a coastal hazard outlook for the island, warning of the elevated risk of coastal inundation and erosion associated with the strong El Niño effect of 2015-2016.
- The Fiji wave model has been adapted to provide a 7-day forecast of wind and swell wave conditions (since January 2016). The forecast page of the WACOP website has become the 3rd most popular page and is being used by

the fishing and surfing community of Suva, and by meteorological officers. The forecast system and the numerical model will be transferred to the Fiji Meteorological Service as a component of their inundation forecasting tools.

- The forecasting tools and numerical model are being reused and expanded in the WMO ‘Coastal Inundation Forecast Demonstration Project (CIFDP)’ for Fiji, and will be expanded to produce a coastal inundation warning system for Tuvalu towards the recovery of the tropical cyclone Pam of March 2015.
- Coastal communities on Ovalau (Fiji) have received advice from an inundation survey after the tropical cyclone Winston (February 2016) to reconstruct villages on safe locations.
- The Fiji Meteorological Service released in March 2018 its first inundation impact forecast using the WACOP forecast model of Viti Levu.

Policy implications

- Recommendations to the Pacific Meteorological Council (PMC), resulting in the establishment of the Pacific Islands

Marine and Ocean Services (PIMOS) panel in 2015. It will investigate options and advise the PMC on how best to improve their marine observations, forecasting and early warning in the context of coastal hazards.

Sustainability

- SPC continues to collect oceanographic information in Maui Bay (Fiji) and extend the project dataset.
- New WACOP wave climate reports have been produced following requests from the Tuvalu government and the University of New South Wales (Australia).
- SPC is updating all the WACOP wave climate reports as part of the COSPPac project.
- WMO is funding the development of an inundation forecast system for Fiji – based on WACOP findings – which was successfully used in May 2018 by the Fiji Meteorological Service to release its first inundation impact forecast following a large swell event.

TESTIMONIALS



**Arieta D. Baleisolomone, Climate officer,
Fiji Meteorological Service, Fiji**

“Wave information for the Pacific existed prior to the project in a format designed for researchers looking at wave information on a broad ocean scale. Transforming this information into a product relevant at island scale and in a format that is accessible for non-technical people was a key driver in producing the WACOP climate reports. I liked working on the wave climate reports. It gave me a much better understanding of the various waves that were being experienced in different parts of Fiji.”



**Ravind Kumar, Director,
Fiji Meteorological Service, Fiji**

“The wave models and research on wave inundation in Fiji of the WACOP project have created tools that demonstrate the feasibility of an early warning system for coastal inundation. Ultimately, we want to ensure resilience and sustainability for coastal communities. This tool will contribute towards saving lives, coastal infrastructure and assist with decision and policy making, especially with regard to infrastructure in coastal areas.”

ACP-EU Co-Operation Programmes in the fields of Higher Education and Science, Technology and Research

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ACP Research for Sustainable Development (Caribbean and Pacific)

GoLoCarSce – Global-Local Caribbean Climate Change Adaptation and Mitigation Scenarios



Regional socio-economic scenarios workshop at UWI, Trinidad and Tobago (March 2015).

SUMMARY OF RESULTS

The understanding of climate change effects in Caribbean island states was improved. A set of 4 regionally based socio-economic scenarios was developed to examine the medium- to long-term effects of climate change based on projected impacts on crop yields of sweet potato (*Ipomoea batatas*) and fine cocoa (*Theobroma cacao trinitario*), transmission of vector borne diseases to human beings, water availability, coastal vulnerability, and forest biodiversity. Projected changes represent different climate change scenarios at 20 year time-slices around the 2030s, 2050s and 2090s. Each scenario – presented as a storyline and supported by economic modelling – represents a distinct political economy pathway where combinations of policies can be developed to address regional climate change impacts and inform governments on management decisions. The project outputs will support the UN’s Intergovernmental Panel on Climate Change (IPCC) 6th Assessment Report (due in 2021) to continue to push for the 2016 Paris Agreement ambition of <1.5°C increase in average global temperature by 2100.

PROJECT IMPLEMENTATION PERIOD

August 2012 – July 2016

CONSORTIUM

- The University of the West Indies (UWI), Trinidad and Tobago
- Caribbean Community Climate Change Centre (CCCC), Belize
- Caribbean Agricultural Development Institute (CARDI), Trinidad and Tobago
- The Cropper Foundation (TCF), Trinidad and Tobago
- Stockholm Environment Institute (SEI), Sweden

PROJECT CONTACT

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PROJECT WEBSITE

www.golocarsce.org

BACKGROUND

In its 5th Assessment Report (AR5), IPCC outlined a number of key research and data gaps for small islands starting with: lack of climate change and socio-economic scenarios and data at the required scale; lack of knowledge on economic and social costs of climate change impacts and adaptation options; and lack of investment and attention to climate and environmental monitoring frameworks. The project addressed these gaps in the Caribbean islands which are heavily reliant on their natural environment to support their economies and which are severely threatened by sea level rise, increasing sea surface temperatures, increases in extreme events, such as storms, more intense rainfall and resulting floods, and loss of biodiversity and ecosystem services. These impacts are overlaid on a landscape where unsustainable land conversion and resource consumption patterns are evident, and the risk of natural disasters is inherently high.

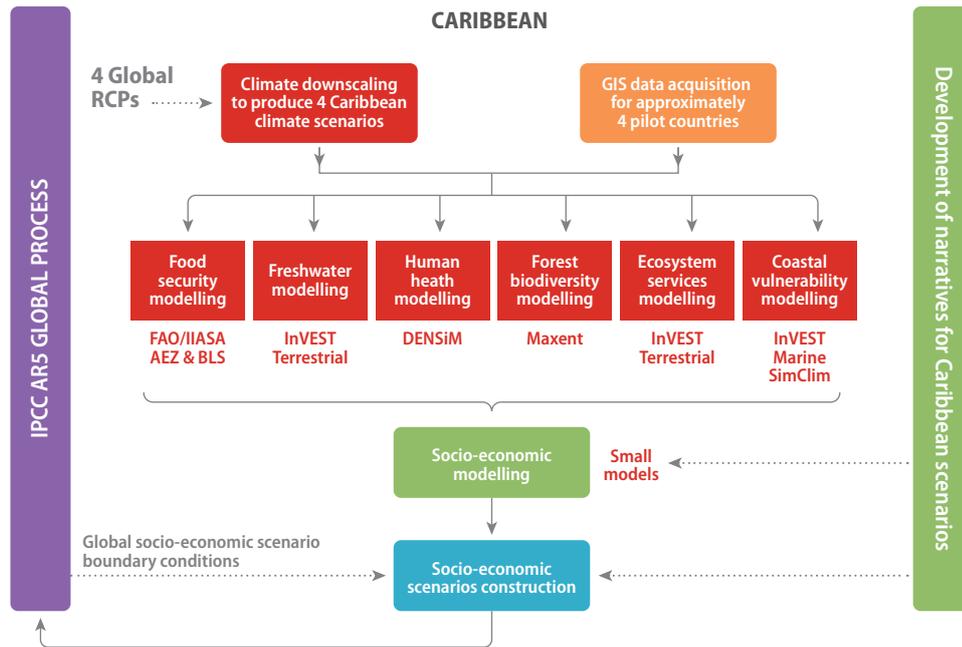
The project demonstrated the ability to address cross-cutting issues specifically within the socio-economic component whereby the region as well as other Small Island Developing States (SIDS) can change with the aim of promoting a sustainable future. The first required step was to examine

alternative futures for different scenarios and the subset of the cross-cutting indicators. A set of socio-economic scenarios was developed to examine the medium- to long-term effects of climate change based on projected impacts on food and water availability, human health, terrestrial biodiversity, and coastal erosion. This was done by 3 SIDS case studies with different economic sectors contributing to their Gross Domestic Product (GDP), but all depending on the natural environment: Barbados (tourism), Trinidad and Tobago (petroleum) and Jamaica (mixed agriculture, tourism and minerals).

After modelling projected changes, e.g., temperature and precipitation to the year 2100, scenarios were developed of the projected impacts of these changes on food, water availability, human health, forests, and coastal infrastructure. The knowledge acquired improved the Caribbean island countries’ resilience and built their adaptive capacity towards promoting more sustainable forms of development and sustainable livelihoods. Finally, support was provided to Caribbean climate change negotiators involved in the establishment of climate limits at global negotiations on climate change related to global mean surface temperature limits and the potential implications for SIDS.



METHODOLOGY



Climate downscaling

Climate change projections (e.g. temperature, precipitation, relative humidity, solar radiation) for Jamaica, Barbados and Trinidad and Tobago have been generated based on a dynamic downscaling technique using the median of an ensemble of 40 downscaled Global Circulation Models (GCM) and then pattern scaling techniques as used by IPCC (AR5). The data was then fed into other specialised impact models (e.g. AquaCrop, crop-water productivity; MAXENT, maximum entropy; and WEAP, water evaluation and planning) to determine climatic suitability for crops, e.g., sweet potato (Jamaica) and cocoa (Trinidad), terrestrial forest biodiversity (Trinidad), and water availability (Barbados), as well as the transmission of vector borne diseases to humans (Trinidad and Tobago).

The projected changes are for representative low, medium and high climate change scenarios at 20 year time-slices around the 2030s, 2050s and 2090s using three Representative Concentration Pathway scenarios (RCP 2.6, 4.5 and 8.6) compared to a 1986-2005 baseline. These pathways provide time-dependent projections of atmospheric greenhouse gas (GHG) concentrations.

Socio-economic modelling

A set of 4 new mathematically based macro-economic models and associated socio-economic scenarios were developed for typical tourism, industrial and agricultural type economies in the Caribbean in order to assess the potential socio-economic effects of projected climate change.

Socio-economic scenarios

Using an adapted methodological foresight approach to regional socio-economic scenarios for the Caribbean for 2050, two scenarios workshops and a Delphi study (forecasting future scenarios) were held with participants from ministries, industry and academia from around the Caribbean region. These sessions served to develop scenario storylines based on the political economy of the small open economies of the region. This foresight process included three step-wise yet iterative phases:

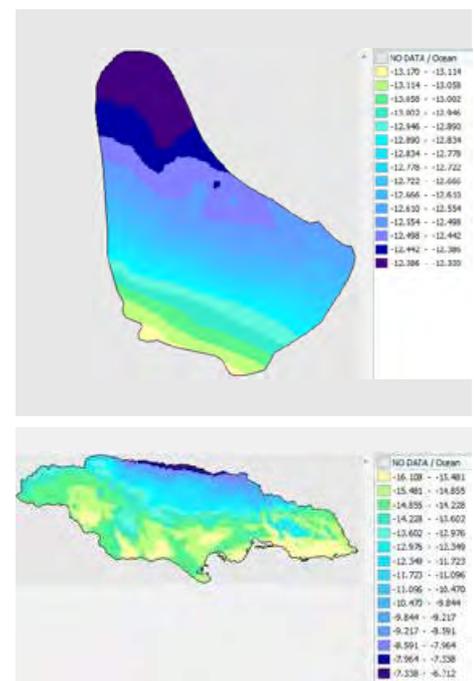
- 1 – developing regional scenarios: desktop research, expert interviews and workshops.
- 2 – ‘up-linking’ to global scenarios: incorporating global trends into the regional storylines using Bayesian Conditional Probability Theory.
- 3 – downscaling from the regional to national level: case studies and systems dynamic modelling to make economic projections.

At each phase, different methods were used to feed into the development and robustness of the final scenarios.

Economic growth models for various climate change scenarios in the identified economy types (tourism, industrial or agriculture based) were then generated using the Vensim systems dynamic software, a computer simulation software for improving the performance of dynamic feedback systems. The models were calibrated with historical data from Barbados, Trinidad and Tobago, and Jamaica. 4 bottom-up regional socio-economic scenarios, one with two variants, were mapped onto

the global Shared Socio-economic Pathways (SSPs) 1, 2, 3 and 4.

The outputs inform management decisions by governments in the region. They are also being published to support IPCC in the upcoming AR6 Report (2021) to continue to push for the Paris Agreement ambition of a <1.5°C increase in average global temperature by the year 2100 as first advocated by Caribbean countries in the UNFCCC negotiations.

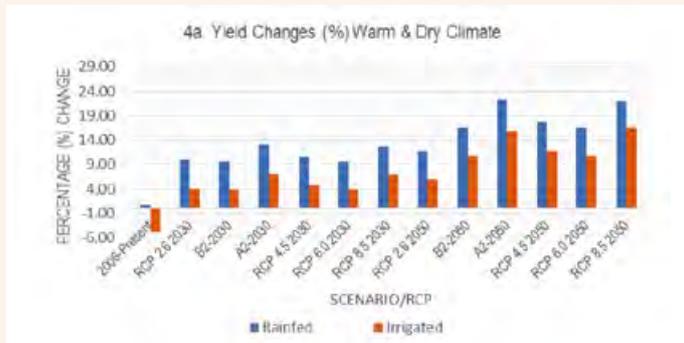


40 GCM median projected precipitation change (%) for RCP 8.5 by the 2050s compared to 1986-2005 baseline (left: Barbados; right: Jamaica).

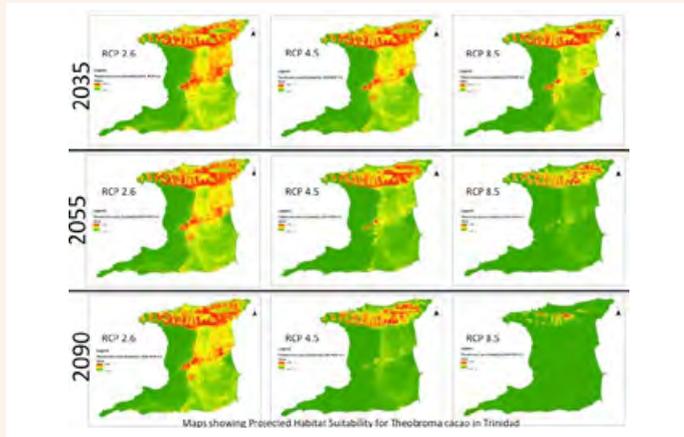
→ Outputs

Climate projection data

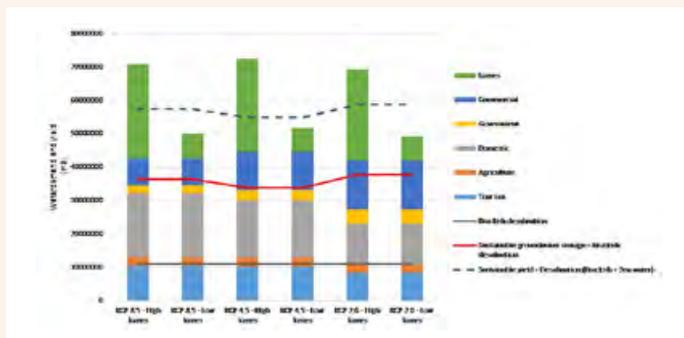
- An ensemble of climate projections down to 10 km scale for the Caribbean islands. The projections are available through to 2100 for RCP 2.6, 4.5 and 8.5.



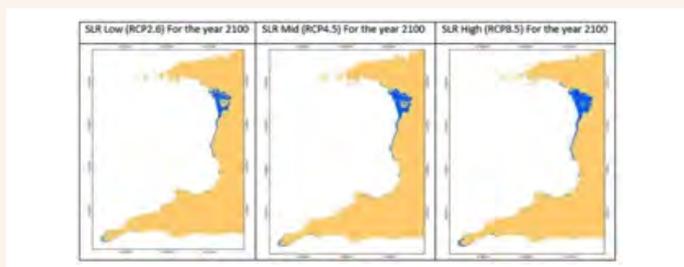
Projected crop yield changes for sweet potato in Jamaica under warm and dry conditions.



Projected climate suitability for cocoa production (red = high, yellow = medium, green = low) across 3 time slices for 3 Representative Concentration Pathway scenarios (RCP 2.6, 4.5 and 8.5) and representative temperature change of 1.2 to 5.0 °C.



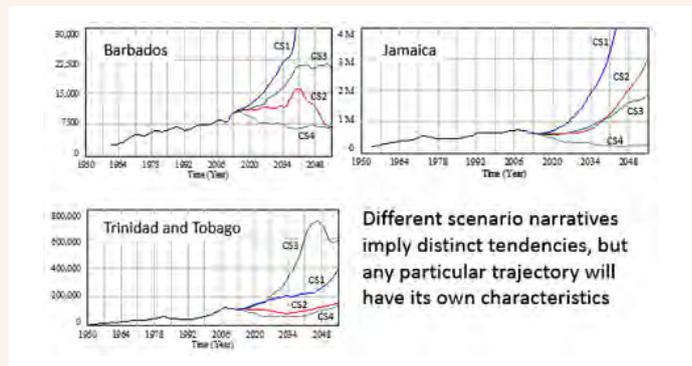
Projected water availability in Barbados in 2050.



Sea level rise projected flooding along the west coast of Trinidad for low, medium and high scenarios by 2100 (Baldeoisingh et al.; in press).

Foresight scenarios

- 4 bottom-up regional socio-economic scenarios for the Caribbean region to guide future policy and enhance the decision-making of the regional leaders with respect to climate change management, presented as storylines with engaging Caribbean type names for communication purposes: *Cool Runnings*, *Islands in the Sun*, *the Harder they Come*, and *Pirates of the Caribbean*.



