

A photograph of two women in a rural setting. The woman on the left is wearing a light blue shirt and a beaded necklace. The woman on the right is wearing a white sleeveless top and a blue headwrap. They are both looking at a smartphone held by the woman on the right. The background is a lush green field with tall plants.

Annual report 2019



CIALCA 2017-2020

Catalyzing partnerships,
capacity building and research
towards entrepreneurial
farming in Central Africa

AUTHORS AND ACKNOWLEDGEMENT

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Preface

Dear friends of CIALCA,

It is with great pleasure that we present to you the Annual Report 2019 of the Consortium for Improving Agricultural Livelihoods in Central Africa, also known as CIALCA.

We're writing this preface in the midst of the Corona virus crisis, which is disrupting daily life and human health globally. The CIALCA network is strongly connected with each other and we monitor the situation and how it impacts rural livelihoods in the Great Lakes Region. We thereby also realize how critical our three pillars of action are as a strong backbone for a resilient consortium: partnerships, capacity building, and innovations. This backbone has withstood numerous challenges over time that we have faced in the Great Lakes Region, from war to volcanic eruptions to food crises. Where useful and where requested CIALCA will make its network and services available to help fight this global crisis.

For CIALCA, 2019 was a good year. We made excellent progress along our three Pillars, had a very successful Mid-term Review meeting with strong partners and donor representation, attracted complementary funding to ongoing CIALCA initiatives, and launched our CIALCA-data-base (CIALCA-base) as an integral part of our new website www.cialca.org.

As part of our work under Pillar 1 'Partnerships and Policies', we signed a Memorandum of Understanding with the American Refugee Committee (ARC) and existing collaborations with the National Agricultural Research Systems of Burundi, Rwanda and DR Congo and other partners were continued, renewed and even expanded. Under Pillar 2 'Capacity Development', we are happy to report that currently 8 PhD-students are conducting their doctoral studies with Belgian Universities under the CIALCA umbrella. In this Annual Report, several of them share their personal stories. Under Pillar 3 'Innovation and Scaling', we completed a first season of fertilizer trials for cassava in Rwanda, Burundi and eastern DR Congo and the second season has been planted. This means that we can start calibrating the digital fertilizer recommendation tool in the region, for which there is a lot of interest from agricultural service providers.

Two other 2019 achievements that are worth highlighting are the launch of CIALCA-base as integral part of our new website, and attracting additional investment that builds on or

strengthens the CIALCA work. First, CIALCA-base is the first step in realising a long-term ambition of CIALCA to bring together and avail all CIALCA data in one centralised, online database that is accessible for our staff, partners and students. It has also demarcated the start of standardised household and agricultural data collection across all CIALCA activities. Second, CIALCA collaborated with the African Cassava Agronomy Initiative (ACAI) in attracting USD 1 Million from the CGIAR Research Program on Roots Tubers and Banana (RTB) to scale the cassava fertilizer recommendation tool with private sector partners, and to other crops in the region. In addition, the IAEA funded a regional Technical Cooperation Project of EUR 1.5 Million for 4 years which will focus, with the technical support of the Joint FAO/IAEA Programme on Nuclear Techniques in Food and Agriculture, on strengthening capacity in Burundi, Rwanda, DR Congo and 12 other countries on the use of isotopes for enhancing productivity and climate resilience of cassava-based systems through improved nutrient, water and soil management. Lastly, the Bill and Melinda Gates Foundation and the Rwandan government are co-investing USD 2 Million in the Rwanda Agricultural and Livestock Resource Development Board (RAB) and IITA to develop a Rwanda Soil Information Services (RwaSIS) that can inform country-wide investment decisions on soil fertility and erosion control, and aligns with the site-specific fertilizer recommendation work under CIALCA. These are good examples of how CIALCA continues to leverage and attracts investments in agricultural development in the Great Lakes Region.

In terms of our agricultural research for development mandate and role in the Great Lakes Region we are entering interesting times. The largest global agricultural research for development partnership, the CGIAR that also governs CIALCA, is redefining its position and agenda as part of transition towards 'One CGIAR'. As part of its transition process, it is moving towards a new agenda that focusses on addressing the world's grand challenges around five areas of impact. CIALCA is strongly positioned to guide such new agenda and investments in the Great Lakes Regions, which is why we decided to organise this CIALCA Annual Report 2019 around those five Areas of Impact: Gender, Climate, Poverty, Nutrition, and the Environment.

On behalf of all colleagues, partners and friends of CIALCA, we wish you pleasant reading of this CIALCA 2019 Annual Report.

Dr Marc Schut (CGIAR/ IITA)
Dr Roseline Remans (CGIAR/ the Alliance of Bioversity International and CIAT)
Dr Gerd Dercon (FAO/IAEA)
CIALCA coordinators

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Highlights 2019

in the Great Lakes Region

1

How understanding heterogeneity strengthens inclusive commercialisation of agriculture

CIALCA is supporting One Acre Fund in better understanding and tailoring agricultural innovation delivery to its 300,000 men and women farmer clients in Rwanda. This research co-invested by CIALCA and One Acre Fund, has resulted in the generation of six potentially representative farm types of Rwandan agricultural systems and the development of a mobile phone application "Know your farmer". This is a pioneering step that One Acre Fund and partners consider a promising mechanism to more inclusively serve their diversity of farmer clients with tailored packages and more efficiently identify new ones.

For more information, please see page 11.

2

How isotopes help build resilience to climate change

Climate change is expected to cause an increase in frequency and duration of dry spells in Central and Eastern Africa. This will lower yields of cassava and banana consumed daily by approximately 6 million people in the highlands of Burundi, DRC and Rwanda. To cope with problems of drought stress in cassava and banana cropping systems, CIALCA adapts stable isotope techniques based on carbon-13 and oxygen-18 for cassava and banana systems. Those innovative techniques will help the national research systems and businesses accelerate the variety selection, choice of planting time and fertilizer application to counteract the effects of drought in cassava and banana production.

For more information, please see page 15.

3

How ICT improves productivity

Low cassava and banana yields and inefficient use of inputs remain a major bottleneck for farmers to increase their income. In collaboration with national and international research institutes, including the International Fertilizer Development Center and the African Cassava Agronomy Initiative (ACAI), CIALCA is developing digital decision support tools to optimize farmer's return on fertilizer investment in the Great Lake Region. To this end, CIALCA conducted this year 121 nutrient omission trials in the three countries and has 120 new trials on the ground. The harvested information feeds into decision tools that can support national fertilizer subsidy programs and recommendations.

For more information, please see page 21.

4

How systems approaches improve nutrition in the Great Lakes Region

Diet diversity in the Great Lakes Region is particularly low, with very low consumption and limited supply of vegetables, fruits, nuts and seeds, and animal-based products. To act upon this, CIALCA continues to help mainstream nutrition and agrobiodiversity in agriculture and markets through nutrition-smart metrics, technologies and partnerships. In 2019, a new co-investment partnership model has been signed with ALIGHT in Rwanda, to support the development of more sustainable and healthy food systems, that can help diversify the diets of their 150,000 refugees and hosting communities. For banana-based systems, synergies and tradeoffs between nutritional yield and operating profit have been identified depending on farm typology. This helps inform options for commercialization pathways that can benefit and do not harm household nutrition.

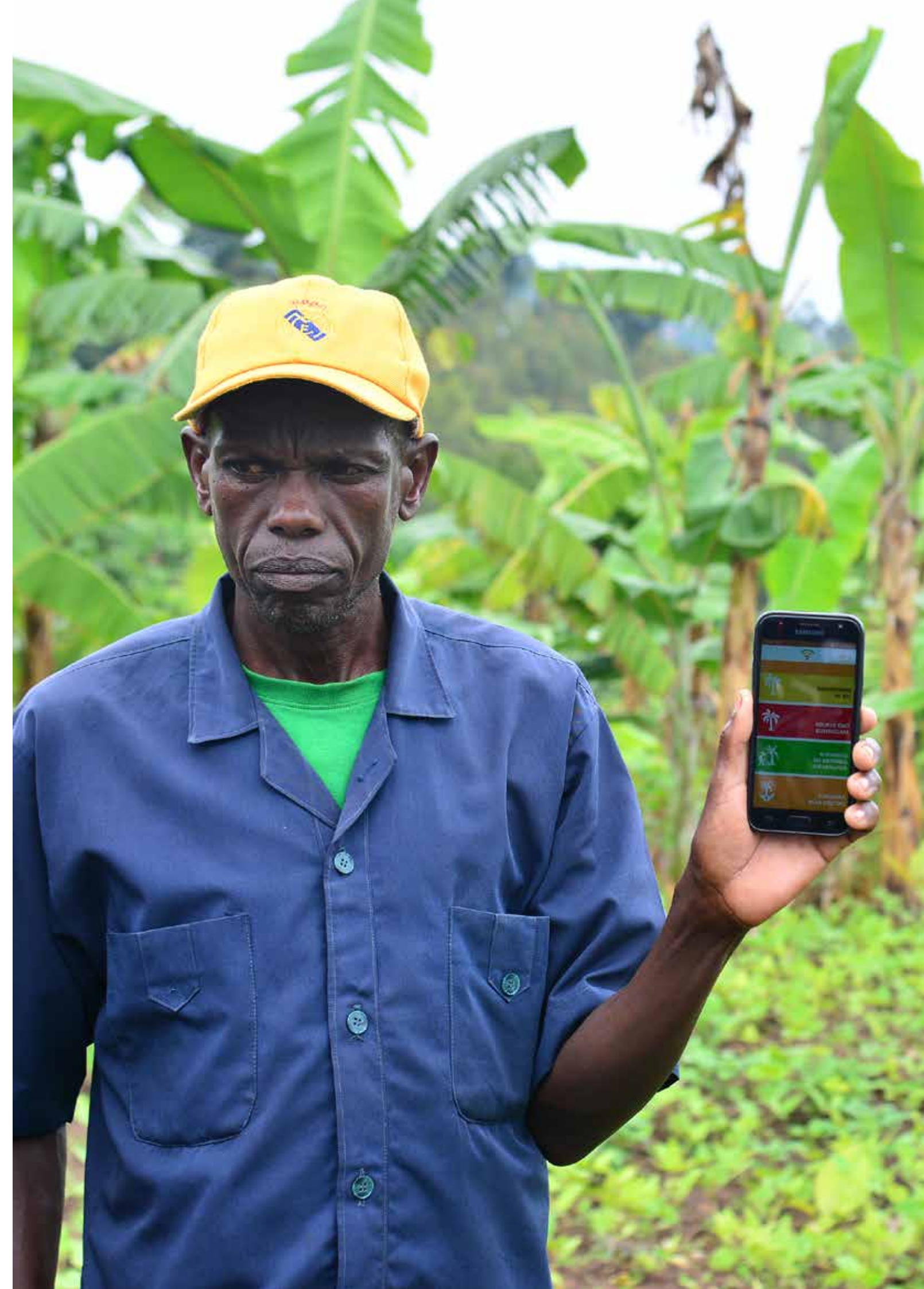
For more information, please see page 25.

5

How agriculture can be a positive driver for environmental sustainability

High population density, unsustainable farming practices and climate change put pressure on the beautiful and diverse ecosystems in the Great Lakes Region. In collaboration with the national research systems, CIALCA explores strategies for increasing the resilience of banana-based agroecosystems and the supply of ecosystem services in those production systems. Agro-ecological practices, such as the integration of shade_ and drought_tolerant crops, the management of hedges and small habitats, nitrogen_fixing and cover crops show promising potential in a variety of settings in the Great Lakes Region to improve soil fertility and moisture retention, reduce the weed burden, narrow yield gaps and increase overall ecosystem biomass productivity.

For more information, please see page 31.



Five areas of impact

This annual report is structured around the five key areas of impact: gender, climate, poverty, nutrition, and environment. For each of those impact areas, CIALCA builds partnerships, capacity, scientific innovations and knowledge services - its three pillars of action. Progress and findings are described under each impact area, and further illustrated by statements from partners and students.

