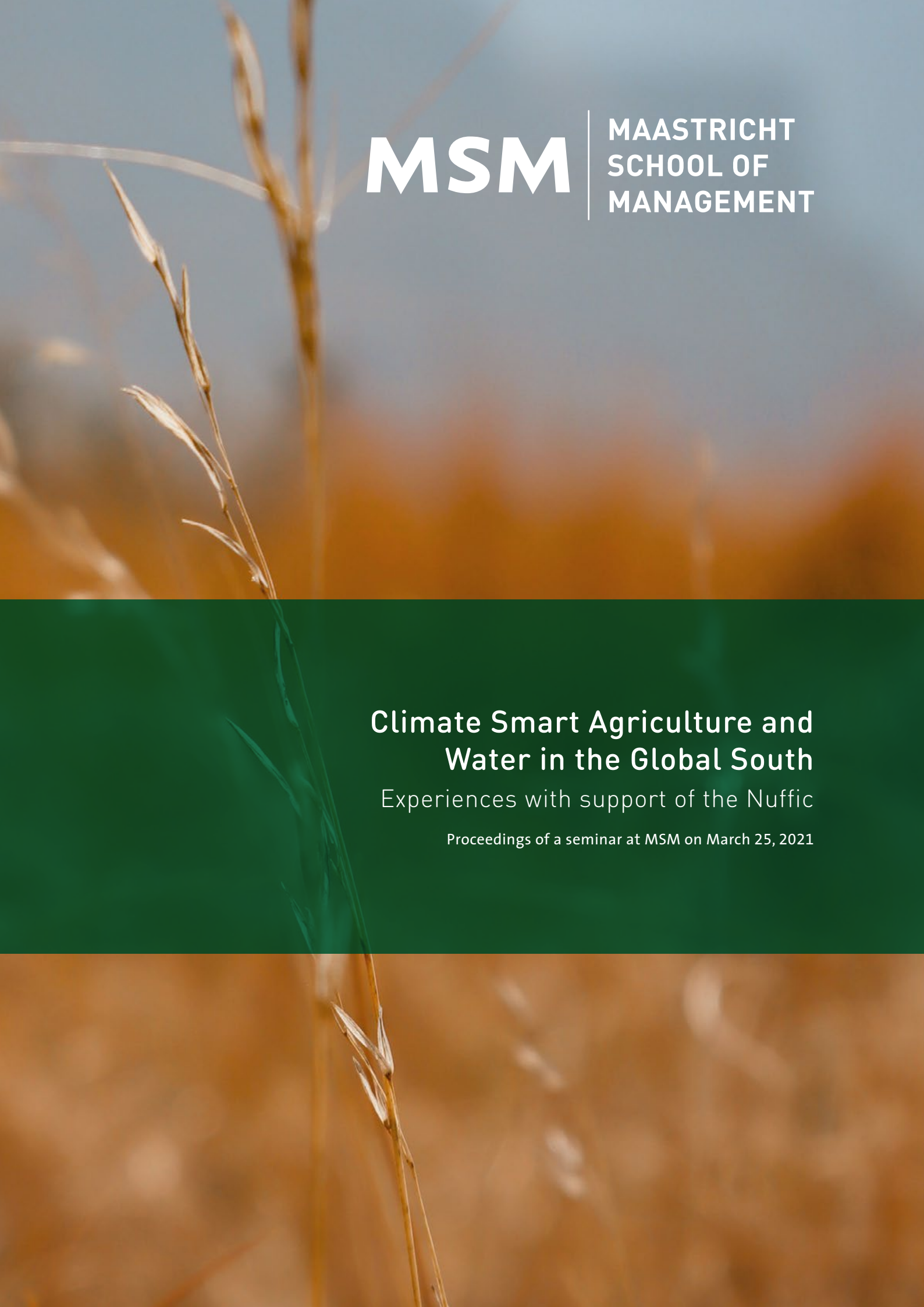
The challenges of multi-actor collaborations in climate-smart agriculture under the landscape approach



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Climate Smart Agriculture and Water in the Global South

Experiences with support of the Nuffic

Proceedings of a seminar at MSM on March 25, 2021


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Introduction

Dr. Diederik de Boer, Director International Projects / Expert Center for Emerging Economies at Maastricht School of Management

The Expert Center for Emerging Economies (ECEE) of the Maastricht School of Management (MSM) is currently working on different donor-funded capacity building projects for education and government institutions in the field of agriculture in 15 different countries around the world. Multiple of these projects are being funded by donor organization NUFFIC and in these projects climate smart agriculture (CSA) is an important aspect. Due the importance of CSA in many of our projects, a hybrid seminar was organized in March 2021 where MSM staff and project partners presented papers where CSA was the central focal point.

Within these projects the ECEE carries out activities such as: curriculum development, advising on strategy and leadership in higher education, applied research on labor market-linkages as well as policy related topics such as climate smart agriculture and value chain analysis (VCA). Other topics related to the positioning of an educational organization within a so-called triple helix – would be cooperation between government, the private sector and higher education organizations. In most of these capacity building trajectories the ECEE of MSM is the project-manager and supported by other technical organizations in the field of water and agricultural development.

In many of the ECEE's projects climate smart agriculture is becoming increasingly important. What kind of new climate smart techniques can be introduced to the students but also what kind of managerial solutions can support this? Important is also the awareness amongst leadership in academia and government. But most important is to learn from practices and sharing of knowledge amongst the stakeholders the ECEE is working with.

