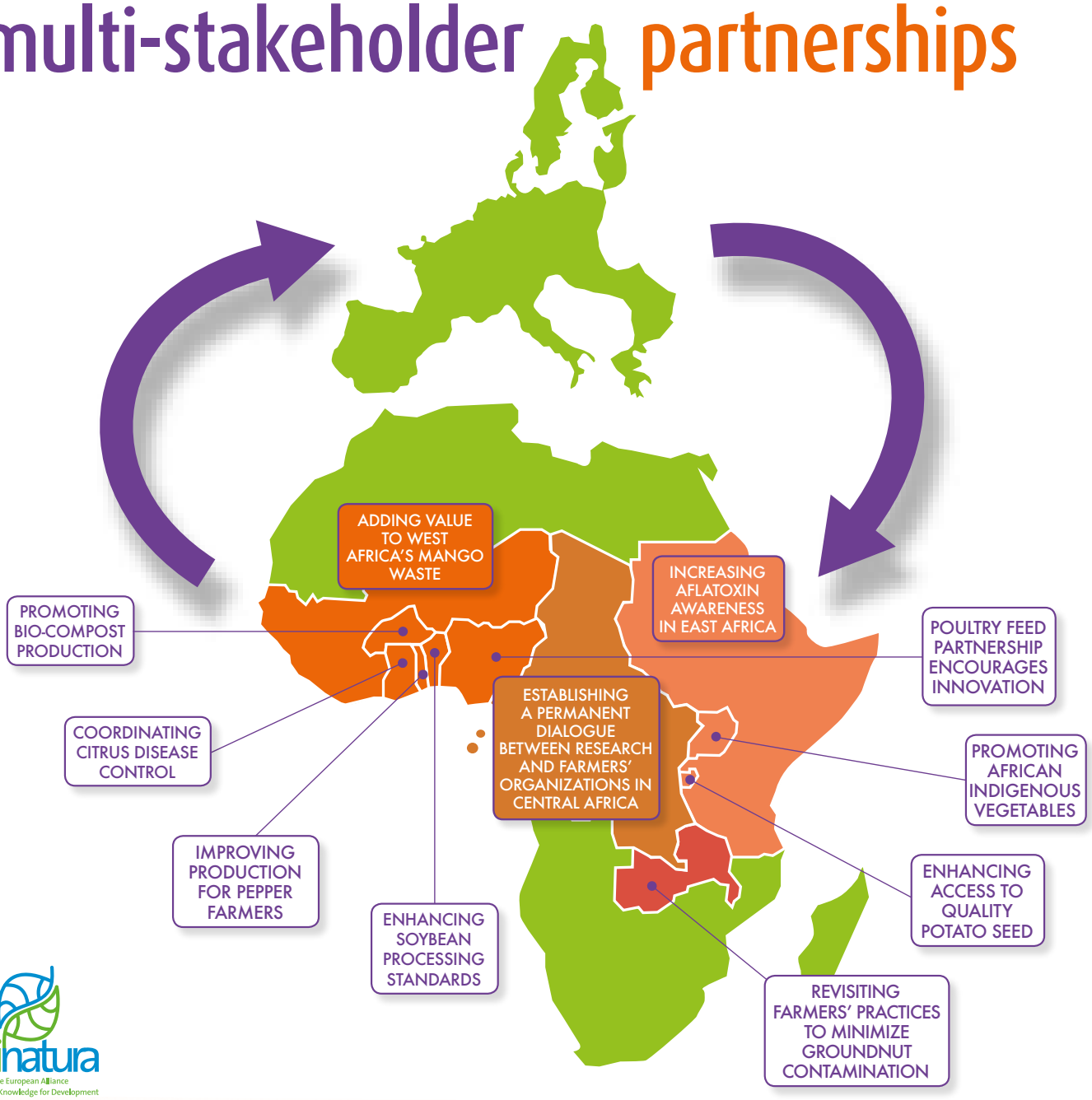
PAEPARD

FARA
Forum for Agricultural Research in Africa

Achievements, challenges and lessons of the PAEPARD multi-stakeholder partnerships



agrinatura
The European Alliance on Agricultural Knowledge for Development

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Agricultural fair visit during the capitalization workshop of all the consortia promoted by PAEPARD, Benin, 2017.

Foreword

For two decades of its existence, the Forum for Agriculture Research in Africa (FARA) has been promoting the Integrated Agricultural Research for Development (IAR4D) concept in which all stakeholders starting by farmers through private sector, non-governmental organizations, policy makers to researchers, work together to achieve innovation and impact harnessing the power of science, technology and indigenous knowledge. This concept marks the shift from the long-term linear construct which focused on technology generation.

To operationalize this shift, FARA has hosted a series of flagship projects that cut across the sub-Saharan African continent. One of these projects is PAEPARD that FARA and AGRINATURA had the privilege of implementing in collaboration with other African and European partner institutions. For twelve years, PAEPARD fostered the IAR4D concept under the multi-stakeholder partnerships (MSP) approach which matured into the users-led process (ULP). The MSP-ULP promoted by PAEPARD brings together all stakeholders in the research-to-impact process including farmers and entrepreneurs, researchers and extensionists, academia and policy making. This inclusiveness ensures that research addresses the needs of the end users, its outputs are demand driven and its outcomes have an impact. At the same it offers end-users and intermediate actors the forum to contribute their knowledge and feed into the research process any changes in their context.

PAEPARD has been known for its specific strong communication character reaching out to ARD stakeholders across the world with different information on funding opportunities, scholarships, resources and upcoming events, among others. It has also produced and shared with stakeholders different publications documenting its internal processes.

We are very pleased that PAEPARD has documented in this book, experiences from the diversity of case studies conducted from ULP, consortia, CRF funded projects, distributed from different agro-ecologies and contexts of sub-Saharan Africa. We have no doubt the book will add to the current knowledge and inform the methodologies to be applied in leveraging science, technology and innovation to drive the continent's agricultural transformation.

Our hope is that this book which is written in a common-man language will be largely disseminated through PAEPARD Dgroup and other FARA and AGRINATURA's channels to reach as many as possible farmers, practitioners and researchers to improve their mind-sets, practices and processes to Agricultural Research for Development. This will help to achieve the desired African agriculture transformation.

Both FARA and AGRINATURA are much thankful to the Directorate General for International Development and Cooperation (DevCo) of the European Commission for the long-term financial support without which PAEPARD could not have achieved such tremendous results and gained such an audience. We are particularly humbled by the fact that the Users-Led Process (ULP) developed and implemented by PAEPARD is feeding the new funding mechanism called the Development Smart Innovations through Research in Agriculture (DeSIRA) recently set up by DevCo.

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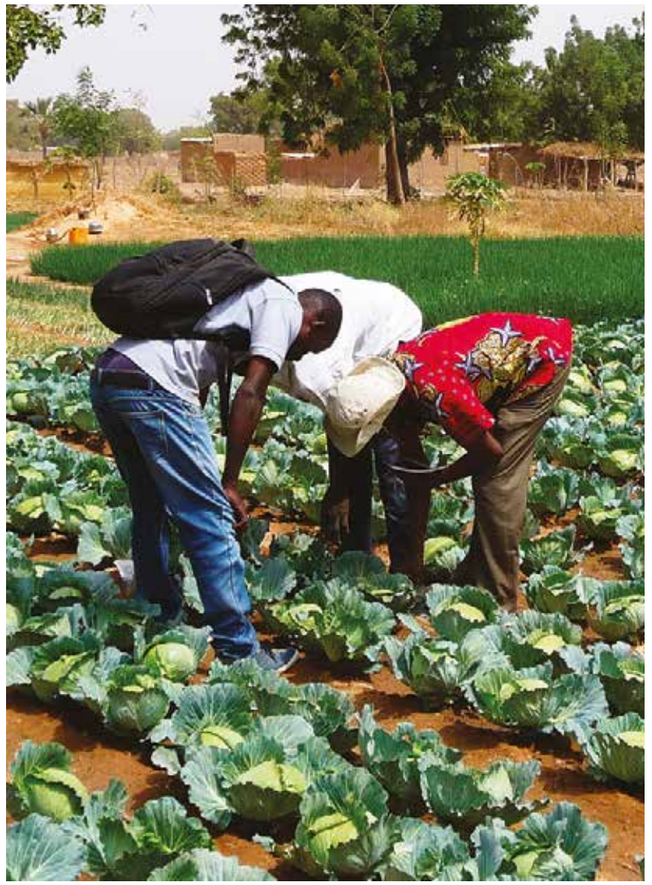
list of acronyms

ACP: African, Caribbean and Pacific
AFLANET/AFLAZ: The aflatoxin networking project in Kenya
AIF: Agricultural innovation facilitators
AIV: African indigenous vegetables
ARD: Agricultural research for development
ARFA: Association pour la Recherche et la Formation en Agroécologie
ASARECA: Association for Strengthening Agricultural Research in Eastern and Central Africa
AU: African Union
BMEL: The German Federal Ministry for Food and Agriculture
CAAPP: Central Africa Agricultural Productivity Program
CAPAD: Confédération des Associations des Producteurs Agricoles pour le Développement
CASADD-VR: Centre d'Action pour la Sécurité Alimentaire le Développement Durable et la Valorisation des Ressources
CIGMAG: Citrus Growers and Marketing Association of Ghana
CIRAD: Centre de coopération internationale en recherche agronomique pour le développement
CNOP-CAM: Concertation Nationale des Organisations Paysannes du Cameroun
COLEACP: *Comité de Liaison Europe-Afrique-Caraïbe-Pacifique pour la promotion des exportations horticoles*
CRF: Competitive Research Fund
CSB: Consortium Soja du Bénin
DARS: Department of Agricultural Research Services
DRC: Democratic Republic of Congo
EAFF: Eastern Africa Farmers' Federation
EMBRAPA: Brazilian Agricultural Research Corporation
EPFC: Eastern Province Farmers' Cooperatives
EU: European Union
FAN: Feedmillers Association of Nigeria
FANRPAN: Food Agriculture Natural Resources Policy Analysis Network
FAO: The Food and Agriculture Organization
FARA: Forum for Agricultural Research in Africa
FIRCA: Fonds Interprofessionnel de la Recherche et du Conseil Agricole
FUPRO: Fédération des Unions des Producteurs du Bénin
GAP: Good agricultural practices
GIZ: Deutsche Gesellschaft für Internationale Zusammenarbeit
GnVC: Groundnut value chain
ICRISAT: The International Crops Research Institute for the Semi-Arid Tropics
IF: Incentive Fund
INERA: Institut de l'Environnement et de Recherches Agricoles
INPH-B: Institut national polytechnique Félix Houphouët-Boigny
INRAB: Institut National des Recherches Agricoles du Bénin
IP: Innovation platforms
IRD: Institut de recherche pour le développement
ISABU: Institut des Sciences Agronomiques du Burundi
ISA-Lisboa: Instituto Superior de Agronomia - Universidade de Lisboa
KALRO: Kenya Agricultural and Livestock Research Organization
MRI: Max Rubner-Institut
MSP: Multi-stakeholder partnerships
NASFAM: The National Smallholder Farmers' Association of Malawi
NGO: Non-governmental organization
NIPOFERD: The Nigerian Poultry Feeds Research and Development
NRI: Natural Resources Institute, University of Greenwich
NWO/WOTRO: The Netherlands Organisation for Scientific Research
ODECO: Organisation du développement, des études, de la formation et du conseil au Cameroun
OSIRIS: Online System to Improve Relationships by Information Sharing
PACA: Partnership for Aflatoxin Control in Africa
PAEPARD: The Platform for African-European Partnership in Agricultural Research for Development
PAN: Poultry Association of Nigeria
PLFS: *Pseudocercospora* leaf and fruit spot
PROPAC: Plateforme Régionale des Organisations Paysannes de l'Afrique Centrale
ProSAM: Re-engineered soybean Afitin and soybean milk processing technologies in South and Central Benin
ROPPA: Réseau des Organisations Paysannes et des Producteurs de l'Afrique de l'Ouest
SOJAGNON: Association for the Development of Soybean in Benin
SSA: Sub-Saharan Africa
UAC/FSA/LSA: Université d'Abomey-Calavi, Faculté des Sciences Agronomiques – Laboratoire des Sciences des Aliments
UCP – Zogbodomey: Union Communale des Producteurs de Zogbodomey
ULP: Users-led process
WAAPP: West Africa Agricultural Productivity Program
WHO: The World Health Organization
WUR/FQD: Wageningen University & Research/Food Quality and Design



The farmer's field as the place for multi-stakeholder partnership. Burkina Faso, 2017.

Introduction

Launched in April 2007, the Platform for African-European Partnership in Agricultural Research for Development (PAEPARD) aimed at building an African-European platform for mutual learning and knowledge sharing. At the end of the initial phase of PAEPARD in September 2008, the platform observed that, within the existing African-European partnerships for agricultural research and development (ARD), the research agenda was, in most cases, defined by European researchers. Based on this observation and learning from its probable causes, a second phase of PAEPARD was established in December 2009 with the specific objective to foster "enhanced, more equitable, more demand-driven and mutually beneficial collaboration between Africa and Europe for ARD with the aim of attaining the Millennium Development Goals," now the Sustainable Development Goals. Through this paradigm shift, PAEPARD II succeeded in involving non-research actors, such as farmers, the private sector and NGO in Africa and Europe who, in collaboration with researchers, would define the research needs and, at the same time, drive the research agenda.

To achieve the above objective and to nurture African-European multi-stakeholder partnerships (MSP), PAEPARD launched two open calls, which resulted in the formation of over 150 multi-stakeholder consortia around common innovation challenges between African and European ARD stakeholders.

However, research users involved in PAEPARD – mainly farmer organizations – criticized the formation of MSP in this way – stating that, because the MSP were driven by the requirements of the 'calls', their research would be too 'top down' and would not give all actors sufficient time to come together and reflect on the local challenges.

To address this issue, PAEPARD designed a brokerage mechanism that would enable the MSP research outputs to be led by the intended end users. The mechanism, which gave a more prominent role to research users in defining the ARD agenda, was named the 'Users-Led Process' (ULP).

To operationalize the ULP concept, five PAEPARD research user partners each formed a regional partnership and engaged in the process around the following five value chains:

- **Eastern Africa Farmers' Federation (EAFF):** *Extensive Livestock value chains in Eastern Africa (Kenya, Uganda).*
- **Plateforme Régionale des Organisations Paysannes de l'Afrique Centrale (PROPAC)**: *Urban horticulture crops value chain in central Africa (Congo, DR Congo, Cameroon).*
- **Réseau des Organisations Paysannes et des Producteurs de l'Afrique de l'Ouest (ROPPA)**: *Rice value chain in Benin, Burkina Faso and Mali.*
- **Food Agriculture Natural Resources Policy Analysis Network (FANRPAN)**: *Groundnut value chain in Zambia and Malawi.*
- **Comité de Liaison Europe-Afrique-Caraïbe-Pacifique pour la promotion des exportations horticoles (COLEACP)**: *Adding value to Mango non-food uses in West Africa (Burkina-Faso, Côte d'Ivoire, Senegal).*

The five partners have been engaged in the ULP since 2012, alongside researchers, NGO, the private sector and policy makers. The objective of their involvement was to mobilize more partners and funding around 'federating themes' identified through national and regional dialogues, with the ultimate aim of establishing a framework of permanent dialogue that would continue after PAEPARD.

At the mid-term review of PAEPARD in 2012, it was recommended that an internal funding mechanism be established and made accessible by consortia through competition. The Competitive Research Fund (CRF) was operationalized with the financial support of the European Commission. The fund was tested alongside a more flexible and operational approach to help consortia organize inception workshops, conduct studies specific to their needs, and organize write shops for proposal development.