Background

We live at a critical moment in time, where we have an urgent need and opportunity to transform our food systems, for human and planetary health, for equity and social justice. The CGIAR is the only worldwide research partnership addressing agricultural research for development, and plays a challenging but unique role in catalyzing a food system transformation that works for and offers opportunities for the most vulnerable. To meet this ambition, the CGIAR research strategy and program for 2022-2030 will be restructured around five impact areas: gender, climate, poverty, nutrition, and environment.¹

The Great Lakes Region of Central Africa is a compelling example where acting upon those five areas of impact is critical for sustainable development. More than 1 in 3 children in the region is still chronically undernourished or stunted (38% in Rwanda, 43% in DRC, 56% in Burundi)². Despite economic growth, more than half of the population still lives in poverty with less than 1.9\$ per day (55% in Rwanda, 72% in DRC, 75% in Burundi)³. Investments

in education are being made, but only 30% of students enrolled in secondary education are girls (30% in Rwanda, 32% in Burundi)⁴. Climate change threatens some of the positive developments. Rising temperatures, increased variability in rainfall, floods and longer dry spells, add pressures to promising agricultural developments⁵. The region's diverse ecosystems are particularly vulnerable to increased temperatures and heavy rainfall which can threaten biodiversity, and exacerbate soil erosion and land degradation. With ~300 people per km², the Great Lakes Region is also among the most densely populated region in Africa, with 90% of its population engaged in small-scale agriculture.

The Consortium for Improving Agriculture-based Livelihoods in Central Africa (CIALCA), is an innovative partnership operating in Rwanda, eastern DR Congo and Burundi, that is already working on those five areas of impact - gender, climate, poverty, nutrition, and environment - through research-for-development. CIALCA thinks long-term and thereby aims to contribute to real transformation. CIALCA investigates demand from partners and leverages a variety of partnerships, to connect farmers in the Great Lakes Re-

¹ www.cgiar.org/news-events/news/whats-next-for-cgiar

² The Global Nutrition Report, 2018: Country profiles for Rwanda, DRC, and Burundi.

³ The World Bank 2019, IMF World Economic Outlook Database 2019.

⁴ UNESCO Institute for Statistics 2018.

⁵ Climate Risk Profiles Rwanda, Burundi and DRC.

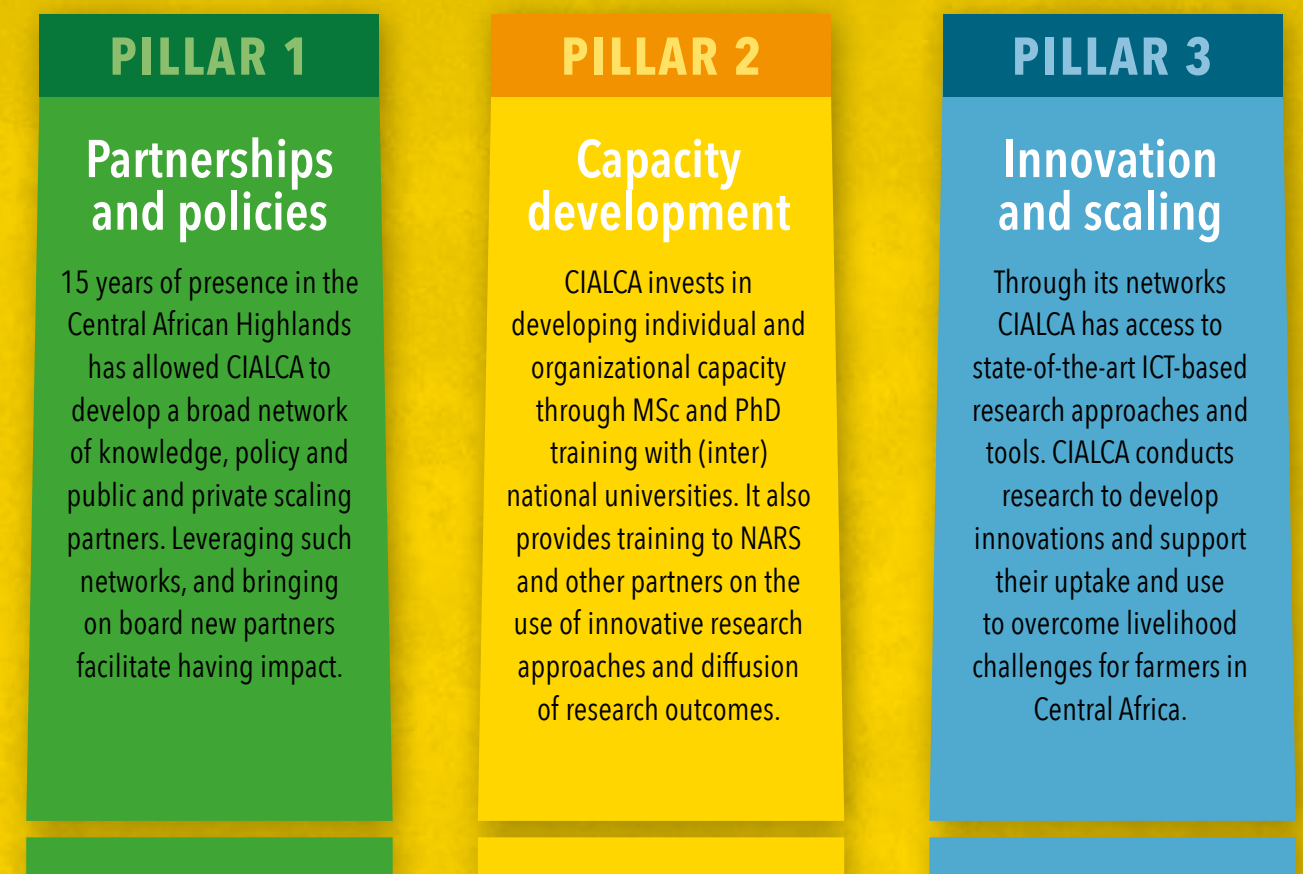


FIGURE 1: Three integrated pillars of action through which CIALCA operates.

gion to a choice of options for transitioning out of poverty and contributing to sustainable agri-food systems. Together with Belgian and regional universities, CIALCA builds in-depth problem solving and analytical capacity across a variety of themes through MSc, PhDs, and innovative training modules. CIALCA tailors specific innovation and implementation models to different agro-ecological (e.g. highland, lowlands) and geographical zones (dynamic, intermediate or hinterland), but also to the needs and interest of farmers of different socio-economic, gender and age groups engaged in different value chains.

CIALCA is led by IITA, the Alliance of Bioversity International and CIAT, and FAO/IAEA and has a 14-year legacy of conducting agricultural research for development in Central Africa.

Three pillars of action

CIALCA acts through 3 integrated Strategic Pillars. Under 'Pillar 1: 'Partnerships and Policies', CIALCA has established numerous partnerships, in signed agreements, with

research, development and private actors. For example, CIALCA is supporting One Acre Fund in better understanding and tailoring agricultural innovation delivery to its 300,000 farmer clients in Rwanda.

As part of 'Pillar 2: Capacity Development', CIALCA has supported 150 MSc, PhD and Bachelor students and developed innovative training modules. It currently has 8 PhD students under its umbrella who are pursuing their degrees at Ghent University, Katholieke Universiteit Leuven (KULeuven), Université catholique de Louvain (UCL), and Université de Liège (ULiège) in Belgium. All PhD students are also linked to local research organisations.

Under 'Pillar 3: Innovation Development and Use', CIALCA is supporting the National Agricultural Research Systems in developing and scaling innovations that can improve agricultural productivity, nutrition, environmental sustainability, and income in an integrated way.

GENDER

How understanding heterogeneity strengthens inclusive commercialization and related service delivery of agriculture in the Great Lakes Region

CIALCA has continued and expanded its collaboration with Once Acre Fund (see Annual Report 2018). The co-funded research resulted in the generation of six potentially representative farm types of Rwandan agricultural systems that are of interest to One Acre Fund as a mechanism to better serve their 300,000 men and women farmer clients in Rwanda with tailored packages and more efficiently identify new ones.

This is a pioneering step in moving beyond desk-based typologies, towards improving service delivery and agricultural extension through an inclusive tailored approach. Erik Slingerland, previously from the International Fertilizer Development Center (IFDC), noted in the CIALCA midterm meeting *"I think you really nailed it on the farm typologies research. To move towards tailored based packages and extension"*.

Use of farm types, or typologies, can improve the understanding of farm diversity and drive the development of decision support tools, applying the insights gained to speed up extension-farm interactions and empower extension providers with information and tools to efficiently and effectively target farmers. The decision support tool 'Know-Your-Farmer' currently in development by CIALCA- One Acre Fund is an example of such a typology-based tool.

At the moment, Know-Your-Farmer is a simple decision-tree, categorising farms into the six farm types based upon farmers' responses to four questions. Know-Your-Farmer holds the potential to be built into a more complex platform where tailored agricultural innovation and intervention packages sensitive to the needs and capacities of farms can be recommended to clients. These typology-based recommendations are beneficial for both farmers, receiving usable and relevant information, and for extension providers through improved efficiency and cost-effectiveness. However, despite the benefits of farm typologies they can be underutilised or not useful if not grounded in local conditions. To address this and ensure the validity and relevance of Know-Your-Farmer a novel, multi-step, and multi-actor validation methodology was developed, bringing together the perspectives of farmers and local experts to triangulate the results and ground truth the existence of the typologies and support the framework behind them. Validation is determined through extensive one-one interviews and farmer self-categorisation, combined with expert focus group discussions. The outputs of these interactions are used to identify significant overlaps between farm types derived from statistical analyses, farmer self-categorisation of farmers, and local expert-based categorisation.

So far, roughly 100 households from the original survey have been re-interviewed. The preliminary results are encouraging suggesting that:

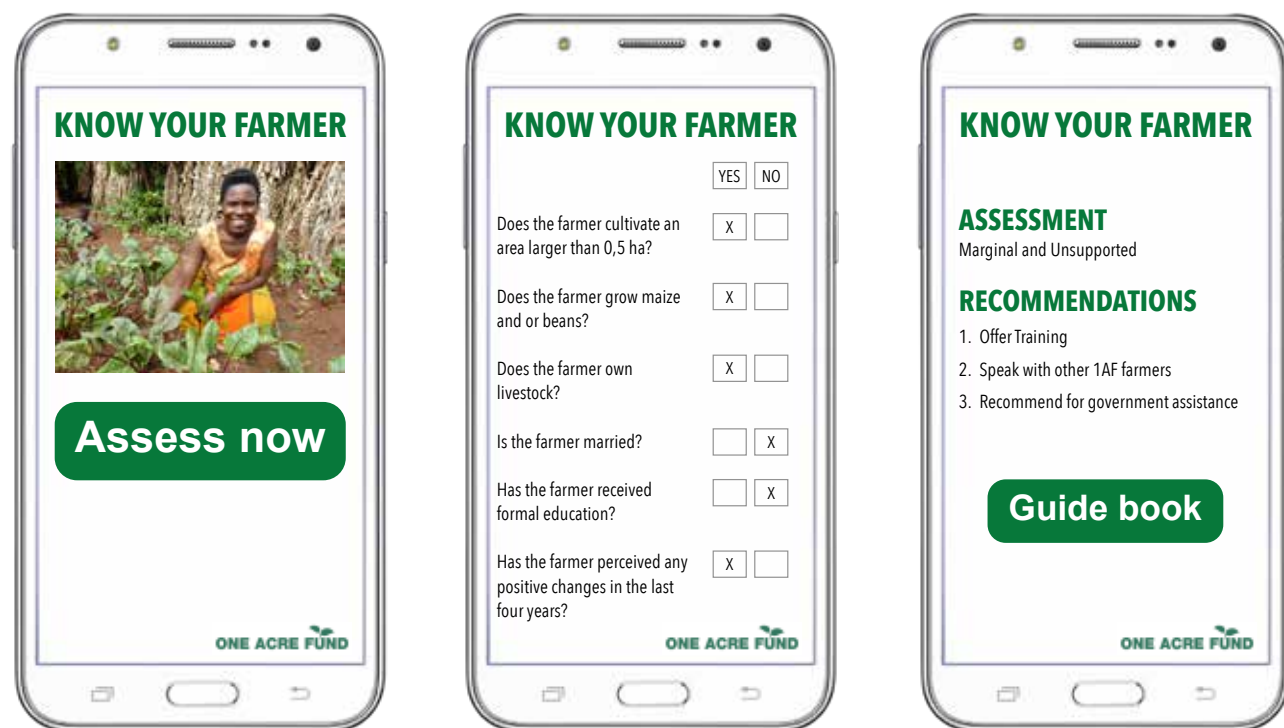


FIGURE 2: Mock-up of the Know-Your-Farmer decision-support tool for one of the CIALCA partners One Acre Fund.

farmers use similar mechanisms for grouping themselves and other farms to the statistical clustering (e.g. farm size, educational and marital status, livestock ownership, and crop choice); and they recognise their own farms in the statistical developed typologies. These results, if confirmed by local experts, would ground-truth the existence of the typologies, and validate the framework behind 'Know-Your-Farmer'. From this, tailored typology specific innovation and intervention packages could be developed and tested for One Acre Fund client and non-client farmers.