Different scenario narratives imply distinct tendencies, but any particular trajectory will have its own characteristics

Networking

- The increased pool of scientists and professionals in the field of environment / development in Barbados, Trinidad and Tobago and Jamaica has established a climate change research cluster.
- A forum for foresight scenarios development.

Capacity building

- 22 experts in planning, economics and climate change research (8 female, 14 male) from: UWI; CCCCC; CARICOM; CARDI; ministries responsible for Planning and Environment in Trinidad, Jamaica, Barbados and St. Lucia; the Institute of Marine Affairs in Trinidad and Tobago; the Meteorological Services in Trinidad and Tobago; and the Centre for the World Economy in Cuba (CIEM) trained in scenario development and modelling the effects of climate change within the Caribbean region (Freshwater availability, Food security, Coastal vulnerability, Forest biodiversity, Human health).

Visibility

- 1 IPCC press release.
- 2 TV interviews.
- 1 blog article.

Publications

- Rankine D.R. et al., 2014. Parameterizing the FAO Aqua Crop model for rainfed and irrigated field-grown sweet potato. *Agron. J.* 107(1):375-387.
- Centella-Artola A. et al., 2015. Assessing the effect of domain size over the Caribbean region using the PRECIS regional climate model. *Climate Dynamics* 44: 1901.
- Coy, A. et al., 2016. Increasing the accuracy and automation of fractional vegetation cover estimation from digital photographs. *Remote Sens.* 2016, 8, 474.
- Chadee D.D. et al., 2016. *Aedes aegypti* (L.) in Latin American and Caribbean region: With growing evidence for vector adaptation to climate change? *Acta Tropica* 156: 137-143.
- Kemp-Benedict E. et al., 2018. Export-led Growth, Global Integration, and External Balance of Small Island Developing States. *Economies* 6 (2), 1-25.

RESULTS



Outcomes

- Knowledge of utilising a high performance computing server at UWI.
- Experts trained in modelling (Freshwater availability, Food security, Coastal

vulnerability, Forest biodiversity, Human health) the effects of climate change are expected to do climate impact models on agriculture, water availability, public

health, forest and coastal erosion, and use knowledge to reduce poverty within the Caribbean region.



Impacts

Usage

- The 4 bottom-up regional foresight socio-economic scenarios can be expected to act as a catalyst for developing policies to shape the future of the region: decision makers can assess how effective a policy may be under various economic conditions.
- Outputs related to climate change projections will feed into the Caribbean Community's (CARICOM) future regional Climate Change Adaptation Plan.
- Outputs incorporated into Trinidad and Tobago's New National Spatial Planning

initiative and Environment Policy towards sustainable development.

Policy implications

- Information on future scenarios in the Caribbean region will be available for use in the IPCC 6th Assessment Report (due in 2021)
- Information on future scenarios in the Caribbean region may be inserted in the 3rd National Communication to UN Framework Convention Climate Change (UNFCCC).

Sustainability

- SIDS across the world can benefit from the case studies presented: they can better plan for, coordinate and mitigate impacts of climate change on their islands.
- Producing new economic models developed for tourism, industrial and agriculture based island economies to support socio-economic development and growth.



Examination of the medium- to long-term effects of climate change based on projected impacts on crop yields of sweet potatoes in Jamaica (August 2013).

TESTIMONIALS



Mr. Carlos Fuller, negotiator of the Alliance of Small Island States (AOSIS), liaison officer of CCCCC, Belize, and Chair United Nations Framework Convention on Climate (UNFCCC) Subsidiary Body of Scientific and Technological Advice (SBSTA)

“The Global-Local Caribbean Climate Change Adaptation and Mitigation Scenarios project to develop consistent regional scenarios/storylines for AR5 RCPs for impact studies is downscaling RCP 4.5 and RCP 8.5 to 10 km² for four Global Circulation Models for selected Caribbean islands. It is projected that GoLoCarSce in association with CORDEX - the Coordinated Regional Climate Downscaling Experiment of the World Climate Research Programme (WCRP) that evaluates regional climate model performance through a set of experiments aiming at producing regional climate projections - will be expanded to Central and South America. Furthermore, the CCCCC has entered into memorandums of understanding with partners in the Indian and Pacific Oceans to expand the downscaling work in the Caribbean and support work on downscaling in these regions.”



Dr. Leslie Simpson, CARDI, Trinidad and Tobago

“The Project Scenario Development workshop was facilitated by the renowned scenario expert Dr. Eric Kemp-Benedict from the Stockholm Environmental Institute. Participants were exposed to factors such as ‘critical uncertainties’ and ‘intuitive logics’ and an analysis technique known as ‘Cross Impact Balance (CIB)’. Collectively these techniques and tools will be used to build and refine models under this project. From these models, scenarios for the Caribbean will be developed and these may even be extrapolated to development scenarios for Small Island Developing States. At the end of the workshop it was suggested that a similar session be conducted at a CARICOM Heads of Government meeting. The intention would be for them to seriously develop shared scenarios for a unified Caribbean which could guide their decisions and actions and those of their successors.”

ACP-EU Co-Operation Programmes in the fields of Higher Education and Science, Technology and Research

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ACP Research for Sustainable Development (Caribbean and Pacific)

The application of solar-powered Polymer Electrolyte Membrane (PEM) electrolysers for the sustainable production of hydrogen gas as fuel for domestic cooking

SUMMARY OF RESULTS

The viability of sustainable production of hydrogen gas (H₂) by electrolysis powered by solar energy has been demonstrated. Water was successfully converted into hydrogen gas – for cooking purposes – using a Polymer Electrolyte Membrane (PEM) and solar energy. Gas was stored in 22.4 litre propane cylinders which were retrofitted to ensure safety. Stoves and cylinder fittings were modified to ensure efficient and safe usage of the gas. The two major hurdles, enabling the hydrogen flame to be visible with a colour and detectable by smell (odorised), were solved in laboratory trials. In field trials at three households and UTech, the modified stoves and cylinders were used to prepare complete meals. Trial participants were fully satisfied with their usage. The results have been communicated to the general public through workshops, conferences and publications. The Bureau of Standards and the Ministry of Science, Technology, Energy and Mining of Jamaica are currently reviewing the results for policy adaptation and standardisation for local application.



Cooking with Sol-H₂ gas at UTech's Research Day, Kingston, Jamaica (20 March, 2014).

PROJECT IMPLEMENTATION PERIOD

August 2012 - January 2016

CONSORTIUM

- University of Technology (UTech), Jamaica
- The University of the West Indies (UWI), Jamaica
- Brunel University (BU), United Kingdom
- Bureau of Standards Jamaica (BSJ), Jamaica
- Ministry of Science, Technology, Energy and Mining (MSTEM), Jamaica

PROJECT CONTACT

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PROJECT WEBSITE

<https://www.facebook.com/notes/utech-jamaica/utech-pioneers-research-on-solar-hydrogen-gas-for-domestic-fuel-in-jamaica/10151462943901258/>

BACKGROUND

Jamaica, like the majority of Caribbean States, has a high dependence (over 90%) on imported petroleum fuels for meeting its energy needs. The region has an abundance of renewable energy resources of solar and wind, and to a lesser extent, geothermal, biomass and hydro-potentials. The increased use of these resources will have a positive impact on its development through the availability of more funds for infrastructural works from savings obtained from reduced expenditure on fossil fuels.

The renewable energy project was sustainable and cross-cutting in that it contributed towards ensuring regional energy security by sustainably producing hydrogen gas, as a fuel for cooking for the domestic market, while reducing adverse environmental impacts from deforestation, thus building resilience to climate change impacts. Deforestation is of particular concern because of the frequency of extreme climate-related events like droughts, flooding, tropical storms, and hurricanes that Jamaica has experienced in recent years. These events cause environmental impacts such as loss of soil in agricultural areas, silting of the oceans, and loss of biodiversity.

In addition, the project provided opportunities for the development of small manufacturing enterprises, for example, to

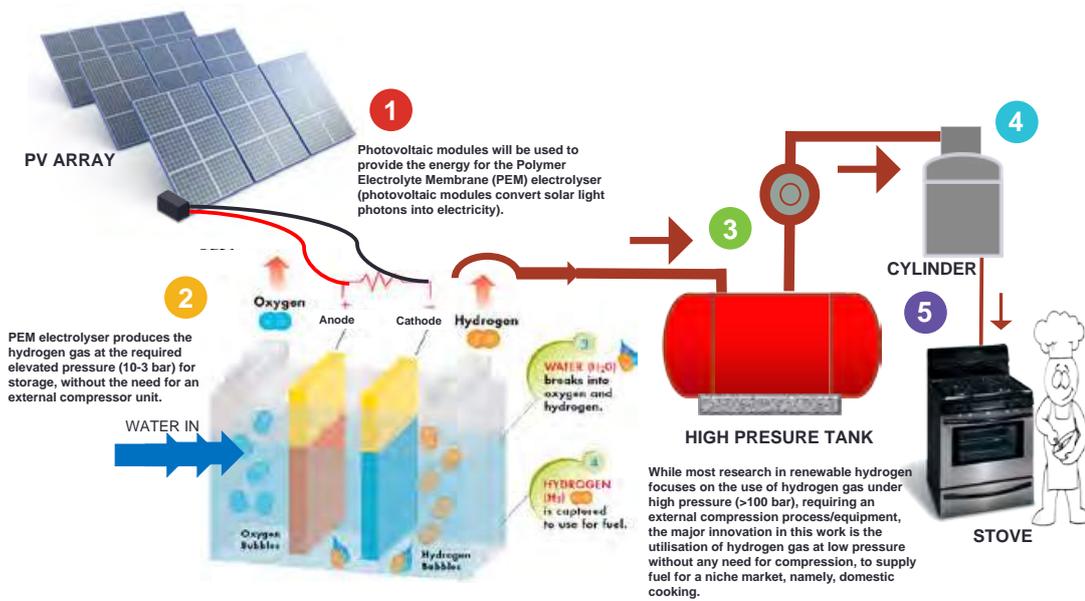
manufacture parts required for the retrofitting of existing stoves to use hydrogen gas and also the building of completely new hydrogen-stoves. As such, use of the results will assist in closing the gap between academia and industry which is particularly common in the Caribbean region.

The major stakeholders involved in the project were: householders / domestic consumers of Liquefied Petroleum Gas (LPG), wood, and charcoal as fuel for cooking; academic staff and students involved in renewable energy research; and standards and certification organisations.

Hydrogen was produced from water by means of a Polymer Electrolyte Membrane (PEM) electrolyser. The gas was stored in high pressure tanks (10 bar) and subsequently regulated down to 3 bar and stored in low pressure storage tanks, ready for distribution to householders for domestic use. The 3 bar storage tanks are ordinary cooking gas (propane) cylinders from which the hydrogen gas can be fed through an ordinary gas regulator to a conventional stove that was modified to use hydrogen. The project also investigated cylinders made from materials such as fibre-glass composite, aluminium, moulded plastic and Kevlar. Stove and cylinder fittings were also modified to accommodate the burning of hydrogen gas.



METHODOLOGY



Design of PV array to power electrolyser

The (photovoltaic) PV modules provide the energy for the electrolyser. As part of designing the PV power system, it was important to characterise the power of the photovoltaic modules for low latitude applications. Three brands of PV modules were tested and the one with best power output under low latitude conditions was used.

Selection of the most suitable electrolyser

After a detailed literature review, the Polymer Electrolyte Membrane (PEM) electrolyser was selected as the most suitable option. The PEM electrolyser matched the controlled criteria: environmentally friendly; self-pressurising (no external compressor); only water and electricity as inputs to generate high purity H₂ gas for direct storage; robust and compact.

Selection of high pressure storage cylinder for hydrogen gas

To store the equivalent of 11 kg of hydrogen as a gas requires a pressure above 333 bar, depending on the volume of the cylinder. In this case, a cylinder capable of holding a pressure of 20 bar was the largest available.

Selection and modification of intermediate storage cylinder for hydrogen gas

Detailed research went into selecting the 'right' cylinder for households. A typical propane cylinder is made of steel and thus heavy. As such, to hold H₂ gas at 3 bar pressure the fibreglass composite was chosen because of its light weight, high tensile strength, UV resistance, and explosion proof shell.

Modification of typical domestic gas stove to burn hydrogen gas safely for cooking

The safe handling and burning of H₂ gas is paramount. The gas flow and burner mechanism

of a propane stove cannot be used with H₂ gas. Hence, experiments were conducted to ensure that the modified design assured safety and reliability in the burning of H₂ gas. A burner (patent pending) was developed that greatly muffles the sound produced by ignition and creates an even flame spread. Additionally, flame arresters and blowback devices were installed on the cylinder side for guaranteed safety.

Additional Steps

Field tests. Three households and the UTech Hospitality Training Centre were provided with a modified stove and a cylinder filled with H₂ gas. Observations focused on: comparing the performance of H₂ gas for cooking with LPG; assessing the viability of using the solar-powered PEM electrolyser to produce H₂ gas for domestic use; and determining how easily householders adapt to using the H₂ gas modified stove and cylinder.

Safety and Operation Manuals. A Safety and Operation Manual for the handling of a hydrogen cylinder and stove, and a set of Guidelines for the retrofitting and/or building of stoves and cylinders were developed. The

safety manual outlines the precautions to be taken when operating the domestic system. The guidelines for retrofitting are crucial for small manufacturing enterprises which may seek to avail themselves of the opportunity to satisfy the new market that may develop.

Determination of the requirements to build the solar-powered PEM electrolyser - hydrogen gas producing plant at commercial production scale, storage, and distribution of the fuel to household consumers. In the Caribbean, propane gas is distributed to householders in 11 kg and 45 kg steel cylinders. A similar distribution scheme for H₂ gas in lightweight composite cylinders was envisioned, and the requirements for a commercial solar-hydrogen plant to service 5,000 households were determined.

Cost-benefit analysis. A cost-benefit analysis (CBA) was conducted to determine the optimal commercial plant size required (in terms of H₂ gas output per day) to be more competitive than LPG on a cost basis.



Experiments on stove modifications at UTech, Kingston, Jamaica (January 2013).



Public demonstration of cooking with hydrogen stove system at UTech, Kingston, Jamaica (March 2014).

→ Outputs

Facilities

- A hydrogen laboratory equipped with a PEM Electrolyser, furnishings, solar equipment, stoves and accessories at UTech (Jamaica) to produce the H₂ gas using solar power.

Apparatus

- Safely modified propane stove and cylinder to allow use of H₂ gas.
- Specialised H₂ gas burner.
- Integration of system components (PV panels, PEM electrolyser, storage cylinders, stove).



Modified stove with specialised H₂ gas burners connected to a low pressure gas storage cylinder and PEM electrolyser powered by a PV system (June 2015).



PV System (PV Panels, inverter, charge controller, batteries) used to power PEM electrolyser (September 2014).

Techniques

- Power characterisation of PV modules at low altitudes.
- Methodologies for adding odour to and safe burning of H₂ gas.

Documents

- Cost-benefit analysis: H₂ gas compared to liquefied petroleum gas as fuel for cooking.
- Safety Manual 'Handling of hydrogen cylinder and stove'.
- Guidelines for the retrofitting and/or building of new stoves and cylinders for the use of H₂ gas as fuel.
- Draft standards / safety guidelines for hydrogen household cooking appliances.
- Hydrogen conference proceedings.

Capacity building

- 1 PhD. specialised in solar-powered H₂ gas producing plant to generate hydrogen as an alternative cooking fuel in developing countries.
- 1 MSc. specialised in development regulatory framework for using H₂ gas as a fuel for domestic cooking in Jamaica.
- 3 technicians trained in sizing PV power systems.
- Training and sensitisation of selected householders on the safe use of hydrogen stoves and cylinders. 8 householders and 2 trainee chefs were trained in the first phase of training sessions (7 female, 3 male). Three households and the student chefs were selected to participate in the field test and as a result, received further specialised training. Of the 3 households selected, 2 were female led and the other male. The two student chefs (1 female, 1 male) who were trained demonstrated use of the hydrogen stove in the kitchen used for training students in culinary arts at UTech.

Visibility

- Project brochures, videos and flyers displayed at various events (videos: https://www.youtube.com/watch?v=CXodV-BIaZ_w; <https://www.youtube.com/watch?v=zwOpkTzKI0>)
- Radio interview: <https://www.youtube.com/watch?v=wf38Y9-vhEo>
- Print media.
- UTech Research Day (March 20, 2014).
- Project website www.solarhydrogen.utech-sapna.com
- International hydrogen conference 'The hydrogen economy – a sustainable energy diversification option for the Caribbean' (3-4 November 2015).
- CARICOM Energy Week Supplement as

a Special Advertisement Section in the Jamaica Observer (November 11, 2015).

- Presentations to graduate students and staff at Brunel and London South Bank Universities (January 2016).
- 5 presentations (oral, poster) at the Centre for Sustainable Energy Use in Food Chains (CSEF, Brunel University) events in the UK.
- Project exhibition at Jamaica's premier trade expo (April 2016).