In 2014, a call was launched to the 19 consortia selected through the two open calls and to the five ULP mentioned above to select the MSP that would receive funding through the CRF. The four proposals selected through an external and independent selection process were:

- *Stemming aflatoxin pre- and post-harvest waste in the groundnut value chain in Malawi and Zambia to improve food and nutrition security in smallholder farming families* **(GnVC). *Malawi and Zambia***
- *Testing organic fertilizers enriched with local Trichoderma sp. applied to vegetable crops in the sub-Saharan area* ***(Trichoderma). Burkina Faso***
- *Re-engineered Soybean Afitin and Soybean Milk processing technologies in South and Central Benin* **(ProSAM). *Benin***
- *Enhancing nutrition security and incomes through adding value to African indigenous vegetables in East and Central Uganda* **(AIV). *Uganda***

At the end of PAEPARD II, seed money from the CRF allowed the four consortia to mobilize more funding and new partnerships. In parallel to the CRF, other MSP consortia benefitted from an Incentive Fund (IF), which provided financial support for consortia to initiate new partnerships and strengthen their capacities, particularly in the development of concept notes through inception workshops, write shops and exchange visits between partners.

MSP bring together partners from varying backgrounds, with different capacities and perspectives. The continued strengthening of partner capacities is a key feature of PAEPARD consortia and relates to project management; proposal development; the ability to conduct advocacy activities – for instance, to influence policies; and the ability to secure project funding. In order to assist consortia in achieving the latter, PAEPARD organized write shops to enable the MSP to respond to research calls. This strategy paid off and, by the end of PAEPARD II, partners who benefitted directly and/or indirectly from this capacity building raised over US$45 million.

As part of the capacity strengthening, communication by each consortium was facilitated by PAEPARD for sustained partner engagement, commitment and visibility. From 2014, a communication strategy of PAEPARD II was developed, which consisted of a diverse set of tools (internet and intranet websites, d-group, blogs and social media) to stimulate ownership over PAEPARD activities and facilitate the engagement of different stakeholders.

From consortia formation through to ULP development and the implementation of CRF and IF, each PAEPARD MSP has followed their own route and learned from experiences according to their specific context, with some consortia paths crossing-over. This evolution was reported during the PAEPARD capitalization workshop that took place in Cotonou, Benin during 2–6 October 2017, to draw on and share lessons learned from different consortia.

This book, which closes PAEPARD publications, intends to gather in a systematic way, different PAEPARD experiences with an emphasis on achievements, challenges and lessons learned, as well as an examination of the way forward and sustainability of the consortia – through stories told by themselves. The lessons learned can be adapted and adopted by other stakeholders and up-/out-scaled to create greater impacts for the intended users. Not all PAEPARD-facilitated consortia could be documented in the book, but information regarding all MSP can be freely accessed through the PAEPARD website (www.paepard.org).

This book documents case studies from the four CRF-supported projects, three ULP (EAFF-livestock, PROPAC-Urban Horticulture, COLEACP-Mango waste); and four consortia (Angular Leaf Spot on citrus in Ghana, quality seeds of potatoes in Burundi, Poultry feed in Nigeria and Pepper in Togo). These case studies cover different commodities, agro-ecologies, geographies and contexts, and therefore inspire lessons that can be exchanged across the entire sub-Saharan Africa region.

The two final products innovated by ProSAM in Benin, stabilized soya milk and soya-based afitin called Dadonu.

Enhancing soybean processing standards in Benin

INTRODUCTION

In Benin, 23% of the population is estimated to be nutritionally insecure. Meat is generally not affordable or accessible to many poor people, especially in rural areas. Improving the production and processing of vegetable proteins such as soybean, cowpea and moringa, which the majority of the population already consume daily, is key for achieving nutritional security.

After the decline in cotton production in the 2000s, soybean was promoted as an alternative crop for oil production. This effort was led by private companies, farmer organizations and NGO through external funding from donors, which created awareness of the potential opportunities in the production and utilization of soybean. As a result, soybean processing employs an increasing number of people in the country, particularly women.

Several useful end-products are derived from soybean, including soybean milk, cheese, cookies, infant foods and *'Afitin'*. The latter is a condiment traditionally obtained from *Parkia biglobosa* (African locust bean) seeds, but is now increasingly processed partly or entirely from soybean due to the increasing pressure on the African locust bean supply market. However, soybean processing has been constrained by the low productivity of processing units and lack of standardized processes, which results in lower quality soybean milk and *Afitin.*

In order to address the constraints related to soybean processing in Benin, a multi-stakeholder platform, known as *Consortium Soja du Bénin* (CSB), was set up to create an enabling environment for public-private partnership in soybean value chains. In 2014, CSB won a grant to implement a 3-year project, *Re-engineered soybean Afitin and soybean milk processing technologies in South and Central Benin* (ProSAM). Specifically, the project aimed to address the low shelf life of soybean milk, which did not last more than 24 hours at room temperature due to the poor quality of the product. With such a short shelf life, consumers were reluctant to buy soybean *Afitin* or milk and the labor-intensive processing of soybean products did not seem worthwhile.

In 2013, a soybean regional forum in Bohicon, Benin – organized by Alliance Soja (a partnership between four NGO) – that involved a range of soybean

stakeholders, including farmers, processors, extension services, researchers and NGO, revealed the low productivity and quality of processed soybean foods and low market demand for such products. The forum also pointed to the low technical support soybean processors received, and underlined the lack of cooperation between researchers and processors that constrained the emergence of solutions adapted to the challenges encountered by the processors. In addition, through their organization, *Union Communale des Producteurs de Zogbodomey* (UCP – Zogbodomey), soybean processors clearly indicated the strong need for methods to stabilize soybean milk and soybean *Afitin* in order to extend their shelf life.

CSB was initially composed of SOJAGNON (Association for the Development of Soybean in Benin), *Société des Huileries du Bénin, Institut National des Recherches Agricoles du Bénin* (INRAB) and *FC Agro-industriel France* (Agboton *et al.,* 2018). The consortium members channelled their combined efforts into strengthening soybean value chains because of the strategic importance of this crop economically and nutritionally. The consortium focused on the improvement of soybean value chains in order to produce good quality soybean-derived products available at affordable prices for the Benin population.

The composition of the consortium is dynamic and the required expertise have been mobilized to develop and implement projects. Thus, in response to the PAEPARD II CRF call for proposals, the consortium was composed of SOJAGNON, *Fédération des Unions des Producteurs du Bénin* (FUPRO), INRAB, *Université d' Abomey-Calavi, Faculté des Sciences Agronomiques - Laboratoire des Sciences des Aliments* (UAC/FSA/LSA), *Instituto Superior de Agronomia - Universidade de Lisboa* (ISA-Lisboa) in Portugal, and Wageningen University & Research/Food Quality and Design (WUR/FQD).

> Activities and achievements

SOJAGNON coordinated ProSAM and was in charge of overall project management, monitoring and evaluation, internal and external communication, and dissemination of project results. The NGO works with farmers' and processors' associations in Benin, by promoting innovation along the agricultural food chain in general, and specifically focuses on the soybean value chain through partnerships with the public and private sector. SOJAGNON organized stakeholder platforms for participatory discussions and surveys, trained its members on farming and processing techniques and facilitated the marketing of soybean products. Soybean processors were identified and mobilized by SOJAGNON to assess the challenges linked to the use of traditional processing technology. Women processors expressed their constraints relating to low productivity and poor product quality, and were linked-up with researchers to develop appropriate and improved processing technologies and products.

As part of ProSAM, FUPRO – the national federation of farmers' unions (which includes processors' unions) – was in charge of mobilizing its members to participate at every stage of the development, validation and dissemination of soybean processing technologies. However, the initial momentum was not maintained and FUPRO's involvement in project activities was marginal.

INRAB, with its extensive experience in food technology and mechanical engineering, was responsible for the development of improved processing technology for soybean milk. INRAB worked closely with processors and ISA-Lisboa to stabilize soybean milk, which was a major constraint for processors, and carried out physico-chemical analyses on the stabilized milk to check its quality. A technical manual on the production of stabilized milk was also developed.

Improvement of soybean *Afitin* processing technologies as initially stated in the objective was adjusted in the course of the project. The adjustment was made to match processors' capacity with consumers' demand. Thus, a new soybean-based product, *'Dadonu'*, was formulated, based on soybean *Afitin*-processing technologies. *Dadonu* is a taste enhancer formulated in powder form, which can be stored longer than soybean *Afitin* and has higher commercial potential. As soybean *Afitin* is not particularly well-liked by consumers, the name *Dadonu* was suggested by processors to avoid confusion and enhance its marketing potential.

UAC/FSA/LSA, a public university, led the development of *Dadonu* with support from WUR/FQD, a higher education and research center based in the Netherlands. WUR/FQD carried out consumer preference assessments and integrated these preferences in the product design.

ProSAM carried out four main activities:

- an inventory of existing soybean processing technologies;
- an assessment and documentation of the nutritional value, safety and microbial composition, and consumer preference of soybean milk and soybean *Afitin;*
- the development and adaptation of soybean milk and soybean *Afitin* processing technologies; and,

Products derived from old and new soybean processing technologies.

- capacity building of soybean processors on the improved processing technologies and dissemination of the project's outputs to actors involved in soybean value chains and policy makers.

SOJAGNON also developed a communication strategy for the consortium through the dissemination of informative material (flyers on soybean-derived products, illustrated technical sheets on production of soybean cheese) and organization of promotional tools and events (local and national exhibitions and fairs, radio and TV interviews, social media). The NGO has increased the consortium's national and international exposure and recognition by facilitating relations with public authorities in Benin and the Ministries of Education and Agriculture, as well as the European Union.

The Benin soybean consortium aimed to co-innovate improved and sustainable technologies for the production of high-quality soybean products. Through ProSAM, the consortium has improved soybean milk processing technology. Soybean milk has been stabilized and its shelf life has been extended to at least 6 months under room temperature, compared to just 24 hours when the milk is processed using traditional technologies (Figure 1). This has been a great relief for the processors, as the extended shelf life increases the market value of their soybean products and they can now preserve them more easily over a longer period of time.

Several actors are benefiting from the improvement of soybean processing technologies. The main beneficiaries of the ProSAM project are women processors living in six rural soybean production areas – the municipalities of Abomey-Calavi, Aplahoue, Bohicon, Bonou, Glazoué, Zogbodomey – who were trained in new processing techniques and hygiene practices. In total, 97 soybean entrepreneurs were trained to process stabilized soybean milk. In addition, 12 women cooperatives received training in other processing technologies to relay to their 1,500 members.

Technical support in terms of training and the provision of basic equipment (for example, a stainless steel pressure steam autoclave and mill for milk production in Zogbodomey and a dryer for *Dadonu* production in Saclo, Bohicon) has rekindled the interest of processors in soybean products and has increased their production along with the quality of soybean products. The soybean processors reported that, with the advent of new processing technologies, they had tripled their production over 3 months. Production of stabilized milk and *Dadonu* are profitable. A profitability analysis showed that processors have a net profit of 247.92 francs CFA ($0.43) per kilogram and 408.2 francs CFA ($0.71) per liter for *Dadonu* and milk, respectively.

A partnership with the Dutch-funded 2Scale program and *Coopérative de Transformation, d'Approvisionnement et d'Écoulement de Soja* – a farmers' cooperative in Benin – was established in April 2015 to develop an additional soybean by-product that can be consumed in a sauce: soya *'goussi'*. Soya *goussi* tastes almost identical to traditional *goussi* (made from *Citrullus sp.*), but it is more nutritious, more profitable and far less labor-intensive to produce. Together with farmers, 2Scale developed marketing activities to increase soya *goussi* sales, which involved creating attractive packaging, promotional messages for radio and print, and organizing sessions where people could test the food. In less than 2 years, soya *goussi* has become the main source of protein for at least 11,000 families in southern Benin.

In 2018, based on the ProSAM outputs, the consortium established a partnership with a German development agency-funded project, Agricultural Technical Vocational Education and training. The aim of the partnership was to extend the dissemination of ProSAM results in the municipalities of Glazoué, Azovè, Djougou, Kouandé, Zogdodomey, and Abomey-Calavi in Benin. Ninety processors were reached through training workshops organized under the new partnership in June 2018.

> Challenges and lessons

The main factors that led to ProSAM's success were:

. The commitment of the partners to drive change in the soybean value chain by tackling major constraints faced by actors, especially processors;

. The early involvement of end users, especially processors. In addition, engagement with women processors in the consortium enabled researchers to simplify scientific information so that it was user friendly and met the women's needs;

. Involving many partners in a research and development project requires good coordination mechanisms and so the establishment of a consortium agreement, which defined fund allocation, key responsibilities of each partner, and was signed by all the partners and sent to the funder, was essential as it served as a guideline for governance and fund disbursement;

. The expertise and complementarity of the partners involved in the consortium. All partners brought their long-standing experiences in multi-stakeholder partnerships and their technical know-how in addressing the identified challenges into the consortium. Complementarity between the partners avoided duplication and helped in efficient fund allocation;

. Good internal communication enabled the partners to discuss challenges and the progress of their work, which was driven by SOJAGNON. External communication was also important to better expose the project's achievements to the public at national and international levels;

. Organization of workshops to validate research outputs with processors enabled researchers to refine their research in order to meet the beneficiaries' needs.

Another key element of success was collaboration with European partners. For example, ISA-Lisboa set up the research agenda relating to soybean milk in close collaboration with INRAB, and participated in field and exchange visits in Benin. In collaboration with UAC/FSA/LSA, WUR/FQD defined detailed research methodologies and an action plan for the improvement of *Afitin.* WUR/FQD also contributed to a nutritional and microbial quality assessment of *Afitin* (traditional and reengineered) by offering laboratory facilities to UAC/FSA/LSA staff for analyses. Moreover, WUR/FQD participated in exchange visits in Benin, whilst partners from Benin also had some exchange visits to the Netherlands.

Although involving European ARD organizations and researchers remains a challenge, it was not too complicated for UAC/FSA/LSA to involve WUR/FQD as both institutions have been collaborating for over 30 years. This long-standing collaboration contributed to the success of the *Dadonu* formulation process and strengthened the existing research relationship.

> Looking ahead and sustainability

CSB benefited from many capacity building workshops through PAEPARD, the Regional Universities Forum for Capacity Building in Agriculture, NWO/WOTRO (a Dutch funding agency) and the International Centre for Development Oriented Research in Agriculture. From 2012 to 2018, PAEPARD and its partners funded several proposal write shops. As a result of the training and capacity building, CSB is now able to respond to new funding opportunities. The consortium has already successfully received a grant from NWO/WOTRO for its proposal on *Enhancing Kersting's groundnut (Macrotyloma geocarpum) production and marketability in Benin* (Projet Doyiwé).

SOJAGNON, INRAB and UAC/FSA/LSA have also won an 18-month grant of US$54,505.77 from the West Africa Agricultural Productivity Program, with support from a new partner, *Direction de la Qualité des Innovations et la Formation Entrepreneuriale,* to out-scale ProSAM outputs across the major soybean growing areas in the country.

The consortium interventions and especially the outputs of ProSAM, have served as a basis for advocacy for better inclusion of soybean in Benin's Ministry of Agriculture, Husbandry and Fishery policy. This is exemplified by the inclusion of soybean as a strategic crop in the *Plan National d'Investissements Agricoles et de Sécurité Alimentaire et Nutritionnelle de seconde génération* (PNIASAN, 2017–2021), (Agboton *et al.,* 2018; Houssou *et al.,* 2018). The inclusion of soybean in this strategic plan for agricultural investment, food and nutritional security will promote further investment in the development of soybean value chains.

FOR MORE INFORMATION

https://paepard.org/?SojagnoN

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Farmer's field trials were used by the consortium to convince vegetable producers about innovative practices such as using enriched compost with local strains of Trichoderma.

Promoting bio-compost production in Burkina Faso

INTRODUCTION

Desertification, the overuse of chemical pesticides, increased human population density and climate change have led to continued soil degradation in sub-Saharan Africa (SSA). This trend places increased pressure on fertile lands to produce sufficient food for the growing population of SSA. To reverse soil degradation, the use of organic matter must be encouraged and the availability and affordability of quality biofertilizers improved.

For a long time, farmers have used composting as a technique to improve the quality of organic inputs, to maintain soil fertility and to provide essential nutrients for crop production. Living organisms in the soil (e.g. soil fauna, micro-organisms) produce organic compost naturally, but additional organic inputs can be added to the soil to stimulate micro-organism activity and speed up the composting process. For example, *Trichoderma sp.* is a naturally abundant soil fungus, which has been proven to accelerate the breakdown of organic matter into compost and improve the structure of soil.