CIALCA training workshop on integrating gender and nutrition in agriculture

Continuing CIALCA's core tenet of capacity development, 30 specialists from across multiple fields gathered in Kigali in January 2019 to participate in CIALCA's 'Gender and Nutrition training workshop'. The workshop combined theoretical lectures, interactive plenary exercises, and hands-on team assignments to demonstrate how gender and nutrition can be integrated into research for development.

The training aimed to assist participants in understanding and their articulation of how and why gender and nutrition matter for sustainable agriculture and rural development and how doing gender and nutrition responsive research

can improve outcomes. The agenda was planned to ensure participants first understood the basic concepts in gender and nutrition before transitioning into the applicable linkages, pathways, indicators and research questions.

Over the workshop's three days, the CIALCA PhD cohort took centre stage leading working groups and using their research to frame the theoretical knowledge gained during the lectures. The team assignments were designed with the aim of letting participants think through the research design process to increase understanding and skill of where, how and when to integrate gender and nutrition in agricultural research for development.

Rwanda Agriculture and Animal Resources Development Board (RAB) researcher Svetlana Gaidashova highlighted that: "We all talk about gender and nutrition but this helped us to target and focus research for different users". Nancy Safari, (Bioversity DR Congo) noted "I learned so much on gender and I understood we can integrate gender in all the work we do. I also realize I was never thinking about nutrition before, yet I now understand it is very important, also for myself". The workshop also provided lasting impacts on the PhD students, with Damas Birindwa concluding "Gender and nutrition bring humanity into research".

A personal perspective by CIALCA MSc Aline Ishimwe

RESEARCH TOPIC

The agricultural innovation process: Insights from female-led household in Rwanda

RESEARCH PROBLEM

Relying on the potential success of using agricultural technologies, public and private institutions in developing countries have been endeavoring to provide inputs and extension services to farmers. As a principal inputs-providing organization in Rwanda, One-Acre Fund an NGO that works closely to the goals of increasing agricultural production in East African countries seeks better information to understand farmers they serve. They are interested to know whether a specific group of farmers is more or less likely to adopt technologies than others. An initial stage of getting this understanding revealed that more than 80% of less-adopters were female-led households. This MSc thesis research meant to understand why female-led households are less likely to adopt agricultural technologies promoted by One-Acre Fund.

THE KEY FINDINGS

The results revealed that households' farm income, access to off-farm income, access to training, access to credit and having good perception on technologies had a positive relationship to the agricultural technologies' adoption decision-making. Through interviews, female-led households stressed that it would be helpful if they had a specific group and specific training that not only teaches them about farming practices but also builds their capacity in other fields like farm and households management.

ALINE'S PERSONAL PERSPECTIVE

I would say that challenges facing rural farmers are more or less similar. However, rural farm-households are heteroge-

neous which might hinder the commercialization and related service delivery of agriculture to some particular group of farmers. For instance, female-led households are more challenged with doing multiple households' tasks limiting them to engage jobwise in the agricultural activities. If these farmers' can be trained on the effective way to combine households' tasks and farm activities their participation in previously mentioned initiatives can significantly increase, thus inclusive agriculture and rural development.



MORE INFORMATION

www.cialca.org/the-unforgettable-m-sc-thesis-research-journey-of-aline-ishimwe

UNIVERSITY

CIALCA MSc student at the University of Ghent (UGhent), Belgium



CLIMATE

How isotopes help build resilience to climate change in the Great Lakes Region

It is predicted that climate change will cause an increase in frequency and duration of dry spells in Central Africa, the target region of CIALCA. This will lower yields of cassava and banana consumed daily by approximately 6 million people in the highlands of Burundi, DRC and Rwanda.

To cope with problems of drought stress in cassava and banana cropping systems, stable isotope techniques based on carbon-13 or ^{13}C (related to water use efficiency) and oxygen-18 or ^{18}O (related to stomatal conductance) are being developed by the Soil and Water Management & Crop Nutrition (SWMCN) laboratory of the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture in Seibersdorf, in close collaboration with the International Institute of Tropical Agriculture and the University of Leuven. Once these techniques are established and validated, they will help in decision making processes related to variety selection, choice of planting time and fertilizer application to counteract the effects of drought and cassava and banana productivity.

Drivers of water use efficiency in cassava: from greenhouse experiments to field trials

In 2018, the focus of the research activities coordinated by the Joint FAO/IAEA Division was on how to sample leaves of cassava to assess water use efficiency based on ^{13}C and ^{18}O stable isotopes.

One year later, in 2019, the emphasis was further laid on the understanding of the drivers of water use

efficiency in cassava, with emphasis on soil fertility, in particular potassium availability in the soil. Therefore, a set of experiments focusing on the application of potassium to alleviate drought stress was carried out in the SWMCN greenhouses. Cassava plants, originating from Democratic Republic of Congo, were grown on sand substrates with nutrient solution either high or low in potassium. Water use was monitored every other day by weighing the pots and water content adjusted to field capacity. At two months after planting, a dry spell was simulated by lowering by 50% the irrigation amounts for half of the plants for 17 days. To follow the translocation of new assimilates and compare the different treatment combinations, plants were put in an airtight walk-in growth chamber. The air inside the growth chamber was enriched with $^{13}\text{C}\text{-CO}_2$ so the plants assimilate the heavier carbon-13 isotope.

First results of the water use data indicate a higher water use for plants that received the nutrient solution low in potassium in the periods where all plants received the same amount of water. These results will be checked against the biomass production and ^{13}C and ^{18}O values of the same plants to see whether this difference in water use also leads to a difference in water use efficiency.

This potassium effect on water use, in relation to other nutrients, is now being further validated through field trials in Burundi, the Democratic Republic of Congo and Rwanda, implemented by the CIALCA team in the targeted region, in close collaboration with national agricultural research institutes (e.g. Rwandan Agricultural Board) and international organizations such as the International Fertilizer Development Centre (IDFC).

Isotope techniques

An alternative for traditional measurements of drought tolerance / water use efficiency?

Conventional techniques for assessing drought tolerance or water use efficiency require focus on visible screening of water stress in the plant or labour intensive and complex measurements of crop physiological parameters, in combination with often installation of expensive equipment including soil moisture sensors. Such approach reduces the possibility of replicability area-wide.

Through stable isotopes of carbon and oxygen drought tolerance and water use efficiency can be screened over larger areas, at a lower cost, and under on-farm conditions. Once calibrated and validated, the isotopes give information on the link between water use efficiency and variety, planting time and fertilizer management, and this integrated over the crop cycle.

In total 121 nutrient omission and planting scheduling trials were implemented to better understand how varieties, planting time and fertilizer management can help make cassava production more climate-resilient. Close to 3000 leaf samples have been taken for stable isotope and ICP-MS analysis, allowing to evaluate the role of fertilizer application in drought tolerance and water use efficiency.

Further ongoing is the ^{13}C analysis of the enriched cassava plants. With these data we expect to extract information on the translocation speed from shoot to root and compare the different treatments. Our main question is whether differences in potassium supply affect the translocation rate of assimilates towards the roots, in view of the well documented phenomenon that translocation is an additional mechanism to counteract drought effects on cassava. 180 levels will also be analysed and will be used as a proxy for stomatal conductance, an important factor in water use efficiency.

Validation of the use of isotopes and leaf temperature for assessing drought stress in banana

Under the guidance of the Soil and Water Management & Crop Nutrition (SWMCNL) and the Plant Breeding and Genetics (PBGL) Laboratories of the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, a new Peaceful

Uses Initiative (PUI) project, funded by the Belgian Government, has been initiated in 2019 to better understand how soil and water management and varieties can be improved for better climate change adaptation and enhanced disease resilience of banana-coffee cropping systems in Sub-Saharan Africa.

Using isotope techniques, the adaptation of these cropping systems to climate change impacts can be accelerated. They help improve banana and coffee varieties, and soil, water and crop management, but also establish recommendations for policies, enabling environments and a transformational adaptation in which farmers substitute varieties and explore alternative farming strategies.

A first data collection campaign was organized during July and August 2019 in Arusha, Tanzania. In an ongoing field-trial, two banana varieties were investigated under different watering treatments in the dry season (rainfed and optimal irrigation). Hence, the effects of drought stress could be monitored. The main purpose of the campaign was to assess the usefulness of stable isotope techniques for the evaluation of water use efficiency (WUE) and drought stress. Isotope signatures have been proven to strongly correlate with WUE. Their relationship is however not straightforward. Isotope signatures are affected by many different parameters, both environmental and plant-related. As such, the variability in isotope signals should first be explored and correlated with potential influencing factors, to distinguish their effect from the effect of drought. This will allow us to comprehend isotope signatures in banana plants and use them for the purpose of WUE evaluation.

Variability in carbon signatures (^{13}C) was investigated at field-, plant- and leaf level. Samples were taken from both varieties under the different watering treatments. Both mother plants and on-growing suckers were sampled. Within every plant, leaves of a different age were sampled. Finally, the within-leaf variability was explored by taking 6 or 10 samples per leaf (depending on the size) according to a predetermined pattern. Environmental conditions were carefully monitored with a weather station and the soil water content in every treatment was followed up daily, using time domain reflectometry sensors. This detailed sampling, with in total 2000 samples, and their stable isotope analysis will allow to establish an innovative stable carbon isotope sampling protocol for banana.

A personal perspective

by CIALCA PhD Damas Birindwa Rutega

RESEARCH TOPIC

Novel stable isotope techniques to assess differences in water use efficiency of cassava cultivars. A key to intensify cassava productivity in Sub-Saharan Africa.

RESEARCH PROBLEM

In DRC, climate change affects rainfall distribution, with an increase in frequency and duration of dry spells. Therefore, the current agricultural calendar is often not any longer suitable. This leads to seed losses as farmers are often obliged to seed twice or more times a year. Indeed, they proceed by trial and error to plant on the basis of the effective period of return of the rains after the dry season. The start of the rainy season is not well fixed in time, and often the rain comes and goes, and can even stop for 30 or more days. This situation causes more damage to cassava as the most critical period to its growth is the first 5 months of its life.

THE KEY FINDINGS

The capacity of adapting to water stress of cassava depends on the genetic potential of cultivars. It appears also that in the three first months after planting the cuttings, which is the critical period of the growth of the cassava plant, the second month is more critical than the first one. So, the question is whether potassium or another nutrient factor can improve adaptation to drought, especially in the 2nd month after planting?

DAMAS' PERSONAL PERSPECTIVE

Cassava is the most important crop in DRC as it is planted by everybody – men, women, girls and boys. The demand for cassava is always higher than its supply on the market. In the urban areas, cassava flour is nowadays imported from foreign

countries. Research on how to improve yield should be the priority in the region for creating economic stability and increase the income of families. Cassava diseases remain also an important topic to be investigated in the climate change context.

UNIVERSITY

CIALCA PhD student at Katholieke Universiteit Leuven (KULeuven), Belgium



As an additional measure for water stress and stomatal closure, leaf temperature was evaluated over the course of a day. Typically, stomata close when water supply becomes insufficient, leading to an increase in leaf temperature. Temperature was measured in a large number of plants and on both sides of the leaf, to account for the large variability. A low-cost contactless infrared thermometer was used, allowing for fast data collection.