Publications

- Topriska E.V., Kolokotroni M., Dehouche Z. and Wilson E., 2015. *Solar hydrogen system for cooking applications: Experimental and numerical study*. Renewable Energy, Vol 83, November 2015, Pages 717–728.
- Topriska E.V., Kolokotroni M., Dehouche Z., Novieto D. and Wilson E., 2016. The potential to generate solar hydrogen for cooking applications: Case studies of Ghana, Jamaica and Indonesia. Renewable Energy, Vol 95, September 2016.
- Topriska E., Kolokotroni M., Dehouche Z., Potopsingh R. and Wilson E., 2015. Renewable energy in the service of mankind: Selected topics from the World Renewable Energy Congress WREC 2014, Chapter 18, Vol 1, August 2015.
- Topriska E., Kolokotroni M., Dehouche Z., Potopsingh R. and Wilson E., 2014. The application of solar-powered Polymer Electrolyte Membrane (PEM) electrolyzers for the sustainable production of hydrogen gas as fuel for domestic cooking. Proceedings of the World Renewable Energy Congress XIII, 3-8 August 2014, London, UK.
- Topriska E., Kolokotroni M., Dehouche Z., Wilson E. and Novieto D., 2015. Analysis of domestic cooking fuels demand in Ghana: Field work and case study application of solar hydrogen cooking system. World Renewable Energy Congress XIV, 8-12 June 2015, Bucharest, Romania.
- Topriska E., Kolokotroni M., Dehouche Z. and Wilson E., 2015. Solar-powered electrolysis for the generation of hydrogen as an alternative cooking fuel. 29th EFFoST International Conference, 10-12 November 2015, Athens, Greece.
- Schmidt X., Topriska E., Azapagic A. and Kolokotroni M., 2015. Environmental comparison of current cooking fuels and a solar-powered electrolysis for the production of hydrogen as a source of domestic cooking fuel. 29th EFFoST International Conference, 10-12 November 2015, Athens, Greece.

RESULTS



Outcomes

- The practicality of using hydrogen as a domestic fuel for cooking demonstrated.
- Those who used the hydrogen stove for cooking expressed a more accepting attitude towards using hydrogen as an alternative fuel for cooking.
- Policy makers, innovators, scientists, industry players and the general public made aware on the 'Hydrogen economy' and the potential of producing hydrogen gas on a

commercial scale and a viable alternative fuel for both cooking and the transportation sector.



Impacts

Usage

- Opportunities for the development of small manufacturing enterprises, for example, to manufacture parts required for the retrofitting of existing stoves to use H₂ gas and for the building of completely new hydrogen-stoves, as well as to manufacture adapted cylinders for gas storage.
- Case-study for communities in Ghana and Indonesia were developed following the methodology for the rural communities in Jamaica (results are under assessment).
- The experimental results on the examination of the storage patterns, temperature and filling times under different hydrogen generation pressure points acted as a base to develop and validate a numerical model in TRNSYS (TRAnSient energy SYStems Simulation software), based on FORTRAN programming.

- Replication of power characterisation of photovoltaic modules in other low latitude territories.
- The determination of the requirements to build the solar-powered PEM electrolyser H₂ gas producing plant at a scale for commercial production, storage, and distribution of the H₂ gas to household consumers is applicable as an assessment tool to the Caribbean and Equatorial regions.

Policy implications

- H₂ gas was accepted for inclusion in Jamaica's Draft Gas legislation.
- The use of H₂ gas as a fuel for cooking is envisaged to be incorporated into the national / regional energy supply mix and will thereby contribute to the diversification of energy supplies and the development of better adapted renewable energy technologies.

- The cost-benefit analysis of H₂ gas compared with LPG as fuel for cooking can be used as a decision making tool on hydrogen production for the Caribbean community.
- The Bureau of Standards Jamaica is reviewing the results of the project for standardisation as a cooking system for Jamaican householders.

Sustainability

- Hydrogen when used as a cooking fuel has no obvious effect on the environment and is a clean and alternative renewable energy source for cooking.
- When the hydrogen producing technology is mature and fully adopted, the expected increased use of hydrogen produced from solar energy will see a reduction in the import of oil, leading to a reduction in the import bill, and a reduction in deforestation, which should have a positive impact on regional development.

TESTIMONIALS



Jody, student chef, University of Technology, Jamaica

"There were no difficulties in handling the stove. The hydrogen stove cooks slower than the propane fuelled one, and takes about 5-10 minutes longer to cook the same meal. No deposits or soot were observed. There was no noticeable odour when lighting or burning the fuel. I was satisfied with flame height and control of flame height. For the hydrogen stove, the heat is not as high as propane so it allows the food to cook evenly and with much less adjustment in the flame height, I get better cooking results with hydrogen. I prefer cooking with the hydrogen stove than with the propane stove."



Marsha, householder, Portmore, Jamaica

"The system is just as easy to use as the propane one. It takes a little getting used to the popping sounds when lighting and turning off the gas, but the sound is not loud enough to give you a fright. I noticed that when using the hydrogen stove, less heat is radiated into the space. The room does not feel as hot in comparison to when using the propane stove. This system is a better stove for the concrete houses in Portmore."



Sheldon, householder, Jamaica

"The set-up of the stove and cylinder is very simple. It is just as easy to cook with this system as when using the propane stove. The only difference is that the cylinder is much lighter than the propane one. This would make life much easier for a single man householder to go and buy a replacement cylinder. You could easily walk with it or carry it on a bicycle. I like the system!"

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ACP Research for Sustainable Development (Caribbean and Pacific)

Developing sustainable disease management strategies to improve vegetable production towards self-sufficiency and food security in the Caribbean region

SUMMARY OF RESULTS

Disease assessment surveys for tomato, cowpea and pumpkin were carried out in Trinidad and Tobago, St. Vincent and Grenadines and Guyana: disease incidences were recorded and new diseases identified. For full proof identification of diseases, several classical and advanced DNA-based diagnostic methods were developed and optimised for all the pathogens observed. Integrated Disease Management (IDM) methods were then developed and demonstrated in farmer's fields, and were found to be more economical and environmentally sustainable compared to conventional disease management methods. The disease diagnosis methods and IDM practices were transferred to agricultural officers, researchers, lead farmers and representatives of NGOs involved in sustainable agriculture in the Caribbean. The Plant-Microbe research laboratory at UWI continues to assist vegetable growers, the Ministry of Agriculture and farmer associations on diagnosing plant disease problems. Elite seed lines of tomato, cowpea and pumpkin were collected and preliminarily tested for disease resistance.



Regional Sustainable Plant Disease Management Workshop on vegetables, UWI, St. Augustine, Trinidad and Tobago (June 2016).

PROJECT IMPLEMENTATION PERIOD

August 2012 – September 2016

CONSORTIUM

- The University of the West Indies (UWI), Trinidad and Tobago
- National Agricultural Research and Extension Institute (NAREI), Guyana
- Ministry of Agriculture, Rural Transformation, Forestry and Fisheries, St. Vincent and the Grenadines

PROJECT CONTACT

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FACEBOOK

Plant-Microbe ACP EU

BACKGROUND

For the Caribbean region, there is no published data-based evidence on the list of diseases prevailing in major vegetable crops (tomato, *Solanum lycopersicum*; cowpea, *Vigna unguiculata*; and pumpkin, *Cucurbita pepo*) including emerging diseases which were possibly introduced from outside the region or transported between the islands, through breeding of pathogens or as an effect of climate change phenomenon. This may be related to the absence of a permanent tracking mechanism or system (like trap plots) to monitor the prevalence of pathogens. There is also limited technical and infrastructural capacity available in crop disease diagnosis and pathogen detection, and this is likely the reason for the absence of effective disease management systems. Vegetable growers are unaware or sceptical of integrated disease management (IDM) practices and sustainable disease management practices involving minimum chemical usage. Growers currently practice control methods which are primarily chemical dependent and less sustainable. The use of chemicals needs to be limited by incorporating multiple treatments and approaches in the form of IDM systems for individual crops. Adoption of IDM systems will, therefore, make plant protection strategies more sustainable, environmentally friendly and economically sound.

The project has:

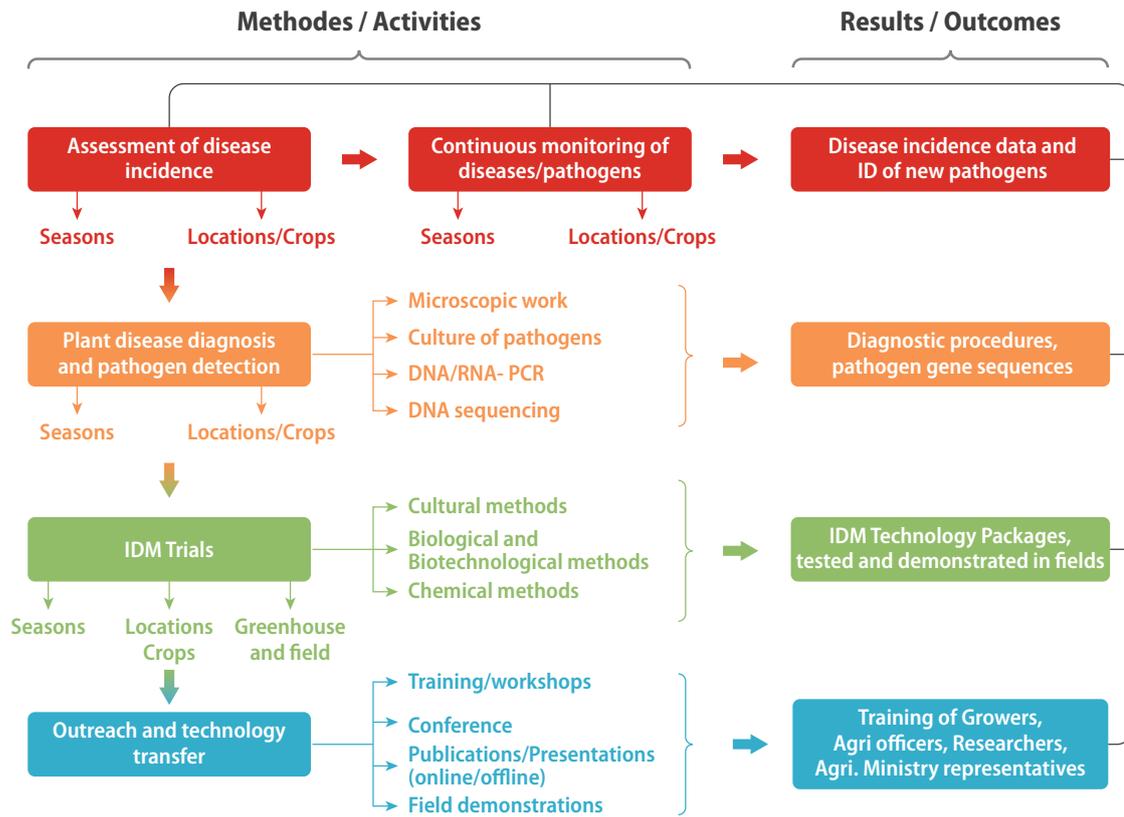
- quantified the prevalence of diseases of tomato, cowpea and pumpkin in the Caribbean region through disease assessment surveys and disease management trials;
- developed tools and techniques for early and efficient diagnosis of plant diseases;
- developed IDM practices for growers with respect to field and post-harvest diseases;
- established a varietal collection of locally grown as well as of exotic vegetable cultivars for continual performance and disease resistance evaluation.

The acquired knowledge was transferred to farming communities (farmers and farmers' organisations) and agricultural extension personnel (mainly public) through training events and information networks.

The direct beneficiaries of the project results were: growers' associations and small farmers' groups; agriculture ministries / divisions of the Caribbean member states; vegetable processing units; vegetable marketing associations; small agri-business owners; agricultural co-operatives; consumer associations and universities.



METHODOLOGY



Assessment of disease incidence

- Extensive field surveys were conducted in the Eastern and Southern Caribbean region (Trinidad and Tobago, Guyana, Barbados, St. Vincent and Grenadines, St. Lucia, Dominica, Antigua and Grenada) on the prevalence of diseases in the vegetable crops tomato, cowpea and pumpkin.
- The diagnosed plant diseases were verified for the causal agents by laboratory analysis involving pure culture / microscopy and molecular methods.
- Permanent trial plots were established at multiple Caribbean locations (Trinidad and Tobago, St. Vincent and Grenadines, and Guyana) to constantly track the activity of pathogens.
- Interviews and baseline surveys were conducted in the cropping regions for collection of data on disease incidence, pesticide usage, disease management methods and cultivation practices.

Plant disease diagnosis and pathogen detection

Development of disease / pathogen diagnostic tools

- Disease / pathogen diagnostic tools were developed, including oligo nucleotide primers, and polymerase chain reaction (PCR) procedures which can be used for DNA and RNA-PCR techniques.
- The PCR diagnostic methods were optimised by laboratory work.

IDM Trials

Field and greenhouse experiments

- Field and greenhouse experiments were conducted to develop and evaluate integrated disease management (IDM) practices which include cultural, biological, chemical and non-conventional methods. Treatments comprising of inputs including soil amendments, biological agents, plant products, micronutrients, elicitor compounds and plant activator biomolecules were evaluated. Chemicals with low residual toxicity, broad spectrum of activity and possessing minimum environmental risks were screened and suggested for needs-based use.
- Demonstration plots were laid out in farmers' holdings for method demonstration and evaluation of efficiency by farmers themselves.

Collection of crop varieties, local selections and clones

- Crop varieties, local selections and clones of the vegetable crops were collected from the Caribbean and maintained at UWI as a collection for future studies on disease resistance screening and growth adaptability.

Outreach and technology transfer

Training workshops

- Government-agricultural field officers, technicians and vegetable growers from the Southern Caribbean were trained through workshops and training programmes on classical and molecular diagnosis of plant diseases and IDM technologies.

Dissemination

- The data on disease incidence and etiology of pathogen occurrence, disease / pathogen diagnostic protocols, and IDM trials and methodologies were published.
- Several publications were produced in several formats (including online) and made accessible to growers, government-agricultural field officers and technicians free of charge, for non-profit use.
- Research results were disseminated at training workshops and conferences conducted by the research group.
- Governmental, educational and research institutions, as well as NGOs and Ministries of Agriculture from Trinidad and Tobago and other southern Caribbean states were advised, through periodical reports and meetings, of the project outputs for possible inclusion in development and formulation of future policy. The importance of IDM practices were emphasised at local, national and regional level. The project partners regularly participated in various outreach meetings and workshops organised by the Ministry of Agriculture and farmers' associations from Trinidad and Tobago.

Stakeholders' participation

- 14 groups: growers' associations and small farmers' groups; agriculture ministries / divisions of Caribbean member states, vegetable processing units; vegetable marketing associations, small agri-business owners; agricultural co-operatives; consumer associations; UWI; University of Guyana.

→ Outputs

Disease and pathogen identification

- 5 databases on diseases and disease management.
- 4 identification keys on diseases and pathogens.
- Novel strains of viruses.
- Simple, fast and accurate RNA/DNA-based pathogen / disease diagnostic methods.

Crop protection

- Multiple low-cost organic crop protection methodologies.
- IDM components of major vegetable crops (efficiency demonstrated in the field).
- IDM methods involving cultural, biological and chemical methods and technologies evaluated under field conditions and demonstrated to farmers.

Collections

- Local germplasm for conservation and future varietal improvement research.

Capacity building

- 6 training workshops on disease identification and IDM methods: 150 participants (60 female, 90 male) - farmers, agricultural extension officers, technicians, public servants and researchers.

Recommendations

- List identifying high toxicity and persistent chemicals to avoid their usage in regular cropping.
- Judicious usage of low toxic and low persistent chemicals for the agriculture ministries of Southern Caribbean states.
- Minimum usage of chemicals in farming systems for government-agricultural field officers, technicians and researchers.

Documents

- 4 technical manuals on disease and pathogen identification and IDM prepared and distributed to agricultural personnel.
- 55 published research publications: research papers, reports, brochures, posters, research abstracts, proceedings, book articles, review articles, newspaper articles.

Presentations

- 33 presentations (oral / posters) at 13 international conferences.
- 10 seminar / guest lectures.

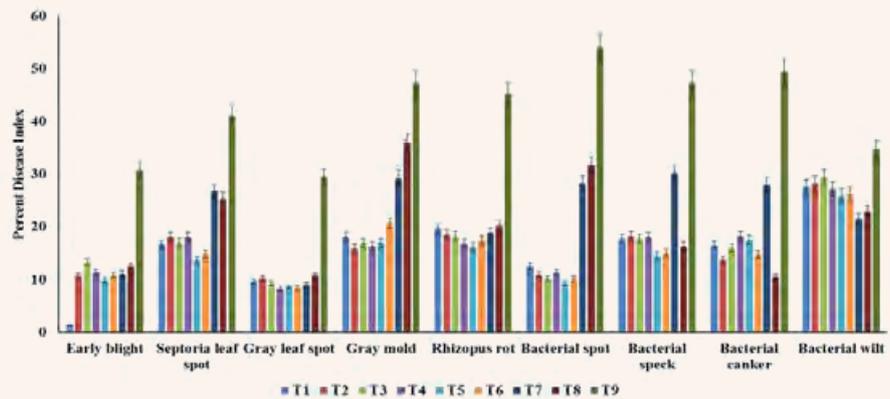
Visibility

- 4 press releases.