In Africa the ECEE is working in 9 different countries on this theme of climate smart agriculture
In Tanzania, the ECEE is working in the horticulture sector. Our partners are the National Council for Technical Education, the Horticulture Association and three agricultural vocational training centers. The focus here is on industry linkages in the horticultural sector in order to decrease youth unemployment. In this report we have one research paper from Meine Pieter van Dijk addressing climate smart agriculture in Tanzania.
In South Africa, the ECEE is working with six TVET colleges strengthening skills of TVET staff and students for optimizing water usage & climate smart agriculture. The project is also piloting a farmer centric triple helix construct for climate smart agriculture. In light of this program the ECEE is establishing an online and blended learning platform in collaboration with Stellenbosch University. One of the research papers from Hans Nijhoff, Meine Pieter van Dijk and Mireya Fischer is focusing on open innovation eco-systems addressing CSA related to this project.

In Ghana, The ECEE is working with CINOP[1] for the Ministry of Agriculture to introduce new problem based agricultural curricula which also deal with climate smart agricultural solutions. The different programs are tested and further developed in three different ATVETS. One research paper from Ishak Shaibu relates to best practices on climate smart agriculture of this project.

In Kenia, the ECEE is working amongst others with Q-Point[2] focusing on two ATVET colleges and one Agricultural University (Egerton University) to further strengthen skills and training capacity in the horticultural sector in Kenya. Aspects of climate smart agriculture in this case deal with issues of irrigation. Moreover, here we are also testing the working with so-called telephone farmers, investors who often have another job, are highly educated and are managing their farms via a mobile telephone. A research-paper from Meine Pieter van Dijk is dealing with the so-called medium sized farmers visa vis a desired supportive eco-system addressing CSA. Another research paper by Julius Gatune and Fridah Munene is addressing the innovative approaches to CSA in the Kenyan context.

[1] CINOP is a consultancy in vocational learning, training and development.
[2] Q-Point is an agricultural consulting firm specialized in supply chain management and food safety and quality systems.

In Uganda the ECEE is working on strengthening skills and training capacity in the horticulture sector with Kyambogo University and Bukalasa Agricultureal College (BAC). The project is focusing on three main output areas: curriculum review and development, institutional capacity development and the establishment of a triple helix horticulture innovation platform. The research paper from Andre Dellevoet and Ronja Kurtzahn is addressing best practices on CSA from this project looking at multi-actor collaboration in climate-smart agriculture under a landscape approach.

In Mozambique the ECEE is working with an agricultural technical college in addressing CSA innovations. This project promotes resource smart green technologies in technical professional and higher education in order to increase Mozambique's food production and nutrition security.

In Rwanda, the ECEE is working with the Rwanda Development Board, one Rwanda Polytechnic and three TVET/agri-TVET colleges in the Western part of Rwanda. The project aims to deliver institutional capacity building in horticulture and agri-tourism. Hereby are ecological and irrigation related topics of key-importance.

In Egypt, the ECEE is working with the University of Sadat City and Kafr el Sheikh University enhancing water efficiency and food security through Egyptian TVETs addressing curriculum development, linkages with the industry and applied research on CSA. This report consists of two contributions from this project one form Farouk El-Aidy on the need for CSA given the disastrous consequences of climate change for Egypt and one research paper form Aida Allam on potatoes and beans production in the desert of Egypt focusing on water stress and irrigation.

In Ethiopia, the ECEE is working in the South of Ethiopia with Arba Minch University and in the North of Ethiopia with the Ethiopian Technical University on improving agricultural vocational training. Within these projects CSA is dealt with partially through irrigation development concepts to be dealt with in curriculum development processes and institutional development trajectories.

Other capacity building projects of the ECEE in Africa, Asia and South America are ongoing in Sudan, Liberia and Sierra Leone, Jordan, Bangladesh, Georgia, Armenia, Bhutan, Indonesia, Colombia, Surinam and Peru.
For this report we received additional papers which relate to our projects in Georgia. Patrick Martens looks in his paper at challenges and opportunities for CSA in Georgia and Meine Pieter van Dijk looks on how the agri-business curriculum can become more CSA focused.

I Theoretical contributions

How the Open Innovation Ecosystem approach can support local CSA farm operations

Hans Nijhoff, Meine Pieter van Dijk, Mireya Fischer Femenias, Maastricht School of Management

Abstract

Research among Climate Smart Agriculture (CSA) farmers and organizations in horticulture sectors of South Africa, Tanzania and Jordan demonstrates the need for creating CSA ecosystems. While being fully focused on managing their CSA innovations, few farmers have time to develop these CSA partnerships and networks. To guide these efforts, we identified the key aspects for CSA ecosystems to focus on in their support to CSA farmers. We argue that for reaching optimum results, the business model of the CSA farm should include a local ecosystem that provides support to its operations from private, public and academic stakeholders. It should be a farmer-focused ecosystem, aimed at providing local solutions for localized problems. Using the Open Innovation Ecosystem Model allows us to suggest ways to facilitate the development and coordination of such an ecosystem, either by a lead CSA farmer or by other CSA stakeholders.

Introduction

Climate Smart Agriculture (CSA) innovations are increasingly important across countries in Africa and the Middle East. Both regions need to make big steps in becoming food secure and/or increase food exports. A large share of the population, especially in rural areas, depend on the agriculture sector for employment and income. In many countries the agriculture sector accounts for around two-thirds of the country's total water usage. For the agriculture sector to sustain and grow, farmers invest in water-smart skills and technologies. However, this puts an unequal share of the costs of climate-sensitive food production on the shoulders of the farmers, and not on its consumers or policy makers. After all, one might say that CSA farm technologies have a societal relevance since it serves a common goal.