Preliminary results indicate that rainfed plants in the dry season clearly heat up more during the day than irrigated (and presumably non-stressed) plants. The difference in temperature between rainfed and irrigated mother plants becomes as large as 6°C at 14:30h. Interestingly, sucker plants, which are protected from direct sunlight by the canopy, show a lesser increase in temperature. This demonstrates the importance of canopy protection for optimal sucker development.

The leaf temperature was related to the ^{13}C data of the banana leaves, with a correlation of about 50% (R^2), showing that the use of leaf temperature measurement with infrared thermometer can be used as a new approach for drought stress evaluation in banana.

How do we build capacity in the use of isotope techniques for cassava and banana?

Through CIALCA and the related PUI project, three PhD studies, one MSc study and one trainee have been provided technical and financial support by the Joint FAO/IAEA Division. All studies are implemented with the academic guidance of the University of Leuven. Two of the three PhD

studies are further supported by the University of Natural Resources and Life Sciences in Vienna.

Further an IAEA funded regional Technical Cooperation Project on 'Enhancing productivity and climate-resilience in cassava-based systems through improved nutrient, water and soil management (2020 – 2023)' was approved and will start in 2020. About 13 targeted countries from West, Central and East Africa will participate in this project focusing on capacity building in the use of isotope and related conventional techniques for climate-smart and sustainable cassava production.

Testing isotope techniques in the field.





POVERTY

How ICT improves productivity in the Great Lakes Region

Low cassava and banana yields and inefficient use of inputs remain a major bottleneck for farmers to increase their income. CIALCA works with partners to optimize farmers return on fertilizer investment. Together with IFDC and the African Cassava Agronomy Initiative (ACAI), site-specific fertilizer recommendations are developed through nutrient omission trials and combined with digital decision-support tools and spatial agro-ecological information layers.

How far can fertilizer application increase cassava root yield in the CIALCA countries?

With a collaboration of national research systems and strategic international institutes, like IFDC who is leading in Burundi research activities to implement the national fertilizer subsidy program, CIALCA is investing in the development of decision support tools (DST) to optimize farmer's return on fertilizer investment in the Great Lake Region. To generate datasets that are required to calibrate the DSTs, CIALCA conducted during the 2018-2019 cultivation season 121 nutrient omission trials in the three countries and, for the 2019- 2020 cultivation season, has on ground 120 new trials (to be harvested end of December 2020). Yield data of the first-year trials pointed out promising nutrient combinations, although results need to be confirmed with the second-year trials. In general, nitrogen appeared as the most important nutrient to increase cassava root yield the three countries (Figure 3). Nutrient combination that did not contain nitrogen (i.e., PK application) produced low cassava roots in comparison of the nutri-

ent combinations that contained nitrogen (i.e., application of NP, NK and NPK). The first-year yield data indicated also that a combination of nitrogen with P or K (NP- or NK-application) should be more cost-efficient than including of all macro-nutrients in fertilizer formulation (i.e., NPK application). There was no difference in the yields NP, NK and NPK treatments although the later contains all three macro-nutrients. Irrespective of nutrient combinations, the highest cassava root yields were obtained in DR Congo, followed by Rwanda. In Burundi, cassava root yields are low, even with fertilization. The first-year yield data did not show yield increases while secondary/micro or lime/dolomite was added to macro-nutrients

How can the increase in cassava root yield due to fertilizer application be improved with site-specific recommendation?

In practice, decision support tools allow farmers to decide on the best nutrient combinations for a particular field (site-specific recommendation) versus a common approach of applying a single nutrient combination across all fields (blanket NPK recommendation). Results indicated that, compared to blanket NPK-recommendation, site-specific recommendation should increase cassava root yield in average of 8 and 4 t h⁻¹ in DR Congo and Rwanda/ Burundi respectively (Figure 4). Cassava root yield with site-specific recommendation and proper field weeding should represent about 6, 4 and 2 times of the current yields in DR Congo, Rwanda and Burundi.

A personal perspective

by CIALCA PhD Fidele Barhebwa Balangaliza



RESEARCH TOPIC

Environmental, socio-economic and agronomic traits of cassava-based farming systems in Kivu (eastern DR Congo)

RESEARCH PROBLEM

Regardless of their importance in human nutrition and role in sustainability of agricultural systems, cassava yields are low and unstable across seasons and environments in Eastern DRC. In the early nineties, it was determined that the most important constraint for cassava production was the management constraint followed by pests and diseases, soil infertility, varietal misfit, post-harvest processing and climate. Despite the occurrence of fertile land for cassava and the previous research efforts to be at the forefront in promoting

cassava production crop yields remain low. In South-Kivu, RDC, several factors are hypothesized to be responsible for the low productivity. This study hypothesizes that environmental, socio-economic and agronomic traits of cassava-based farming systems in South-Kivu might be very important to rise production and productivity of cassava.

THE KEY FINDINGS

For the moment we have all the data from the first visit. The soil samples are being dried in the IITA laboratory for the preparation of the analyses. Other data from the first visit collected from ODK, including socio-economic data and field observations are available. We are in the cleaning phase and then we will move on to the analysis.

FIDELE'S PERSONAL PERSPECTIVE

This first visit allowed us to know well the study area but also to install the quadrants for the second and third visit. The use of ODK made it possible to have the data quickly and to follow the enumerators easily. The fieldwork has also been challenging with regards to administration and security, but overall the work is on schedule.

UNIVERSITY

CIALCA PhD student at Universite Catholique de Louvain (UCL), Belgium

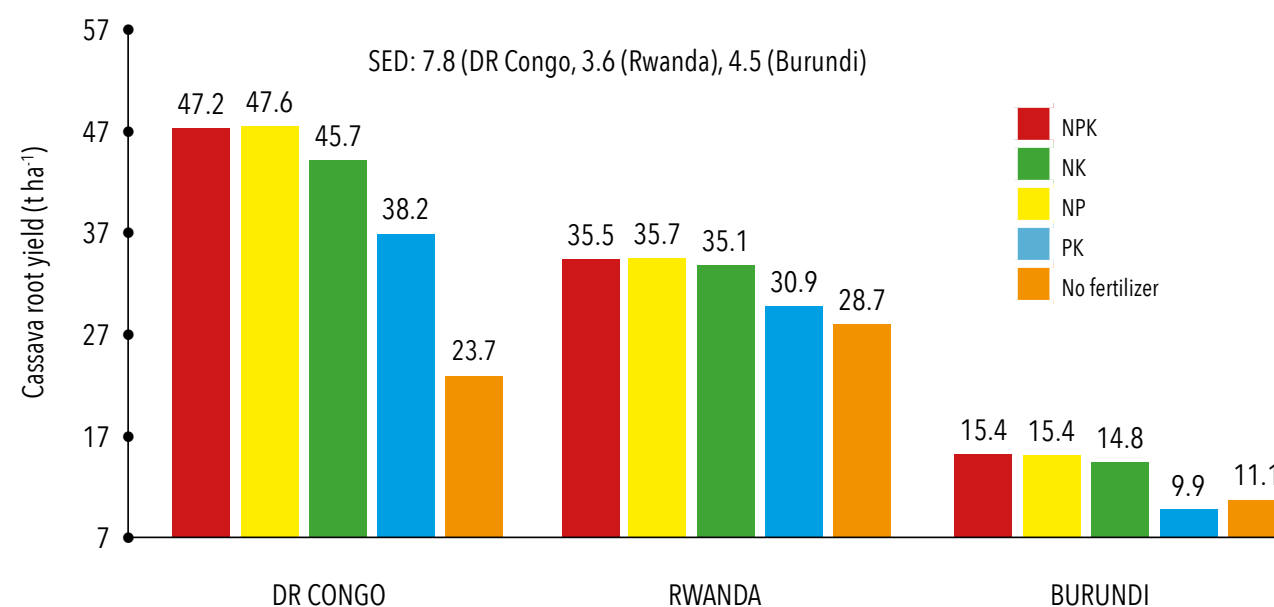


FIGURE 3: Average cassava root yield of the main nutrient combinations.

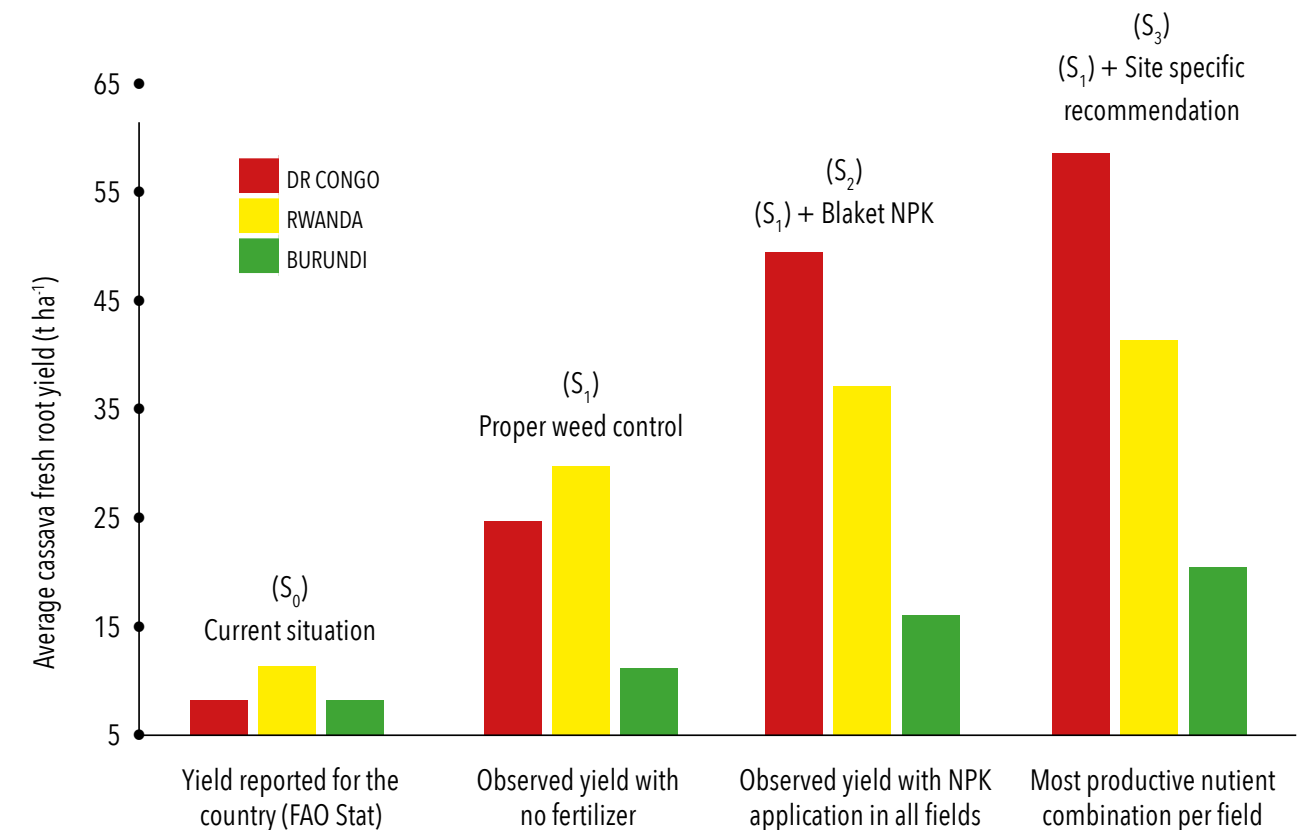


FIGURE 4: Cassava root yield of different intervention approaches (S₀: current situation, S₁: proper weed control with no fertilizer, S₂: proper weed control with blanket NPK application and S₃: proper weed control with site specific recommendation). SED = 7.8, 3.6 and 4.5 t ha⁻¹ for DR Congo, Rwanda and Burundi respectively.

CIALCA organizes an ICT for Agriculture workshop for 20 PhD-students and partners

CIALCA aims to strengthen the capacity of national scientists and practitioners to facilitate sustainable agri-food system transformation. To do so, CIALCA understands that scientists and practitioners need access to and understanding of innovative digital technologies, to empower research and decision-making.