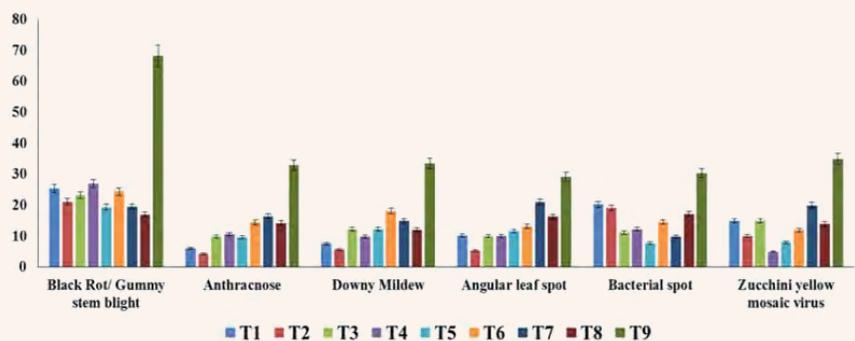
Publications (examples)

- Ramkissoon A. *et al*, 2016. Bio-efficacy of a chitosan based elicitor on *Alternaria solani* and *Xanthomonas vesicatoria* infections in tomato under tropical conditions. *Annals*

Integrated Disease Management in Tomato



Integrated Disease Management in Pumpkin



X axis represents different types of diseases prevalent in the crop during the experimental trial. T1-T8 are different sets of IDM treatments which incorporated cultural, biological and chemical methods. T9 is the negative control. Y axis represents percent disease incidence in tomato and pumpkin crop after application of treatments.

of Applied Biology (*John Wiley*).

- Ramkissoon A. *et al*, 2017. Phytoelicitor activity of three native seaweed species on suppression of tomato diseases in Trinidad, West Indies. *Journal of Applied Phycology.* (*Springer*) (In Press).
- Ali N. *et al*, 2016. Ascophyllum extract application causes reduction of disease levels in field tomatoes grown in a tropical environment. *Crop Protection (Elsevier)* 83: 67-75.
- Chinnaraja C. *et al*, 2016. First report of whitefly-transmitted Tomato yellow leaf curl virus infecting tomato in Trinidad. *Plant Disease (APS).*
- Chinnaraja C. *et al*, 2015. First report of Zucchini yellow mosaic virus and Squash mosaic virus infecting cucurbits in Trinidad. *Plant Disease (APS).*
- Ali N. *et al*, 2015. The effect of *Ascophyllum nodosum* extract on the growth, yield and fruit quality of tomato grown under tropical conditions. *Journal of Applied Phycology.* *Springer.*
- Jayaraj J., 2018. Induced resistance - a sustainable biotechnological approach

of plant disease management. In: *Plant, Pathogens and People.* Editors, P. Sharma *et al.*, *Indian Phytopathological Society, New Delhi, India.* (In Press).

- Jayaraj J., Ali N., 2015. Use of seaweed extracts for disease management of vegetable crops. *Sustainable crop disease management using natural products,* Editors, S. Sangeetha, V. Kurucheve and J. Jayaraj, *CABI publications,* 160-183.
- Jayaraj J., Alleyne A., 2015. Biocontrol agent formulations for sustainable plant disease control of plants. *Sustainable crop disease management using natural products,* Editors, S. Sangeetha, V. Kurucheve and J. Jayaraj, *CABI publications,* 213-233.
- Rajendran R., Jayaraj J., 2015. Chitosan for plant disease management – Prospects and problems. *Sustainable crop disease management using natural products,* Editors, S. Sangeetha, V. Kurucheve and J. Jayaraj, *CABI publications,* 198-213.
- Sangeetha S., Kurucheve V., Jayaraj J. (Eds.), 2015. Sustainable crop disease management using natural products. *CABI publications,* 413p. (Research reference book).

RESULTS

Outcomes

- Increased awareness on prevalent diseases in the region, their symptoms, causal agents and vectors by lead vegetable growers, government-agricultural field officers, technicians and researchers.
- Vegetable growers and agricultural officers able to track the prevalence of diseases by trap plots and surveys.
- Increased knowledge of agricultural officers, technicians and students on contemporary DNA/RNA-based diagnoses.
- Agricultural officers, technicians, research personnel and students able to apply molecular techniques for pathogen detection and disease diagnosis.
- Improved understanding of vegetable growers and agricultural officers on the importance of IDM practices as the only meaningful way for sustainable disease management and strategy to improve quality food production.

Impacts

Usage

- By practicing IDM methods which involve cultural, biological and chemical treatments, vegetable growers will cut down the use of chemicals (by at least 50% for those having participated in the project). They will use more cultural and biological methods, avoid the use of more toxic chemicals and replace these with low residual toxic chemicals.
- Farmers and agriculture ministries will continually monitor the diseases by means of trap plots.
- Cultural and biological based crop disease management methods will be increasingly adopted by growers to minimise the input costs.

Policy implications

- Ministries of Agriculture, Health and Environment and NGOs active in agriculture and food safety are convinced of the ill effects of chemical-based farming systems and will be developing policies to encourage sustainable farming methods and food production.
- Consumers are made aware of the ill effects of chemicals and can demand quality produce and may support the food produced through IDM systems.

Sustainability

- Farmers are interested to participate in further experimental research and adopt new farming methods.
- Farmers were taught and trained to use

only permitted and less toxic chemical fungicides which in fact resulted in low demand for highly toxic chemicals. Agrochemical dealers are also moving towards marketing alternative inputs and improved plant varieties.

- The Agricultural Society and the Ministry of Agriculture in Trinidad and Tobago have become lead beneficiary organisations. This will lead to a shift in farming technologies through internal training and outreach.
- UWI continues to provide technical and intellectual assistance.
- UWI continues to pursue research and outreach activities connected to sustainable disease management through other research initiatives and grants.

TESTIMONIALS



Alfred Koondaya, vegetable grower, Valencia, Trinidad

“The researchers in this project have worked with me for the past 4 years. They conducted several field experiments on my farm. I was very interested to learn about the new IDM practices developed through the project. I have followed these practices for the past 2 years when growing cowpea, sweet peppers and tomatoes. The quality of produce is extremely good. I am now able to export some of my sweet pepper which has brought me big revenue. This was all possible due to the new IDM methods developed by the researchers. I really owe a big thanks to them and I am very interested to continue to assist them in other research projects.”



Angela Laltoo, vegetable grower, Trinicity, Trinidad

“I have been farming on 10 acres of land for the past 35 years. Up until 2013, I was using routine methods of disease management which involved the continuous use of chemicals. The researchers in this project explained to me about the ill effects of chemical-based systems. They taught me the IDM methods which I have been using since 2015 and I am getting very good yields and high quality produce harvest of cowpea, pepper, tomatoes, eggplant and crucifers. I am now saving a lot of money by cutting down my costs spent on chemicals, and my friends and neighbouring growers are doing the same. I am very happy that I was able to learn about the new technologies from them which fully changed my way of growing crops. I am very enthusiastic to continue working with them in the future towards the betterment of growers and the country.”



**Deanne V. Ramroop
Deputy Director Research Crops, Ministry of Agriculture, Land and Fisheries (MALF), Trinidad and Tobago**

“I have benefited immensely from the workshops with lectures and hands-on training highlighting research work in a range of relevant areas. They were participatory, interactive and allowed for the exchange of information. The knowledge gained was shared with the agricultural professionals involved with plant disease diagnosis and management at our Ministry and further disseminated to the farming community. The research work is very timely and relevant. It will allow farmers to improve their crop management practices leading to improved production efficiency and subsequent reduction in costs. Beyond training, the UWI team is maintaining a very good working relationship with our Ministry in responding to our technical needs.”

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ACP Research for Sustainable Development (Caribbean and Pacific)

Impact on a freshwater lens in atoll environments under different climate and abstraction scenarios

SUMMARY OF RESULTS

The development of a three-dimensional variable density model providing a rare example of physically based island simulation enables the analysis of both freshwater volume and fluxes of submarine groundwater discharge. Numerical groundwater modelling of different climatic and abstraction scenarios supports technical and management options for improved and sustainable freshwater supply in atoll environments. In Kiribati, Tuvalu and the Marshall Islands, the concept of sustainable groundwater management with a focus on managing freshwater resources to maintain water quality suitable for potable purposes was reinforced. Communities have been provided with options for self-determination of groundwater management based on a variable abstraction rate predicated by changes in salinity that can be maintained over defined periods in different climate and water security situations. The socio-economic costs of maintaining an acceptable salinity or 'freshness' of the supplied water are beneficial in comparison with the costs of providing an alternate water source, e.g. desalination of sea water.



Water Engineering Unit staff, Ministry of Infrastructure and Sustainable Energy, undertaking water quality monitoring at monitoring bores, Bonriki, Kiribati (November, 2013)

PROJECT IMPLEMENTATION PERIOD

August 2012 – September 2016

CONSORTIUM

- Pacific Community (SPC), Fiji
- University of the South Pacific (USP), Fiji

Associated partner:

- Flinders University of South Australia, Australia

PROJECT CONTACT

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<http://caia.gsd.spc.int/>

BACKGROUND

Atoll countries in the Pacific region are concerned about the impacts on fragile freshwater lenses under projected changes in rainfall and increased population demands. Access to quantified information on the impact on water resources will allow communities and government alike to participate in the discussion on the potential impacts, challenges, opportunities and practicalities of proposed mitigation options. In the long term, this will improve the resilience of Small Island Developing States (SIDS) and their development opportunities.

SIDS have particularly vulnerable freshwater resources. Their physical characteristics preclude surface water resources, with a corresponding reliance on rainwater harvesting and groundwater. Many SIDS in the Pacific have insufficient knowledge on the impact of climate and abstraction on freshwater lenses, which are strategically important, particularly during droughts, and in many cases provide the dominant source of freshwater. The management and development of these resources is different from continental groundwater sources due to their highly dynamic nature and the risks associated with salinisation.

The research project was set up to model the impacts under modified climate or abstraction scenarios on freshwater lenses. This was

done to develop practical, technical and management options to improve water security in atoll environments, and support national, social, and economic development, as well as environmental protection in future. Two case studies were executed:

- The Bonriki Water Reserve in Tarawa (Kiribati) is one of the most relied upon and highly 'worked' aquifers in the Pacific. It is currently at the limit of its sustainable abstraction and at risk of salinisation, especially during drought periods.
- The island of Vaitupu (Tuvalu) has very limited water resources. During extended dry periods the main water source, rainwater harvesting, is severely impacted. During these water stressed periods, communities rely upon groundwater from shallow wells for some of their water needs.

The research findings are applicable to other SIDS in the region. For instance, during times of extended dry conditions, Majuro atoll (Marshall Islands) relies extensively upon the fresh groundwater resources beneath Laura islet. As with other fragile freshwater lenses, abstraction needs to be controlled through targeted monitoring to minimise the potential for salinisation which can render the groundwater unsuitable for potable water use.



METHODOLOGY

Technical and national advisory groups	<ul style="list-style-type: none"> • Identification of appropriate field sites, case studies. • Review of existing data sets, identification of appropriate modelling approaches and required field data collection.
Field investigations	<ul style="list-style-type: none"> • Field investigations – geophysics, bore monitoring, rainfall data collection and analysis, water quality monitoring and record groundwater abstraction – to characterise the groundwater resource and allow model conceptualisation. • Mapping of the extent of the fresh groundwater resources in Vaitupu, Tuvalu.
Numerical groundwater modelling development	<ul style="list-style-type: none"> • Construction and development of a 3D numerical groundwater model and its calibration. • Development of appropriate trigger levels, and climate and abstraction scenarios.
Optimised abstraction under different climate considerations	<ul style="list-style-type: none"> • Assessment of modelled impact on groundwater systems from identified scenarios. • Cost-benefit analysis of different management options, incl. alternate water sources to provide required water volume.
Drought response and operational guidance	<ul style="list-style-type: none"> • Development of pragmatic responses to agreed trigger levels for improved operation and management. • Drafting of operational management rules for drought response implementation. • Identification of ongoing monitoring strategies to assist with operationalisation of identified management responses.
Extension of results	<ul style="list-style-type: none"> • Publication of results in peer-reviewed journals, presentation of results at international conferences. • Application of results to other Pacific Island Countries (PICs). • Cost-benefit analysis to demonstrate social and economic advantages and challenges for different management options.

Advisory groups

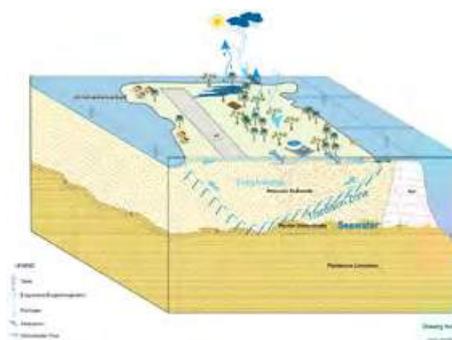
Local stakeholders were consulted to address the sustainability of water supplies and develop practical mitigation options:

- Kiribati: Ministry of Public Works and Utilities, Public Utility Board, Kiribati Meteorological Service, National Disaster Management Office.
- Tuvalu: Ministry of Public Works, Vaitupu Kaupule, National Disaster Management Office, Tuvalu Meteorological Service, communities of Vaitupu.
- Marshall Islands: RMI Environmental Protection Agency, Majuro Water and Sewerage Company, National Disaster Management Office, Majuro Weather Service, water users of Laura.
- Government / communities' representatives.

The technical advisory group guided the project team to assess the technical feasibility of project components. National advisory groups – key government agencies and community representatives – guided site selection, model scenario options and operational management. The advisory groups assisted in developing the concept and process for establishing sustainable yield in the small island atoll environment and appropriate trigger levels to guide abstraction rates.

Field investigations

The development of numerical models and increased understanding of the groundwater system relies upon relevant and accurate field investigations and monitoring data. Extensive monitoring in Bonriki (Kiribati) ensured that when combined with historical data the modelling confidence is increased. Mapping of fresh groundwater resources in Vaitupu (Tuvalu) used electrical resistivity techniques.



Conceptual model developed for the Bonriki water reserve, Kiribati (2013).

Numerical modelling

Numerical representation of the conceptual model of the Bonriki water reserve was developed using the SEAWAT programme. Collected field data provided evidence-based calibration and confidence in the model outputs, providing insight into how to best operate and manage the freshwater lens. The development of the numerical hydrological model was supported by the 'Bonriki Inundation Vulnerability Assessment (BIVA)' project which assisted with data collection and ongoing monitoring from the existing monitoring network.

Optimised abstraction

Optimisation of abstraction under different climatic conditions while maintaining agreed water quality limits was assessed. An ensuing cost-benefit analysis identifying different management options guided decision makers in developing evidence-based policy for drought response and future management and mitigation actions which is relevant for other Pacific atolls.



Geophysical identification of fresh groundwater resources in Vaitupu, Tuvalu (June 2015).

Drought response

One practical application of the research was to provide guidance on impact-based drought management and responses which can be applicable to other atolls. Numerical modelling of the different climate and abstraction scenarios helped identify the most sensitive parameters in the lens and the triggers which can be easily monitored. Numerical modelling also provides guidance on impact and mitigation responses.

Results extension

Results have been shared within the Pacific through specific presentations with communities and governments. In addition, technical conferences have been attended and two peer-reviewed papers produced to share the results with a wider audience.

→ Outputs

Models

- State-of-the-art three-dimensional numerical groundwater model of the Bonriki Water Reserve (Kiribati) demonstrating the dynamic groundwater behaviour of a freshwater lens under different climatic conditions, applicable to other atoll environments.

Maps

- Groundwater resources of Vaitupu (Tuvalu) for consideration in future development as a potable water source, and for land use planning and water security purposes.

Water management

- Design options for communities and government for the development of groundwater resource as a drought reserve.
- Recommendations to the government of the Marshall Islands on increased abstraction without adversely impacting the water quality of the freshwater lens.
- Validation of SPC's field-based quantified water bacteriological sampling and analysis procedure for use in remote study sites where opportunities to undertake laboratory analysis are not possible.

Documents

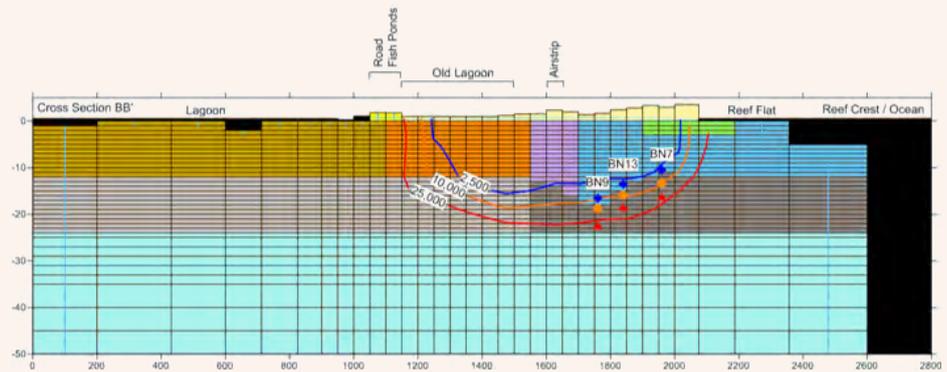
- Briefing note for the National Disaster Council in Kiribati to seek its endorsement for the incorporation of sustainable management procedures into the South Tarawa Drought Response Plan, to be implemented during times of water stress such as those caused by drought and overtopping.

Capacity building

- 8 training sessions with >40 stakeholders (6 female; national government agencies and departments, community and island government representatives) trained in water resource assessment and monitoring techniques (water quality sampling and analysis) across Kiribati, Tuvalu and the Marshall Islands.
- Numerical groundwater modelling training in Kiribati for 5 participants (3 female).