Support to CSA farmers can however come in many ways, and we believe that different societal stakeholders, such as government, academics, and development partners should be organized in a local, farmer-focused, support platform. This platform will be referred to as ecosystem throughout this paper. The goal of the ecosystem is to increase the success of a farmer's investment in CSA operations through collective action. These ecosystem stakeholders will unanimously work towards successfully supporting CSA farm operations. If coordinated and facilitated well, such an ecosystem can become a key component to a farmer's CSA business model. Among CSA farmers in Africa and the Middle East, we identified a strong need for understanding who the ecosystem partners can be, what support roles they can play, and how ecosystems can be set up and maintained. This will lead to defining a successfully driven ecosystem from the ecosystem stakeholders' perspective.

In this paper, we look at CSA solutions at the farm level as technological innovations and will make use of the Innovation Management (IM) Theory to better understand how a local ecosystem can support CSA farm operations. Where the management is focused on the CSA operation at the farm level. Therefore, the aim of this study is to identify success factors of local stakeholder ecosystems that help CSA innovations to succeed at the farm level. To do so, we will examine a local ecosystem, its desired composition and the linkages to key required farm skills and conclude how this can provide the stakeholder driven ecosystem to successfully support CSA farm operations.

This paper firstly describes the aim of this study by clearly expressing the research questions. Secondly, a brief literature review dives into past CSA research on organizing stakeholders to provide support to CSA farmers. This paper then builds a line of argument and provides a theoretical reasoning for using the innovation management theory as a basis for facilitating ecosystems that support CSA farm operations. Based on locally identified challenges of CSA farmers, ecosystem stakeholders can use the theory to embed structured planning and action. We then describe the methodological approach to this study. To better understand the direction of ecosystem support to CSA farmers, a case study research method is our proposed approach to answering our research questions further. This study will be done in the period after submitting this paper. Finally, we conclude by mentioning the limitations and implications of this study.

Research Questions

At the end of 2019 and beginning of 2020, Maastricht School of Management collected data through surveys that identified a clear need for supportive ecosystems among medium-large sized farmers. The term ecosystem will be defined more specifically in section four of this paper. As farmers spend most of their time focusing on CSA technologies and the management of their operations, they lack the time necessary to find supportive partners who can help them bring forward their CSA operations. We argue that CSA therefore does not solely depend on the functioning of highly technical factors but that it also depends on managerial skills and competencies that can bring together supportive stakeholders. These are the non-technical factors that are needed for CSA to succeed. These non-technical factors, which help manage innovations, can and should be found within a supportive ecosystem (Brons, 2016). These success factors have been identified within ecosystems in other industries, mainly the high-tech industry. However, such an ecosystem has yet to be explored and its success factors which must be driven from a stakeholder's perspective and identified within the field of CSA.

Therefore, we plan to conduct case study research to examine a contemporary phenomenon in a real-life context through in-depth interviews which will answer our following research question (Yin, 2008):
"What factors influence the success of an innovation ecosystem in supporting CSA farm operations?"

This research question will be answered by combining the following sub-questions:
1. "How can different stakeholders support CSA operations?"
This sub-question helps us identify the current ecosystem set in place by exploring what the issues are that farmers face and who the actors are that are needed, their roles and contributions to an ecosystem that supports CSA operations at the farm level. This helps us set the scene to then examine our second sub-question.
2. "How can an ecosystem best be developed to play this supportive role to CSA farmers?"
This second sub-question looks at translating theory into practice. We will be testing a theoretical approach based on the innovation management theory to determine the success factors of an ecosystem that helps support CSA farm operations.

The following section dives into literature and prior research done based on our first sub-question.

Literature Review

Climate Smart Agriculture is an innovative response from the agricultural sector as a contribution to climate change. As such, CSA requires efficient innovation management. In this study, we argue that CSA requires collective action between multiple stakeholders who drive local solutions (Ostrom, 2009). By this we mean that stakeholders must be brought together to achieve a joint objective in an ecosystem for farmers to successfully manage their CSA operations. In this section, we discuss who these stakeholders should be based on proceeding literature.

Importance of organizing CSA Stakeholders

Research continuously highlights the importance of a unanimous contribution towards CSA solutions. As CSA should have a socially driven agenda, many stakeholders are needed to bring about a CSA operation. CSA stakeholders include representatives from different organizations in the private, public, and academic sector. This brings forward stakeholders within a triple helix platform (Brons, 2016). These include state and district agriculture departments, extension offices, agriculture research institutions, NGO's and donor agencies, private sector, local resource persons and farmers. Organizing these stakeholders is a challenge. Most have different priorities however, research has shown that collectively, when it comes to initiatives focusing on specific areas of the triple wins of CSA, most stakeholders choose to prioritize food production (Khatri-Chhetri, Pant, Aggarwal, Vasireddy, & Yadav, 2019). Investment into mitigating greenhouse gas emissions and adapting to the vulnerabilities left by climate change are activities that are mainly prioritized at a national and sub-national level. More location specific CSA action plans can help bring these initiatives to the local level.

Research has shown that scaling CSA operations and initiatives at a local scale, requires collective action. Mainly this includes community driven organizations, cooperatives, and farmer-producer organizations. Not only that but an action plan must have multiple activities that contribute to scaling CSA operations at the local area. This involves several different stakeholders (Khatri-Chhetri & Shirsath, 2017). Therefore, we look at innovation ecosystems, a term we will explore in the following section, because it is built on multiple partnerships between all actors in the required ecosystem to support CSA operations.