Between 4-5 September 2019, 20 CIALCA scientists, researcher, PhD students, and partners from Burundi, DR Congo, and Rwanda gathered in Bujumbura for an intensive two-day course on the use of digital tools for data collection. The workshop was developed to provide participants an introduction to the use of digital tools in agriculture and provide a foundation for applying them in research.

On the first day, participants were introduced to how digital tools are revolutionizing agricultural practices and research and how CIALCA is harnessing them for its research. Participants were provided with the basic skills required for

using Open Data Kit (ODK) (a digital tool for developing customizable data collection forms) to collect data from the field. CIALCA scientists and researchers provided walk-throughs of the basics of ODK and shared their experience on how to develop easy-to-use forms for field-trial (simulating CIALCA's Nutrient Omission Trials) and household data collection (simulating CIALCA's extensive household surveying). On the second day, participants applied ODK in the 'real-world', in situations that they might find themselves: scanning bar-codes to assign fields in NOTs trial; performing household surveys. Finally, participants applied the skills they'd learnt to develop their own data collection forms, receiving assistance from other participants and experienced insights from trainers.

Neema Ciza, CIALCA PhD student from the University of Liege, offered that the skills gained from the workshop will "...allow me to save more time, guarantee certainty and credibility in data quality by reducing errors in data collection."

NUTRITION

How systems approaches improve nutrition in the Great Lakes Region

Previous CIALCA research showed that diet diversity in the Great Lakes Region is particularly low, with very low consumption of vegetables, fruits, nuts and seeds, and animal-based products. Both physical and financial access to highly nutritious food items is too limited to ensure nutrient adequacy among vulnerable population groups. And appropriate knowledge with regards to nutrition practices (basic nutrition concepts, post-harvest handling, dietary diversity/combination, food safety and hygiene) remains a challenge.

Acting upon those needs, CIALCA works on three fronts with partners in development to improve diet quality and nutrition outcomes: 1) on the production side: identifying strategies to increasing the production and integration of a diversity of nutritious foods in the production systems, 2) on the consumer side: understanding consumer heterogeneity and creating increased demand for a diversity of nutritious foods through training and knowledge building e.g. on availability and nutrition value of local agrobiodiversity; and 3) on the market side: to identify synergies and tradeoffs between agricultural commercialization and nutrition.

Nutrition-smart agricultural metrics, such nutritional yield, nutritional diversity, and the agrobiodiversity index have been developed by CIALCA scientists and are used and integrated in the field trials and trade-off analyses. An example is shown in figure 5, with scenarios that allow both increase in nutritional Vitamin A yield and operating profit, as well as scenarios that maximize operating profit and with a potential reduction in Vitamin A yield.

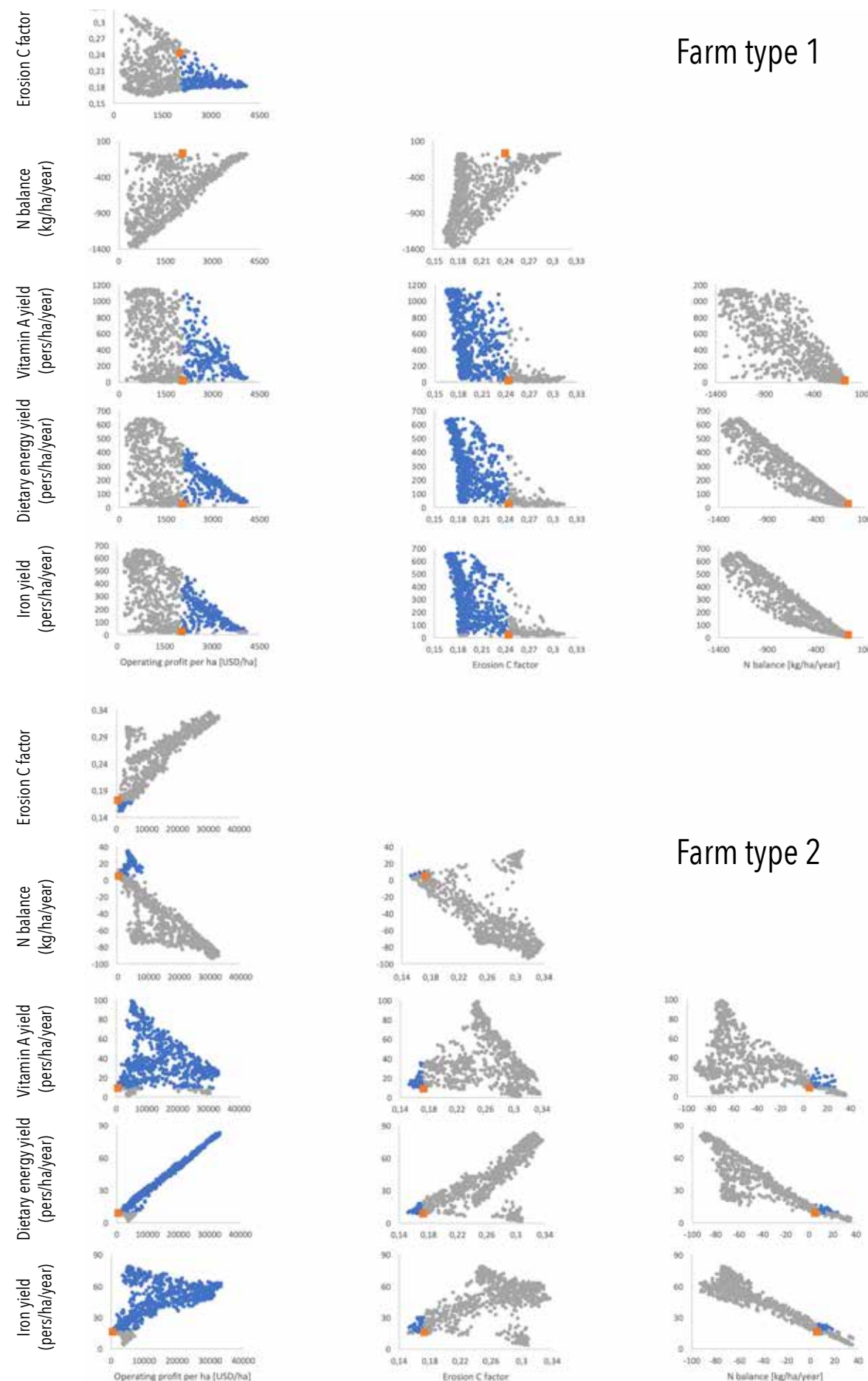
As described in the gender section, CIALCA trained 30 PhD students, CIALCA partners and national institutions, on integrating gender and nutrition in agriculture and agricultural research. Several of those nutrition-smart metrics and analysis tools were part of the workshop curriculum.

In 2019, a new Memorandum of Understanding for partnerships was signed between the American Refugee Committee, ARC or since 2020 called Alight, and CIALCA whereby CIALCA is supporting ARC in identifying more sustainable agri-food systems pathways for the refugees and their hosting communities. Currently Rwanda is host to more than 150,000 refugees from Burundi and Democratic republic of Congo, most of who (79%) reside in six camps provided by the Government of Rwanda and the remainder in urban settings (ARC, 2018). Refugees come to these camps with diverse skillsets in farming and non-farming enterprises and some have varied experience in arable farming due to different socio-cultural backgrounds (GHI, 2017).

Some key research questions that CIALCA is supporting in answering include:

- What are the current constraints, gaps and opportunities with regard to access to and consumption of diverse nutritious foods by refugees and their surrounding hosting communities?
- How can nutrition-sensitive agricultural interventions be integrated on limited land to support both nutrition and livelihoods needs of refugee and their hosting communities?

Initial results are expected by June 2020.



A personal perspective

by CIALCA PhD Yves Dider



RESEARCH TOPIC

Farming income, farm heterogeneity, dietary diversity and child nutritional status in rural Rwanda

RESEARCH PROBLEM

Despite the efforts in increasing the number of food secure households in Rwanda with increased productivity, the consumption of food items rich in nutrients such as protein and micronutrients is low among some population groups. Increasing productivity and income alone may not necessarily be enough to improve nutritional outcomes such as diet diversity and anthropometric outcomes, in particular in transitional phases when farm households face limited market access to sell their own produce and buy additional food. Thus, the need for understanding farm heterogeneity, farming income and diet diversity towards improving child nutrition outcomes.

THE KEY FINDINGS

So far, I have mainly focused on developing my proposal, doing course work and preparing the field data collection in Rwanda. I am very eager to start the field work once I have received ethical clearance.

DIDIER'S PERSONAL PERSPECTIVE

It was a great experience working with CIALCA in line with not only strengthening or improving my research capabilities but also supporting my institution (University of Rwanda) in conducting nutrition longitudinal studies. I have been assisted in the process of proposal development, I already have the ethical clearance from Rwanda, and I am waiting for the ethical clearance from Ghent University so I can start collecting data

UNIVERSITY

CIALCA PhD student at University of Ghent (UGhent), Belgium

FIGURE 5: Potential trade-off between operating profit and Vitamin A yield for two types of farm – a more subsistence oriented farm (farm type 1), and a more commercially oriented farm (farm type 2). There is a solution space (blue dots) that allow both operating profit and vitamin A yield to increase, but if operating profit is 100% maximized, there can be a reduction in vitamin A yield. From MSc Thesis from Clara Gambert (2019).

A personal perspective

by CIALCA PhD Willy Désiré Emera

RESEARCH TOPIC

Agri-Food System Pathways to Improve Human Nutrition in Banana and Cassava Based System in Burundi

RESEARCH PROBLEM

In the Great Lakes region, a high diversity of crops is grown and livestock raised. However, this diversity doesn't meet nutritional satisfaction. This is explained by the food misuse due to insufficient knowledge on the local production processing, or to disparities between household wealth categories. Thus, the region remains under pressure of malnutrition, i.e. in Burundi, population face three malnutrition burdens such as chronic malnutrition (56.6%), acute malnutrition (5%) and wasting (29 %) affecting children under five years respectively. According to recent data, 19% of women of childbearing age (15-49 years) are underweight while 8% are overweight.

THE KEY FINDINGS

In Burundi, there is a kind of seasonality regarding to the food security which implies the instability in household food intake. From the focus group discussions organized in 16 communes of Ngozi and Muyinga provinces, based on the diversity of crops grown and animals raised in these communes, this diversity is likely to play an important role to improving nutrition. However, it has been noted that the majority of the community members have limited knowledge regarding to the management of the diversity of food products to ensure dietary diversity. This study will contribute to identify agri-food systems pathways to improve human nutrition.



WILLY DÉSIRE'S PERSONAL PERSPECTIVE

From my own experience, the more a household is able to produce or acquire a wide variety of crops and livestock products, the more household's members have an acceptable nutritional status. However, exploring study sites, despite the production diversity, the dietary diversity remains insignificant at household level because a major part of the production is sold at urban market. Also limited household income and knowledge on how combining available foods hamper dietary diversity.

UNIVERSITY

CIALCA PhD student at University of Ghent (UGhent), Belgium.



ENVIRONMENT

How agriculture can be a positive driver for environmental sustainability in the Great Lakes Region

Yield gaps in banana-based production systems have increased in the past two decades due to declining soil fertility, drought and biotic stresses. Sustainable, environmentally sound and economically viable strategies for intensification in these systems are urgently needed. New CIALCA research shows that certain Agro-Ecological Intensification (AEI) practices, such as the integration of shade and drought-tolerant crops, nitrogen-fixing and cover crops, and hedges show promising potential in the Great Lakes Region to improve soil fertility and moisture retention, reduce the weed burden, narrow yield gaps and increase overall biomass productivity in these systems. This is found to be particularly valuable to more sustainably restore the banana-based systems after they have been hit by major banana diseases.

The Banana Xanthomonas Wilt disease (BXW) has in the past drawn huge attention regionally due to its severe impact on production systems and its fast rate and diverse modes of spread. The disease causes rapid wilting after tool-mediated infections and premature ripening and rotting of fruits in florally infected plants, leading to a complete loss of the infected plants. Delayed intervention can result in up to 100% yield loss. The management of BXW in the Great Lakes Region is further influenced by the high population density and small (<2 ha) fragmented farm sizes that drive cultural practices at field or farm level.