To address the increasing degradation of soil in Burkina Faso, in 2015, PAEPARD supported the establishment of a consortium focused on promoting the use of *Trichoderma sp.* in the production of bio-compost for vegetable farming. As a biofertilizer, *Trichoderma sp.* facilitates the release of nitrogen, phosphorous and potassium into the soil and produces phytohormones that significantly increase root length and lead to better plant growth. The fungus is also an effective biological control agent for a number of soil-borne pathogens, including aflatoxins, as it can out-compete pathogenic fungi to colonize carbon substrates in the soil and produces enzymes that digest pathogens.

The consortium received a grant of €250,000 from the Forum for Agricultural Research in Africa (FARA) under the PAEPARD CRF call for agricultural research for development proposals. In a joint venture with private sector companies GIE BIOPROTECT and BIOPHYTECH, the consortium has helped reduce the use of chemical inputs for enhanced sustainable production in Burkina Faso.

> Activities and achievements

The *Trichoderma* consortium is driven by GIE BIOPROTECT, which is based in Burkina Faso and

specializes in the supply of organic farm inputs, as well as training and advice on organic farming and good agricultural practices. Since participating in the consortium, GIE BIOPROTECT has invested in the training of skilled human resources in project management, microbiology and sales. In coordination with the NGO partner, Association for Research and training in Agroecology (ARFA), and producer groups *(Union des groupements Neerbûli-Burkina Faso, Union des groupements Maasom-Province de Zondoma and Téga Wendé)*, GIE BIOPROTECT has provided training within the consortium in the transfer of composting technologies. They have also assisted the consortium with the acquisition of compost production and packaging equipment, as well as laboratory equipment, to improve the availability of indigenous *Trichoderma sp.* strains.

BIOPHYTECH, a French company which focuses on bio-technological and industrial research, has supported GIE BIOPROTECT in the scientific coordination of the project. BIOPHYTECH's role is specifically focused on the transfer of technology for the production, formulation and manufacture of locally-adapted *Trichoderma sp.* strains. In January 2015, the consortium sent samples of soil and organic matter to BIOPHYTECH in France, from which 10 *Trichoderma sp.* strains were isolated in the laboratory. Those strains were then sent to *L'Institut de recherche pour le développement* (IRD) laboratory in Dakar for genotype sequencing. The strains were later produced in Burkina Faso and compared to French strains on their potential to control pathogens, degrade organic matter and assimilate minerals, including phosphorus.

Organic compost enriched with *Trichoderma sp.* was applied to potatoes, onions and tomatoes in two zones of production, Gourcy and Fada, in Burkina Faso. The field trials showed that the addition of *Trichoderma sp.* to organic matter improved yields of tomatoes by 22%, potatoes by 11% and onions by 4%, on average. Beyond improved yields, the use of *Trichoderma sp.* reduced the incidence of fungal diseases in vegetable crops by 75–100%.

In parallel to the field trials, GIE BIOPROTECT started to commercialize the production and distribution of bio-protectants and bio-fertilizers from *Trichoderma sp.* The Téga Wendé women's group, which produces and sells compost, worked with the consortium to provide the necessary composting for field schools to demonstrate the benefits of *Trichoderma sp.*-enriched compost to local farmers.

With Téga Wendé on board, the consortium activities saw a significant expansion in the production and use

Debriefing with donors and farmers about enriched compost with Trichoderma.

of organic matter by local farmers. In fact, the Téga Wendé group almost doubled its compost production from 45 tons in 2014 to nearly 76 tons in the first half of 2017. The revenue generated by compost sales also increased four-fold over this period to €2,763 in the first half of 2017. In addition, studies of Téga Wendé's *Trichoderma sp.* production have made it possible to replicate the processing structure used by the group to establish 12 new rural composting units in Burkina Faso, which has helped to provide new jobs in the sector.

As part of the commercialization process, *Institut de l'Environnement et de Recherches Agricoles* (INERA) conducted a market study and tested three types of bag for optimum packaging and storage of *Trichoderma sp.*-enriched compost. The different packaging was revealed to have no effect on compost quality so the most economical material – a polypropylene bag with a plastic bottom – has been recommended for compost storage.

ARFA has leveraged its pre-existing relations with GIE BIOPROTECT and BIOPHYTECH in the promotion of organic farming to bridge the gap between these companies, public authorities (e.g. the Burkinabé Chamber of Commerce and Industry and INERA) and producers, in order to promote the production and use of *Trichoderma sp.*-enriched compost. The NGO disseminated facts and evidence about the benefits of *Trichoderma sp.*, led activities to raise awareness, and trained extension workers to promote uptake of Trichoderma sp.-enriched compost among small-scale farmers in several regions of the country.

The consortium held 13 training sessions on the value of *Trichoderma sp.*-enriched compost and techniques for applying it, which were attended by 238 people. A further 400 participants were involved in six guided visits around field schools applying *Trichoderma sp.*-enriched compost. A video on the use of the compost, as well as production factsheets published in French and local languages, have also been disseminated by the consortium. In total, over 4,000 producers have been trained on composting techniques and the use of *Trichoderma sp.* in vegetable production.

As a result of the consortium interventions, there has been a boom in *Trichoderma sp.* production, with 300 tons of compost now being enriched with *Trichoderma sp.* per year in Burkina Faso. The compost has enabled producers to increase their gross margins by 45% for tomatoes, 15% for potatoes and 3% for onions. Furthermore, the *Trichoderma sp.* products are environmentally friendly and contribute to the preservation of biodiversity, as well as the protection of groundwater and surface water by reducing the use of synthetic chemical fertilizers and pesticides.

> Challenges and lessons

Burkinabé political factors influenced the consortium progress. The public uprising and *coup d'état* of 2014, followed by terrorist attacks in September 2015, meant some areas where the consortium had planned to work were classified as too dangerous to operate in. However, with the formation of the collective citizen for agroecology – an organization that brings together associations, companies and producers to promote agroecology – and the election of a member of this collective as a member of national parliament, issues of sustainable production were introduced to policy dialogue. A civil society victory over the use of transgenic cotton, maize and cowpeas by multi-national agriculture company, Monsanto, also contributed to increased interest in green production. Finally, in June 2017, the National Assembly passed a law on limiting the use of chemical pesticides, which has now been implemented and is an incentive for the use of biopesticides. The new law thus contributes to facilitating the consortium efforts to mobilize producers and roll out the application of *Trichoderma sp.*-enriched compost in fields.

The consortium did not foresee the time investment required for the development and implementation of the research activities and the need to recruit full-time staff to manage these activities. As a result, there were insufficient resources to carry out all of the consortium's activities and requirements. For example, the consortium's action plan was not updated to incorporate the budget reduction agreed during contract negotiations between consortium members. Furthermore, the budgetary allocations seemed to be rigid and not very operational, which limited the consortium's ability to respond to underestimations of the time and human resources required.

Another challenge was that research and private sector partners did not always interpret the research needs and results in the same way. The ULP – developed by PAEPARD to generate demand-driven research – helped to change the mindset of IRD researchers to respond to the specific research needs expressed by GIE BIOPROTECT and ARFA to develop effective and affordable products in a timely fashion. For the consortium to work, it was necessary that all the actors pursued the same interests.

The geographical distance between the different partners also made it difficult to bring all actors together for certain workshops and physical meetings. However, cooperation and collaboration among consortium partners was improved through the establishment of a formal framework of permanent dialogue, conceived as a place for the exchange of knowledge and information (through both physical meetings and video conferences), which will allow the results of the consortium to continue after PAEPARD comes to an end.

A key element of the consortium success has been that the products proposed by the consortium respond to specific needs expressed by many of the targeted producers, including fertilization, soil fertility conservation, and crop pest and disease control. The involvement of target groups in the project implementation also helped to consolidate ownership of consortium activities.

>Looking ahead and sustainability

The involvement of private actors within the consortium and their appropriation of the research results are a guarantee of the consortium sustainability. Before the CRF support from PAEPARD came to an end, BIOPHYTECH invested in Senegal and Côte d'Ivoire and developed two more joint ventures. The company used the same approach of partnering with national research and development entities to transfer technology to local processors and promote the local production of indigenous *Trichoderma sp.* strains. BIOPHYTECH invested capital and knowledge into the consortium and helped to build the capacity of young scientists to scale out of the consortium's research results and become innovative entrepreneurs in *Trichoderma sp.* production.

It will be necessary to produce the *Trichoderma sp.* inoculum to sustain the 12 units producing *Trichoderma sp.*-enriched compost across Burkina Faso. To produce sufficient inoculum, GIE BIOPROTECT will have to employ qualified technicians in its fermenting production facility based in Fada N'gourma, which will create job opportunities for local graduates (microbiologist technicians, agricultural extension engineers, technical sales men, etc.). The 12 units producing compost enriched with *Trichoderma sp.* will also provide another source of employment.

FOR MORE INFORMATION

http://paepard.org/wakka.php?wiki=BioprotecH

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Group photo of the consortium during a field visit in Ghana (2017).

Coordinating citrus disease control in Ghana

INTRODUCTION

In southern Ghana, over 60% of the population work in the agriculture sector with citrus being a major cash crop. Sweet orange (*Citrus sinensis* (L.) Osbeck), for example, is an important source of income for over 20,000 farmer members of the Citrus Growers and Marketing Association of Ghana (CIGMAG). Therefore, although not a food security crop, citrus serves as a major source of income for small-scale farmers and is particularly important for women who market the fruit throughout the country (MoFA, 2007).

The citrus-growing area in Ghana has expanded significantly in recent decades and, as a result, more than 671,000 tons of citrus fruit have been produced in the country each year since 2012 (FAOSTAT, 2012). The crops are also important horticultural exports, with demand from Sahelian West African countries and Europe, and provide significant contributions to foreign exchange earnings.

However, despite their importance to Ghana's economy, substantial losses in citrus fruit yields have been identified by CIGMAG due to the prevalence of pests and diseases, use of infected planting materials, declining soil fertility and poor post-harvest handling techniques. The continuous cultivation of fruit crops without replenishing soil nutrients has also led to nutrient mining, which has further impacted on citrus yields in the country (Lawson *et al.,* 2017). However, little attention has previously been paid to such issues or to increasing citrus yields and crop quality.

In 2005, a new fungal disease known as *Pseudocercospora* leaf and fruit spot (PLFS) – or angular leaf spot – was observed in Ghana. This disease attacks young citrus leaves, fruits and twigs, resulting in premature abscission and dieback, and leading to yield losses of 50-100% (Brentu *et al.,* 2013). PLFS reached an epidemic level in Ghana in all citrus growing regions, devastating plantations in the country. However, no systematic efforts were made to address it and as a result, in a bid to earn an income, farmers started cutting down their citrus trees to sell to illegal miners.

With the potential to collapse Ghana's citrus industry in just 3 years if PLFS was left unchecked, through PAEPARD, FARA facilitated the initiation of a Ghana citrus consortium in 2012 to coordinate a nationwide effort to control the disease. The consortium brought together a range of stakeholders to address the high level of fruit losses, and to help control angular leaf spot disease and fruit flies in the regions where citrus is produced.

> Activities and achievements

Facilitated by PAEPARD, the consortium organized an inception workshop in Accra in 2012 to build a strong partnership among stakeholders and to develop a 1-year project, *Control of Angular leaf spot of citrus in Ghana.* To enhance the consortium's ability to produce a detailed and 'bankable' research proposal, a representative of the multi-stakeholder partnership participated in two PAEPARD-organized write shops in Entebbe, Uganda in 2012 and 2013. The consortium submitted a proposal to the Agricultural Research Fund, to the Dutch Government, and to the Sub-Saharan Challenge Programme. From the latter, the consortium received US$100,000 in funding for the creation of regional Citrus integrated Innovation Platforms (IP).

The IP are forums for researchers, private sector actors (including banks), NGO and farmers to discuss solutions to local agricultural challenges. Training on IP management and Integrated Agricultural Research for Development was provided to the consortium by experts from FARA in Kumasi, Ghana in 2014. Three IP have since been established by the consortium in Mankranso Town in the Ashanti region, in Assin Foso in the Assin North Municipality of Central region and in Kade in the Kwaebibirem district of the Eastern region. These forums have provided a platform for various stakeholders in the citrus value chain to discuss major constraints to the industry, such as the issues of pests and diseases, poor agronomic practices, bottlenecks in marketing and a lack of financial support to farmers.

As part of the citrus consortium, CIGMAG organized farmers to engage with the multi-stakeholder partnership and to adopt good agricultural practices (GAP). The central involvement of CIGMAG also enabled the consortium to tailor their research developments to the specific needs of small-scale farmers. CIGMAG also carried out on-farm research with the farmers and disseminated information on the consortium's developments.

Other stakeholders involved within the consortium included the Plant Protection and Regulatory Services Directorate of the Ministry of Food and Agriculture, who were also responsible for mobilizing farmers and providing them with extension services, such as advice on the identification and control of pests and diseases. The University of Ghana led on all the consortium's research activities in partnership with the *Instituto Valencia no de Investigaciones Agrarian,* a Spanish research organization. The university also took charge of financial management of the consortium's grant funds.

Local private sector processing companies also engaged with the partnership, for example, Pinora Ltd and Fruitland Ghana Ltd provided farmers with agro-inputs and training in citrus agronomy best practices. Outside of Ghana, international organizations *Deutsche Gesellschaft für Internationale Zusammenarbeit* (GIZ) and the Centre for Agriculture and Bioscience International, assisted the partnership in producing posters, fact sheets and flyers to disseminate information on the consortium work. This enabled the citrus partnership to scale out their research results and technologies to farmers and other stakeholders outside of the IP.

GIZ has also implemented more than six 1-week training courses since 2012 to show nearly 2,000 local farmers and ministry staff how to work more effectively and use new farming methods. The participants also learned how to control pests and how to better protect their plants and soil in future. The farmers are now using better seeds – as encouraged during the training – and have almost tripled their yields using the productive cultivation methods. The quality of the farmers' produce has also improved, meaning products like orange juice can be sold on the international as well as at the local market.

The angular leaf spot disease is now managed in Ghana through the use of a chemical spray that has been tested in accordance with European GAP and Global GAP. Farmer adoption of the spray technology and other agricultural good practices, including weeding, have led to a big reduction in citrus fruit losses. Since 2013, over 3,000 citrus farmers have been using the spray technology across Ghana. With increased yields and crop quality, farmers, citrus fruit transporters, small traders, processing companies and agro-input dealers have all benefited from the outputs and impacts of the project.

Through the IP, the consortium trained members in the use and maintenance of spray equipment in order to form 'spraying gangs'. Members of these gangs are also provided with other agricultural inputs to manage angular leaf spot and fruit flies. The local citrus farmers engage their services and pay for the labour and inputs. After covering the sprayers' wages, any additional money generated from these services goes in to a revolving fund to sustain the activities of

the IP after the project. So far, US$30,000 has been accumulated.

Two members of parliament from the Ghanaian government are involved with the IP in Mankranso. Due to the momentum around citrus that has been created by the IP, it is expected that the Ministry of Food and Agriculture will increase its support to the citrus industry. The district assemblies are also in the process of enacting a law to enforce the spraying of all fruits to avoid the occurrence of contamination and spread of PLFS.

The consortium also trialled the use of leaf water extract from an indigenous plant, *Pimenta dioica,* which contains high amounts of natural methyl eugenol to repel some species of fruit flies, particularly *Bactrocera dorsalis.* The farmers, who were given the extract in 2013, recommended that CIGMAG make it available for use in the following citrus season. The consortium has since raised about 50 seedlings of the plant to distribute to each CIGMAG farmer so that they can harvest the leaves themselves.

Citrus fruit crop damaged by fungal disease in Ghana.

> Challenges and lessons

The consortium had difficulties in securing funding to respond to emerging constraints in the citrus industry due to the fact that potential donors do not consider citrus to be a food security crop, nor is southern Ghana – where citrus is mainly cultivated – considered a poverty-stricken region.