Visibility

- >20 presentations on project activities and results in Kiribati and Tuvalu: audiences ranging from community through to government ministers.
- >12 presentations at technical working group meetings.
- 2 videos: Water lens animation, climate and abstraction impacts on atoll environments.
- 4 conferences: Science, Technology, and Resources Network STAR, Nadi, Fiji 2015 and 2016; Saltwater Intrusion Meeting (SWIM), Cairns, Australia, 2016; Water Resource Sustainability Issues on Tropical Islands, Hawaii, 2015.



Numerical model domain and model cross section, Bonriki water reserve, Kiribati.



Water Engineering Unit staff, Ministry of Infrastructure and Sustainable Energy, undertaking training in geophysical assessment techniques, Bonriki, Kiribati (February, 2014).

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- Werner A. *et al.*, 2017. Hydrogeology and management of freshwater lenses on atoll islands: Review of current knowledge and research needs. *Journal of Hydrology*. Volume 551, p. 819-844.
- Bosserelle A.L. *et al.*, 2018. On the resilience of small-island freshwater lenses: evidence of the long-term impacts of groundwater abstraction on Bonriki Island, Kiribati. *Journal of Hydrology*. Volume 564, p. 133-148.
- Galvis-Rodriguez S. *et al.*, 2017. Climate and Abstraction Impacts in Atoll Environments (CAIA): Sustainable management of the Bonriki Water reserve, Tarawa, Kiribati.
- Sinclair P. *et al.*, 2017. Climate and Abstraction Impacts in Atoll Environments (CAIA): Groundwater field investigations Vaitupu, Tuvalu.
- Sinclair P. *et al.*, 2017. Climate and Abstraction Impacts in Atoll Environments (CAIA): Assessment of the 2015-2016 drought impacts on the fresh groundwater lens at Majuro Atoll, Republic of Marshall Islands.
- Jolliffe J., 2017. Climate and Abstraction Impacts in Atoll Environments (CAIA): Cost benefit analysis of sustainable management options of the Bonriki Water Reserve, Tarawa, Kiribati.
- Loco A. *et al.*, 2017. Climate and



Explanation of the fresh groundwater lens development to the community in Vaitupu, Tuvalu, (June, 2015).

Abstraction Impacts in Atoll Environments (CAIA): Groundwater chemistry investigations, Bonriki water reserve, South Tarawa, Kiribati.

- Loco A., 2017. Climate and Abstraction Impacts in Atoll Environments (CAIA): Flow meter testing, Buota and Bonriki Water Reserves, Tarawa, Kiribati.
- Loco A. *et al.*, 2017. Climate and Abstraction Impacts in Atoll Environments (CAIA): Assessment by USP to validate and improve the SPC field bacteriological water sampling and analysis methodology using E. Coli compact dry plate.

RESULTS

Outcomes

- Pacific Island Countries (PICs): awareness and understanding of groundwater resource potential and management improved through the use of numerical groundwater modelling and geophysics.
- Tuvalu: increased access to water resource information for improved water resource management.
- Kiribati and Tuvalu: improved water security with applicable information for future groundwater and land use planning.
- Marshall Islands: identification of impacts on groundwater resources from droughts and measures to improve access and sustainable abstraction.
- SPC: improved expertise and skills in numerical groundwater modelling and its application in the Pacific region.
- Well documented novel approach from broader international academic community to sustainable management of fresh groundwater in atoll environments based on water quality to guide groundwater abstraction.

Impacts

Usage

- Tuvalu: identification and mapping of the fresh groundwater resources in Vaitupu resulted in the development of an infrastructure project proposal to develop a supplementary groundwater supply in Vaitupu.
- Kiribati: monitoring and management of the groundwater based on water quality (salinity) implemented, installation of variable pumps to better manage the resource without adversely impacting on water quality. The Marshall Islands expressed interest in following this approach.
- Effectiveness of electrical resistivity tomography as a non-invasive and cost-effective technique for use in atoll settings.

Policy implications

- A prescriptive and impact-based approach to drought response management with clear roles and responsibilities of government agencies developed with stakeholders in Kiribati which is applicable in other PICs.
- Policy promoting the use and future development of groundwater to improve drought resilience and overall water security in Tuvalu and the Marshall Islands.
- Increased reliance on groundwater during drought in the Marshall Islands, with resultant cost saving.

Sustainability

- The novel approach of utilising water quality (salinity) to guide sustainable groundwater management and abstraction optimisation in atolls can be further developed and applied in other atoll settings.

- The economic cost-benefit analysis results indicate the effectiveness of the proposed management response.
- Short-term management and proposed abstraction regime options to meet water supply needs identified so as to minimise any long-term impact on the freshwater lens.
- Groundwater abstraction identified as the most cost-effective freshwater source in atoll settings with economic and environmental benefits.
- Coordination of agencies during drought resulting in improved management and communication of the water resource status and its operation (Kiribati).
- Communities reliant upon fresh groundwater resources are more engaged with better understanding and improved communication of resource status.

TESTIMONIALS



Avafoa Irata, Permanent Secretary Public Works, Funafuti, Tuvalu

“I am most appreciative of the support for the assessment of the groundwater resources in Vaitupu to improve water security, as this is a long outstanding matter that we as stakeholders are desperate to know. Water security is a very important element in our national development plan. Water is regarded as a core element of the livelihoods of our people and is essential to the daily live of our people.”



Community leaders, Vaitupu, Tuvalu

Melton Tauetia – Kaupule Secretary, June 2015 (Kaupule = Island Council): “During extreme situations, all major water bodies are managed by the Kaupule. This is the only time that the Kaupule will execute its power under the governance structure to manage water for all. The strategy during droughts is to have centralised water storage points in the village, ready for people to take water. During times of drought when water storage is low, the water is rationed. We will use the maps of where to locate the best freshwater for our future water sources. This water will be protected for use as an emergency water supply available to everybody.”



Peregrine Tonking, CEO Public Utility Board, Kiribati

“Good, quality water is key to the health of a community. Without good quality water, you have poor health and a diabolical situation on your hands. The majority of people don’t have access to potable or well water in South Tarawa. There is a tremendous amount of pressure on the water reserves there. There is almost not enough water for the community there. The CAIA project has developed a leading model of the fresh water resources in Kiribati. The work is very impressive and certainly provides substantial insight on the sustainability of the water supply in freshwater lenses.”

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ACP Research for Sustainable
Development (Caribbean and Pacific)

Enhancing productivity of land and labour through small-scale mechanisation for subsistence farmers in Papua New Guinea and Solomon Islands

SUMMARY OF RESULTS

Prototype small-scale farm machines such as a solar dryer, the 'Kisar' manual rice mill and a peanut sheller have been designed, constructed and piloted in several farming communities in Papua New Guinea and the Solomon Islands. A farmer participatory research approach allowed farmers to learn by doing, resulting in them gaining the confidence to make their own machines. The approach also resulted in a better understanding of farmer realities, including the use and lack of access to farm machinery, particularly for rice and peanut production. The research capacity in the design and development of farm machines was enhanced and mini-engineering workshops and a thermo-physical laboratory were established. An economic assessment of the prototype machines showed that the 'Kisar' rice mill was the most cost beneficial machine as compared to other rice mill machines as its usage in rice growing communities reduces transport and milling costs for farmers who normally bring their rice to rice mills (for household consumption) in urban centres.



Training of farmers making a 'Kisar' rice mill during a practical session at Takom Model Farm in Morobe Province, Papua New Guinea (December 2015).

PROJECT IMPLEMENTATION PERIOD

August 2012 - July 2016

CONSORTIUM

- National Agricultural Research Institute (NARI), Papua New Guinea
- Ministry of Agriculture and Livestock (MAL), Solomon Islands

Associated partners:

- Papua New Guinea Women in Agriculture Development Foundation, Papua New Guinea
- Kastom Gaden Association, Solomon Islands
- Project Support Services Ltd (PSS Ltd), Papua New Guinea

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BACKGROUND

Most of the rural farmers in Papua New Guinea and the Solomon Islands use traditional hand tools such as machetes, spades and wooden digging sticks. Using these tools requires many man hours with limited returns as compared to mechanised agricultural production inputs, and as such contributes to low land and labour productivity. This is against the backdrop of both an increasing population and demand for food, as well as degradation of natural resources, particularly declining soil fertility due to shorter fallow periods. Moreover, insufficient access to farm machinery, its limited use, repair and maintenance, combined with imported machines that are not adapted to local circumstances and with limited R&D in farm machinery, restrict a needed increase in farm productivity.

The inefficient, high-labour input production systems with low returns for farmers formed the premise of the project to improve agricultural productivity in farming communities through farm mechanisation.

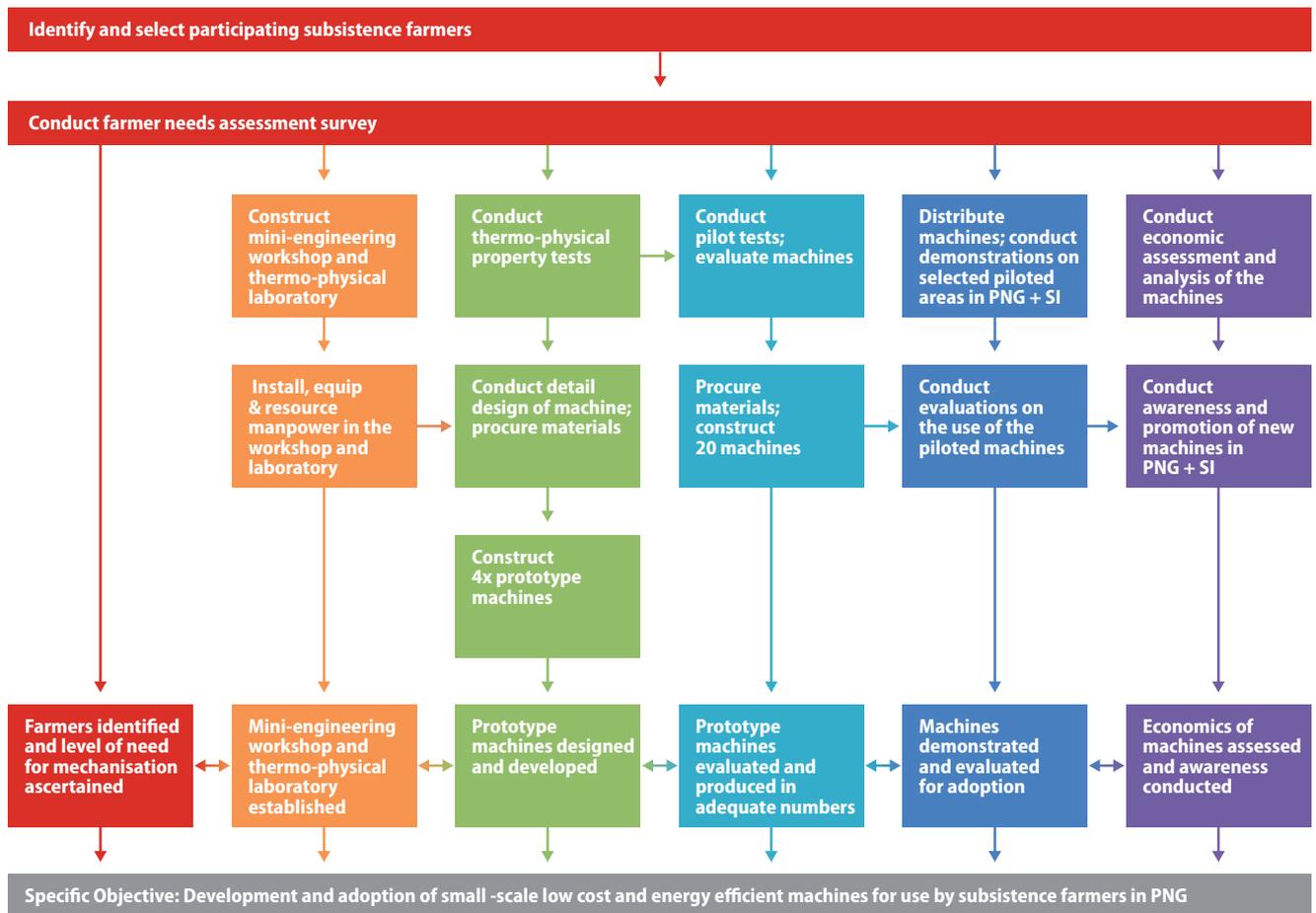
The project sites in Papua New Guinea (Madang, Morobe and Eastern Highland provinces) and the Solomon Islands (Western and Isabel provinces) were selected because of their dominant rice and peanut production and related demand for access to farm machinery. The demand for farm

machinery for other major crops such as sweet potato, taro and banana is low, partly because these crops are not commercially grown as yet. Rice and peanut were introduced in Papua New Guinea nearly 100 years ago by missionaries and European colonisers, but access to machinery, particularly rice mills, has remained one of the major production constraints. Although motorised rice mills were introduced, farmers face continuous breakdowns and difficulties to access spare parts. Rice is not a staple crop, partly because farmers do not get the maximum production output with attractive returns from their limited investments due to the lack of an ideal milling solution. The challenge with milling services has resulted in declining rice production and rice farming being restricted to certain isolated rural communities that use locally invented or traditional milling technologies, such as the wooden 'Kisar' mills.

Baseline surveys to ascertain the understanding and scope of farm mechanisation were followed by the designing and prototype testing of small agricultural machines for smallholder farmers, and farmer training on usage and reproduction. The farmer participatory methodology increased awareness of these machines through farmer field days, videos, print media, social media, radio and agriculture shows.



METHODOLOGY



Several stakeholders with complementary roles collaborated on the project. In Papua New Guinea: an agricultural research institute to design and develop farm machinery, a farm machinery manufacturer, and an NGO that coordinates and supports woman farmer groups in agricultural development. In the Solomon Islands: an NGO that promotes the strengthening of food security and sustainable livelihood development in isolated rural communities, and the Ministry of Agriculture and Livestock to coordinate project activities, reproduce machines developed by the project and facilitate farmer training in the use of the machines.

I Baseline surveys in selected communities in Papua New Guinea and the Solomon Islands. These comprised of farmer interviews and personal observations to elicit information on current farming practices and methods of mechanisation, and identify research needs, in particular on appropriate machinery for rice and peanut processing.

III Design, development and piloting of prototype machines. The machines for rural farmers were designed and developed at the mini-engineering workshop and thermo-physical laboratory at NARI. The prototype machines were designed in a way where materials to building them, particularly the 'Kisar' rice mill and the peanut sheller, are

readily available in the rural communities:

- After development, including a pilot and field test assessments, the prototype machines of the manual rice mill and the manual multi-nut roaster were re-modified or dropped for not being economically or mechanically viable. Hence, the simple 'Kisar' manual rice mill, introduced from Indonesia, was subjected to rice milling tests.
- The development of the peanut sheller was based on the design of the 'Kisar' rice mill and re-modified for shelling peanuts, followed by peanut shelling efficiency tests.
- The solar rice dryer was developed and evaluated through tests on moisture reduction of rice at NARI and at the project sites in Papua New Guinea (the Highlands Agriculture College in Mt. Hagen in the Western Highlands province, and Madang in Madang province).
- The performance of the prototype machines was assessed during piloting in farming communities at the project sites in Papua New Guinea.
- Training-of-trainers through participatory approaches took place on the use and reproduction of the 'Kisar' rice mill, peanut sheller and solar dryer.

II Economic assessment of the prototype machines by collecting data through questionnaires during demonstration of the

machines at the project sites: Garam village in the Markham District in Morobe; Wasab and Karkum villages in the Sumkar District, and the DAL 2 station in Madang; and DAL station in the Eastern Highlands (Papua New Guinea). The survey included interactions with both rice and peanut farmers:

- *Rice solar dryer and 'Kisar' rice mill.* A non-probability (purposeful sampling) technique was used to select samples which allowed only for farmer's trialling the prototype machines to be interviewed.
- *Peanut sheller.* A separate demonstration and interview were conducted for the assessment of the prototype peanut sheller at the Lae main market. This interview was conducted specifically with the peanut sellers who usually sell roasted peanuts.
- *Conventional drying and power mill.* A probability sampling technique was applied using a simple random sampling method to select samples for assessment of this prototype. It was observed that all rice farmers use conventional drying, while only a few farmers have access to motorised rice mills (micro and bigger mills). Hence this method allowed equal representation of both the model and non-model farmers. Model farmers are progressive farmers or champions in rural communities, which were selected to partner in the project.

→ Outputs

Models

- Modified wooden 'Kisar' manual rice mill.
- Modified iron manual peanut sheller.
- Solar rice dryer.
- Winnower basket (developed in Asian countries and promoted to rice growers in Papua New Guinea).



Solar rice dryer



Winnower basket



Kisar rice mill

Models, Solomon Islands (July 2015).

Facilities

- 2 engineering workshops: at NARI (Papua New Guinea) and MAL (Solomon Islands).
- 1 thermo-physical laboratory at NARI (Papua New Guinea).

Capacity building

- 14 farmer training workshops (12 in Papua New Guinea, 2 in the Solomon Islands):
 - 340 Trainers-of-Trainers trained in the development and use of the 'Kisar' rice mill.
 - 57 Trainers-of-Trainers trained in the development and use of the peanut sheller.
 - 68% male and 32% female farmers.

Networking

- Extensive networking with rice growers associations in Eastern Highlands, Madang and Morobe provinces (Papua New Guinea) and Isabel province (Solomon Islands).



Demonstration of peanut sheller at Garam village in Markham, Morobe province, Papua New Guinea (December 2015).