Theoretical Reasoning

Bringing together stakeholders from different backgrounds requires effective innovation and management. Whilst this management must contribute to successful innovations, management practices must be adapted to specific innovations. In this paper, management focuses on managing CSA operations at the farm level. This means that innovation management must organize stakeholders in such a way that it supports the innovation at the farm level. This leads to creating an ecosystem in which all stakeholders are partners who take collective action to support CSA innovations. In this section, we examine the meaning of ecosystems through innovation management and their theoretical evolution by following the innovation management theory and why this theory is most applicable to answering our research question.

The Development of the Innovation Management Theory

CSA innovations across the water-smart horticulture sector have turned one of the oldest industries into a modernized and highly digitalized field. With the ability to adapt to disruptive forces, such as disastrous impacts from climate change, and to the increasing demand for food production, such technologies are necessary to keep up with the world's growth. Naturally, this means that farms must be at the frontlines of innovations. With artificial intelligence, analytics, connected sensors and other emerging technological approaches, innovation management must keep up with all areas of this industry's needs (Lutz Goedde, Menard, & Revellat, 2020). To do so, in this study we argue that following the innovation management theory makes practical sense as it is aimed at organizing the management of innovations within an organization.

The innovation management theory was initially developed in the 1970's when the big boom of innovations around technological advancement first started. This theory aims to take an academic and theoretical approach to explaining phenomena observed in the real world. As the world became more and more digitalized, six research paradigms evolved from this theory.

The Open Innovation Ecosystem is one such paradigm (Bouwer, 2017) and we selected it as the most suitable to investigate our research question on stakeholder support to CSA innovations at farm-level.

Choosing the Open Innovation Ecosystem Model

The Open Innovation Ecosystem (OIE) theory, one research paradigm which evolved from the Innovation Management (IM) theory, captures the managerial structure needed for such successful CSA innovations (Bouwer, 2017). The OIE theory is built upon three main research areas. Specifically, Open Innovation mainly by Prof. Henry Chesbrough and Ecosystem Innovation by Prof. Ron Adner and the Business Model Innovation by Dr. Alexander Osterwalder (Bouwer, 2017). Researchers now make use of this theory to explain how corporations should be networking to create a competitive advantage. Similarly, in this study we use this theory by taking it into the agricultural (more specifically, the horticultural) industry to investigate how CSA innovation can succeed by successfully managing CSA innovations. As mentioned earlier, CSA innovations are highly digitalized and using a theory which evolved together with the digital world, makes logical sense.

As an extension to the OIE theory, the Open Digital Innovation Platform Ecosystem theory was developed. This however focuses its full attention on a digital platform business innovation model. In the CSA industry we still require human touch and connectivity, and as we focus our research mainly on partners jointly managing innovations, we therefore choose to not make use of this extension within our study.

Moore (1993), was the first to make use of the word 'ecosystem' as a metaphor for *"an economic community supported by a foundation of interacting organizations and individuals*", making these the "*organisms of the business world*" (Peltoniemi & Vuori, 2008). This links to our hypothesis, which is that "stakeholder partnerships [as an economic community of interacting organizations and individuals] increase the success of CSA operations". Many researchers within the business world have however adapted their own versions of the word ecosystem. Since we want to understand what partners are needed in an ecosystem to support CSA farm operations, we choose to use Adner's (2016) definition of an ecosystem, who defines it as *"the alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize"* (Adner, 2016). In this study, the '*alignment structure'* refers to the roles and activities each partner must enact, '*multilateral'* refers to how with multiple CSA stakeholder perspectives, backgrounds, and resources they, the '*set of partners'*, aims towards the same *'focal'* goal, which in our case is successfully managing the CSA innovation at the farm level.

The Open innovation Model was first proposed by Chesbrough (2006), to describe how the process of managing innovations should evolve (Bénézech, 2012). The Open Innovation Model is a business management model which stems from the wish to create an industry ecosystem and encourage collaborations beyond one's own business to enhance innovations (Bouwer, 2017). In other words, this means that businesses are open to using outside resources within their innovation process, including ideas, technologies, processes and sales channels (Zapfel, 2018). In fact, organizations, across the industry, in an ecosystem can benefit from open innovation even if they themselves do not create new products or processes (Vanhaverbeke & Roijakkers, 2013).

Making use of The Open Innovation Ecosystem Theory in our Study

Open innovation was mainly aimed at large corporations who should manage their innovations in a new way. However, Chesbrough has argued that it should not be limited to large, highly technological corporations. In fact, more industries could take on the open innovation model, including the agriculture and horticulture industries. Nevertheless, Bénézech (2012) argues that an open innovation model should be followed not only by one organization, but by all organizations within an industry. This is conditional, so that all organizations can take up the benefits of an open system of innovation. This leads us to combining the open innovation model with the ecosystem innovation model, in order to focus on how to manage successful innovations within an open (agriculture) innovation ecosystem across the water-smart horticulture sector. In doing so, we make use of the Open Innovation Ecosystem (OIE) Theory in our study, which stems from the Innovation Management Theory. We will use the OIE Model as a basis to analyze which types of ecosystem stakeholders are needed to successfully support CSA farmers to manage their innovations at the farm-level.

In using this model, we also argue that CSA farmers need to be open to sharing their own experiences with others to build and maintain their ecosystem. This includes forming direct and indirect partnerships and networks. Literature on CSA practices shows that such partnerships and networks have to include various actors, such as other CSA farms, sector organizations, agribusinesses, agriculture financing entities, development organizations, research institutes, education and training providers, and civil society organizations. All must take on the responsibility of flexible planning and working together (Williams, et al., 2015). The role of the public sector is often highlighted in relation to introducing CSA-related policies at the national, regional, and local level, to decreasing a CSA-knowledge gap among actors, and to financial support to CSA initiatives.
Durst and Poutanen (2013) identified several success factors that facilitate open innovation ecosystems. These are grouped in the following dimensions: resources, governance, strategy and leadership, organizational culture, human resources management, people, partners, technology and clustering. The authors found these factors by conducting a literature review on different industries that follow an open innovation ecosystem. Extensive case study research by Brons (2016) showed that from these success factors there are certain critical factors that are needed for an ecosystem to sustain and grow. These critical factors are managerial factors that must be taken on by ecosystem partners to support managing innovations. Figure 1 shows Moore's illustration of a general ecosystem that surrounds the core business where the innovation takes place and needs to be managed.