Most of the citrus farmers were not members of the national association (CIGMAG), which was responsible for mobilizing farmers and disseminating consortium information. This made management of PLFS more difficult.

The presence of two local processing companies at the IP meetings helped to broker new relationships between the agribusiness and the farmers. In the past, there had been misunderstandings between the two groups because they did not have a forum for discussion. Since the IP were established by the consortium, the farmers and processors have been able to more easily discuss issues relating to, for example, which type of fruits should be harvested and what their prices should be.

The angular leaf spot disease project strengthened the citrus consortium by, for instance, creating awareness of the partnership and its work, engaging producers to join the consortium, and through its training to members on collective management of the disease. Such strengthening was most evident in districts where the IP were in place. In view of this, other developmental organizations, such as GIZ, have taken a keen interest in the IP and are now more engaged with programs that involve IP to improve Ghana's citrus industry. IP are thus effective in creating a platform for donors who want to support smallholders and engage with farmer groups.

The consortium launched a WhatsApp group in order to quickly and easily disseminate project information among stakeholders. Through this communication channel, the consortium was also able to scale out its activities to new partners and beneficiaries by adding them to the group as they engaged with the project. Information and communication technologies are therefore important tools for communicating research findings and project updates to existing partners and for engaging with potential beneficiaries.

> Looking ahead and sustainability

Currently, the market for citrus fruits produced by smallholders in Ghana is limited to the domestic market. Further, one of the only two citrus processing factories in the country, Fruitland Ghana has closed while the remaining facility, PINORA, has frequent machine breakdowns resulting in gluts of fruit that cannot be processed during peak production seasons. As a result of these constraints, interest among consortium members has waned. What is needed is investment in the fruit processing industry to create a market for farmers' fruits.

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Poultry feeding in Nigeria is a major issue if to be done with local products.

Nigerian poultry feed partnership encourages innovation

INTRODUCTION

The high cost and poor quality of poultry feed is a major constraint for farmers in Nigeria, with formulated feed accounting for 60-70% of production costs. Specifically, the rising demand for maize, soybean and groundnut for alternative industrial uses has driven up the cost of these important raw materials in a region that has never produced enough to meet the demand for human consumption, the beverage industry and livestock production.

Cassava is the most important food crop in the humid tropics in terms of energy – yielding about 40% more carbohydrate than rice and 25% more than maize per hectare – making it the cheapest source of calories in both human and animal diets. With an output of more than 14 million tons of cassava each year, Nigeria produces about 25% of sub-Saharan Africa's output; however, millions of tons of the crop and its byproducts go to waste. As well as containing low levels of protein (2%), cassava contains toxic compounds (endogenous cyanogenic glycosides) which breakdown to form hydrogen cyanide, limiting the value of unprocessed cassava. Traditionally, poultry feed containing cassava has also been dusty and results in high fecal moisture that attracts flies, curbing adoption by farmers.

Recent research efforts at the Federal University of Technology in Owerri, Nigeria, have yielded two processed cassava products that have been shown to address these shortcomings. Such research efforts point to the production of value-added cassava products that could completely replace maize in poultry feed. The transfer of such skills and knowledge – on simple machinery development and the formulation of poultry feeds from processed cassava products – to poultry farmers in Nigeria, is therefore a high priority.

To improve poultry production and the incomes of small-scale farmers, academic actors (Federal University of Technology Owerri, University of Ghent), as well as private sector practitioners (Farmer Unit 6 Multipurpose Farmers' Cooperative), and farmer organizations (Poultry Association of Nigeria [PAN], Feedmillers Association of Nigeria [FAN], Imo State Cassava Growers Association) have come together to form the Nigerian Poultry Feeds Research and Development (NIPOFERD) consortium. The consortium

is specifically promoting the development and adoption of enhanced knowledge in innovative feed production and poultry feeding technologies, as well as establishing a viable industry-researcher network that targets small-scale farmers, feed millers and research organizations.

> Activities and achievements

PAEPARD provided investment and support to NIPOFERD, including in the form of two agricultural innovation facilitators (AIF), and enabled consortium representatives to participate in a number of write shops, training workshops and conferences. This backing enabled the consortium to hold a 1-week training workshop – Knowledge transfer towards cost-effective poultry feeds production from processed cassava products to improve the productivity of small-scale farmers in Nigeria – in 2016 to build the capacity of small-scale farmers to develop value-added cassava feed. The aim was to transfer knowledge (on equipment fabrication, processing of fresh or pre-dried cassava roots to value-added products, poultry feed formulation and production) to small-scale farmers in order to scale up the production and supply of cassava-based poultry feed.

Participants in the workshop included a PAEPARD representative, an AIF from the Federal University of Technology Owerri, a representative from the University of Gent, 13 farmers, one student, one early-career lecturer, seven resource persons and two NIPOFERD staff members. Seventeen presentations were made and the workshop's daily proceedings were disseminated widely on Facebook, Instagram, WhatsApp and the PAEPARD blog (https://bit.ly/2zE2pbv).

During the workshop, a number of presentations covered topics including: properties of cassava that make it a better alternative to maize for use within poultry feed; production and use of processed cassava products; feed quality schemes and regulations; simplified technologies for on-farm production of poultry feed; the value of sun drying and fermentation to reduce the hydrogen cyanide content of cassava; feed milling equipment requirements and maintenance; precautions to avoid mycotoxin contamination; and emerging food borne diseases of poultry. A field trip to Phenomar Farms Ltd – a 350,000-layer and broiler facility that has been in production for 40 years – also enabled participants to discuss potential future collaboration, particularly in the area of knowledge exchange on the use of processed cassava products in the production of poultry feeds.

The workshop resulted in the:

. dissemination of knowledge on technologies and equipment needed for production of processed cassava products for poultry feeding;

. transfer of knowledge on poultry feed formulations that utilize cassava in place of maize;

. increased interest of farmers in the adoption of cassava-based poultry feed;

. training of poultry farmers knowledgeable on the use of cassava in producing poultry products;

. creation of a farmer-researcher nucleus for collaboration on future challenges in the industry;

. development of a model for research collaboration between Nigerian universities and the cassava industry;

. creation of a group of agricultural researchers with experience in science technology innovation transfer;

. creation of sub-regional awareness of the value of cassava as raw material for poultry production;

. publication and distribution of 1,000 hard copies of the workshop proceedings at major agricultural events in Nigeria and beyond; and

. presentation of four poster papers on the consortium experience capitalization activities during the 43rd Conference of the Nigerian Society for Animal Production at Owerri in March 2018.

Particularly important was the participation of the farmers' organizations and the private sector actor within the workshop. Their involvement not only ensured that the consortium addressed a pressing and relevant challenge for Nigerian poultry farmers, but also enabled the smooth transfer of knowledge on the processing of fresh or dried cassava into poultry feed and other value-added products. Using their knowledge and training in the safe production and quality regulation of cassava feed, the members of these organizations have been able to scale-up the innovation in Nigeria. A *WhatsApp* group created during the workshop has also enabled participants to easily keep in touch and share updates on their activities.

Poultry raised in an organic way (regional site of Songhaï, Benin).

Cassava pellets.

As a direct impact of the workshop, the PAN Abia State branch, Farmer Unit 6 Multipurpose Cooperative, and Imo State Cassava Growers Association joined NIPOFERD. As a mark of its increasing confidence within the consortium, the PAN Imo State branch also invited research partners from Federal University of Technology Owerri to co-organize its 2016 Annual Conference and Celebration of World Egg Day in 2016.

> Challenges and lessons

. Trust built up within the consortium was key to the success of the workshop. Specifically, the consortium's brokerage activities helped to sensitize and attract the excellent range of expert resource persons to the workshop. In addition, no project management challenges were encountered during the workshop because of excellent coordination and communication of consortium goals, and the trust established through sustained consortium activities;

. The NIPOFERD policy of working with active farmers and experts that have generated evidence-based research outputs worked well in terms of selecting the right participants for the workshop;

. The PAEPARD policy of proposing consortia work with AIF worked negatively in this instance, probably because they were not based near the intervention location of the consortium and therefore needed funding to continue their participation in NIPOFERD activities. The two AIF proposed by PAEPARD became disinterested in consortium activities. The external AIF, for example, failed to show up to the workshop, but the consortium was able to address this challenge by using the services of the consortium's in-house AIF;

. The participation of the consortium European partner, a West African participant from Burkina Faso and a PAEPARD representative gave the workshop an unexpected international image and was appreciated by the farmers and other resource persons. The online visibility of the event also enhanced the profile of the consortium and enabled content to be disseminated to a wider audience;

. To prevent the workshop becoming a 'sit down, listen, talk and lecture' show, the organizers introduced a 'world café' segment (content reflection), interactive discussions, and a 1-day learning event out in the field. These two actives were well received and commended in subsequent podcasts created by the participants;

. Few of the presentations during the workshop were products of on-station research and were not designed with development projects in mind. The organizers tried to address this with question and answer sessions and content reflection exercises; however, the capacity of research partners to design appropriate studies that can be translated into development activities needs to be developed;

. Initially two workshops (one for PAN and another for FAN members) had been proposed, so only having one resulted in fewer numbers of farmers being able to interact. There is the need to tailor future workshops arrangements to meet the special needs of the different farmer organizations.

> Looking forward and sustainability

Sustaining cost-effective quality poultry feed production requires the continuous transfer of ideas from research partners through training, demonstrations and other multi-stakeholder engagement activities to farmers and feed millers. Publications, such as books, pamphlets, posters and videos from consortium activities will continue to be routinely produced and distributed to relevant stakeholders. The NIPOFERD consortium will also continue to seek funding for more project activities on the subject of cost-effective quality poultry feed production for small-scale farmers in order to extend its activities to the rest of the country, and beyond.

FOR MORE INFORMATION
https://paepard.org/?Nipoferd

Experimental field joined visit of Togo and Brazil pepper breeders.

Improving production for Togo's pepper farmers

INTRODUCTION

Pepper (*Capsicum sp.*) is a highly popular and profitable commodity in Togo, and is cultivated by over 75,000 smallholder farmers. Local varieties are preferred for their hot taste and resilience to pests. However, native seeds are not readily available on the Togolese market, and there are no national breeding programs.

Due to the absence of improved local cultivars, hot and bell pepper yields are often low with poor fruit quality. Imported varieties are expensive and therefore out of reach for most farmers, who, as a result, perpetuate seeds through bulk selection. To address these issues and increase farmer incomes and food security, it is crucial that Togolese smallholders are provided with better access to good quality seed of popular local varieties.

In order to contribute to the development of Togo's pepper value chain, an informal women's group was established in 1998 to process hot peppers. In 2006, this informal group was transformed into a private sector company called AGROCOMPLEX, which worked to improve pepper product quality and build the capacities of local smallholders. In particular, to enhance pepper production, the company supported producers to secure supplies of raw materials, such as chili pepper seeds. In 2002, AGROCOMPLEX members decided to create a new network, which was called *Centre d'action pour la sécurité alimentaire le développement durable et la valorisation des ressources* (CASADD-VR). The network purpose was to develop partnerships within the pepper value chain and to identify funding opportunities for actors. The network now consists of 60 local farmers' organizations and small agribusiness companies, as well as pepper producers, traders and microfinance institutions.

Although both groups have helped to support pepper production – and local farmers – many challenges remain. Thus, in 2011, PAEPARD held a partnership inception workshop in Lomé, Togo, to bring together various local stakeholders. Through the workshop, a pepper consortium was formed with the aim of identifying and addressing key challenges within the pepper value chain.

> Activities and achievements

During the 2011 PAEPARD inception workshop, the multi-stakeholder consortium developed a strategy which consisted of three main objectives:

. To build and strengthen a multi-stakeholder platform around the pepper value chain;

. To develop project ideas and proposals to address the current needs of beneficiaries;

. To work together to design, implement, monitor and evaluate the project processes.

In 2014, in partnership with the Brazilian Agricultural Research Corporation (EMBRAPA), the consortium launched a 3-year project, *Local value seeds promotion: farmer led breeding and distribution of green pepper and red pepper varieties.* The aim of the consortium's research was to enhance Togolese farmers' incomes by improving pepper productivity through increased local genetic resource conservation. The specific objectives of the project were to:

. Select and characterize local varieties of red and green peppers (through two cycles of mass selection);

. Select imported cultivars of chili pepper and bell pepper from Brazil through a germplasm exchange program and assess suitability for Togo's growing conditions;

. Train farmers in pepper seed production and replication;

. Increase smallholder pepper farmers' incomes by 20% in the long term.

Other than CASADD-VR and AGROCOMPLEX, partners of the pepper consortium include EMBRAPA, Lomé University's School of Agronomy, MKTPlace – an international funding initiative to develop cooperative research projects – FARA, local farmer organizations and members of Togo's Ministry of Agriculture.

Pepper variety of high quality for the consumers in Togo.

The consortium adopted the ULP approach to engage farmers in project activities and better meet their specific needs. The consortium also carried out participatory variety seed selection with farmers to ensure the research focused on their preferred seed varieties. Through this inclusive approach, the following activities were completed:

. The evaluation of pepper production and pest management in five regions of Togo;

. The collection and characterization of 19 local varieties;

. Germplasm exchange – 25 varieties were imported from Brazil;

. The evaluation of 18 EMBRAPA cultivars for their agro-morphological characterization;

. Selection of 5 local varieties of red pepper;

. Farmer selection of 5 Brazilian varieties adapted to local conditions and farmer needs;

. Thirty farmer leaders trained in seed production and replication.

Comparative performance analyses and characterization of local varieties focused on determining agronomic traits of the peppers, such as yield, fruit quality and disease occurrence. The on-farm trials, as well as market information assessments, were carried out with farmers to ensure there was sufficient demand for the selected varieties, and that they would be adopted for replication. A performance assessment was also carried out for the Brazilian cultivars to establish their adoption potential by Togo farmers. The consortium promoted the selected local and Brazilian varieties through field visits, and local and national workshops with farmers and other value chain actors.

Thirty farmer leaders were trained in seed replication by the EMBRAPA Brazilian team, and helped to disseminate knowledge on the process within local villages. Almost 2,000 pepper farmers have been reached through village meetings and it is estimated that 2,500 farmers have the skill to produce seeds and grow better quality material for processing.

As a result of adopting improved pepper varieties, 10,000 pepper farmers – mostly young men and women – have increased their production by 10% and their revenues by 20%. With the introduction of improved varieties, the seed value chain also represents an alternative market for pepper farmers with new income opportunities.

As part of the project, AGROCOMPLEX was responsible for managing the logistics and marketing of pepper seed production (e.g. collecting, sorting, packaging and distributing labelled seeds), and its participation in the consortium helped to develop an efficient business environment among consortium partners. CASADD-VR played a critical role in the transfer of technology and knowledge between research entities and farmer groups, in order to create value from the research results for farmers and entrepreneurs. As consortium leader, CASADD-VR succeeded in empowering all partners to participate in their various roles. The network also provided backstopping for participatory approaches concerning the incorporation of community ideas within innovation development.

Within the consortium and during the project, EMBRAPA provided technical information and assistance regarding varietal breeding and cultivation technology. Lomé University provided tutorship to trainee students so they could assist the consortium with project implementation. Technicians from the central region's administration of agriculture monitored project activities to record them within national policy agendas and reports. Togo's national seeds directorate also assisted the consortium by providing seed import permits from Brazil and by carrying out seed quality control.

As well as providing initial brokerage to the consortium, MKTPlace and FARA provided funding to the consortium and also carried out administrative and financial monitoring, as well as project process monitoring and evaluation.

Pepper farmer in Togo.

Although Togolese farmers have cultivated peppers for many years, the introduction of new cultivars from Brazil has increased interest in pepper production across the country. The active participation of multiple stakeholders in the consortium's research development, and the interaction between the Togo and Brazil teams, also positively influenced the project results.

The Brazil team from EMBRAPA visited Togo in November 2016, after which the consortium members set up a *WhatsApp* communication channel. This led to faster, more convenient and interactive communication among partners. The visit also facilitated interaction among the two teams, which helped to build trust and confidence between consortium members.