Farmers producing 'Kisar' rice mills at Garam, Markham district, Morobe province, Papua New Guinea (December 2015).

Visibility

- 1 video on the 'Kisar' rice mill to raise awareness and adoption of the simple innovation in rice milling in rural rice growing communities.
- Print media, social media, TV, radio.
- Posters.
- Agriculture shows.
- T-shirts and mugs.



The PNG National newspaper (March 2016).

Documents

- Prototypes evaluation at Highlands Agriculture College (HAC), Kagamuga, Western Highlands Province, Papua New Guinea, April 2015 (NARI Technical Report).
- Farmer participatory video on the production of Kisar rice mill in Papua New Guinea, 2015 (NARI Technical Report, unpublished).
- Smallholder use of farm machinery in communities in Papua New Guinea and Solomon Islands, 2016 (internal NARI report).

Publications

- Engagement of farmers in participatory development of farm machines in Papua New Guinea and Solomon Islands, 2015 (NARI Technical Report; draft for Journal publication).
- Economic assessments on the prototype machines for rice milling and peanut shelling (NARI Internal Report; draft for journal publication).

↑ Outcomes

- 'Kisar' rice mill adopted by 25 rice farmers throughout Papua New Guinea and peanut sheller by 2 peanut farmers in Morobe province.
- Farmer communities made aware of benefits of small-scale farm mechanisation.
- Enhanced technical skills for research technicians in Papua New Guinea and the Solomon Islands in the development of appropriate small-scale farm machines.
- Enhanced farmer learning on simple machine development.

 **Impacts**

Usage

Innovations in farm mechanisation have brought significant social changes in rural communities:

- Farmers in the Markham district, Morobe province (Papua New Guinea) are producing their own ‘Kisar’ rice mill using local construction materials: 15 ‘Kisar’ mills with 3 of them donated to 3 local governments for awareness raising and training.
- Farmers in the Markham district no longer transport rice to mills in Lae. Smallholder rice growing farmers who can save by 80% with less processing costs (transport, milling) will require less labour with the use of the ‘Kisar’ rice mill and increase household income through the sale of rice within farming communities.
- Farmers who owe a ‘Kisar’ rice mill can mill and cook for family consumption.
- Rice that is dried, to correct moisture content, can extend the food storage period.
- Farmers are re-training other farmers in

‘Kisar’ production in various communities in the Markham district and in Madang (Papua New Guinea).

- The use of wood for the construction of the ‘Kisar’ rice mill and the peanut sheller has led to community appreciation of forest conservation, particularly in Wasab village, Madang (Papua New Guinea).
- Improved networking between extension agencies and growers in Papua New Guinea.
- After a decline in rice production in Western and Isabel provinces (Solomon Islands), farmers are now growing rice again and milling using the ‘Kisar’ mill.

Policy implications

- Awareness has been created on the role of small-scale farm mechanisation in agricultural development in Papua New Guinea.
- Recommendations to the National Department of Agriculture and Livestock of Papua New Guinea for more focus on

appropriate farm machinery to increase productivity for food security and household income.

Sustainability

- The participatory research approach will continue to bridge the gaps between research and farming communities – in view of the dysfunctional extension system in Papua New Guinea – and hence enhance the adoption and production of small-scale farm mechanisation tools.
- A new solar-derived rice milling innovation is currently being evaluated on a pilot scale in Morobe province (Papua New Guinea) for commercial rice processing.
- Institutionalisation of farm mechanisation at NARI: follow-up projects such as the solar water harvester (concluded in 2017) and the new solar rice mill.
- MAL in the Solomon Islands has recruited a research technician to reproduce machines and conduct farmer training.

TESTIMONIALS



Andrew Fei, Aronis village, Sumgilbar, Madang Province, Papua New Guinea

Andrew Fei is the model farmer who introduced the ‘Kisar’ rice mill from Indonesia. As a trainer, he trained other farmers. “I have used the ‘Kisar’ rice mill for almost 5 years now and with 10 bags of 50 kg rice, I was able to feed my family from this rice for almost 3 years. I used the ‘Kisar’ rice mill to mill just enough for the day, which has sustained me and my family. While other villagers ran out of food during drought, we have more than enough to eat. In addition, my children do not wait for me or their mother to mill rice; rather it is easy for them to mill their own rice and cook when they are hungry. We have to be self-reliant and the ‘Kisar’ rice mill contributes to self-reliance. Most of the motorised rice mills break down and need spare parts which are difficult to access and the ‘Kisar’ rice mill is the answer since farmers can make these mills from local resources.”



Jasper Kopiridin, Isabel province, Solomon Islands

“Rice was on the decline until the project assisted us to participate in the training workshop on the ‘Kisar’ rice mill. Now there is hope for us. Prior to this project and despite good rice harvests, and since Solomon Islands is a maritime country, it was costly and difficult for farmers and rice co-operatives to transport rice by boats to rice mills in nearby towns. This was the major constraint confronted by rice farmers in rice growing provinces. Our Ministry of Agriculture and Livestock purchased motorised rice mills, but when these machines broke down, we had problems repairing them or there were no spare parts to repair them. This has led to many rice farmers giving up rice production and rice production had been on the decline until the project came to our rescue.”



Doris Awian, Garam, Markham Valley, Morobe Province, Papua New Guinea

Doris Awian, a female rice farmer, showing rice winnowing after milling using the ‘Kisar’ mill at a ‘Kisar’ rice mill training at the Takom Community Resource Centre, Markham Valley, Morobe Province, Papua New Guinea (December 2015). “Travelling long distances to mill rice by local rice farmers in Markham district will be minimised thanks to the introduction of the ‘Kisar’ rice mill into the community. The ‘Kisar’ rice mill training comes at a crucial time when rice farmers have struggled over the years to get their rice to the nearest rice mill in the provincial capital Lae which is costly. The costs incurred include return transport costs, freight changes, and milling charges. We have now been equipped with skills to develop our own ‘Kisar’ mill and the winnower. This farm mechanisation training will translate into positive outcomes and enable us to reap the full benefits from our rice and peanut farms. Now we can grow and mill our own rice.”





ACP Research for Sustainable Development (Caribbean and Pacific)

CASCADE – Climate change adaptation strategies for water resources and human livelihoods in the coastal zones of small island developing states

SUMMARY OF RESULTS

Several tools for planning and managing the use of water resources in Small Island Developing States of the Caribbean were produced:

- A set of individual climate change vulnerability indicators.
- A framework for integrated, multi-hazard vulnerability assessment, coastal mapping, vulnerability analysis of individual threats, and options for strengthening water governance.
- Adaptation strategies for water management.

Stakeholder panels with representatives of public and private decision-making groups, community groups and intermediate groups (water, tourism, agriculture, coastal communities, civil society and private sector) allowed an interactive dialogue on the salient issues in freshwater vulnerability and how climate change and its domino effects need to be handled.



Case study stakeholder panel meeting in St. Vincent (September 2013).

PROJECT IMPLEMENTATION PERIOD

August 2012 - July 2015

CONSORTIUM

- The University of the West Indies (UWI), Trinidad and Tobago
- Centro Euro-Mediterraneo per i Cambiamenti Climatici S.c.a r.l. (CMCC), Italy
- Caribbean Community Climate Change Centre (CCCCC), Belize

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PROJECT WEBSITE

<http://www2.sta.uwi.edu/cascade>

BACKGROUND

With a growing world population, unsustainable practices and inefficient water allocation will intensify water scarcity. Climate change is also placing considerable water constraints on Small Island Developing States (SIDS), particularly in the tourism, agriculture, and coastal community sectors. The UN's Intergovernmental Panel on Climate Change (IPCC) explicitly identifies SIDS as a 'hot-spot' area where climate change effects are present or imminent and where urgent action is required in the water sector. The characteristics of SIDS constrain effective management of water resources, which are dispersed among numerous government agencies. The lack of an integrated and holistic approach to freshwater resource management has led to many conflicts in use and allocation, and ultimately a mismanagement of this critical natural resource.

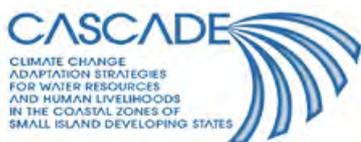
The CASCADE project was designed to facilitate scientific, technological and research infrastructure and related human resource capacity on climate change adaptation in the water and sanitation sector of SIDS. The aim was to reduce human livelihood impacts and advance SIDS towards sustainable development.

The project provided a comprehensive Vulnerability Assessment Framework for the impact of climate change on livelihoods as a

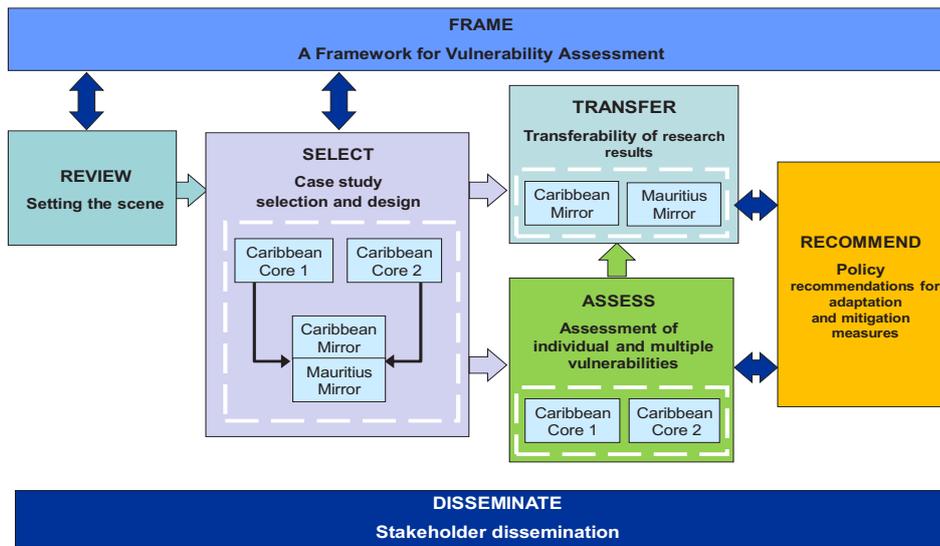
result of changes in freshwater systems. This framework was applied to a series of Caribbean island 'core' case studies (Saint Vincent and the Grenadines, Saint Lucia) where tourism and agriculture play an important economic role. The scaling up and research transferability of these methodologies were tested on other small island 'mirror' case studies (Grenada and Mauritius) by assessing water stress and climate change impacts.

A set of generalised adaptation strategies for water management in SIDS was developed with an emphasis on community-based risk reduction, institutional strengthening, and economic policy instruments for the achievement of water security.

A multi-stakeholder focus on academic public policy and public attention on water related climate change impacts and the necessity of no-regrets adaptation policies were promoted via dialogue among the stakeholders involved in the project: students, researchers, government officials and policy makers. They represented interests in the water sector (Water and Sewerage Authority, regulatory authorities), the relevant ministries (Ministries of the Environment, Public Utilities, Agriculture, Tourism), businesses (mainly tourism and agriculture), coastal communities and civil society.



METHODOLOGY



Review

In order to set the scene for water security and sustainable development in response to climate change in the Caribbean region, a desktop review of past projects on climate adaptation, integrated water resource management, natural hazards, disaster risk reduction, and vulnerability / resilience assessment was conducted. This review formed the base for the case study and policy-oriented research. A theoretical framework for climate change vulnerability was produced. An overview of the impact of climate change on water resources in SIDS provided input into the socio-economic survey of the two core sites.

Frame

A conceptual model of vulnerability – a Sustainable Livelihoods Vulnerability Index – was produced showing the extent to which human livelihoods are at risk through climate change (and other) shocks as well as the inherent adaptive capacity of the socio-economic system to adjust to such shocks. An empirical framework for vulnerability analysis with respect to climate and non-climate risk drivers of freshwater systems in St. Lucia and St. Vincent and the Grenadines, and the impacts of these upon water security and human livelihoods, was also produced (climate scenarios; estimations of exposure to climate impacts, linking drivers and stressors of water security).

Select

Two core case studies (St. Lucia and St. Vincent and the Grenadines) and one mirror case study (Grenada) were prepared. They highlighted the main geographical, demographic and other important features related to the

supply, use and management of fresh water resources. Stakeholder panels were established in the core and mirror sites with representatives of the water sector (the Water and Sewerage Authority, regulatory authorities), the relevant ministries (environment, public utilities, agriculture, tourism) and businesses (mainly tourism and agriculture). The panels facilitated the research work among the communities and the dissemination of findings, as well as contributing to findings and initiating policy initiatives.

Assess

In the core sites, the comprehensive Vulnerability Assessment Framework was applied by mapping the impacts (analysing the vulnerability of threats) from climate-induced changes in freshwater supply and demand, to human livelihood changes, at different levels of spatial and stakeholder scale.

Transfer

The applicability of the research methodology of assessing vulnerabilities was tested on the mirror sites (Grenada and Mauritius), islands with similar conditions.

Recommend

Community-based action plans were developed as adaptation measures in response to water security challenges brought about by climate change. Presentations were made at conferences and a number of papers were also produced. This climate change vulnerability analysis was also used to determine how the strengthening of institutional capacity of water governance agencies and community stakeholders may reduce vulnerability and water security threats. Outputs from the vulnerability assessments and community action plans were used to develop SIDS relevant adaptation strategies.



Case study stakeholder panel meeting in St. Lucia (September 2013).

→ Outputs

Networking

- Stakeholder panels with representatives of public and private decision-making groups, community groups and intermediate groups (water, tourism, agriculture, coastal communities, civil society and private sector) formed a consultation platform on sustainable freshwater management.

Documents

- Project database on climate change.
- Toolkit on Multi-hazard Vulnerability Assessment.
- Livelihood Vulnerability Framework.
- Community and hazard profiles for climate-related threats to the water and sanitation sector.
- Multi-stakeholder adaptation action plans.

Visibility

- Website.
- Facebook page.
- 1 e-newsletter.
- Paper presented to over 200 academics entitled 'Water management issues and vulnerability to climate change in the Caribbean Small Island Developing States' at the EWRA Conference 2013, 26-29/06/2013 Porto, Portugal.
- Papers presented in a special session titled 'Climate Change in Small States II' at the 15th Annual SALISES conference held at the Hyatt Hotel, Port-of Spain, Trinidad, 23-25 April 2014. This conference attracted approximately 150 delegates from more than 12 countries, including France, Germany, Italy and England.
- Project results were presented at an international conference in St Lucia in January 2015, as well as at other conferences in Europe and the Caribbean, notably at the annual SALISES conferences.

Publications

- Mycos M.A., 2017. Beyond 1.5 °C: vulnerabilities and adaptation strategies for Caribbean Small Island Developing States. *Regional Environmental Change*, 13 November 2017, pp 1–13.
- Amadio M. *et al.*, 2014. Multi-hazard assessment of water security in the context of the Caribbean Small Island Developing States. *European Water* 47: 45-54.

Name of project	Website
ACCC	http://www.caricom.org/jsp/projects/macc%20project/accj.jsp
Adaptation measures to Climate Change Impacts on coastal aquifer systems in the Caribbean	http://www.caribbeanclimate.bz/closed-projects/unesco-ihp.html
AIACC	http://www.aiaccproject.org/
CAMI – Caribbean Agro-Meteorological Initiative	http://63.175.159.26/~cimh/cami/
CARIWIN	http://www.mcgill.ca/cariwin/
CCCRA – CARIBSAVE	http://www.caribbeanclimate.bz/closed-projects/2009-2011-the-caribsave-climate-change-risk-atlas-cccra.html
CLIMATEWATER	http://www.climatewater.org/
CPACC	http://www.ima-cpacc.gov.tt/
CREW – Caribbean Regional Fund for Wastewater Management	http://www.gefcrow.org/
Database Management System for a Regional Integrated Observing Network for Environmental Change in the Wider Caribbean	http://www.caribbeanclimate.bz/ongoing-projects/idb-data-management-system-dms.html
ENSURE	www.ensureproject.eu
EPI WATER	http://www.feem-project.net/epiwater/
GEF-IWCAM	http://iwcam.org/
Livelihoods and Climate Change project	http://www.iisd.org/cristaltool/
MACC	http://www.caricom.org/jsp/projects/macc%20project/macc.jsp?menu=projects
MOVE	http://www.move-fp7.eu/index.php?module=main
Planning for Climate Compatible Development in the Caribbean Regional Framework	http://www.caribbeanclimate.bz/ongoing-projects/2009-2021-regional-planing-for-climate-compatible-development-in-the-region.html http://cdkn.org/project/planning-for-climate-compatible-development-in-the-caribbean/
PRECIS-CARIBE (RCM)	http://precis.insmet.cu/eng/Precis-Caribe.htm
REFRESH	http://www.refresh.ucl.ac.uk/
RiVAMP	http://www.unep.org/disastersandconflicts/Introduction/DisasterRiskReduction/RiVamp/tabid/55004/Default.aspx
Saint Lucia – Water Sector Reform: Supply Infrastructure Improvement & Technical Assistance	http://documents.worldbank.org/curated/en/2009/06/10908755/saint-lucia-water-sector-reform-technical-assistance-project
SPACC	http://www.caribbeanclimate.bz/closed-projects/spacc.html
WATCH	http://www.eu-watch.org/links
WATER2ADAPT	http://www.feem-project.net/water2adapt/it/

Websites of interest.