CIALCA has a strong legacy in contributing to the control and management of BXW in the region, with innovative, effective practices such as single

diseased stem removal, led by Guy Blomme and Walter Ocimati. In collaboration with the national research systems, CIALCA is now investigating how BXW impacts environmental or ecosystem services and explores strategies for managing banana agroecosystems to boost their resilience and the supply of these ecosystem services.

To this end, a combination of on-station and on-farm trials, farm surveys and integrated modelling, show that the banana crop is critically important for certain services, such as avoiding soil erosion, and that AEI practices, more specifically the integration of shade and drought-tolerant crops, nitrogen-fixing and cover crops, and hedges can improve soil fertility and moisture retention, reduce the weed burden, narrow yield gaps and increase overall biomass productivity in these systems.

Because the banana crop serves multiple functions in the banana-based landscapes across the African Great Lakes region supporting the resilience of the smallholder households and farms, the recent outbreak of BXW disease has put the banana-based agroecosystems under intense pressure, compromising livelihoods of the households, communities and the resilience of the entire agro-ecological production system. As for other diseases, previous studies have been mainly focused on provisioning services, especially yield, and not on regulatory services, such as water retention and soil fertility. CIALCA has thereby taken a pioneering step in adding an ecosystems perspective to banana disease investigation and management.



BXW outbreaks reduced the dominance of banana across farms and landscapes, whereas crop species richness increased at farm level. The banana crop was lost directly through death of plants and massive uprooting of infected fields or mats, with most farms reluctant to replanting fields or mats (Figure 6). Crop diversity increased at household level but not at landscape level. BXW effect on supply of supporting and regulatory ecosystem services was also demonstrated. For example, erosion levels were determined to be lower under banana compared to cassava and other annual crops (Figure 7). Strategies to contain the disease will thus need an ecosystem services framework targeting the banana crop and other replacement crops in BXW affected landscapes. Such a framework will understand and appreciate the potential of the different crops in our agroecosystems to supply different ecosystem services and inform decision making at the different levels and by different actors, including policy making. An ecosystem services-broad framework is applicable for the management of similar constraints of banana (e.g. banana bunchy top disease, Fusarium wilt) and diseases of other crop species without a profound effect on the environment. Results also have led to recommendations on agroecological practices (e.g. such as cover crops, hedges, crop cultivar mixtures) for improving the buffering and adaptive capacity of the banana-based agroecosystems affected by BXW disease.

AEI practices tend to close nutrient cycles and reduce dependency on external inputs on agricultural systems by increasing on-farm diversity. These practices have been reported to improve the productivity of banana-based systems in the Great Lakes Region, although the extent to

which they are implemented differs between and within regions. The impact of these practices on farm performance for a broader range of objectives including the environmental and nutritional objectives, is hardly quantified and recommendations on how to improve the farm performance, given these options, have been lacking. With CIALCA, farm typologies have been developed based on AEI practices, that allow to classify the banana-based subsistence farms into two extreme groups, with on average 11.0 and 16.4 AEI practices applied on farm while more commercially oriented farms were moderately intensified (i.e. 13.0 practices). The FarmDESIGN model identified the farms with more agro-ecological practices to have a higher species diversity, relatively higher profitability (2039 to 3270 \$/ha/year) and nutritional yield, although relatively high soil erosion levels and negative N balances (-72 to -50 kg N/ha/year) are indicative for unsustainable practices. In contrast, more commercial oriented farms with more market access were less diverse and market oriented. Their commercial orientation necessitates investments in soil fertility management, resulting in low soil erosion levels and positive N balances (5 kg/ha/year). Bananas and other perennials played a key role on optimal farm redesigns. Explorations with *Calliandra calothyrsus* (*Calliandra*) hedges or *Mucuna pruriens* (*Mucuna*) cover crops increased on-farm mulch production, improved sustainability indicators and profitability of the systems.

AEI practices are promising to improve the farm and ecosystem performance, although a more intensive use would be beneficial.

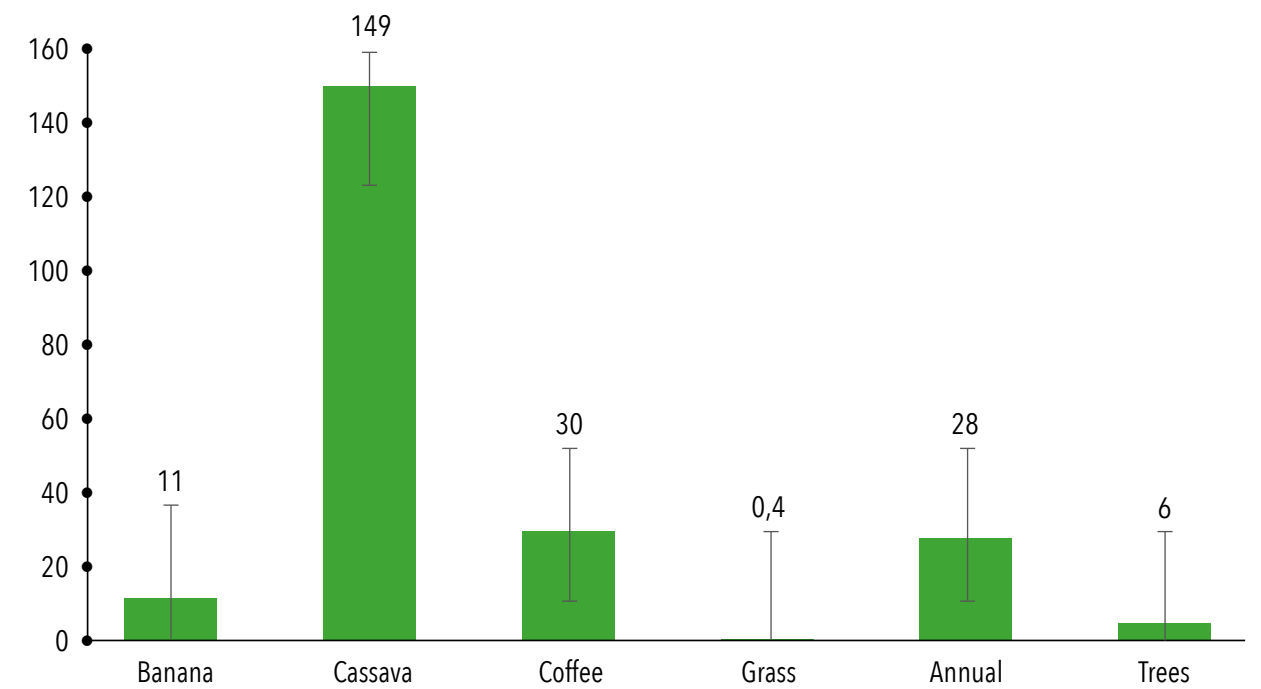


FIGURE 6: Responses and/ or coping strategies in reaction to *Xanthomonas* wilt across different banana growing communities/ landscapes in eastern DR Congo. Error bars represent standard errors.

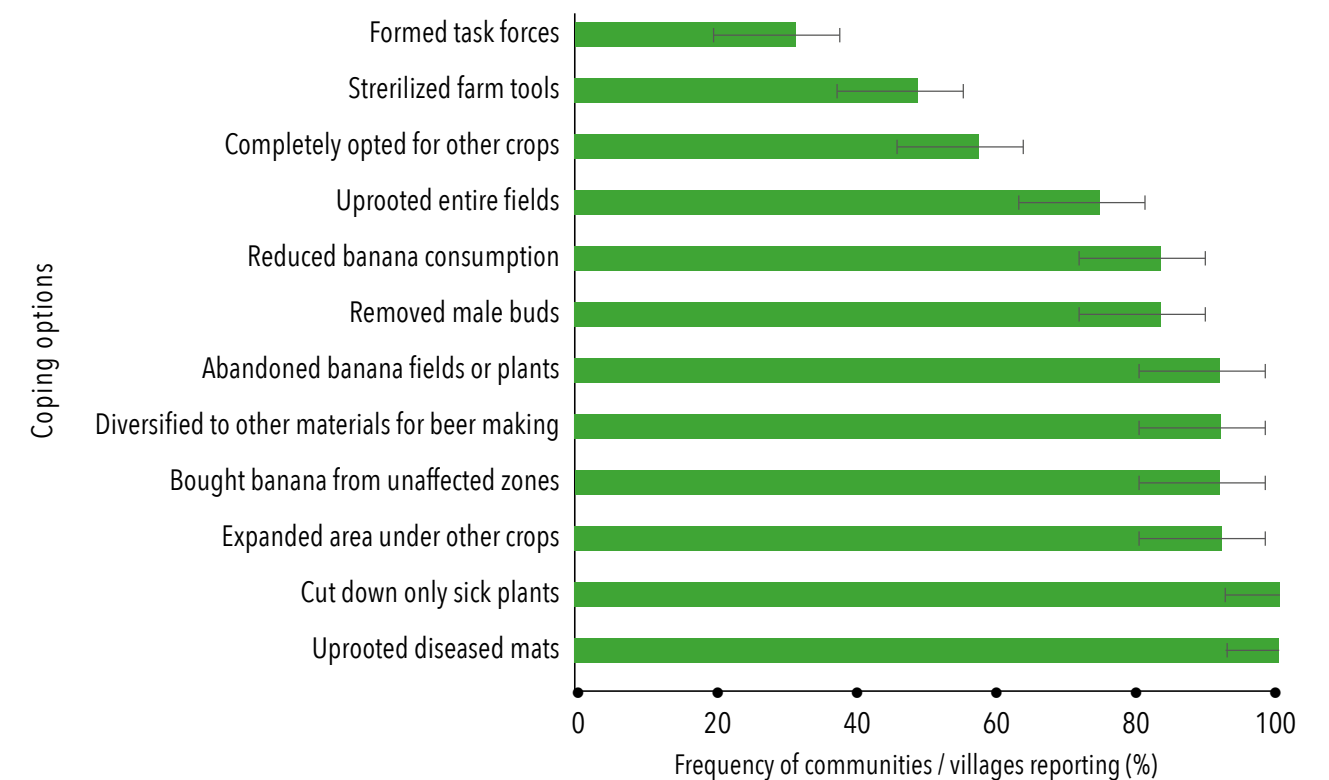


FIGURE 7: Amount of eroded soil (Mg ha⁻¹ year⁻¹) computed using the RUSLE equation for different crop/plant covers on farms across landscapes affected by *Xanthomonas* wilt disease in eastern DR Congo.

A personal perspective

by CIALCA PhD Walter Ocimati



RESEARCH TOPIC

Sustainability of banana-based agroecosystems affected by *Xanthomonas* wilt disease of banana

RESEARCH PROBLEM

The *Xanthomonas* wilt disease (XW) of banana outbreak in East and Central Africa has compromised food and income security of households and communities in the banana-based agroecosystems. In my past ten years working on the epidemiology of the disease and its management, I noted that much of the focus was on the role of banana for food and income. I could see as part of the management and in frustration farmers were cutting down plantations and the effect of these practices and the disease in general on other potential services/ benefits such as regulating soil erosion, pollination and maintenance of water quality among others received little or no attention, yet could be affecting the sustainability of these agroecosystems. More still, the current XW management efforts have been entirely reactive and mitigative leading to its persistence and continued spread. Understanding of the broader effects on XW on land-use and ecosystem services, XW risk factors at landscape and field/ farm level has thus been of interest for a more holistic and sustainable management strategy. In this study, I thus explored strategies for preventing and minimising shocks caused by XW disease.