> Challenges and lessons

Involving farmers at the early stages of research development was a risk; more assistance and care from the technical team was required during, for instance, sample collection and plot maintenance activities of the project. The training of graduate students in laboratory activities and their participation in field experiments was conducive to obtaining results, as the students were then able to guide and assist farmers with project activities on a daily basis.

The first challenge was to teach farmers how to understand and follow the varietal selection process. This constraint was mitigated by the assistance of the students, technicians and trained farmers. Technical support provided to the project by the experienced team from EMBRAPA – in pepper seed production and breeding – was also essential to the project's success.

> Looking ahead and sustainability

Togolese smallholder farmers need to improve their planting techniques for better management of soil, nutrients, water/irrigation, disease and pests. Improved practices are also important to enhance post-harvest management of pepper fruits and improve produce quality to enable farmers to access export – as well as local and regional – markets.

The partnerships created within Togolese organizations, and between the Togolese and Brazilian teams, are expected to continue to respond to the remaining challenges that constrain the pepper value chain. The consortium intends to mobilize further funds through new research opportunities and calls. However, although pepper is still the consortium principal focus, in future, the partnership will not be limiting itself to this particular commodity.

FOR MORE INFORMATION
https://paepard.org/?PeppermiX

Processing mango kernels into essential oil for cosmetics: the challenge is not only technological, reason for prospecting on specialized fairs like Vivaness in Germany.

Adding value to West Africa's mango waste

INTRODUCTION

The West African region provides more than 80% of Africa's mango exports to European markets. In 2016 alone, Burkina Faso, Côte d'Ivoire, Mali and Senegal produced 500,000 tons of the crop, 54,000 tons of which was exported to the EU. However, almost half of mango production is lost due to damage caused by fruit flies. Limited on-farm storage, transport services and effective packing management at processing facilities also result in significant post-harvest losses in the mango value chain.

Before Cote d'Ivoire developed a new plant protection strategy in 2015, management guidelines to help control fruit fly populations had not been implemented in a sustainable way in the West African mango industry. Orchard phytosanitary health instructions for the cleaning and protection of orchards to avoid fruit fly development – as proposed by national research institutes – were also under-applied by small producers. Fruit fly infestations of mango tree production areas limits the expected impacts of integrated pest management, which combines a set of phytosanitary measurements, including the cleaning of mango orchards and the burying or burning of damaged mangoes. The recommendations also include the avoidance of intercropping with certain plants, such as chillies and cucumbers, which attract the invasive fruit fly species *Bactrocera invadens* (CTA, 2013).

In order to reduce mango losses and add value to smallholder farmers' crops post-harvest, concrete prospects for value-added uses of fallen fruits must be explored for non-food sectors, such as energy, fertilization, animal feed and cosmetics. West African food processing companies are also concerned with their own levels of mango waste and are looking to identify opportunities for value addition.

COLEACP is a civil society organization whose main purpose is to support the development of a sustainable and competitive agriculture sector and create an enabling environment for agribusinesses in African, Caribbean and Pacific countries. As a representative of the private sector in the horticultural industry, COLEACP has participated in the PAEPARD partnerships process to coordinate a pilot project, which focuses on adding value to mango waste by developing alternative (non-food) products under the user-led process (ULP) in West Africa.

> Activities and achievements

In 2013, COLEACP organized a regional workshop in Dakar, Senegal, with PAEPARD support, to bring together stakeholders of the mango value chain and identify research problems that could be addressed through collaborative partnership. Consultations with producers, exporters, processors and importers within the COLEACP network confirmed that the ULP consortium's federating theme should focus on mango waste. The main issue raised by value chain actors was the high volume of mango waste due to the invasive fruit fly situation. The ULP therefore identified three sectors in which to develop non-food, value-added mango waste products: animal feed, cosmetics and energy-compost.

At a PAEPARD inception workshop in 2014, the ULP launched three separate consortia – involving 23 different partners – to focus on the development of the identified products. For the animal feed consortium, Burkina Faso's INERA took on the leadership role along with the European NGO, *Aide au Développement Gembloux*. The cosmetics consortium was led by private sector company DACOM, based in Burkina Faso, and co-led by Côte d'Ivoire's national research institution, *Institut national polytechnique Félix Houphouët-Boigny* (INPH-B). The African NGO, SNV Burkina Faso, was selected to lead the energy-compost consortium along with mango processing and exporting company Gebana, both based in Burkina Faso.

The PAEPARD strategy of building partnerships under the six-stage ULP allowed time for stakeholders to conceive a long-term vision for creating and implementing their projects. The large scope of accumulated expertise of the various partners also helped to identify relevant and impactful solutions to the identified research problem, as well as contribute to wider development goals. For example, as well as creating the potential for reducing post-harvest loss and increasing income opportunities for smallholders and processors, these non-food derived products offer employment opportunities for youths in rural areas. Development of the identified value-addition activities could also help to reposition and strengthen the role of women entrepreneurs, who play a significant role in growing, collecting, processing and distributing mangos in the region.

Stakeholders from across Burkina Faso, Côte d'Ivoire, Mali and Senegal who participated in the regional workshop in Dakar joined the ULP, and the partners produced three concept notes to submit to international donors. The animal feed consortium,

Huge mango waste in West Africa.

for instance, submitted their research proposal to an African Union research call in 2016; however, their proposal was not selected. To enhance stakeholders' ability to write clear and robust research proposals, the ULP worked with a private consultant to act as their AIF. The AIF, who was identified by the COLEACP network and recommended by PAEPARD, facilitated various processes involved in producing the proposals, such as the desk study, regional workshops and concept note development.

To encourage the sharing of ULP research results among members, and to better communicate the work and activities of individual partners, PAEPARD supported the ULP to set up their own participative intranet website platform called the Online System to Improve Relationships by Information Sharing (OSIRIS). Training sessions on how to use OSIRIS were initially delivered by PAEPARD and continued by COLEACP to ULP members via Skype calls during 2015 and 2016. The work of the three consortia was promoted to the public as well as potential partners and donors via the PAEPARD website.

Activities of the separate consortia during the 3-year period (2015-2017) included the following:

Animal feed

- In 2015, INERA attended a communication tools workshop organized by PAEPARD in Accra, Ghana. The main objective of this workshop was to familiarize participants with OSIRIS in order to improve communication among consortia members, and to enhance project management;
- During a PAEPARD side event at the 7th FARA General Assembly in Kigali in 2016, COLEACP and INERA delivered a presentation to promote the ULP activities developed by the three consortia. At the same event, INERA met with NIPOFERD – another PAEPARD-supported consortium based in Nigeria. The animal feed consortium was able to share its experiences of using mango in poultry feeds with NIPOFERD during a PAEPARD workshop held in Nigeria in 2016;
- At the 2016 FARA assembly, and at a biennial meeting of the Regional Universities Forum for Capacity Building in Agriculture in Cape Town in the same year, COLEACP renewed contact with a previous ULP partner, WUR. WUR offered to help develop certain aspects of the alternative mango uses research, notably by providing the animal feed consortium with technical support;
- INERA developed machinery for mixing animal feed ingredients and patented this design with the African Intellectual Property Organization in 2016;
- In 2018, INERA and the Interprofessional Fund for Agricultural Research and Council Fonds (FIRCA) signed an agreement for developing the animal feed machinery to be used in Côte d'Ivoire.

Cosmetics

- In 2015, INPH-B attended a PAEPARD-organized reflection workshop in Entebbe, Uganda to share experiences of the ULP. During the workshop, tools to better evaluate the progress of consortia activities were highlighted, such as the use of reflection diaries and project timeline spreadsheets;
- Also in 2015, COLEACP visited Vivaness, the international trade fair for natural and organic cosmetics, held in Nuremberg, Germany. The objectives of this visit were to better understand current regulations within the beauty and food industries; to make contact with European companies already producing mango-based products and to enquire about potential funding; as well as to identify new mango oil-based products that could be introduced to the market. During this visit, COLEACP met with German company, All Organic Treasures, which specialises in the extraction of oil from a variety of fruits, nuts and plants using CO2, and which had already been working with one of the cosmetics consortium members on other products. The company were interested in the consortium's methods of oil extraction without solvent – which could decrease their production cost – and their proposed beauty products;
- During a second visit to Vivaness in 2016, which was also attended by the consortium leader DACOM, new contacts were made with French companies Melvita et L'Occitane Laboratories, and organic seed oil company Emile Noël;
- The consortium identified three popular export mango varieties, of which two are produced in high quantities but experience significant losses due to fruit fly infestations. The third has the highest oil content of the three, but is produced at lower levels, and thus less is wasted due to infestations. In 2015, samples of these identified varieties were sent to Emile Noël

The consortium during the inception workshop in 2014.

for oil content analysis. The company did not expect a fee for their collaboration and expressed an interest to work with the consortium but, unfortunately, due to conflicting agendas, they could not continue their involvement with the consortium.

Energy-compost

- In 2015, COLEACP visited Biofach, the world's leading trade fair for organic food in Nuremberg, Germany. Whilst there, they met with German consultancy Soil and More, which specializes in soil regeneration worldwide, but notably in Africa. The company showed interest in mango waste for improved compost production;
- COLEACP met with Soil and More again at Fruit Logistica 2017 in Berlin, where it was established that Soil and More was very interested by the mango compost concept and was ready to integrate the practice into their training module for producers. However, for Soil and More to promote the work of the energy-compost consortium, they required financial reimbursement which the consortium could not provide;
- In 2016, during a PAEPARD management team meeting in Prague and a European Forum on Agricultural Research for Development meeting, COLEACP engaged in a discussion with the bio-protect Trichoderma consortium from Burkina Faso. The Trichoderma consortium was interested in developing a synergy with the energy-compost consortium by combining their identified strain of fungus with mango waste for improved compost development. A member of the bio-protect consortium took over as the leader of the energy-compost consortium in 2018;
- Inter-consortium business relationships were also established. SNV Burkina Faso and FIRCA, for example, teamed up to exchange technical information regarding mango drying equipment. Gebana Burkina Faso (a mango processing and export company) and the Ivorian company of Tropical Technology (specialized in agro-industrial processes and equipment), also worked together to build up a semi-industrial biodigester in Côte d'Ivoire for the consortium's experimental procedures.

> Challenges and lessons

The inception of a ULP should be organized by a coordinator and an AIF in order to achieve a balance between the number of private and public sector partners involved. A ULP should consist of no more than 10 stakeholders per consortium to provide the required expertise to set up an action plan, which should include details of the budget for research

Banfora mangos.

funding and development activities, but also procedures for day-to-day management. A diversity of stakeholders should allow for flexibility within a research strategy to adapt to the requirements of potential donors, and ensure ULP research activities are led by the users' needs.

Some steps within the ULP required more care and attention than others. The first step of selecting the federating theme, for example, was more difficult than expected due to the wide scope of expertise and varied interests of consortium partners. The various stakeholders had different ideas on what research would have the most beneficial impacts for producers.

During the inception workshop for the mango ULP, the specific role of each partner was not thoroughly discussed. The absence of regular meetings among ULP stakeholders led to further confusion on the expected responsibilities of each partner. The internal intranet communication platform was established to enhance communication among ULP members and the development of activities. However, ULP partners lacked capacity to use the tool, which limited its effectiveness. The majority of ULP members were also not available to take part in the Skype training sessions proposed by the ULP coordinator on how to use OSIRIS, due to conflicting schedules and problems of internet connectivity.

The cosmetics and animal feed consortia were more successful in their communication because the leaders of these consortia requested regular reports on their updates. To enhance the coordination of ULP activities and to keep all members informed of developments, a communication strategy should therefore be formalized and implemented from the start of the process.

From the end of 2015, the energy-compost consortium did not have a leader. The SNV Burkina Faso representative was no longer in charge and no one replaced him. The Gebana co-leader also left in 2016. In the absence of a lead and co-lead representative, the consortium did not have the capacity to initiate any projects at this time. The ULP renewed contact with these two entities in 2017 when they expressed their interest to continue to work with the consortium, but without any leading responsibilities. In January 2018, the bio-protect Trichoderma consortium took the lead and has proposed a work plan to be developed for 2018 and 2019.

The ULP members met face-to-face only three times – at the regional workshop in 2013, at the inception workshop in 2014, and at a 'boosting' workshop for ULP consortia members in 2018. Conflicting agendas and political events in some countries made travel and identifying appropriate places to meet more difficult. As a result, interactions between stakeholders were limited, hindering the formation of sustainable and meaningful relationships.

A change to the PAEPARD IF allocation procedure in 2015 left the consortia without any financial resources for developing their activities. PAEPARD were awaiting EU approval on their proposed amended procedure for 7 months. The consortia stakeholders were therefore forced to use other means to progress towards the ULP objectives and, as such, implemented activities under their own company or institution agenda. From 2016, the ULP did have access to the IF, but only COLEACP was allowed to apply on behalf of the consortia and was responsible for fund management. This meant that the separate consortia were not provided with the necessary autonomy to organize themselves according to their agendas and work plans.

The ULP did not secure further funding sources outside of PAEPARD to continue their activities and were therefore unable to deliver on the objectives they had outlined during the inception workshop in 2014. The EU research and consultancy partners could not commit themselves to work with the ULP due to the funding status. The AIF was also not able to work with the ULP during all stages of the process because the funding was not sufficient to pay for their continued involvement. ULP consortia should thus attempt to generate their own financial resources to develop their research projects. The consortia could then act as self-sufficient groups and would be considered more credible by potential new partners and donors when responding to research calls. The formation of business relationships among consortia within the PAEPARD network would help to achieve financial independence, and partners of the mango waste ULP did start this process as well as share experiences and resources with each other consortia (e.g. the Bio-Protect and energy-compost consortia).

One condition for ULP success is the continued strengthening of consortium capacities. The skills and technical abilities of each partner should be evaluated i.e. for computer literacy, communication, proposal writing and financial management to identify where the strengths and weaknesses of the consortia lie. AIF should be involved to provide support during the processes where capacities are limited.

> Looking forward and sustainability

INERA continues to study the impact of mango waste on pork and poultry meat quality but their research is limited by a lack of funding. Currently, the organization itself or individual researchers of INERA are contributing financially to the work.

A COLEACP program, Fit for Market, which is funded by the EU and will run from 2016 to 2020, is giving support to stakeholders of African, Caribbean and Pacific (ACP) horticultural value chains (producers, exporters, processors) by adding value to agricultural waste. Under the program, COLEACP are sharing experiences from their 9-year PAEPARD partnership with the ACP entities involved. Adding value to mango waste is part of the program's research and, in 2018, cosmetics was selected as the most promising sector in terms of producing potentially high-value market products for export.

Identification of West Africa's key players involved in the cosmetics sector, and a review of existing processing techniques for producing mango oil – as well as identification of potential European research institutes able to improve this technology – has also been carried out in 2018. The objective is to create a continuum between the Fit for Market program and the work of the mango waste ULP by supporting promising private sector development activities. For example, through the program, COLEACP and a member of the cosmetics consortium representing Mango-So in Burkina Faso will work together to develop a methodology to extract mango oil. Testing is planned to be carried out with the French research institute, CRT-CRITT-CAR Laboratory, on oil seed content for a range of mango varieties, and on a new oil extraction process for mango seed.

FOR MORE INFORMATION

https://paepard.org/?PublicationsPaepard/download&file=Leaflet_ULP_COLEACP.pdf

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Regional dialogue between research and farmers' organizations in central Africa (Douala, 2015).

Establishing a permanent dialogue between research and farmer's organizations in central Africa

In January 2013, following a PAEPARD multi-stakeholder research question workshop (to establish the research focus of the consortium) in Brazzaville, the capital of Congo Republic, a consortium of stakeholders from the urban horticulture value chains of Cameroon, Congo Republic and the Democratic Republic of Congo (DRC), was established. The aim of the consortium was to 1) develop research projects around a topic determined as a priority by producers in Central Africa and 2) improve dialogue between farmer organizations and national and international research institutions, under the PAEPARD ULP approach.