RESULTS

Outcomes

- Improved stakeholder knowledge on the impacts of climate change on freshwater vulnerability in SIDS in the social, economic and environmental domains, and on adaptation and mitigation policies.
- Advanced knowledge in water governance on SIDS.
- The participatory approach between academic research, community and public and private sector allowed knowledge sharing and inclusion of most affected groups (communities) in decision making on freshwater management.

Impacts

Usages

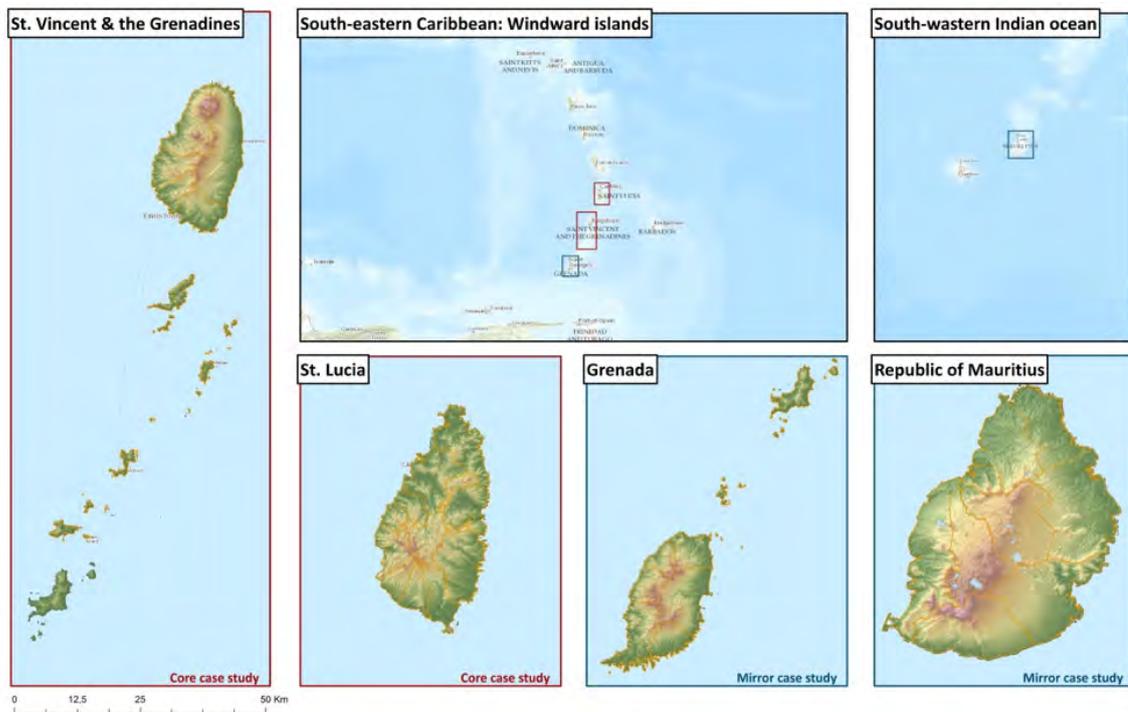
- The knowledge uptake by scientists and members of the policy, water, agricultural and tourism sectors will directly guide their future research work and decision making in freshwater systems on their islands.
- There was considerable outreach to non-direct target groups who through their own networks and other communication channels will disseminate knowledge acquired through CASCADE.
- The Multi-hazard toolkit and other research findings are being utilised in follow-up research work on transforming the freshwater security sector in Caribbean SIDS.

Policy implications

- Project outputs are expected to serve as key methodological and empirical inputs into the development of Integrated Water Resource Management plans in other SIDS.
- The improved knowledge in water governance may initiate inclusive processes to reduce conflicts, apply gained knowledge, and achieve a degree of consensus among water managers and consumers for sustainable freshwater and land use governance.
- Data sharing among key water governance actors is expected to enhance collaborative decision making.

Sustainability

- A flexible portfolio of solutions for sustainable water management that produces benefits regardless of the impacts of climate change ('no-regret' solutions) is recommended. Implementing these solutions adaptively, and step by step, allows policies to evolve progressively.
- Because sustainable land management, particularly in sensitive watersheds and coastal zones, is imperative under the predicted climate change scenarios, strengthening institutional capacity is required to enforce land use planning laws, land use zoning regulations, site development standards and building codes.



Core and mirror case study countries.



ACP Research for Sustainable Development (Caribbean and Pacific)

Improving Caribbean food security in the context of climate change

SUMMARY OF RESULTS

Significant capacity in advanced germplasm management was built and *in vitro* facilities were strengthened. Risk maps for flooding, salinisation and drought for several locations in Barbados, Belize, St. Kitts and Nevis, and Trinidad and Tobago were developed and published, including detailed maps of the agro-ecological zones in these countries. Climate resilient germplasm of sweet potato, maize, cassava, pigeon peas and beans were identified and one germplasm bank of climate-resilient cultivars was established in each country. The banks are used to distribute the climate resilient germplasm to farmers. Genetic fingerprinting was completed for selected sweet potato varieties, providing the region with verifiable evidence of genetic differences / similarities among the various cultivars planted by farmers.



CARDI scientists collecting sweet potato drought trial data, Trinidad (March 2016).

BACKGROUND

CARICOM's food import bill now exceeds USD 4.5 billion and has increased the region's vulnerability to external threats. Overconsumption of highly processed imported foods has also led to the current epidemic of chronic non-communicable diseases (NCDs). These have now become the leading cause of morbidity, low labour productivity and death in the Caribbean. Growing food and nutrition insecurity in the region has been exacerbated by climate variability and change. The current germplasm used by farmers is projected to become less productive as the climate models predict changes towards more extreme dry and wet seasons and stronger storms. This impacts all regional residents but is of particular importance to producers, processors and decision makers.

- Are the identified cultivars genetically distinct? If so, what does that mean for nomenclature among the countries?
- What technical and policy capacity exists in the region to manage climate resilient germplasm and the associated governance systems?
- Will farmers adopt the new germplasm within their farming systems and how will the process of new knowledge dissemination and application be managed?

The project was designed to serve the needs of CARICOM through targeted research in Barbados, St. Kitts and Nevis, Belize, and Trinidad and Tobago, four countries which represent the climate quadrants of the region. The work included: the identification of important food and nutrition security crops; agro-ecological zone characterisation and the development of drought, flooding and salinisation risk maps; field experimentation to identify climate resilient traits among selected cultivars; germplasm management (conservation, sharing and utilisation); capacity building among key stakeholders; and the distribution of climate resilient cultivars to producers.

The critical questions to be answered by this project included:

- Are there distinct agro-ecological zones within the Caribbean that will support varying levels of production from crops that are important to food and nutrition security?
- What are the vulnerabilities of the identified agro-ecological zones to drought, flooding and saline intrusion?
- Can we identify and conserve climate resilient, market acceptable germplasm of the region's important food crops?

The 100+ stakeholders who benefited from the project included farmers' organisations, producers, extension officers, technicians, scientists from the national agricultural research systems and CARDI scientists.

PROJECT IMPLEMENTATION PERIOD

September 2012 - September 2016

CONSORTIUM

- Caribbean Agricultural Research and Development Institute (CARDI), Trinidad and Tobago
- University of Wageningen, the Netherlands

PROJECT CONTACT

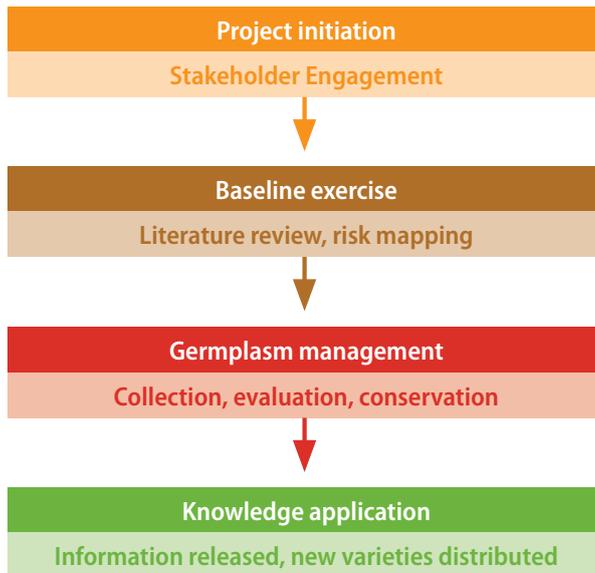
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PROJECT WEBSITE

<http://www.cardi.org/commodities-themes-2/climate-change-for-development/10th-european-development-fund-edf-project-improving-caribbean-food-security-in-the-context-of-climate-change/>



METHODOLOGY



CARDI technician collecting data from a bean drought tolerance trial in Belize (February 2015).

Project initiation

The initial engagement of local stakeholders to discuss the project and to get buy-in was a critical first step which ensured that they understood and had the opportunity to contribute to the project implementation process.

Baseline exercise

A literature review and scoping activity were performed to determine and quantify the edaphic, climatic and socio-economic architecture of the baseline. This consisted of sampling sites in specific agro-ecological zones and conducting interviews with stakeholders living in those areas. Time series climate data were collected and analysed. Agro-ecological data were also collected at various sites in the participating countries and drought, flooding and salinisation risk maps were developed.

Germplasm management

For the development of germplasm banks, searching the databases and collections of the national systems and dialoguing with farmers and other stakeholders enabled the identification of candidate varieties of the food crops important for food and nutrition security (FNS). These included: sweet potato (*Ipomoea batatas*), maize (*Zea mays*), cassava (*Manihot esculenta*), beans (*Phaseolus* spp, *Vigna* spp.) and pigeon peas (*Cajanus cajan*). Some candidate varieties of maize were obtained from Belize and then trialled in Trinidad and Tobago. This was followed by the establishment of replicated trials in the different agro-ecological zones to determine statistical variation. Trials were done primarily to establish drought and flood tolerance and the resulting data were subjected to statistical analysis. Germplasm banks were established in each country to preserve the identified climate resilient cultivars.

Technicians, farmers and extension officers received training in weaning and hardening of tissue culture material, as well as in the establishment and maintenance of germplasm banks. This was done through different means: hands-on regional training sessions in Barbados aimed primarily at technicians; national trainings for farmers and extension officers held in each country; and additional training sessions conducted in collaboration with the Ministries of Agriculture for farmers to build capacity in the cultivation and management of the new germplasm. Two CARDI scientists were also trained at the Centre for Pacific Crops and Trees in Fiji in advanced germplasm management systems.

Knowledge application

For the distribution of selected climate resilient cultivars to farmers, suitable sites were prepared and the germplasm introduced into existing banks. Where banks did not already

exist, new germplasm banks were established. Introduction into existing germplasm banks necessitated their rehabilitation and strengthening, including the provision of irrigation systems to ensure sustainability. Two tissue culture facilities in Barbados and Tobago were strengthened to increase regional *in vitro* capacity to service the requirement for cross-border tissue culture services.

Stakeholders were re-engaged with dialogues on: climate change and its effects on agriculture and FNS, the role that climate resilient germplasm plays in strengthening FNS in a changing climate, the impacts on stakeholders (especially farmers), the responses needed to support agriculture sector resilience, and the need for supporting policy for the entire system. Project validation workshops provided the platform for dialogue and attending farmers were given improved maize germplasm.



Sweet potato drought trial data collection, Longdenville, Central Trinidad (March 2014).

→ Outputs

Data

- Drought, flooding and salinisation risk maps of agro-ecological zones in the Caribbean that represent the major farming areas.
- A crop modelling system that routinely collects data from meteorological stations for use in crop trials. The data more accurately match plant growth and development to measurable ambient conditions.

Crops

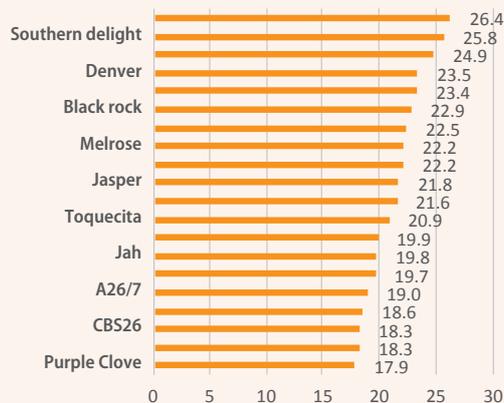
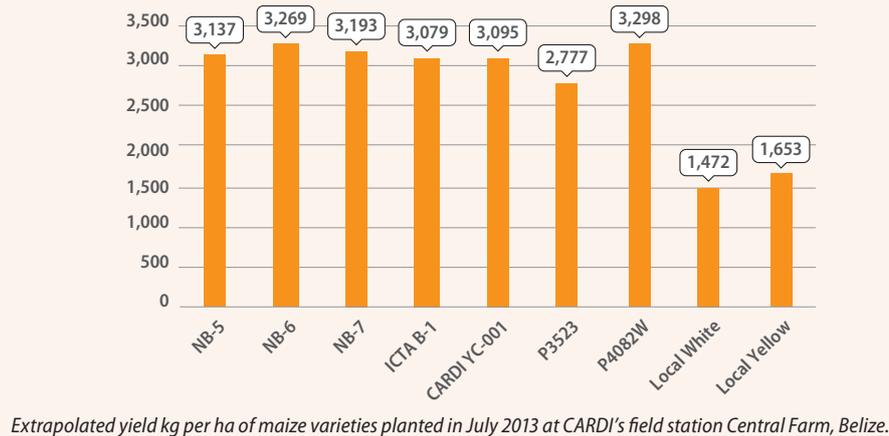
- New cultivars of maize (2 in Belize, 2 in Trinidad and Tobago), sweet potato (5 in Trinidad and Tobago, 2 in St. Kitts and Nevis, 2 in Barbados), pigeon peas (2 in St. Kitts and Nevis), cassava (1 in Barbados) and beans (2 in St. Kitts and Nevis, 2 in Belize) established and provided to farmers to enrich their selection of crops important for food production and climate resilience.
- Corrected identification of sweet potato varieties that have gone by different names in different parts of the region and even in the same country.

Facilities

- 1 germplasm bank of climate resilient cultivars of sweet potato, pigeon peas, maize, beans and cassava – 1 each in Barbados, Belize, St. Kitts and Nevis and 2 in Trinidad and Tobago.
- 2 national *in vitro* laboratories in Barbados and Tobago are equipped to produce, wean and harden tissue culture material for distribution to farmers.

Capacity building

- 3 scientists (1 female) trained in the protocols for germplasm collection for DNA fingerprinting.
- 15 scientists (9 female) trained in crop modelling using the ‘Decision Support



Sweet potato trial in Barbados: mean yields of upper 20 performers (t/ha).

System for Agrotechnology ‘Transfer (DSSAT)’, a software application programme that comprises dynamic crop growth simulation models.

Technical papers

- Evaluation of sweet potato landraces and cultivars for climate change resilience to drought.
- The impact of climate change on different soil types in agricultural risk areas in

various CARICOM countries.

- Evaluation of maize landraces for resistance to drought and high temperatures.

Publication

- Gibson N. *et al.*, 2018. The role of plant genetic resources in building agriculture climate resilience in the Caribbean. Policy Brief. CARDI Publication. CARDI Headquarters, St Augustine, Trinidad and Tobago.

↑ Outcomes

- Widespread recognition among regional policy makers that plant genetic resources (PGR) must play a significant role in building agriculture sector resilience.
- Farmers are more aware of the climate change agenda and its effects on agriculture.
- Farmers and farmers’ associations are pushing for mainstreaming climate-smart agriculture.
- Scientists and technicians are able to establish and run sophisticated germplasm management systems.

- Strengthened links with key regional and national stakeholders, including the Agricultural Society of Trinidad and Tobago, the Barbados Agricultural Society, the West Indies Central Sugarcane Breeding Station in Barbados, the Department of Agriculture in St. Kitts and Nevis, the Ministries of Agriculture in Barbados, Belize, and Trinidad and Tobago, the Tobago House of Assembly, the Caribbean Farmers Network, The University of the West Indies (UWI), the Sugarcane Feeds Centre, the Inter-American Institute

- for Cooperation on Agriculture (IICA) and the Food and Agriculture Organization of the United Nations (FAO).
- Improved capacity of CARDI staff in germplasm management and risk mapping.
- CARDI, WUR and the Ministries of Agriculture in the participating countries have a clearer perception of which localities in Barbados, Belize, St Kitts and Nevis and Trinidad and Tobago are at risk from floods, droughts, salt water intrusion and other environmental hazards relative to crop production.

Impacts

Usage

- Farmers are using germplasm identified during the project and progress is underway towards more widespread adoption.
- The use of climate resilient varieties will: reduce the proportion of wheaten flour in food preparation in the Caribbean (cassava); improve the outcomes of persons suffering from nutrition-related non-communicable diseases (NCDs) (sweet potato); enable foreign exchange savings by reducing imports of this commodity (maize); and improve plant protein nutrition of rural communities (pigeon peas and beans).
- With the planned development of a PGR centre in Guyana and the increased capacity for germplasm management to produce materials for farmers, the expectation is that there will be reductions in food imports and increases in domestic economic activities.