THE KEY FINDINGS

This study shows BXW to still be an important threat across landscapes in the ECA region. BXW was observed to be driving changes across affected landscapes, with the main trend towards a decline in the dominance of the banana crop, and subsequent increase in area under annual crops. The disease

was observed to affect the supply of a broad range of services such as regulation of soil erosion, water quality, pollination and nutrient recycling that we obtain from our surrounding banana farmlands. At landscape level, high precipitation, and poor crop and disease management increased BXW risk. A spatial map of ECA and Africa from this study highlights disease hotspots, frontlines and vulnerable landscapes that are a good entry point for BXW management. At field level, understanding the risk factors associated with the role of other plant species and crop management practices (e.g. leaf pruning, intercropping) is important. For example, some intercrops and weeds are potential alternative hosts to *Xanthomonas campestris* pv. *musacearum* the causal organism of BXW. XW risk on farm is also lowered by banana cultivar mixtures and higher access to information on disease epidemiology and management but increased by presence of susceptible ABB banana types. This study also proposes agroecological practices (e.g. cover crops, hedges, cultivar mixtures) for improving the buffering and adaptive capacity of the banana-based agroecosystems. Sustainable BXW management will thus require a proactive and holistic measures taking to account the broader range of services from our farmlands is crucial at farm and landscape level for managing BXW.

WALTER'S PERSONAL PERSPECTIVE

This PhD study enabled me to fulfill my urge of looking at BXW in a more holistic agroecosystem-broad dimension. It was especially interesting to explore disease effects on a broad range of services obtained from our agroecosystems and explore with farm models alternative and more sustainable farm configurations. Studying at Wageningen University and Research in the Netherlands offered a conducive, competitive and multi-cultural learning environment. The PhD also involved working in multiple countries and networking with multiple and diverse people. The settings of the PhD demanded hard work; improved my ability to work independently and my professional links, and ability to work in multi-cultural settings.

UNIVERSITY

CIALCA PhD student at Wageningen University, the Netherlands





CIALCA-base

CIALCA-Base was envisaged as a repository for all household surveys performed historically, presently, and part of all future CIALCA work. CIALCA-Base is a collaborative resource for CIALCA researchers, students, and partners to understand the minutiae and diversity of farming households across central Africa. Over the past 18 months, CIALCA-Base has grown into a database containing more than 3000 households with information covering 1200 variables (household, economic, agronomic, and nutritional variables). The data held within this database provides a base for extensive learning on the key pillars of CIALCA and could form the basis of developing sustainable development innovations and interventions that focus upon food security, income, and diet quality.

CIALCA-Base brings an interactivity to the data being collected, rather than being held in researchers' drawers, CIALCA-Base opens up the data collected under the current phase of the consortium, and in the future will bring data from previous phases online. This will allow researchers, students, extension groups, and governments to generate their own learning on how their focus areas and begin to generate data-led learning to drive their work.

CIALCA-Base is populated by a standardised core of questions – CIALCA-Core. CIALCA-Core is a stripped down, basic version of RHoMIS that focusses on key themes of farming households: demographics, agronomy, food security, decision-making, and income. Using these core themes, and a set of around 40 questions allows for a rich and consistent understanding of farming households, which can be gathered in

roughly thirty minutes. CIALCA-core is currently available in four languages (English, French, Kinyarwanda, and Kirundi) and is available in the survey database of the website. The CIALCA-core variables, along with all other variables included within the database are explained in the metadata section of this document.

On top of the CIALCA-Core users can then add their own modules or include other modules from other surveys performed within CIALCA. All surveys are available in the Survey Library section. Using other surveys' modules helps to reduce processing times and ensure consistency across the surveys.

CIALCA-Base is available on www.cialca.org



FIGURE 8: Screenshot of the CIALCA-Base Indicators.

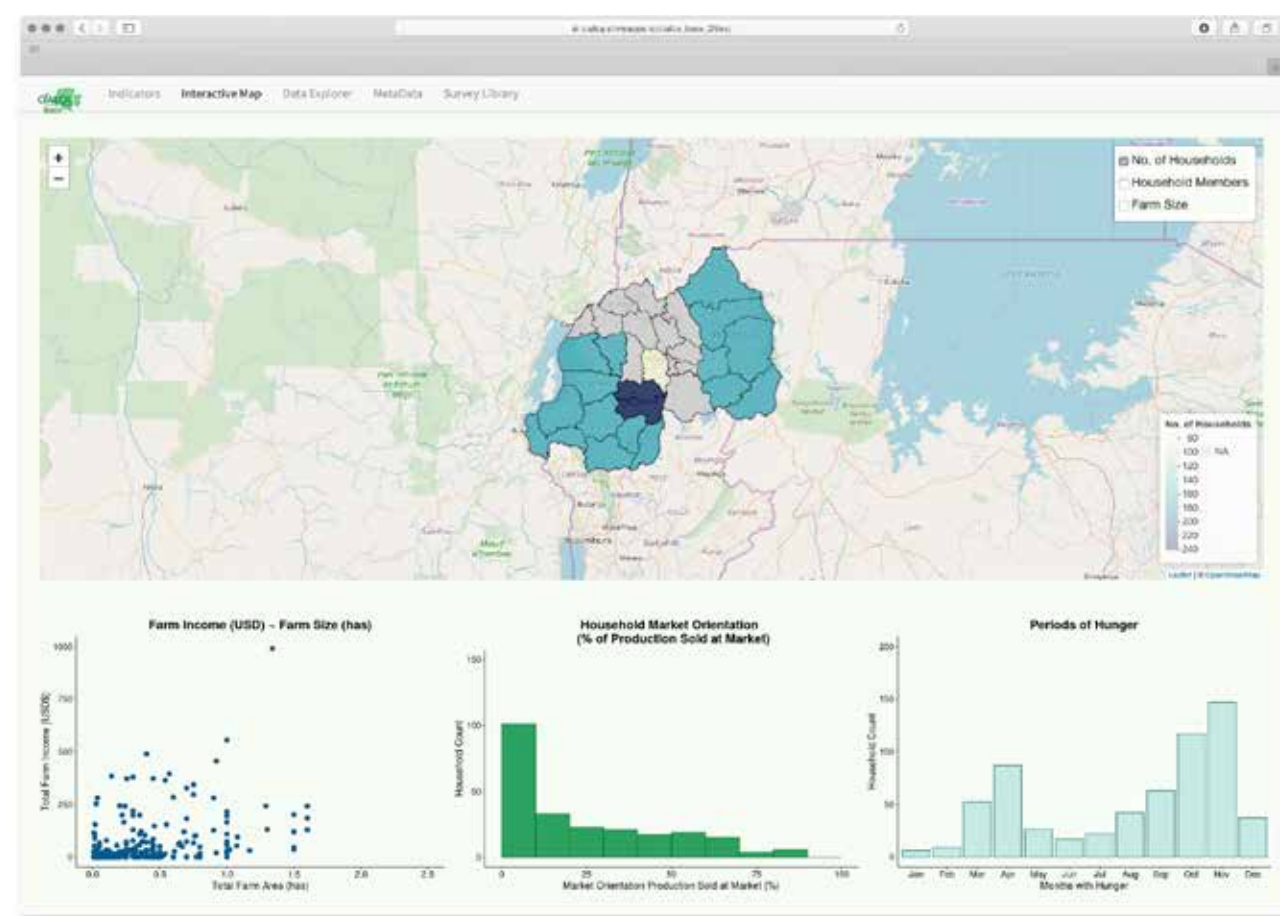


FIGURE 9: Screenshot of the interactive map of CIALCA-Base.

Overview of 2019 achievements

PILLAR 1

Partnerships and policies

ACTIVITIES	OUTPUTS	ACHIEVEMENTS UNTIL THE END OF 2019
Activity 1.1 Mapping of the demand for R4D solutions within RTB systems	By the end of 2017, the demand for research and innovation has been assembled and documented in the CIALCA Theory of Change (ToC)	CIALCA demand-mapping has been concluded and resulted in nine signed MoUs developed with key knowledge and scaling partners
Activity 1.2 Activity 1.2: Agreement on the zones of influence in consultation with scaling partners	By the end of 2017, zones of influence have been agreed upon and are adapted and documented in the ToC on a yearly basis thereafter	A total of four CIALCA co-investment MoUs have been developed and signed. Partners have invested with CIALCA in implementing R4D activities
Activity 1.3 Engagement with value chain partners (private, public) that are active with proven capacity to deliver in the Great Lakes Region	By the end of each year, agreements are reached with development partners on specific contributions from CIALCA	Two agreements are being reviewed and renewed based on a successful collaboration
Activity 1.4 Activation of a participatory, inclusive, and gender-sensitive ME&L framework	By the end of 2017, an ICT-based data collection and ME&L framework is functional and used by stakeholders	CIALCA has been successfully integrated in the CGIAR Monitoring, Evaluation and Learning platform
Activity 1.5 Co-design of government, development, or business R4D investment strategies for sustainable intensification	By the end of 2019, CIALCA has contributed to the shaping of R4D investments of government, and development and business partners	CIALCA's work has led to the successful funding of two CGIAR Scaling Fund projects that will focus on scaling CIALCA innovations. Strategic policy work to mainstream Single Disease Stem Removal for Banana Xanthomonas Wilt management was initiated

PILLAR 2

Capacity development

ACTIVITIES	OUTPUTS	ACHIEVEMENTS UNTIL THE END OF 2019
Activity 2.1 Implement PhD projects	By the end of 2017, at least three PhD candidates and hosting universities have been identified and yearly progress reports approved	<ul style="list-style-type: none"> Five CIALCA PhD students have graduated (2 Burundian, 1 Ugandan, 2 European) Eight PhD students (1 Burundian, 3 Congolese, 1 Rwandan, 3 European) are currently conducting their PhD under the CIALCA framework with Belgian universities (1 on gender, 3 on climate, 2 on poverty, 2 on nutrition, 1 on environment).
Activity 2.2 Implement MSc projects	By the end of 2018 and 2019, at least three MSc candidates and hosting universities have been identified	<ul style="list-style-type: none"> CIALCA accommodated a total of 3 MSc students and 2 interns. All 3 MSc students have graduated. An additional call for students for Burundi has been developed and advertised One MSc student for DRC has been identified
Activity 2.3 Develop a decision support framework and strategy, built on ICT principles, that supports science-based decision making	By the end of 2018, an ICT-based decision support framework and strategy is developed and validated with decision-makers	<ul style="list-style-type: none"> CIALCA now has several ICT based decision support systems in place that were developed with our partners CIALCA has supported other R4D projects in digital data collection and mainstreaming the collection of household data in the Great Lakes Region CIALCA has trained 20 PhD-students and partner staff in digital data collection
Activity 2.4 Activate CIALCA-base, assemble and disseminate information for the Great Lakes	By the end of 2018, CIALCA-base is functional, accessible for partners, and continuously updated with new information	CIALCA base has been developed and is available on cialca.shinyapps.io/cialca_base_2files and will be updated continuously
Activity 2.5 Facilitate the capacity development of last-mile delivery and service providers	By the end of 2018, a first group of service providers have been trained on using CIALCA recommendations and on a yearly basis, groups are added	CIALCA has facilitated 3 capacity development events for last-mile delivery and service providers. A total of 74 partners and students have been trained on core CIALCA themes such as gender and nutrition and the use of ICT and digital tools in research for development

PILLAR 3

Innovation and scaling

ACTIVITIES	OUTPUTS	ACHIEVEMENTS UNTIL THE END OF 2019
Activity 3.1 Develop typologies of farmer characteristics and livelihood strategies in banana- and cassava-based systems that enables better targeting of innovations and implementation processes	By the end of 2018, an inventory of farmer characteristics (location, age, gender, socioeconomic status) and livelihood strategies (production objectives, risk coping strategies, etc.) has been developed	Developing typologies of farmer households has been mainstreamed in other CIALCA surveys carried out in Rwanda, Burundi and DRC. PhD data collection using typology approach is ongoing and R4D other projects have also incorporated CIALCA typology questions
Activity 3.2 Assemble and prioritize production, nutrition, and market access-related interventions towards sustainable agriculture generated by CIALCA and other R&D initiatives	By the end of 2020, production, nutrition, and market access-related interventions have been assembled, integrated in CIALCA-base, and prioritized based on stakeholder demand	<ul style="list-style-type: none"> The CIALCA spin-off project ICT4BXW is supporting the testing and validation of its BXW management decision support tool with 69 Farmer Promoters in Rwanda First season of nutrient omission trials (NOT) are being harvested, and second season is being planted. This data is required to generate the datasets to calibrate the fertilizer decision support tools
Activity 3.3 Validate best-bet interventions including aspects of risk and alignment to the status of agricultural companies	By the end of 2018 and yearly thereafter, a set of production-related interventions has been identified that target different farm classes and are ready for scaling	<ul style="list-style-type: none"> In collaboration with the ACAI project and supported by the CGIAR Scaling Fund, CIALCA has established contact with fertilizer and cassava processing companies to explore the use of fertilizer recommendations as part of their business strategy
Activity 3.4 Evaluate trade-offs of interventions in relation to productivity, nutritional status, value chain access, and environmental conditions	By the end of each R4D campaign, trade-offs of production interventions are understood	<ul style="list-style-type: none"> The topic of trade-offs has been integrated in 2 PhD studies who are starting fieldwork end of 2019. One CIALCA PhD that studied trade-offs in BXW management in banana-based agroecosystems defended successfully One MSc that studied trade-offs in banana-based systems defended successfully
Activity 3.5 Develop production-, nutrition, and market access-related recommendations for integration in the decision support framework (act. 2.3)	By the end of each R4D campaign, lessons learned are integrated in the decision support framework of public and private stakeholders	<ul style="list-style-type: none"> CIALCA is partnering to provide decision support to public and private development organizations (e.g. the International Fertilizer Development Center, the Rwanda Agriculture Board, One Acre Fund, ALIGHT American Refugee Committee) to improve their practices and operations and has attracted additional funding to advance that work



Through partnership projects, CIALCA attracted a total of USD 9.25 Million of additional investments, which equals more than 3 times the DGD investment in CIALCA. It confirms the leveraging role that CIALCA plays in the Great Lakes Region.