Consortium partners included representatives of the Plateforme Régionale des Organisations Paysannes d'Afrique Centrale (PROPAC), which brings together farmers' organizations from 10 Central African countries, the French agricultural research organization CIRAD, COLEACP, the Food and Agriculture Organization, the Central Africa Network of Agricultural Research Institutions, Cameroon's Agricultural Research Institute for Development, CNOP-CAM – the National Concertation of Farmers Organizations in Cameroon, ODECO – the Organization of Development, Studies, Training and Advice in Cameroon, and the French NGO, Agrisud International. To address unmet needs among smallholder farmers on the outskirts of Central Africa's major cities – with an emphasis on Congo, DRC and Cameroon – the consortium selected the theme of urban horticultural value chains.

In September 2013, a second consortium workshop – also supported by PAEPARD, was held in Douala, Cameroon, to train consortia in the development of research proposal concept notes. The urban horticulture ULP submitted five proposals between 2013 and 2018, but, due to the highly competitive nature of the calls, none of the proposals received funding.

PAEPARD support has thus enabled PROPAC to hold capacity building workshops and write shops to strengthen the ability of the consortium to respond to new proposals. In addition, these meetings provided participants with the space to start a dialogue and consult with each other on key lessons related to agricultural research for development (ARD). The PAEPARD network has also facilitated the consortium's participation in symposia and forums, both at the national and international level.

Therefore, although the consortium innovation process is not yet complete, it is well on the way to building frameworks for ARD dialogue, particularly between farmers' organizations and researchers, and improving PROPAC's status with other actors in the region. In this regard, PROPAC has been organizing annual multi-stakeholder regional dialogues since 2014, and will continue to do so in line with the Central Africa Agricultural Productivity Program (CAAPP) and the West Africa Agricultural Productivity Program (WAAPP). The alignment of the consortium with the perspectives of the CAAPP and the WAAPP has been the driving force of PROPAC involvement in consortium activities.

On field potato sizing for seeds together with farmers, technicians and researchers in Burundi.

Enhancing access to quality potato seed in Burundi

INTRODUCTION

Across sub-Saharan Africa, potato production has seen rapid growth and is contributing to food security. A study carried out by the *Institut des Sciences Agronomiques du Burundi* (ISABU) in the country's Mugamba region in 2010 revealed that potato was the leading food crop in terms of income and consumption. This is still true in highland areas. Despite their growing popularity, Burundian potato varieties are competing with imports of *Ndinamagara* and Victoria varieties from Rwanda, which are preferred by farmers due to their early maturing, stress-resistance qualities and by consumers because of their superior taste.

In addition to not meeting consumer expectations, one of the main reasons for the lack of competitiveness of Burundian potatoes is poor yields – often less than tons per hectare – coupled with limited availability of quality seed. Certified foundation potato seed from the formal seed sector is expensive and scarce, covering less than 1% of the country needs. As a result, the 2010 ISABU study found that 50% of farmers sourced their seed from local markets and 37% retained part of their crop from previous harvests. This has resulted in a high incidence of viral and bacterial diseases. Vascular bacterial disease, caused by the pathogen *Ralstonia solanacearum,* is currently the most devastating disease. More than 75% of surveyed farmers were aware of the disease, but they were unaware of how it spread or ways to control it.

To increase the crop performance and resilience of Burundian potato farmers, an agricultural producer organization, research institute, academic institution and private sector practitioners have come together to form a consortium focused on improving farmers' access to quality potato seed.

> Activities and achievements

In 2011, PAEPARD facilitated the creation of a consortium of six partners, led by the umbrella agricultural producer organization, *Confedération des Associations des Producteurs Agricoles pour le Développement* (CAPAD). Other partners include ISABU, the *Université du Burundi*, a group of private

seed growers called *Collectif des Producteurs des Semences du Burundi,* and PHYTOLABU – a private in vitro/biotechnology laboratory. As the calls for PAEPARD support required the presence of a European stakeholder, the Walloon Agricultural Research Center in Belgium was brought on board, with the support of CAPAD's Belgian partner, the *Collectif Sécurité Alimentaire.* These European stakeholders were chosen due to their potato seed expertise and their extensive experience with projects in the region.

At the same time, between 2011 and 2013, CAPAD and ISABU developed and executed a joint project as part of the consortium work, called *Participatory Development of Potato Cultivation Technologies and Promotion of Gender Sensitive Innovations and Environmental Conservation in Burundi.* The project, which aimed to improve the quality of potato seed, received financial support from the Association of Strengthening Agricultural Research in Eastern and Central Africa (ASARECA). With this support, the project developed a range of technologies that were transferable to farmers, such as positive/negative selection of potato seed varieties.

The Burundi potato consortium was formally launched in 2012 at an inception workshop in Bujumbura, Burundi's capital, to initiate and develop a partnership around the seed potato value chain. With support from PAEPARD, the consortium mobilized relevant actors, developed a common understanding among stakeholders on the issues and vision of the project, and created a work plan and charter of values for the functioning and viability of the partnership.

The consortium also developed an action plan and in 2012, submitted a project proposal to the Programme for Food Security and Nutrition, which supports the Ministry of Agriculture to build food security – but it did not receive funding and, following this, two members left. After participating in PAEPARD write shops, the consortium responded to a call for ARD projects from ASARECA in 2012, with a research proposal entitled *Upscaling innovations for quality seed potato production in East and Central Africa.* This was selected for funding and was subsequently coordinated by the National Potato Council of Kenya. Other partners included the Kenya Agricultural Research Institute, the Agricultural Development Corporation, the Uganda National Seed Potato Producers Association and CAPAD.

In 2014, the Burundi potato consortium launched a second project, *Development of potato seed quality based innovations for small scale farmers in the three provinces surrounding Bujumbura town in Burundi,*

Potato variety exhibition in Burundi.

which was funded by the Netherlands Government through the Applied Research Fund with a total budget of €300,000. The four partners consisted of CAPAD, ISABU, the Innovative Technology Development for Rural Entrepreneurship Center and WUR.

The consortium project was innovative because it took into account the issue of smallholder access to quality seed, and focused on directly involving producers in seed reproduction. The farmers, who were CAPAD cooperative members, produced the pre-basic and commercial seeds through a seed plot technique and positive selection. Positive selection involves identification of the healthy parent plants, which present the desired characteristics. Samples from these parent plants are then isolated and used as seeds for the following production season. While this is a standard selection principal, the innovative aspect was in building a sense of ownership of the technique among producers in order to improve the quality of seedlings kept on the farm.

The seed plot technique, through which seeds are sown close together, helps to maximize production through high plantation density and reduces the area required for seed production – freeing-up land for rotation with other crops. Rotation is essential for the improvement of seed safety because it breaks the cycle of pathogen development that can occur through the cultivation of one crop, and thus reduces the occurrence of disease.

The marketing of commercial seeds to potato producers was done by CAPAD. Another role of CAPAD was to monitor the seed production of seed producers under the supervision of the National Seed Control and Certification Board in order to assess the formal status of Burundi's 'quality seeds'.

Project activities included:

- Joint identification by farmers and researchers of innovation challenges;
- Knowledge co-creation and sharing acquired through multi-stakeholder networks;
- Peer learning – from farmer to farmer;
- Guided learning – dissemination of existing research innovations through traditional extension mechanisms;
- Positioning farmers at the center of actions to target and disseminate locally-adapted seeds;
- Valorization of different sources of knowledge, including local knowledge;
- Common/group learning based on multi-stakeholder ideas;
- Building trust with farmers and the private sector so that local innovation becomes an entry point for building partnerships;
- Using low-cost and local equipment/materials for the development of project innovations, such as plant nurseries;
- Continued capacity building of farmer trainers – i.e. in the production of parent plots, the provision of extension services and local administration

From 2014 to 2016, on-farm experiments were carried out on 580 farm plots in three provinces surrounding Bujumbura town in Burundi to improve low potato yields. The experiments incorporated the following techniques/technologies: two new potato varieties (second field generation seed – 'G2' – of *Ndinamagara* and *Mabondo*) with higher-yielding qualities than traditional varieties; the use of early generation seed; earlier harvesting of seed crops; seed storage in a diffused light store; and optimum timing and doses of fertilizers and fungicides. In total, 50.1 tons of seed were certified in 2017 following these trials, and yield increased by up to 80% across all plots. The consortium was able to achieve this by placing farmers at the center of their activities. This approach led to the development of strong relationships with producer cooperatives and resulted in the rapid dissemination and adoption of locally adapted seeds.

Table 1: Result highlights from 580 on-farm plots.

Innovations	Results
New variety	20% yield increase
Improved seed	80% increase in use of improved seed
Early harvest	30% lower yield but less bacterial wilt
Early harvested seed replanted	Drastic increase in bacterial wilt not expected
Seed from diffused-light storage	30% yield increase
Chemical fertilizer use	50% yield increase
Fungicide sprays	60% yield increase

Overall, changes in production methods resulted in high rates of return compared to traditional practices:

- 202% yield increase by planting a new variety compared to the traditional more popular variety;
- 235% yield increase by switching from farmer saved seed to ISABU's *G2* seed;
- 162% yield increase by applying fertilizers;
- 230% yield increase by switching from dark storage to diffused light storage with local materials;
- 185% yield increase by applying chemical fungicides

Since applying the production techniques promoted by the consortium, and with technical support from the project team, Godefride Ndayishimiye, a potato farmer from Busigna municipality, has been able to significantly improve her food security and income. She now produces 100 kg of potato crop from sowing just 7 kg of seed, where before, 100 kg of seed would produce a harvest of 200 kg. With her enhanced income, she has built a house, bought some land, and is now financially independent.

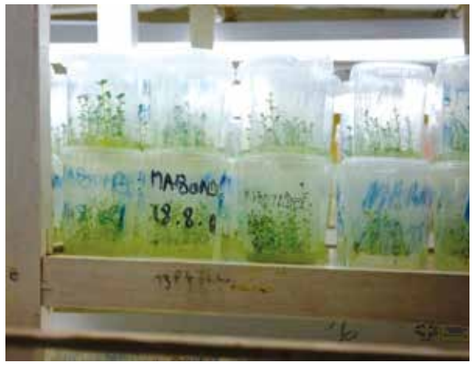
> Challenges and lessons learned

- Maintaining dynamism of the consortium (i.e. motivating and coordinating the team, acquiring financial support and building sustainability) was a challenge;
- Developing and sustaining strong relationships within the MSP was also difficult – particularly with the European partners due to, for instance, a lack of funds to attract them;

- Ensuring all actors of the sector were suitably represented within the consortium (farmers – both men and women – the private sector, policy makers, etc.) was challenging;
- Transforming and/or enhancing production is not sufficient to provide income security for farmers – a ready market for such developments is also required. To foster agricultural transformation and market development necessitates the involvement of policy makers;
- A thorough analysis of local needs and solutions was carried out within the consortium's initial research and as a result, technologies and practices adapted to the needs of smallholder farmers were generated and disseminated;
- By building up trust with local communities, producer cooperatives quickly adopted the project-promoted technologies.

The inception workshop was very useful because it functioned as a catalyst that enabled collaboration among the various partners. Following this workshop, numerous activities were organized and a draft program was developed with partners to help guide the work of the consortium.

An external facilitator was identified and introduced to the project to monitor activities and offer support where required. Certain partners did not think that an external consultant should be responsible for this role, but the identified facilitator was already familiar with some consortium partners and was aware of their main strengths and constraints. This was an asset in determining the key responsibilities of each partner.



Potato seed in vitro.

Potato seed multiplication in the field under proud supervision of the farmer.

> Looking ahead and sustainability

The production of quality seed within Burundi's potato sub-sector is expected to remain a significant challenge for the foreseeable future due to various factors, including the common practice of recycling old seed. The Burundi potato consortium intends to turn this challenge into a business opportunity by increasing the producing of disease-free, quality seed. The consortium has successfully built up trust among its partners, which has enhanced its functioning, but in order to achieve its ambitious goals, additional partnerships to the consortium will be required.

The consortium has struggled to acquire financial support from traditional donors and therefore, whilst they will continue to respond to new research calls as and when they arise, they will also target resource mobilization from a variety of new and different sources.

FOR MORE INFORMATION

http://knowledge4food.net/wp-content/uploads/2018/02/arf1-2c_burundi-potatoes_2pager-final.pdf

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Beef cattle extensive grazing is common in Eastern Africa, and low quality maize is often brought as supplementary feed.

Increasing aflatoxin awareness in East Africa

INTRODUCTION

In Kenya, maize is grown by over 90% of rural farm households with a per capita consumption of 100 kilograms per year. The country is also a hotspot for aflatoxin contamination in maize. Research has shown that human consumption of aflatoxin through the food supply is one of the major causes of liver disease in Africa.

A lack of awareness and understanding among livestock smallholders on the causes and effects of aflatoxin spread and consumption is exacerbating the problem in Africa. Sixty percent of Kenyan farmers, for example, use rotten grains as livestock feed without considering the risk of aflatoxin-contamination within subsequent dairy products. When ingested by livestock, aflatoxin B1 (AFB1) is hydroxylated by ruminal enzymes to aflatoxin M1 (AFM1), which is excreted through the animal's milk. As a result of contaminated feed, the prevalence of aflatoxin-contamination in milk in Kenya is now estimated at 72%, which translates into 3.744 billion liters annually (Gachagua and Muchiri, 2016).

With support from PAEPARD, an East Africa livestock consortium was established in 2012 to bring together African and European stakeholders already working within the pastoralism sector. From the outset, a pertinent issue for the consortium was how to produce the required quantity of livestock feed for the arid regions of Kenya and Uganda; this focus later narrowed in on feed quality and the occurrence of aflatoxins within animal feed. The consortium prioritized information and expert knowledge exchange on toxin control in livestock feeding. The consortium also sought to test aflatoxin-contaminated samples of crops and milk to determine the 'carry-over' level of the poisons when consumed by humans.

Partners of the consortium include the Eastern Africa Farmers' Federation (EAFF) – a regional farmer organization that represents approximately 20 million farmers in eastern and central Africa, the Max Rubner-Institut (MRI) – a federal research institute for nutrition and food based in Germany, the Kenya Agricultural and Livestock Research Organization (KALRO), and local farmer organization, the Kenya Livestock Producers Associations and Cooperative Alliance of Kenya.

> Activities and achievements

A 'core' group of consortium partners, comprising representatives from EAFF, ASARECA, Makerere University, GIZ, CIRAD, the National Agricultural Research Centre, and Tanzania's Sokoine University of Agriculture, developed two proposals in 2013 targeting the PAEPARD CRF. One proposal focused on commercializing the livestock value chain and the other on increasing climate resilience of the livestock value chain, however, neither were selected for funding.

In 2015, the consortium submitted a new research proposal to the German Federal Ministry for Food and Agriculture (BMEL), entitled *Minimization of aflatoxin contamination in the value chain.* MRI took the lead in formulating this project proposal, which was selected to receive funding from BMEL for 1 year and commenced in July 2016. The project achieved its goal of establishing a network of partners eager to address the issue of aflatoxins.

EAFF and MRI also worked on a separate project in 2015 called *The aflatoxin networking project in Kenya and Germany,* or AFLANET. AFLANET aimed to identify stakeholders working within the aflatoxin sector and understand the milestones that had been reached towards their elimination/control. The project ended in January 2018 and the consortium has since developed and presented a proposal dubbed AFLAZ, which is to be a continuation of AFLANET. The AFLAZ project aims to build on the partnerships already established through AFLANET to continue generating farmer awareness on aflatoxin control. The main activities of AFLAZ, which will commence at the beginning of 2019, will entail field trials to demonstrate technologies that prevent aflatoxin contamination in feed and food, and build the capacity of farmers to adopt the tested technologies.

EAFF has been responsible for consortium logistics in regards to organizing field exchanges, seminars and conferences that have taken place in Kenya. For instance, researchers from MRI visited at least seven institutions in Kenya, including F&S Scientific – a supplier of testing and analysis technologies – and government institutions, as well as local farmers dealing with aflatoxin issues. The purpose of this visit was to impart knowledge to the MRI researchers on new technologies for aflatoxin detection, prevention and control, such as the use of *Trichoderma.*

EAFF also championed a roundtable on the theme of 'Building a multi-stakeholder approach to mitigate aflatoxin contamination of food and feed', held in Brussels in January 2016. Some 40 experts from

Aflatoxin contaminated maize.

across Africa, Europe and the US participated in this meeting to assess the real needs of Africa in relation to aflatoxins, to evaluate current expertise to address the problem, and to link the most competent partners from research and funding institutions to implement aflatoxin mitigation strategies. At this event, the livestock feed consortium presented a policy brief they had developed on aflatoxin contamination of food and feed in Africa.