Policy implications

- The CARICOM Council for Trade and Economic Development (COTED) has endorsed the decision by UWI, CARDI and the University of Guyana to develop a regional Climate Smart Agriculture (CSA) training programme for the retooling of agriculture extension officers, other professionals and members of farmers' groups. The programme has been developed and will be taught at UWI.
- The CARICOM Ministers of Agriculture have adopted the resilience agenda that supports sustainable food production

in the context of climate change. Building a climate resilient agriculture sector focusing on the management of key germplasm resources is being recognised as an important feature in safeguarding food and nutrition security. This new thinking is reflected in the following:

- The proposal to make Dominica a Global Agriculture Resilience Centre.
- The decision by CARDI to establish a regional germplasm centre in Guyana to facilitate the conservation, sharing and utilisation of regional germplasm resources.
- The approval by CARICOM Ministers of Agriculture of the CARDI strategic plan 2018-2022 which includes the establishment of a climate resilient food and agriculture system through a robust germplasm management programme.
- The CARICOM strategic plan 2015-2019 that includes environmental resilience building through agriculture.
- Utility of climate resilient germplasm of important food crops for the implementation of the CARICOM Regional Framework for Achieving Development Resilient to Climate Change has been demonstrated. There is now a scientific basis to scale up and scale out these findings and to strengthen the policies that enable the cross-border movement of germplasm within CARICOM.
- CARDI is now a key contributor to the National Climate Outlook Forum (NCOF) organised by the Trinidad and

Tobago Meteorological Services.

- CARDI has adopted a differentiated strategy to serve 14 countries with germplasm investments to strengthen regional food and nutrition security in the context of climate change.

Sustainability

- Continued interactions with farmers have spawned the implementation of a new project in 2017 which uses satellite imagery to rapidly conduct loss assessments on agricultural holdings in at risk Caribbean countries. In this regard, the promotion of new sweet potato germplasm among CARICOM Member States was facilitated by innovation platforms where farmers can influence decision making relative to R&D priority setting for the sweet potato industry.
- The continuation of research into climate-ready food crops will improve food and nutrition security in the Caribbean. The region is now very aware of climate change issues and is ready to support related research, particularly in relation to the new demands for nutrition-rich foods to combat the rise of chronic NCDs as the leading cause of death in the region.
- The enrolment of a young female scientist at Massey University (New Zealand) to read for the PhD in sweet potato breeding, tackling the intersection of climate resilience and nutrition security, particularly considering the epidemic of chronic NCDs in the Caribbean.

TESTIMONIALS



**Jose Antonio Castalleda, farmer,
Valley of Peace, Cayo District, Belize**

“I have been working with CARDI for many years. The maize seeds of improved maize varieties perform better than the traditional seeds I have been planting for many years. The bean seeds I received also performed better. I am very happy to see these results and will continue using them as they provide me a much better income.”



**Ramdeo Boondoo, farmer,
Central Trinidad, Trinidad and Tobago.**

“The project was of great interest particularly because sweet potato and cassava are good for promoting food security and the DNA work is a personal interest. I was proud to see that some of my germplasm was selected for DNA fingerprinting as I am a farmer that practices ‘plant breeding’. As such I was pleased that these selections were chosen for further characterisation work.”



ACP Research for Sustainable
Development (Caribbean and Pacific)

Optimisation of cocoa pollination for increased cocoa yields and income generation



SUMMARY OF RESULTS

Enhanced knowledge was gained on the biology and ecology of cocoa pollination and midge management. Research was conducted in the field and laboratories in Trinidad and Tobago, and Jamaica. A total of 77 persons were trained in pollination biology and midge rearing, suction trap technology and devices, and data collection and analysis. A multi-farm baseline survey enabled the identification of different strains of midges and the separation of those from the main pollinator, in addition to other insects present in the cocoa field. Major achievements included field media manipulation, midge culturing and rearing, synthesis of cocoa floral odours and simulation of adverse weather conditions. An original contribution to the existing body of knowledge was made by documenting the cocoa flower phenology and the complete cocoa crop reproductive cycle.

BACKGROUND

In many Caribbean countries, cocoa bean yields are very low, and the industry is declining in profitability. The Caribbean's interest in further developing the regional fine cocoa industry faced numerous barriers to yield optimisation, including pests and diseases, cultivation methods, rainfall patterns and soil fertility. Finding ways to improve fruit-set and quality in cocoa could be valuable for Caribbean economies and poverty alleviation. In addition, it was essential to establish efficient ways to improve cocoa plantations for biodiversity and sustainability as a future investment in the face of increasing industrialisation of farming practices, diverse crop health threats and climate change. However, from a crop physiological position, the most important limiting factor affecting cocoa yield was pollination.

Pollination in cocoa was still largely not well researched and there was an inadequate understanding of the ecology and biology of cocoa pollination and pollinators. Knowledge and strategies were targeted at individual regions, taking into account local biodiversity and key pollinating species, their interactions with other flora and fauna, and management practices and cultivars of cocoa in use by farmers.

Natural ways to increase pollination have focused on improving the range and number of breeding sites available for pollinating midges. Tree epiphytes and banana pseudo-stem have been shown to provide a suitable habitat for developing midge larvae. There was some evidence that at least some midge species can be reared in laboratory or field stations, but almost no research was conducted on the potential to artificially augment pollinators. A field study suggested that an increased pollinator population (by increasing suitable breeding substrates) can result in higher fruit-set.

The project investigated how to improve cocoa yields through optimal breeding conditions by enhancing pollination, as well as how to make cocoa production more environmentally sustainable and more resilient to the impacts of extreme climatic events and climate variability. The project stakeholders included, among others, cocoa farming groups, cocoa farmers, universities / tertiary institutions, research institutions, government ministries, and cocoa boards. Users of the research results included small-scale farmers using cocoa as one of their most important sources of family income, government ministries and agencies, and research institutions.

Training on cocoa phenology at Centeno, Trinidad
(September 2014).

PROJECT IMPLEMENTATION PERIOD
November 2012 - April 2016

CONSORTIUM

- The University of Trinidad and Tobago (UTT), Trinidad and Tobago
- Natural Resources Institute, University of Greenwich (NRI), United Kingdom
- The Cocoa Industry Board (CIB), Jamaica
- Centre for Agriculture and Biosciences International (CABI), United Kingdom

PROJECT CONTACT

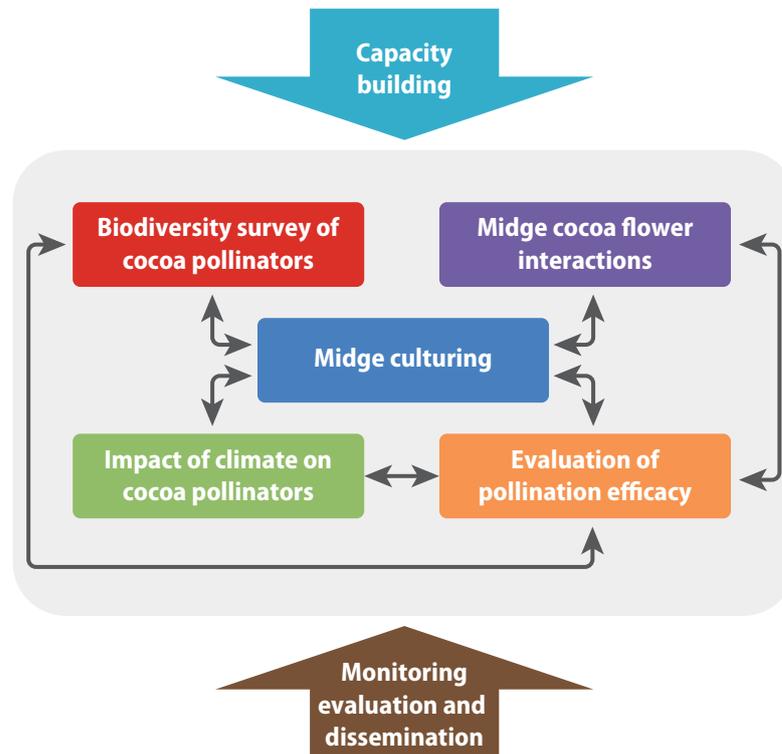
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PROJECT WEBSITE

<http://www.cocoapop.eu>



METHODOLOGY



Capacity building

Farmer meetings and interviews along with field visits were held to establish and build relationships and to select farms on which the baseline surveys were conducted. In preparation for the fieldwork, farmers, farm assistants, field and laboratory assistants and project staff were trained in the use of insect trapping equipment and collection of samples.

Biodiversity survey of cocoa pollinators

Fieldwork included 12-month biodiversity surveys on six estates - two sites per island (Jamaica, Trinidad and Tobago). The collected insect samples were sub-sorted and identified using specially developed protocols.

Selected samples were DNA barcoded and sequenced. DNA extraction processes were optimised to get more reliable DNA from the flies. Usable Cyclooxygenase (COX) sequences for 19-20 Ceratopogonidae (a family of flies known as biting midges) have been obtained. The phylogenetic (or evolutionary) tree is currently not fully resolved, placing some cocoa midges in unexpected relationships to other flies. However, *Forcipomyia* spp. (major pollinators) are all grouped together. Midges from the genus *Dasyhelea*, on which most behavioural work was conducted, showed close relationship.

Midge culturing

Midges were successfully emerged using a culturing technique, and provided with well-rotted leaf litter, rotting fruit and vegetables,



Midge culturing-insectary at UTT Waterloo research campus, Trinidad (October 2015).

a petri dish inoculated with washings from cocoa pods, and kept moist at 26°C. Midges typically emerged for two weeks per month in each culture cage. The cultures were further boosted by an additional 300 reared midges.

Midge cocoa flower interactions

Laboratory behavioural experiments were conducted using a Y-tube olfactometer in which a midge has the choice of two odours (a test odour, such as cocoa flowers, and a control odour, normally the solvent in which the odour compounds are held). The findings showed that three species of cocoa midges were attracted to the natural odours of cocoa flowers. However, the most abundant species in the culture used, *Dasyhelea* cf. *borgmeieri*, was not attracted to a synthetic blend mimicking cocoa flower odour that was developed. This indicated that minor components of the cocoa flower's odour, and not the dominant chemicals, aid midges in finding flowers.

Impact of climate on cocoa pollinators

Midge tolerances were tested under varying environmental conditions to gain life-history parameters, along with evaluation of midge-breeding substrates. Weather variables (rainfall, wind speed, relative humidity and temperature) were simulated with relevant interactions in the insectary to observe mortality and survivability. During the temperature studies, midges were incubated at 45°C in cocoa pod bolus. Samples were monitored every hour for a 12-hour period and then overnight to determine mortality. While the adults were affected, the eggs and larvae were protected in the leaf and pod litter in the soil and withstood the extreme simulated conditions.

Evaluation of pollination efficacy

It was confirmed that there were two distinct flowering cycles, but one major harvest period for Trinidad and Tobago, and two flowering cycles for Jamaica. Cocoa pods and banana pseudo-stems were suitable substrates for midge larvae development. However, cocoa pods substrate improved pods per tree by 50 to 60%.

Monitoring, evaluation and dissemination

Project activities were discussed and findings disseminated throughout visits, stakeholder engagements, meetings and participation in events.

→ Outputs

Toolkits

- 1 set of guidelines for 'Phenology data capture'.
- 1 set of protocols for 'Midge rearing activities'.
- 6 videos of project seminar on cocoa pollination research advances: <https://www.youtube.com/watch?v=LttP2X6L-jco&list=PLRxxXSgFZtXG4tyBNIM-3poaDoECJeXxMU>
- 2 standard operating procedures: 'Insect sampling using suction traps', 'Insect identification on cocoa estates'.
- 1 farmers' bulletin 'Midge nesting sites'.

Infrastructure

- An insectary for midge culturing at the UTT Waterloo research campus (Trinidad).

Capacity building

- 77 individuals (30 students, 9 farmers, 20 researchers, 18 public servants; 49 male, 28 female) trained in the use of insect trapping devices:
 - 32 persons (17 male, 15 female) trained in pollination biology.
 - 2 seminars: Research innovations, Cocoa pollination research advances.
 - 6 workshops: Insect identification (2), Project management (2), Weather station equipment (2).
 - 12 field / laboratory training sessions: Insect trapping (3), Midge culturing (6), Manipulative studies (3).
 - 2 cocoa reproductive phenology courses for field technicians.
 - 4 student field trips to cocoa estates in Trinidad.
 - 1 demonstration of set up and use of equipment and devices used for extraction and collection of cocoa flower odours to staff of the cocoa boards



Demonstration of the use of an insect trapping device in a cocoa field for farmers and Ministry of Agriculture staff in Tobago (March, 2014).

of Jamaica and Trinidad and Tobago, UTT, Ministry of Agriculture and cocoa farmers in Jamaica.

- 1 High Performance Liquid Chromatography (HPLC) training to UTT staff for transfer to local users of HPLC equipment.

Presentations

- 7 research seminars.
- 8 stakeholder meetings.
- 4 conferences.
- 2 agricultural shows – Denbigh (Jamaica).

Visibility

- 2 project brochures, 3 flyers, 2 project posters, 6 activity posters.
- 2 abstracts.
- Project website blog.

- News and media announcements on the UTT website.
- e-Newsletter article of the Caribbean Fine Cocoa Forum (CFCF).

Publications

- Stevenson P.C. *et al.*, 2016. Chemical ecology of cocoa pollination: Presentation to Laboratory Technicians, lab. Trinidad.
- Arnold S.E.J. *et al.*, 2014. Invertebrate diversity and pollinators on Caribbean cocoa estates. Paper presented at the BES/SPE, Lille, France.
- Stevenson P.C. *et al.*, 2015. Pollinator populations, rainfall and diversity on Caribbean cocoa estates. Paper presented at the ENTO'15, Dublin, Ireland.
- Arnold S.E.J. *et al.*, 2016. Insect biodiversity in cocoa estates: Building ecological survey capacity and lessons learned. Paper presented at the International Fine Cocoa Conference, Trinidad.
- Bridgemohan P. *et al.*, 2016. Cocoa floral phenology and pollination: Implications for productivity in Caribbean islands. JHF/23.01.16/0427 – Journal of Plant Breeding and Crop Science.
- Bridgemohan P. *et al.*, 2016. The application of BBCH scale for codification and illustrations of the floral stages of Caribbean fine cacao *Theobroma cacao* L. Journal of Agricultural Science and Technology. 6: 1-10 doi: 10.17265/2161-6256/2016.01.001.
- Arnold S. *et al.*, 2018. The significance of rainfall in the pollinator dynamics of a tropical cocoa agroforestry system. Agriculture, Ecosystems and Environment AGEE : (254) 1–9.
- Arnold S.E.J. *et al.* Specialised flowers of a tropical crop attract a generalised flower visitor using floral odour (*in press*).



Students and employees of the Ministry of Agriculture at an insect identification training workshop in Kingston, Jamaica (May, 2014).

RESULTS



Outcomes

- Increased contribution to the knowledge of cocoa pollination.
- Farmers understand significance of managing leaf / pod litter to create ecological sites for midges to contribute to reproductive cycles.
- Farmers able to build sites for midge nesting.
- Farmers and processors recognise the role of pollinators and how to manage a sustainable environment to increase the midge population.
- R&D agencies understand impact of global warming / climate change on midge biology and pollination.
- Ministry of Agriculture technicians and undergraduates in Jamaica trained in agro-ecological conditions and midge population dynamics on cocoa estates.



Impacts

Usage

- R&D agencies able to transfer the knowledge and techniques in field manipulation to augment midge population.
- The establishment of suitable multiplication sites for midges and substrate manipulation to increase pod / bean yield through increased pollination.
- The cocoa industry can utilise the substrate manipulation technique which can lead to enhanced pollination / fertilisation and increased yield.
- Undergraduates of the College of Agriculture, Science and Education (CASE, Jamaica) created novel cocoa products for the local market.

Policy implications

- Interest in increased farmer training programmes to promote field sanitation and substrate manipulation to enhance pollination.
- The importance of pollination in improving crop productivity should be included in Agricultural Science curriculum of education institutions.
- Across the Caribbean, debate and consensus have been encouraged over best practice guidelines and the need for formal regulatory frameworks regarding habitat protection and biodiversity conservation.
- Two members of the project team sit on the new Cocoa Development Company strategic development committee in Trinidad and Tobago and will contribute to the national cocoa agenda.

Sustainability

- One member of the project team sat on the National Innovation Systems for Competitiveness and Diversification Committee in Trinidad and Tobago which selected cocoa as a priority crop for processing.
- Two large potential producers have shown interest in implementing manipulative augmentation.
- Some innovative farmers have adopted the technology to enhance midge pollination. As these farmers realise the positive impact, more are expected to try the innovative technology.

TESTIMONIALS



**Mr. James Rawle,
Chairman, Cocoa Industry
Board, Jamaica**

“I felt motivated by this project as it involved the diversity that is so important within the region. I am sure there will be fantastic outcomes. Local organisations now need to exploit the work and take action.”



**Jude Lee Sam, cocoa farmer
and estate owner, Couva,
Trinidad**

“Farmers must take responsibility for their cocoa industry and step up. The government invested heavily in free comprehensive education and many previously unavailable resources are now available. Farmers have the skills now and their dependency on government needs to stop. Government is there to facilitate, but farmers must first take up the mantle and take charge of the industry. It was a pleasure to assist and be part of the CocoaPOP project.”



**Mr. Frank Phipps, estate
owner and former CIB
Chairman, St. Mary's,
Jamaica**

“I was anxious to hear about the project. My estate will provide the ideal ecology for the insect sampling and I have agreed to give the CIB access to do the insect sampling supported by my farm staff. It is a great opportunity to be part of this research.”

ACP-EU Co-Operation Programmes in the fields of Higher Education and Science, Technology and Research

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