‘CIALCA is more than a project’

Reflections from the Midterm Review meeting

Improving food and nutrition security and developing climate resilient and profitable agriculture were the main themes discussed during the CIALCA Mid-term Review Meeting that was held in Kigali, Rwanda between 29 October and 1 November 2019.

Over 40 participants from CIALCA's leading organisations, partner and development organisations graced CIALCA mid-term review meeting and commended its continued impact in transforming agriculture and challenged CIALCA to leverage on its 14-year presence and take agriculture to an extra mile.

Five main take-aways

1 CIALCA is more than a project. CIALCA is a long-term consortium that has established a strong network in the region and that brings multiple institutions and backgrounds together. CIALCA has adapted over time to work on themes that are increasingly important in the region – from plot level agronomy, to landscape ecosystem services, innovation platforms, network analysis, and digital inclusion. This flexibility and long-term anchor has made CIALCA a powerful consortium, that has guided and persevered through national and CGIAR reforms and from which a growing number of spin-off projects have originated.

2 CIALCA co-investment model establishes highly valuable partnerships, where people are open and eager to speak up, to jointly learn, constructively criticize, improve and move forward. CIALCA builds partnerships with public and private institutions that see benefit in this co-learning with CIALCA and therefore are willing to co-invest. This takes time and trust to establish such partnerships, but the long term presence of CIALCA in the region and the network it has established through its capacity building allow this.

3 While there are several commonalities between the settings in the Great Lakes Region, there are also large differences between those settings, and between and within households. In this new phase, CIALCA has fully embraced this heterogeneity and made it one of its core research topics, which is embedded across all themes and all PhD topics. CIALCA is thereby a true pioneer in moving towards more tailored and inclusive research and solutions. During the one day field visit, the diversity in settings and technologies was much appreciated, as was the illustration of the digital tools that help capture and interpret the wide range of settings, households, and results.



4 The five areas of impact are high on the agenda in the Great Lakes Region, across the three countries. There is demand from the partners to CIALCA to invest further particularly in 1) in-depth capacity building through contribution to courses, PhDs, MScs, 2) the integration of the different themes, e.g. to develop innovations that are climate- and nutrition-smart, 3) policy engagement.

5 Because CIALCA is a long-term consortium around partnerships, capacity building and scientific innovation & knowledge services, it does not have a very direct and simple theory of change. It is however recommended that the impact of CIALCA is continuously documented, e.g. through pathways and outcome stories. This is now taken up into the 2020 plans.



Dr. Kathelyne Craenen, Attaché Development Cooperation at the Belgian Embassy who represented the Belgian Development Cooperation (DGD), CIALCA's core donor, in the mid-term review meeting mentioned that:

"I have been involved in CIALCA since its very first start in 2005. CIALCA is one of the flagships of DGD in terms of how development cooperation can lead to real innovation, capacity development and impact."

Some key next steps for 2020 are outlined per impact area:

GENDER

Move from one-fits-all approach towards targeted approach in extension through

- Further implementation of typology analyses and applications across CIALCA activities
- Continuation of validation of typologies with One Acre Fund
- Development of tailored packages with One Acre Fund

CLIMATE

Advance isotope and related techniques for cassava and banana research towards use in identifying varieties and management practices that increase drought tolerance

- Calibrate and validate site specificity of the isotope and related techniques in DRC, Burundi and Rwanda.
- Introduce the techniques in climate-smart agriculture Research for Development programmes
- Link nutrient- and water-use efficiency towards identifying climate- and nutrition-smart technologies

POVERTY

Advance rapid and site-specific farmer decision-support on fertilizers and pest control

- Analyze trial results and set up additional trials
- Integrate trial results into the digital tool and platform AKILIMO
- Scaling-up the digital application ICT4BXW to help combat Banana Xanthomonas Wilt disease (BXW)

NUTRITION

Mainstream nutrition further in agricultural research, development and planning

- Mainstreaming nutritional and agrobiodiversity metrics across all CIALCA activities and with partners
- Understanding & exploring leverage points for sustainable pathways between agriculture and nutrition in highly populated refugee settings
- Develop a scaling proposal for now well-tested and well-documented nutrition & climate smart practices, i.e. shade- and drought-tolerant crops in banana systems

ENVIRONMENT

Build in resilience and ecosystem services in agricultural intensification

- Add a module on agrobiodiversity to the CIALCA-base
- Expand partnerships to strengthen and more explicitly incorporate the environmental dimension
- Develop a sustainability model for agro-ecological practices that increase yield, nutritional outcomes, and ecosystem services e.g. cover crops and hedges

Peer reviewed science publications 2017-2018

- Blomme, Guy, Walter Ocimati, Deborah Nabuuma, Charles Sivirihauma, Mark Davey, Stephen Buah, Inge Van den Bergh, Lusenge Vutseme, Liliane Bahati and Beatrice Ekesa (2019). Pro-vitamin A carotenoids content of 48 plantain (Musa AAB genome) cultivars sourced from eastern Democratic Republic of Congo. *Journal of The Science of Food and Agriculture*. doi.org/10.1002/jsfa.10058
- Blomme, Guy, Walter Ocimati, Charles Sivirihauma, Vutseme Lusenge, Mariam Bumba, Jules Ntamwira (2019). Controlling Xanthomonas wilt of banana: Influence of collective application, frequency of application, and social factors on the effectiveness of the Single Diseased Stem Removal technique in eastern Democratic Republic of Congo. *Crop Protection* 118, 79-88.
- Klapwijk, C. J., Schut, M., van Asten, P. J. A., Vanlauwe, B., Giller, K. E. and Descheemaeker, K. (2019). Micro-livestock in smallholder farming systems: the role, challenges and opportunities for cavies in South Kivu, eastern DR Congo. *Tropical Animal Health and Production*, first published 22 November 2019.
- Ntamwira J, Guy Blomme, Liliane Bahati and Walter Ocimati. (2019). Effect of timing of diseased plant cutting, altitude and banana cultivar on efficacy of singly removing Xanthomonas wilt infected banana plants. *European Journal of Plant Pathology*, 154(2), 477-489. DOI: 10.1007/s10658-019-01671-9
- Ocimati, W., van Schagen B., Kozicka, M., Kikulwe, E., Gotor, E., and Blomme, G. (2019). Banishing banana wilt: can it get any easier? Poster and handout presented at the 2nd Meeting of the Joint Boards of Bioversity International and CIAT. Maccaresse, Italy, May 2019. Rome (Italy) Bioversity International. 5p. hdl.handle.net/10568/101557
- Ocimati, W., J. Ntamwira, J.C.J. Groot, G. Taulya, P. Tiftonell, B. Dheda, P. van Asten, B. Vanlauwe, B. Ruhigwa and G. Blomme. (2019). Banana leaf pruning to facilitate annual legume intercropping as an intensification strategy in the East African highlands. *European Journal of Agronomy* 110: 125923. doi.org/10.1016/j.eja.2019.125923
- Sartas, M., van Asten, P., Schut, M., McCampbell, M., Awori, M., Muchunguzi, P., Tenywa, M., Namazzi, S., Sole Amat, A., Thiele, G., Proietti, C., Devaux, A. & Leeuwis, C. (2019). Factors influencing participation dynamics in research for development interventions with multi-stakeholder platforms: A metric approach to studying stakeholder participation. *PLoS ONE* 14(11): e0223044.
- Schut, M., Kamanda, J., Gramzow, A., Dubois, T., Stoian, D., Andersson, J. A., Dror, I., Sartas, M., Mur, R., Kassam, S., Brouwer, H., Devaux, A., Velasco, C., Flor, R. J., Gummert, M., Buizer, D., McDougall, C., Davis, K., Homann-Kee Tui, S. & Lundy, M. (2019). Innovation Platforms in Agricultural Research for Development: Ex-ante appraisal of the purposes and conditions under which innovation platforms can contribute to agricultural development outcomes. *Experimental Agriculture*.
- Turner, D.W. D. Jane Gibbs, Walter Ocimati and Guy Blomme (2019). The suckering behaviour of plantains (Musa, AAB) can be viewed as part of an evolved reproductive strategy. *Scientia Horticulturae* 261 (2020) 108975. doi.org/10.1016/j.scienta.2019.108975

PhD dissertations

- Turolla, M. (2019). Youth in Agribusiness in Uganda. An Ethnography of a Development Trend. Bologna University and Radboud University. Available at: repository.ubn.ru.nl/bitstream/handle/2066/205863/205863.pdf?sequence=1.
- Ocimati, W. (2019). Sustainability of banana-based agroecosystems affected by Xanthomonas wilt disease of banana (Doctoral dissertation, Wageningen University). Available at: library.wur.nl/WebQuery/wurpubs/full-text/505782

Books, conference proceedings and other scientific materials

- Coyne, D., Abberton, M., Adetonah, S., Ayodele, M., Cortada-Gonzalez, L., Gbaguidi, B., Hauser, S., Kumar, P. L., Neuenschwander, P., Schut, M. & Tamo, M. (2019). Making integrated pest management IPM work in sub-Saharan Africa. In *Critical issues in plant health: 50 years of research in African agriculture*, 397-412 (Eds P. Neuenschwander and M. Tamo). Burleigh Dodds Science Publishing Limited.
- Van Laere, J., Willemen, A., Ding, Y., Said, H., Resch, C., Hood-Nowotny, R., Merckx, R., and Dercon, G. Potassium application to alleviate drought stress in cassava production: A growth chamber based carbon-13 pulse labelling experiment. *European Geosciences Union EGU conference 2019*
- Van Laere, J., Birindwa, D., Munyahali, W., Pypers, P., Gruber, R., Resch, C., Heiling, M., Weltin, G., Toloza, A., Slaets, J., Vandamme, E., Merckx, R., Dercon, G. Counteracting the effects of drought on cassava productivity: The role of stable isotopes. *European Geosciences Union EGU conference 2019*

The NEW CIALCA website

In 2019, we have upgraded the CIALCA website with a new modern design and up-to-date information about our activities and achievements. Please visit www.cialca.org.



Blogs and communication materials

CIALCA website newsitems:

- How can you integrate gender and nutrition in your research?
- CIALCA and One Acre Fund join forces in understanding farmers' adoption constraints
- CIALCA organizes an ICT for agriculture workshop for 20 PhD-students and partners
- ICT4BXW releases digital application to fight bacterial wilt disease in bananas
- CIALCA organizes its mid-term review meeting between 29-31 October 2019 in Rwanda
- 2019 mid-term review meeting: CIALCA on track to improve profitable agriculture in the Great Lakes Region
- CIALCA tests for best cassava fertilizers in the Great Lakes Region
- The unforgettable MSc thesis research journey of Aline Ishimwe