KALRO was in charge of the scientific aspect of the consortium's work in terms of identifying aflatoxin-contaminated sample materials to send to Germany for analysis. KALRO also visited MRI in Germany to learn about their aflatoxin management technologies, and subsequently imparted this knowledge to consortium partners and to students at local universities with an interest in food safety.

> Challenges and lessons

Lessons

- The PAEPARD ULP ensures that the end users of the research are part of the entire process;
- MSP are very difficult to steer and the inception phase for projects needs to be longer for multi-stakeholder projects;

Concentration of livestock on water pools needs to be integrated in the management of sustainable pastoralism, here in Northern Tanzania.

- By creating synergies and complementarities in the implementation of research projects, MSP are important to address issues in the field of ARD;
- For the consortium to enhance the profile of its activities and position itself within the research arena of aflatoxin control, constant networking efforts were required by all consortium members. EAFF participated in the first Partnership for Aflatoxin Control in Africa (PACA) workshop held in Addis Ababa, Ethiopia in 2014, and is now a strategic partner of the organization and a member of their board. This has also been beneficial for the livestock consortium as a whole, because PACA are working to increase awareness of the 'carry-over' effect of aflatoxin contamination of feed in food.

Challenges

- Many consortium partners initially did not have a thorough understanding of aflatoxins, particularly the Kenyan stakeholders;
- During exchange visits between Germany and Kenya, it became evident that KALRO had some technical capacity gaps, especially in regard to sample testing and aflatoxin analyses as they lacked the necessary equipment for such activities;
- Partners demonstrated varying levels of commitment to the work of the consortium, therefore, there was inconsistency in the level of detail and timeliness in submission of project documents, such as financial reports and progress updates;
- Calls for proposals are not always in line with the strategies and needs of local farmer organizations. Therefore, they can be difficult to respond to or implement;
- Identifying EU partners was very difficult because most European researchers were more interested in producing academic papers than in development proposals;
- Budget allocations between African and European organizations was an issue – most of the work was being done in Africa, but the African partners received a lower budget than their European counterparts.

> Looking ahead and sustainability

The consortium will continue its activities as the problem of aflatoxin contamination and spread continues to impact agricultural production and human health. A positive result of the consortium's ULP approach under PAEPARD is that local farmers and farmers' organizations are more confident to work with researchers, and to take part in future participatory projects.

The consortium has entered into a partnership with the Food and Agriculture Organization and the International Livestock Research Institute to provide Kenyan farmers with training on the production of poultry, dairy and small ruminants, to reduce aflatoxin intake and spread. They have also responded to an EU call for proposals to develop the commercial livestock sector in Kenya.

The AFLAZ project, which succeeds AFLANET, is an example of how the activities of the consortium will be sustained beyond the PAEPARD lifespan. Moreover, EAFF plans to hold permanent national dialogues between consortium partner members, policy makers and other stakeholders of the livestock sub-sector, on issues relating to livestock feeding – with a focus on aflatoxin control. Through their involvement in the AFLAZ and AFLANET projects of the consortium, EAFF has increased their own visibility to a point where they are now able to mobilize external resources of other research organizations.

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Groundnut field visit in the presence of farmers and researchers for strong impact on innovation adoption or adaptation (Malawi, 2018).

Revisiting farmers' practices to minimize groundnut contamination in Malawi and Zambia

INTRODUCTION

In Malawi and Zambia, groundnut is a staple food and cash crop. In Malawi, it is grown by one-third of the country's farmers, most of whom are women. Because the crop requires minimal investment and has substantial nutritional and dietary benefits, it holds a prominent place in both the human and animal food chain. Groundnut is also a major source of revenue, however, groundnut products from the two countries have very little access to international markets because they have a reputation for containing high concentrations of aflatoxins.

Aflatoxins are poisons produced by a variety of Aspergillus fungal species that are capable of depressing immunity in animal species and humans, blocking nutritive substances of ingested food, and causing cancer. Current estimates from the African Union (AU) suggest that the continent loses up to US$700 million annually in lost exports because agricultural commodities contain aflatoxin levels that are too high for European and other international markets. AU figures also indicate that aflatoxins are responsible for more than 40% of liver cancer in Africa (WHO, 2018).

Various interventions have been promoted at the farmer level to combat aflatoxin contamination, but adoption of new practices and technologies has been low, often because the cost burden lies with small-scale producers. To tackle pre- and post-harvest loss as a result of aflatoxins, and improve food safety in the groundnut value chain, a consortium was founded in 2014 to promote sustainable aflatoxin control mechanisms and, as a result, significantly increase food and nutrition security.

The consortium was made up of partners from the National Smallholder Farmers' Association of Malawi (NASFAM), Zambia's Eastern Province Farmers' Cooperatives (EPFC), FANRPAN, the University of Greenwich's Natural Resources Institute, Malawi's Department of Agricultural Research Services (DARS), the Zambia Agricultural Research Institute, and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). The consortium specifically focused on providing:

1) *Pre- and post-harvest loss research* by identifying, validating and disseminating successful aflatoxin contamination reduction practices and technologies best adapted to smallholder farmers in Malawi and Zambia.
2) *Technical advice* by implementing capacity building initiatives and awareness campaigns to disseminate prioritized practices and technologies.
3) *Policy advocacy* by conducting multi-stakeholder platforms at local, national and regional levels to enable learning and sharing of experiences in order to increase the awareness of policy makers and strengthen policies and regulatory frameworks with evidence.

> Activities and achievements

Pre- and post-harvest loss research

The consortium launched a project in October 2014, entitled *Stemming Aflatoxin pre- and post-harvest waste in the groundnut value chain* (GnVC) *in Malawi and Zambia to improve food and nutrition security in the smallholder farming families,* which ended in July 2018. Project activities included farmers and researchers collaboratively evaluating the effect of several pre- and post-harvest technologies and practices on aflatoxin contamination of groundnuts. Notably, it involved the participatory evaluation of the effects of: (1) optimum plant densities and (2) drying methods for reduced aflatoxin contamination of groundnuts.

During the 2015-16 growing season, research involving 100 farmers across four districts in Malawi found that shifting from planting single to double rows in groundnut cultivation significantly increased yield (by about 20%), but compromised pod development and size. However, there was no significant difference in terms of aflatoxin levels at harvest. On the other hand, while using the common practice of applying crop residues to soil for enhanced soil fertility, the risk of pre-harvest mould development and insect damage significantly increased. However, there was no effect on aflatoxin prevalence, suggesting that the moulds identified were not aflatoxin-producing species.

Inverted windrows (left) and Mandela Cock (right). Source: Matumba et al, 2018.

Prompt reduction in moisture content in harvested groundnuts is critical for reducing aflatoxin contamination during storage. Another project experiment involving 29 farmers during the 2015–16 growing season and 26 farmers during the 2016-17 season, compared two drying methods: the traditional inverted windrow technique (after harvest the groundnuts are laid in between soil ridges with the pods facing upwards); and a new technique – Mandela Cock – which involves a ventilated stack of groundnut plants with a chimney at the centre. Although Mandela Cock is a new technology being promoted in Southern Africa, the experiment found that it led to significantly higher aflatoxin levels compared to the inverted windrow technique (5.7 µg/kg vs 2.5 µg/kg in 2016 and 37.6 µg/kg vs 8.4 µg/kg in 2017) (Matumba et al, 2018). This result clearly demonstrates the need for improved regulation and technology validation if farmers and consumers are going to benefit.

Technical advice

In order to ensure that farmers are aware of the issues caused by aflatoxins, and have the requisite knowledge and skills to reduce groundnut contamination, a number of approaches were deployed during the consortium project. Sensitization meetings and leaflets, for example, were provided to stakeholders with information on the causes of aflatoxin contamination, its effects on humans and livestock, and how farmers and other value chain players can reduce contamination.

Farmers participated in pre- (comparison between double row and single row) and post-harvest (the Mandela and the inverted windrow) on-farm demonstrations and field days as a way of encouraging validation of the practices. Lead farmers were paired with extension officers to provide information to fellow farmers, which enabled the best practices to be spread locally and to strengthen farmer involvement and ownership of the technologies being showcased. Although these events required considerable time and effort, after taking part, the producers more readily adopted the practices as they perceived them to be suited to the local conditions; seeing is believing. In total, the project directly reached 5,708 farmers.

Some participating farmers were also trained in good agricultural practices, as well as on how to collect crop performance and environmental data from the demonstration plots. A video on groundnuts, produced by NASFAM in Chichewa, English and French was also produced and posted on the Access

Agriculture platform (2017), which showcases agricultural training videos in local languages.

Policy advocacy

One of the consortium's aims was to turn research results into policy. In order to contribute to regional policy formation processes, the annual FANRPAN policy dialogues provided a useful platform to reach out to stakeholders on the issues of general post-harvest management and focus in on the problems caused by aflatoxins. Key recommendations stemming from these events include:

- Develop policy frameworks that encourage and promote the participation of entrepreneurs along the groundnut value chain, with particular emphasis on reducing post-harvest losses and improving market access;
- Establish an integrated approach throughout the groundnut value chain to stem aflatoxin contamination. Collaborative MSP are critical;
- Increase funding from governments and development partners to establish and enforce standards that are on par with international standards on aflatoxin control;
- Research and development should be a key pillar in reducing aflatoxin contamination and should consider traditional knowledge on aflatoxin control.

Overall, the consortium has seen an increased uptake of post-harvest management practices and technologies, which has improved food availability and income generation. Synthesizing and communicating groundnut research has also increased knowledge of aflatoxin contamination among farmers, policy makers, the private sector and NGO. The ability of such actors to appraise and use research evidence in decision-making – to support policy processes, investment decisions and programming – has also improved. By 2017, a total of 5,708 farmers (over 50% of whom were women) had either taken part in the participatory research, or received targeted extension services through publications, radio broadcasts or face-to-face demonstrations. On a secondary level, livestock farmers have also benefited because safer, healthier groundnuts will provide them with a source of high-quality animal feed (with potential to scale out).

> Challenges and lessons

- A lack of well-coordinated planning and clear definition of partner roles and responsibilities, as well as the lack of a shared vision among partners, stalled project activities during the first year. As a result, information flow between researchers, extension workers and policy makers was very limited;
. The active participation of NASFAM and EPFC farmer networks in consortium activities was vital to ensuring the dissemination and uptake of aflatoxin control mechanisms (Makwenda et al. 2016), and highlighted the need for a holistic approach to the challenges facing farmers.
. The consortium capitalized on ongoing initiatives at both the national and regional level. For example, joint advocacy actions with the Malawi Partnership for Aflatoxin Control helped to disseminate information to a wider audience, and national and regional policy dialogues held by FANRPAN amplified the consortium's voice.
. Social media platforms were employed to showcase research findings and recommendations to the private sector and development partners.
. Student involvement: In the course of implementation, students from the Lilongwe University of Agriculture & Natural Resources were brought on board to assist with field data collection. The students, who also worked on applying the aflatoxin research, received hands-on participatory training, which will prove useful in their future careers.
. EPFC collapsed part-way through the project and pulled out, which directly affected the numbers of farmers that could be reached in Zambia, and the level of extension services provided, particularly in the 2016-17 season. However, NASFAM stepped in to provide backstopping services to ensure that as many farmers as possible received advisory services.
. The consortium was not able to raise the level of funds it needed to mobilize the required expertise and ensure adequate levels of involvement of all partners. The project, nevertheless, produced various positives – many actors were involved in a research process for the very first time, and smallholders willingly contributed to the project's success and adopted innovative new practices.

> Looking ahead and sustainability

Building on its work so far, the consortium is moving from short-term, informal relationships to a more durable and pervasive relationship where is it not simply concerned with sharing information, but in engaging in joint planning, shared commitments to common goals and contributing to rewards and leadership among all partners.

Project partners have been exposed to various capacity strengthening workshops in communication, resource mobilization and project implementation, which have enhanced their capacities to work with other players of different value chains. NASFAM Commercial, a branch of NASFAM, would benefit from partnering with research organizations (DARS, ICRISAT etc.) to ensure the quality of groundnuts produced by their farmer members meet the requirements of domestic and export markets (Matumba *et al.,* 2015).

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Partnership on AIV was also sharing experience and knowledge among farmers with scientists and practitioners.

Promoting African indigenous vegetables in Uganda

INTRODUCTION

Indigenous vegetables contain vitamins and minerals, which are essential in the absorption and metabolism of food ingested by the body. In East Africa, hundreds of indigenous vegetables exist that contain vital vitamins and minerals such as β-carotene, vitamins C and E, folates, zinc and calcium, but these are not adequately consumed in staple diets. In Uganda, the average consumption of fruit and vegetables is estimated to be 200 g per person per day, which is far below the recommended daily minimum intake of 400 g (FAO-WHO, 2017). The inadequate intake of fruit and vegetables is one of the major causes of malnutrition in urban and rural populations in the country, where over 21% of people are classified as under nourished and 38% of children are malnourished (FAO-WHO, 2017). However, some types of indigenous leafy vegetables in Uganda are popular and widely grown, for example, the most commonly eaten indigenous vegetable in Central Uganda is 'Nakati' (*Solanum aethiopicum*), which is mostly cultivated by women farmers. Some types of Nakati are eaten for their leaves and others for their fruits. *Amaranthus* is another indigenous group of plants that are consumed in the country, including 'Bbuga' (*Amaranthus gracecizans*) and 'Doodo' (*Amaranthus dubius*).

The accessibility of African indigenous vegetables (AIV) in Uganda is limited, especially in urban areas, due to their seasonality and short shelf life. Insufficient attention has been given to AIV as seen by limited funding for AIV research, thus they remain neglected and underutilized (Rubaihayo, 2002; Mbugua *et al.,* 2009; Meldrum, 2018). Subsequently, information regarding effective preservation and processing techniques to ensure a steady supply of AIV throughout the year is scarce. Potential consumers complain about the inconsistency in AIV availability and the poor quality of products, due to the long distances produce has to travel coupled with poor post-harvest handling practices.

Recognizing these challenges, the AIV consortium in Uganda sought to improve post-harvest handling and preservation of indigenous vegetables (especially

Solanaceae sp.) in order to prolong their shelf life. This was expected to increase their consumption among vulnerable populations, while increasing the revenues of those engaged in their production. The aim of the consortium therefore was to demonstrate the economic benefits of AIV cultivation to farmers, and promote the income and nutritional benefits of their consumption.

> Activities and achievements

PAEPARD provided investment and support to the consortium in 2014 following which, the partnership launched a project *Enhancing nutrition security and incomes through adding value to indigenous vegetables in East and Central Uganda,* with the aim of improving post-harvest handling and processing of AIV. It was envisaged that this research would prolong AIV shelf life, even out seasonal supply and, as a result, increase consumption among nutritionally vulnerable populations.

Initial support in convening the AIV consortium was provided by RUFORUM, who subsequently remained an important partner of the group, suggesting stakeholders that might enrich their ongoing research. The work of the consortium was implemented by a core team of stakeholders, namely, the Uganda Christian University (UCU), the Coalition for Health Agriculture and Income Networks (CHAIN) Uganda (a local NGO), and private sector enterprise, FARMGAIN Ltd (FGA). The NRI (UK) was the European partner. These partners were involved in all stages of the research development, from generation of the initial idea and proposal writing, to implementation, monitoring and evaluation. Each partner also had their own specific role and/or activity that they were individually responsible for – as determined within consortium agreements – and research developments were communicated to all stakeholders through monthly and quarterly meetings. UCU was in charge of overall coordination for the AIV project and for providing technical information regarding crop improvement to the consortium. Other stakeholders based in Uganda included sub-county local governments, a local NGO, Caritas Uganda, and farmer organizations – Namulonge Horticulture, Butiki-Kyekidde Women and Youth Irrigation Group, and Mbale Vegetable Farmers – who were all responsible for mobilizing smallholder farmers to engage with the consortium activities.