Business Ecosystem

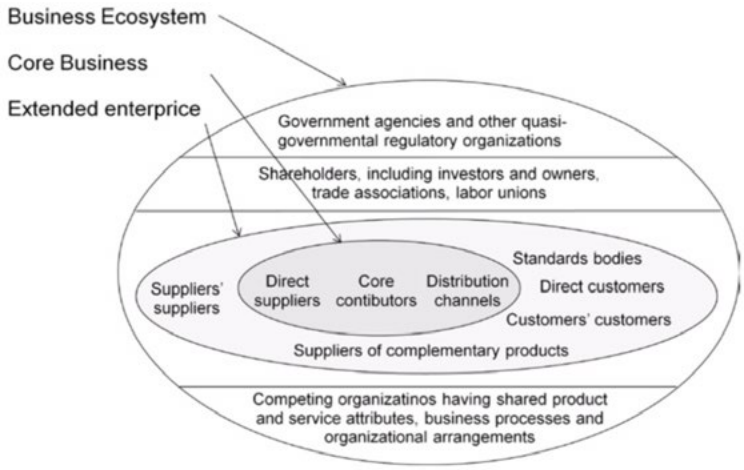

Figure 1: Business Ecosystem, Brons (2016 15) and Moore (1996 27).

In our study, we look at the ecosystem that is developed around the farmer's CSA innovation. This farmer is the "core business" of the ecosystem. Although CSA innovations itself are created by the tech industry, in this study, we focus on an ecosystem that can support the application and management of that innovation by its user – being the CSA farmer. The success factors we research are the management-related activities that take place within the ecosystem, carried out by the ecosystem stakeholders, that allow the ecosystem to support the CSA farmer to operate (and manage and adapt) its CSA innovation at farm level. We will further research the specifics of these success factors in this context.

Innovation Ecosystem Success Factors

Previously we briefly mentioned the critical success factors by Brons which are necessary to sustain an ecosystem. Brons builds her research on theoretical propositions by Moore and others in the context of the four evolutionary phases of the Business Ecosystem Life Cycle (BELC; with the four phases being birth, expansion, leadership, and self-renewal). In the Evolutionary stages of a Business ecosystem (Moore, 1993), the phases are described from a core business point-of-view. For our research we use this to better understand the phases the core business goes through and the cooperative challenges the business faces in each of these phases. The cooperative challenges can then be put in the context of the roles and supportive action of ecosystem stakeholders per phase.

According to Moore (1993), in the birth phase the core business works with customers and suppliers to define the new value proposition around the new (CSA) innovation. The ecosystem is now slowly developed, often spontaneously, around the core business. A key challenge of the core business is to tie up critical lead customers, key suppliers, and important channels. In the second phase, the expansion phase, the core business brings the new (CSA) offer to a large market by working with suppliers and partners, to scale up supply and achieve maximum market share. A key challenge is to ensure that its approach is the market standard in its class through dominating key market segments. In the third phase, the leadership phase, the core business provides a compelling (CSA) vision for the future that encourages suppliers and customers to work together to continue improving the complete offer. A key challenge in this phase is to maintain strong bargaining power in relation to other players in the ecosystem, including key customers and valued suppliers. Finally, in the self-renewal phase, the core business works with (CSA) innovators to bring new ideas to the existing ecosystem. A key challenge is to maintain high barriers to entry to prevent innovators from building alternative ecosystems, and maintain high customer switching costs in order to buy time to incorporate new ideas into own products and services.
If the leadership phase fails, however, then the ecosystem reaches its death. Hence, the leadership phase is critical for the ecosystem to survive (Durst & Poutanen, 2013), and for it not to enter its death stage and continue to have an impact on the community, the ecosystem must be able to renew itself. Specific success factors in the leadership phase are therefore crucial, and the ecosystem stakeholders will need to provide support to these success factors for the (CSA) ecosystem to have impact and be maintained. The assumption here, as described by Moore, is that although in practice the phases blur together in relation to specific needs, theory assumes that each phase differs in its needs, and thus, its success factors too (Moore J. , 1993).
To identify critical success factors of the ecosystem to provide support in the leadership phase, which is the phase to be studied, Brons (2016) made an extensive literature review and focused on four main themes: entrepreneurship, structure, collaboration, and open innovation. From these four themes, through case study research, eight critical success factors of an ecosystem were defined at the leadership phase of the BELC. These are briefly described below.

1. *There is a 'lead firm'*

An ecosystem needs a lead firm that facilitates the organization and management of the whole ecosystem. This lead firm must create a shared strategy, vision, and mission for all partners in the ecosystem to work towards in collective action (Brons, 2016).

2. *Flexibility*

Flexibility in the ecosystem is necessary. It helps partners adapt to chaos, failure, and act in times of crisis situations. Not only then but, business ecosystems also require flexibility when it comes to allowing new organizations to join (Brons, 2016).