Technical backstopping and other forms of research support to the consortium came from international research institutions, such as the World Vegetable Centre, based in Arusha, which provided reference AIV

The consortium contributed to raise awareness among consumers and the youth, mainly through student graduation.

germplasm. From the UK, the Natural Resources Institute was responsible for identifying and cataloguing all available technologies and methods of prolonging the shelf lives of indigenous vegetables, and the Centre for Agriculture and Bioscience International was involved in germplasm collection and sharing information at the innovation platforms they organised.

As part of the AIV project, the consortium aimed to identify appropriate processing and handling technologies, and to deliver quality and competitive AIV-derived products. To achieve this, UCU worked with a consultant from Makerere University and carried out research into appropriate methods of vegetable handling and processing, such as drying, vacuum packing, minimal processing and refrigeration. CHAIN Uganda organized a participatory survey in 2015 to gather information from local farmers and processors regarding the then-current AIV post-harvest handling and processing technologies, such as vegetable drying. Such techniques were then profiled, tested and refined for scaling out by UCU.

Extensive testing of various post-harvest technologies was carried out to determine which were efficient in extending the shelf lives of AIV. A technology based on charcoal and wind energy to cool a chamber was innovated that was eventually able to extend vegetable shelf life from one to four days post-harvest. This additional time allows the farmers to store any vegetables that have not been sold at the market for the next day. Two charcoal coolers have since been constructed by the project in the districts of Jinja and Wakiso, where previously, farmers stored their harvested vegetables in their houses or in the shade of big trees, incurring significant losses.

Further, post-harvest packaging methods for maintaining AIV without degrading their nutritive value, taste and presentational characteristics were also developed with the participation of the project beneficiaries. For instance, thin perforated polyethylene bags were identified as appropriate materials to maintain AIV appearance, texture, flavour and safety during transportation to markets, increasing their popularity at the market. "Quality is very important for our business to thrive. The improved packaging materials have greatly helped us during transportation of our vegetables to the market," says Mr. Odongo, a farmer from Jinja.

A nationwide survey was also conducted by UCU to collect seeds of indigenous vegetables from different regions in the country. Over 180 vegetable accessions – of which 71 belonged to the *Solanaceae* family – were assembled. With these collections, a germplasm and AIV conservation centre has been established at UCU, where the species with farmer-preferred traits (i.e. yield potential and taste) have also been identified. UCU further engaged farmers in participatory germplasm selection to ensure acceptability of the end products. Four accessions are soon to be released for the first time, as varieties for farmers to plant.

To further assess local demand for the collected varieties, market studies were conducted by FGA in the major municipalities of Jinja, Kampala and Mbale. Benefits and costs of indigenous vegetable trade were established and quantified. Farmers were linked with key stakeholders, such as the International Institute of Tropical Agriculture youth group, and with end markets in Jinja and Wakiso district. In addition, farmers were able to open retail markets in Kampala and Entebbe, targeting high-end consumers with high value vegetables, including AIV. The farmers in Jinja, Mbale and Wakiso were also trained in business dynamics. As a result of these interventions, one youth farmer, Eria Matovu from Namulonge Horticulture in Wakiso, has opened a vegetable outlet in Kololo (a high-class suburb in Kampala), at the US embassy in Nsambya, Kampala, and at the UN base in Entebbe.

The consortium also held field demonstrations and training sessions with farmers to develop their capacities and encourage AIV cultivation. The training was multi-disciplinary and included agronomy and related topics such as agro-chemical use; seed processing; AIV nutrition and appropriate cooking methods to conserve their nutritive value; post-harvest handling, storage and preservation; and leadership. Prior to the consortium's work in the project areas during 2016 and 2017, no one in the local communities had grown vegetables for seed production and very few sold their leafy vegetables at local markets. Through the work of the AIV project, seed has become an emerging business and, by July 2017, over 5,390 packs of 50 g AIV seed had been produced and sold by the local farmers to other vegetable producers. Thus, the project enabled farmers to earn beyond their average income by creating an additional income opportunity.

To increase the reach of the consortium's messages about AIV, FGA contracted a media expert to train the project team partners on how to develop radio content. This training aimed at improving the scientists' abilities in communicating the project key messages to the non-scientific, target audience who would be listening to the radio programs. The consortium took advantage of this media opportunity to share results from the ongoing research and also to train farmers on various topics concerning vegetable production. Namirembe FM and NBS FM presenters also promoted the work of the project and used radio scripts and project posters, produced by the consortium, during 20 talk shows between April and September in 2017. Through the radio programs, as well as through other means of information dissemination, such as school farm camps, exhibitions and trade shows, over 5,000 people were reached with project messages.

Over 250 farmers received training through the project and the capacity of 11 undergraduates, seven masters and one PhD student were built. As a result, a total of 12 papers, 18 student theses, four video documentaries, one impact booklet, printed banners and leaflets were published and used at visibility events. These materials are available online at the AFRISOL website (http://afri-sol.org/).

> Challenges and lessons

In relation to the project partnerships, the consortium highlighted the issue with regards to some stakeholders expecting monetary handouts for participating in the project. Due to limited available funds, there were particular challenges with achieving sustained engagement of the European partner. The consortium also highlighted the problem of key stakeholders leaving the group, for instance, Kirinya Farmers Group, who had been on board from the start but pulled away during the process due to the loss of their hired farmland.

In the project districts, the consortium faced unavoidable and unpredictable disruptions related to issues of land fragmentation and the vagaries of nature – i.e. drought, pests and diseases. Other issues concerned the unavailability of inputs, for example, the project started without AIV foundation or breeder

seed. Timing was also a constraint, with only 36 months for the implementation of activities, and this meant that some aspects were still only in their infancy when the project came to a close.

Partnerships are an effective vehicle for running a cross-cutting project like this, which focused on improving aspects of nutrition, income and capacity building among Uganda's vulnerable populations. The multi-stakeholder consortium was able to bring together a plethora of institutions and disciplines to work jointly in creating and disseminating the project solutions. The multidisciplinary nature of the partnership also meant that the project was able to address any research problems as they arose.

The project partners shared a common interest of addressing malnutrition in Uganda and were keen to work together, however, the partnership process is slow and therefore long planning horizons are needed when implementing such a project. Monthly and quarterly interactions are necessary to avoid conflicts and misunderstandings within consortia. Such interactions also provide a feedback mechanism where project issues requiring research attention can be discussed and resolved.

The local universities were very supportive because the priorities of the project fit with their community outreach programs. The consortium work also directly supported the National Seed Policy, as implemented by the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), to create a competitive, profitable and sustainable seed sector where farmers access affordable quality seed and planting material. For research projects to secure local support and partnerships, it is therefore essential that their work fits with the local agenda and policy environment.

It is also necessary to recognize the importance of community input before deciding what project or program to implement. When empowered, communities can play a bigger role within projects, together with other stakeholders such as the private sector, community-based organizations and universities acting as supporting links that come together from diverse sectors of food systems. The leaders in these communities are better placed to advise government and advocate for the needs of those same communities. However, there must be greater investment in long-term research, breeding programs and improved seed supply sources for AIV crops. Such measures would help to ensure AIV can be competitive in the marketplace, and resolve the malnutrition burden in sub-Saharan Africa.

A diversity of high value African indigenous vegetables (AIV) are now available in central Uganda.

Participatory learning is an effective approach for putting smallholders in the 'driver's seat' of research action and encourages technology adoption. In this instance, the approach enabled the farmers to identify the research problems relating to AIV production, and pursue solutions and opportunities, such as vegetable seed production and marketing of value-added products. On the other hand, the participatory approach is a gradual process that requires time to create community linkages, and cut through social barriers such as local language, that need to be addressed and overcome to ensure acceptance and interaction with farmers.

> Looking ahead and sustainability

UCU has positioned itself as a center of excellence for AIV research and development by developing a robust community-centered outreach and engagement program that integrates community nutrition, experiential learning and localization of scientific knowledge. Currently, UCU is breeding AIV varieties with important traits, such as drought tolerance, to help mitigate against the impacts of climate change. This research focuses on increasing the resilient production of *Solanum aethiopicum* by developing irrigation strategies to improve production, using soil amendments to improve soil health, as well as adopting plant preconditioning to improve crop resilience. Biodiverse germplasm collections will also be phenotyped and genotyped to record their resilience to water stress in order to provide markers for breeding. The university will continue to carry out this work, which is led by the UK's National Institute of Agricultural Botany and run in partnership with the World Vegetable Center, the Mikocheni Agricultural Research Institute and the World Agroforestry Centre, until 2021.

[1] http://chainuganda.org/Vegetable_project.html

FOR MORE INFORMATION

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The AIV consortium – as a whole – is continuing AIV research by contributing to the development of a seed system for *S. aethiopicum* and *Ammaranthus sp.* under a new project entitled, *'Development of a Gender Responsive Commercial Seed System for African Indigenous Vegetables in Uganda'*[1]. With funding from the Dutch program NWO-WOTRO, the project is supporting the identification and replication of positive business models for the effective upgrading and deepening of AIV seed value chains. This work is expected to unlock new market opportunities for AIV seeds and, thus, contribute to improving market structures for AIV and functional commercial AIV seed systems in Uganda. The partnership project will run until 2020 and is led by CHAIN Uganda, with UCU providing the technical aspects on the seed, MAAIF providing regulatory oversight with regard to seed certification, and Hanze University of applied sciences (The Netherlands) as the new academic European partner.

Conclusion

This book presents the final thoughts of the project consortia, partners and end users involved in PAEPARD. It does not present an exhaustive list of the lessons learned by the PAEPARD-facilitated MSP consortia, but constitutes a point of reference from which further studies can be carried out. Whereas most of the previous PAEPARD publications have been driven by PAEPARD management, this document is written from the outputs of each consortium, to allow them the opportunity to express their own views and reflections on the MSP formation process facilitated by PAEPARD. The main lessons are therefore taken from evidence and recommendations drawn from the consortia experience of this process.

The evidenced strength of multistakeholder partnership

All consortia members brought long-standing experience and technical know-how to the MSP, which helped to address the identified development challenges. However, a key lesson for many consortia was the need to involve a range of partners with complementary skills. Where the capacities of consortium partners were diverse, a more flexible research strategy was developed to better meet the requirements of donors and end-users. On the other hand, the involvement of numerous stakeholders from different sectors led to difficulties in the development of a shared vision among partners. To address this issue, PAEPARD designed the six-stage ULP process, which encouraged consortia to conceive a long-term shared vision for creating and implementing their projects from the outset.

The ULP approach also turned out to be a key element of success for encouraging ownership of consortium activities among target groups. The participatory method enabled consortia to respond effectively to specific needs expressed by the end users and ensured the innovations were user friendly, effective and affordable. A clear example of this can be seen in the Benin soybean chapter, where women processors were linked with researchers to improve soybean processing technologies and products, such as soybean milk. Twelve women cooperatives with a total of 1,500 members have since adopted the technologies.

Identifying and enabling leadership

Good leadership also played an important role in determining the success of the consortia. In Togo, for instance, the consortium lead CASADD-VR played a critical role in transferring information and technology between research entities and farmer groups, as well as empowering all partners to participate in their various roles. The consortium successfully introduced improved pepper varieties to the country, and, as a result, 10,000 Togolese pepper farmers have increased their production and revenues. Conversely, where strong leadership was lacking, e.g. in the mango waste energy-compost consortium, where the co-leaders – SNV Burkina Faso and Gebana – left, the group did not have the capacity to initiate any project activities. The consortium also had difficulties in sustaining partnerships in the absence of clear leadership, and was unable to deliver on the objectives outlined at the inception workshop.

Strengthening capacity to partnering

Strengthening and sustaining consortia partnerships was a significant challenge for many MSP. The geographical distance between partners exacerbated this issue, and meant bringing actors together for certain workshops and physical meetings was particularly difficult. In some cases, the absence of regular meetings among stakeholders led to confusion on the expected roles and responsibilities of each partner. To overcome this issue, PAEPARD developed an internal intranet platform to communicate research findings and project updates to existing partners, and trained consortia members in its use. The Ghanaian, Nigerian and Togolese consortia also established WhatsApp communication channels, through which they were also able to scale out their activities to new partners and beneficiaries by adding them to the group as they engaged with the project. The use of these interactive and convenient forms of communication helped to build trust among consortia partners, and as PAEPARD comes to an end, will allow for continued information exchange between members.

Training for consortia in communication and knowledge management was also crucial for increasing project visibility, as well as credibility for the 'younger' organizations that needed to strengthen their management systems. As a result of the training, consortia partners came to realize that information and knowledge dissemination are essential for running an innovation project, converting scientific results into impacts, and attracting additional human and/or financial resources. As such, throughout their projects, the consortia produced numerous online and printed publications, both scientific and strategic, to scale-up their findings, their efficiency and their influence. Many consortia also elected a communication officer who was in charge of developing web pages and updating any social media channels for the MSP.

The involvement of in-country representatives from the public and private sectors contributed to enhancing awareness of consortia activities, and project sustainability. For instance, before PAEPARD support for the Burkina Faso consortium came to an end, the NGO partner, ARFA, trained extension workers to promote uptake of *Trichoderma sp.*-enriched compost among small-scale farmers. Additionally, one of the private sector actors, BIOPHYTECH, has invested in and developed two more *Trichoderma* ventures in Senegal and Côte d'Ivoire. The presence of private sector actors within consortia also helped to broker new relationships between farmers and agribusinesses – as seen in the Ghana citrus consortium – and provided a new platform for discussion between the two groups.

Generating support is a learning process

For most consortia, securing funds from donors was the biggest challenge. Initial financial support from PAEPARD provided the fuel required to commence project activities, and momentum generated by the MSP also helped in securing additional funds. However, many consortium partners learned that to be successful and sustainable, they would need to adjust their expectations – from anticipating financial support to creating their own income-generating opportunities. As such, some consortia implemented activities under their own company or institution agenda, or formed business links between consortia members. To secure future opportunities and continue consortia activities, many groups are also looking to diversify their research agendas to match donor priorities.

Several sustainability models are exemplified among the consortia: those that are fully dependent on the facilitation skills of the coordinating partner to scale out the innovation (the soybean and East Africa livestock feed consortia); those that are more federative and are looking at possibilities to scale up or scale out, building on what they have learned over the MSP process (the *Trichoderma* and mango waste consortia); and many others that developed their own path to use their resources to achieve development, impact and prosperity.

PAEPARD

The Platform for Africa-Europe Partnership in Agricultural Research for Development (**PAEPARD**) is an 11,8-million Euros project over 8 years sponsored by the European Commission (80%) and partners' own contributions (20%). It has been coordinated by the Forum for Agricultural Research in Africa (**FARA**) since December 2009, and was extended until end of 2018.

It aims at building joint African-European multi-stakeholder partnerships in agricultural research for development (**ARD**) contributing to achieving the Sustainable Development Goals. On the European side, the partners are **AGRINATURA** (The European Alliance on Agriculture Knowledge for Development, coordinating the European partners), **COLEACP** (representing the private sector), **CSA** (representing the NGOs), **ICRA**, specialized in capacity building in ARD, and **CTA** (the Technical Centre for Agricultural and Rural Cooperation). On the African side and in addition to FARA, the partners are the Pan-African Farmers Organization (**PAFO**), the Regional Universities Forum for Capacity Building in Agriculture (**RUFORUM**), and the Food, Agriculture and Natural Resources Policy Analysis Network (**FANRPAN)**. PAFO involves its members which are the Eastern Africa Farmers Federation (**EAFF**) based in Nairobi, the Réseaux des Organisations Paysannes et des Producteurs d'Afrique de l'Ouest (**ROPPA**) based in Ouagadougou, and the Plate-forme Régionale des Organisations Paysannes d'Afrique Centrale (**PROPAC**) based in Yaoundé. The Southern African Confederation of Agricultural Unions (**SACAU**) is an associate partner of **PAEPARD**.

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