3. *Efficiency*

Efficiency allows the ecosystem to stay up to date with its market needs. All partners must "speak the same language" (Brons, 2016). Certain ecosystems even invest in building a shared company culture. Partners should

also be able to access the same resources. For example, sharing information is inherently important in the ecosystem, but more so is the timing of the information being shared. Information should be accessible to all partners when needed as it is essential for innovations to reach their targets on time (Brons, 2016).

4. Communication
Communication means that there are shared goals, strategies and that the process of collaboration is agreed and understood by all those involved. This effective communication must be clear right from the start (Brons, 2016).

5. Resource Allocation
When investing in resources the ecosystem must make strategic choices. The main importance is not on what resources the ecosystem has but rather how the ecosystem chooses to allocate and make use of its resource. Knowing exactly each partners' resources and capabilities and agreeing on courses of action in the case of a failed collaboration with a specific partner is also part of resource allocation. Another example, investing in a resource to be used across several operations also shows intelligent resource allocation (Brons, 2016).

6. Co-creation
All partners bring new knowledge and resources to the business ecosystem. Therefore, involving them at the earliest possible stage is ideal for developing, creating, and introducing innovations sooner to the market (Brons, 2016). This also leads to building stronger relationships between partners which helps stronger commitment from all towards collective actions.

7. Ecosystem connector
The business ecosystem must be held together and to do so, forging new connections in the ecosystem is a constant role. However, this role should not be taken by one sole partner but rather all partners should take on the responsibility of creating new connections. This gives partners a sense of freedom which builds relationships on sharing ideas and knowledge with each other. Brons argues that the ecosystem should not be seen as having a traditional leadership style but rather it should take on a holistic view (Brons, 2016). All partners should be connected in one form or another.

8. Trust
Trust is one critical success factor that is relied upon to create the ecosystem but also grows with time. The ecosystem should be an interconnected set of partners within a spider web of mutual trust. In an ever-changing industry, flexibility is key and therefore openness and trust allow a business ecosystem to succeed (Brons, 2016).

Brons (2016) examined an ecosystem in the Dutch high-tech industry, in its leadership phase of the BELC, to identify these eight critical success factors. In our study, we will test whether these same eight critical success factors can be applied as success factors for ecosystem stakeholders to support CSA operations of farmers. This should help us answer our main research question: *"What factors influence the success of an innovation ecosystem in supporting CSA farm operations?"* The following section describes the methodological process that we will follow to do so.

Methodology

Our proposed methodological approach for this continued research is using the case study research approach. According to Yin (2018) "a case study is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (Yin, 2008). We follow case study research by Brons (2016), who identified the eight critical success factors of an innovation ecosystem in the high-tech industry (Brons, 2016). We want to test whether these success factors are also critical in an innovation ecosystem in the field of climate smart agriculture. Specifically, we look at medium and large-scale horticulture farmers in four different countries. This will be done through semi-structured interviews with a Dutch organization that has CSA horticulture operations in Ghana, Nigeria, Tanzania, and Zambia. We will first explore the current ecosystem that is in place, including all its stakeholders, as well as analyze the CSA operation, including on it being in the leadership phase of the BELC. We will then test the critical success factors of the ecosystem to provide support, as identified by Brons (2016) in relation to the CSA operation. This will result in a cross-country comparison of ecosystems and will ultimately answer this study's main research question, being *"What factors influence the success of an innovation ecosystem in supporting CSA farm operations?"*

Qualitative Research Findings

Our research is based on a contemporary phenomenon, both ecosystem theory and CSA, that can only be observed in real life (Yin, 2008). Therefore, we will use the case study research approach for building further on a body of knowledge that has already derived from quantitative data from research among over 100 respondents in South Africa, Tanzania, and Jordan. This quantitative data will thus serve as a starting point to define the key issues and actors, which will be further tested using case study research on CSA horticulture farm operations, and specifically on the need of building an ecosystem to support these operations, in Tanzania, Zambia, Ghana and Nigeria. The qualitative research will be used as our empirical approach, and we will follow the Method of Triangulation, namely by collecting data from the following three sources: literature, other case study or studies from literature, and our own case study covering operations in the four countries. As our primary (quantitative) data was collected and explored first, without any predetermined theoretical framework, we follow the inductive approach, while also working from a deductive perspective, since literature research on the most suitable innovation model has helped shape the approach for the qualitative data collection.
These approaches will guide us in our goal to test 'if the Open Innovation Model is applicable to the setting of a local CSA ecosystem supporting CSA innovation management at farm-level'.

Quantitative Research Findings

From our quantitative research we found evidence that supports our line of argument, which is that 'CSA farm operations require an innovation ecosystem to support it in its operations'. In the research data an ecosystem is described as the need for 'partnerships and networks.'

We make use of data that was collected late 2019 and early 2020. In that period interviews were held with horticulture industry actors in Jordan, Tanzania and South Africa. The interviews were done in the context of a labor market needs assessment. The purpose of this assessment was to get a better understanding of the required skillsets that horticulture college graduates should have and bring to the company in case of employment. In total 127 persons filled the questionnaire. The questionnaire was designed based on prior knowledge gained during numerous consultancy assignments, including field and company visits, to horticulture industry actors. Of the total number, 32 were interviewed in Jordan, 48 in Tanzania, and 47 in South Africa. Of the total number, 61% represented the private sector, 24% government, and 13% academic. Of all private sector respondents, two-thirds were horticulture farmers, 29% agribusiness company owners or managers, and 5% represented a horticulture sector association.

Limitations and Conclusion

There are some limitations to this study's approach. Firstly, our qualitative data to be collected will only be derived from one single interviewee, a very extensive interview, nonetheless, from one single person. This leads us to a certain biased view on the conclusions that can be made as we will only have one person's perspective on each one of the four ecosystems to be studied. Hence, we suggest studying an ecosystem from several more perspectives. Ideally, we would interview all ecosystem partners however, due to time constraints and accessibility to each partner, this is unattainable by the researchers.

Furthermore, the interviewee is a European who started CSA operations in Africa. This might lead to biased answers not only in the sense that we are not getting a view from people who live there but also, given the nature of his position, it can be assumed that there is a possibility that his answers will be biased and leaning towards wanting to promote his operations instead of bringing forth the reality of the situation. Nonetheless, this study does have several implications that will be useful for further research to build further on both ecosystems and the field of CSA.

Overall, our study will contribute to the literature by taking on a practical case study approach with a three-fold objective. Firstly, we will test the open innovation ecosystem model through real-life examples in the horticulture industry, looking at how ecosystems can support a farmer in managing (optimizing) its CSA innovations. Secondly, we will use the eight critical success factors needed at the leadership stage of the BELC identified by Brons (2016) for testing these factors according to real-life operations in four different countries. Finally, we will design a practical step-by-step approach for horticulture stakeholders when facilitating building and maintaining a local open innovation ecosystem to support local CSA operations.

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The Challenges of Multi-Actor Collaborations in Climate-Smart Agriculture under the Landscape Approach; In Search of an Alternative

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Abstract

With a growing world population to around 9 billion people in 2050 and the rise of global warming, there are growing concerns about food security for a large part of the world population. This is compounded by other environmental disasters such as deforestation, desertification, water scarcity, pollution and loss of bio-diversity. Human activity is putting more and more pressure on the natural environment. Hence, there is widespread consensus that a more sustainable balance must be struck between human needs and the preservation of natural resources such as land, water and forests (World Resources Institute, 2019).

Generally, the solution to such large and complex issues, has been to call for multi-actor collaboration at international, national and local levels. In 2015, the UN emphasized PPPs as the key vehicle to reach the sustainable development goals. Large programs such as REDD+ concerning deforestation, were set up. Multilateral organizations such as the FAO and World Bank promoted the concept of Climate-Smart Agriculture (CSA) which aims to increase agricultural productivity, enhance resilience and reduce emissions (World Bank, 2020). Management of the these "commons" is achieved through a landscape approach, which aims at multi-actor collaboration. It looks beyond agriculture, integrating it with forestry and other land uses to forge a comprehensive agenda for sustainable development to eradicate poverty, strengthen food and nutrition security (FAO, 2013).

However, these big concepts also face a number of challenges. Empirical evidence about the efficiency of the landscape approach is still scarce and often not as unambiguous as underlined in theory due to many obstacles and measurement challenges (The Ministry of Foreign Affairs of the Netherlands, 2013). One particular challenge is the institutional side of the landscape approach, in terms of its legal, administrative or even political aspects. This paper dives deeper into this topic by focusing on the institutional and governance aspects of the landscape approach in CSA and compares these with another framework for multi-actor collaboration, namely High Performance Partnerships (HPP), to assess which approach might be more successful to achieve the goals of CSA.

Introduction

A short overview is given about the landscape approach in CSA with an emphasis on the (institutional) challenges of the approach. Then the paper describes the HPP framework and provides an overview of diverging and converging elements of both frameworks. The final section highlights a number of lessons learnt from the HPP that also seem applicable to the landscape approach and concludes with a research agenda that can provide further insight into successful landscape approaches.

1. CSA and the Landscape Approach

Latest since the 1980s when the conservation debate in the global South and complex issues such as climate change or sustainability issues arose around the globe, spearheaded by the Brundtland report "Our Common Future" (1987), the need for broader solutions became visible. This shifted the perspective from traditional sectorial land-use planning, policy, governance, and management approaches to a multiple-actor implementation framework. In 2010, the FAO launched the concept of Climate Smart Agriculture (CSA), which integrates the three dimensions of sustainable development (economic, social and environmental) by jointly addressing food security and climate challenges. It is composed of three main pillars (FAO, 2013):

1. sustainably increasing agricultural productivity and incomes;
2. adapting and building resilience to climate change;
3. reducing and/or removing greenhouse gases emissions, where possible.

To maximize the benefits and minimize the tradeoffs, CSA takes into consideration the social, economic, and environmental context where it will be applied. In addition, repercussions on energy and local resources are also assessed.

A key component of CSA is the integrated landscape approach that follows the principles of ecosystem management and sustainable land and water use (Foli et al., 2018). The landscape approach provides a framework to integrate policy and practice for multiple land uses, within a given area, to ensure equitable and sustainable use of land while strengthening measures to mitigate and adapt to climate change. It generally

covers an area large enough to produce vital and related ecosystem services, but small enough to be managed by the people using the land which is producing those services (FAO, 2013). The landscape approach is primarily a versatile strategy which integrates a broad range of stakeholders aiming to develop long-term solutions on different scales (Arts et al., 2017). The idea is to create synergies within the landscape and balance the goals of all relevant stakeholders, including local inhabitants such as farmers, resulting in a win-win scenario for everyone (Reed et al., 2017).

Landscapes are not just spatial units of the natural environment, they are also shaped by social components such as knowledge exchange and social capital. Bottom-up approaches involving multiple stakeholders can create a full understanding of the landscape by recognizing the different relationships between various ecosystems to the different stakeholders, for example as source of income and livelihood or risk mitigation and even as a public good (Horn & Meijer, 2015).

To guide the multifunctional landscape processes, Sayer et al. (2013) developed *ten guiding principles* focusing on the structure of landscape approaches and the social interaction within the multiple stakeholders which are as follows (Art et al., 2017):

1. The dynamic nature of landscapes forms the basis for *continual learning* and adaptive management.
2. Intervention strategies are built on common concerns and *shared negotiation*.
3. Landscape processes are shaped by influences from *multiple scales*.
4. Landscapes are *multifunctional* by nature, which requires choices and trade-offs.
5. Multiple stakeholders frame objectives differently, hence *all stakeholders* need to be *engaged*.
6. *Trust* among stakeholders is crucial to build up a negotiated and transparent change logic.
7. *Clarification of rights and responsibilities*, especially regarding land and resource use, is a necessity.
8. *Monitoring* of progress has to be done in a participatory and user-friendly manner.
9. System-wide resilience is to be achieved through *recognizing threats* and vulnerabilities and the capacity to resist and respond.
10. The complexity of landscape processes requires strong *capabilities* of all stakeholders involved.

In sum; the landscape approach should be seen as a dynamic framework striving for an integration between nature and people (Art et al., 2017).

1.1 Challenges of the Landscape Approach

Although the landscape approach is seen by many organizations as one of the most suitable frameworks to meet the goals of CSA, empirical data is still scarce, and the few available studies sometimes even show some negative effects (Reed et al., 2016). A case in point was the CREMA-project in Ghana. Whereas the project met most of the criteria to successfully manage the trade-off between human activities and wildlife conservation, it remained open about the effectiveness of the landscape management, while two other cases clearly demonstrated design limitations in Ghana and Burkina Faso (Foli et al., 2017). The cases demonstrated that the complexity based on the multi-functionality and the multi-sectoral strategy in different contexts makes landscape approaches so broad that it is quite hard to clearly define, re-fine and measure it (Reed et al., 2017).

Overall, there are more than 80 terms and definitions describing landscapes (Reed et al., 2016). Some of the key challenges are:
First, perspectives on resource availability are highly contested, mostly because natural resource supply and demand are hard to predict and complex in nature to manage. Stakeholders across different sectors, industries, countries and disciplines often disagree on the relative urgency to act on different perceived resource risks and the appropriate responses in mitigation, often ending in a very polarized and simplistic scarcity-abundance debate. Experts and decision makers from both the public and private sectors tend to have four distinct sets of perceptions of natural resource availability: 1) Threats of material exhaustion, 2) Concern about rising costs 3) Long term abundance 4) Social injustice focused on distributional challenges (WEF, 2017). Policy makers tend to base their resource management strategies and policies primarily on one of these four conflicting paradigms and without clearly defining the deeply held assumptions that support them. In reality all four paradigms are valid but only true in specific agro-ecological systems or for specific resources, creating the potential for miscommunication. Moreover, the same underlying data can be framed at times to support multiple, conflicting solutions. Decision-makers are severely hampered, both individually and collectively, when having neither an appreciation of the overall system of resource availability, nor the ability to discuss the issue constructively across sectors and disciplines (WEF, 2017).

Second, there often exists a lack of an efficient framework and governance structure. Landscape spatial units are not the same as the management-administrative power space. Powerful stakeholders dominate the decision process resulting in the situation that the interests of all actors are not proportionally represented and so costs and benefits are unequally distributed. In reality, often ineffective top-down approaches can be found which are conducted by large businesses such as large commercial estates and plantations or governmental institutions (Horn & Meijer, 2015). Good governance also requires having the capacities to manage the trade-offs from all involved actors in the right amount taking the different interpretation of success into account and the time factor since benefits are not always clear from the beginning onwards (Horn & Meijer, 2015). Moreover, historical legacies and weak institutions can adversely affect landscape management through weak property rights and corruption. The question "whose territory" is often not answered and there's a real risk that local populations that have managed these forests since centuries are disempowered by framing forests as global goods (McCall, 2016).

Third, the landscape approach is often challenged by multiple barriers such as a lack of resources, monitoring system and shared vision. The lack of knowledge inhibits a practical understanding of long-term costs and benefits and the lack of financial resources leads to gaps in the capacities of especially local, small stakeholders to act or contribute which undermines their credibility (Reed et al., 2016). Another challenge is that there is inconsistency in reporting and data collection resulting in poor information for decision making. In one landscape project it was found that more than half of the analyzed cases lacked reliable monitoring. The evaluation and monitoring system is often incomplete, yet is quite critical since no baseline level exists (Reed et al., 2017). Not only can this have an effect on the transparency level, it also leads to partial and biased information, further eroding trust amongst the partners (Horn & Meijer, 2015).

2. The HPP Framework

Good governance is crucial to landscape management[3]. It is about the creation and enforcement of rules by institutions. It requires the participation of a range of stakeholders, from organizations of farmers, herders, fishers and foresters to civil servants responsible at the watershed level and beyond. However, as concluded from the previous paragraph, the landscape approach is difficult to reconcile with existing, local governance and social structures. What matters essentially is that stakeholders work collaboratively on a landscape with the aim to achieve benefits for everyone (the nature and the involved stakeholders) while balancing divergent interests. This can only be achieved when the stakeholders know each other, interact and share common objectives and interests, such as the preservation of the natural environment on which they depend.

Hence, instead of the rather diffuse landscape approach, a partnership approach may provide a more useful framework for governance, as it also focuses on multi-actor collaboration but with a stronger emphasis on the actors themselves, rather than the issues they are supposed to resolve. The body of literature about High Performance Partnerships (HPP) may be relevant in this context. The HPP framework assumes that effective collaborations and partnerships create mutual advantages as long as an integrated approach is chosen. Therefore, partnerships should follow the characteristics of an inter-organizational partnership which are: 1) shared goals, 2) a common purpose, 3) mutual respect, 4) willingness to negotiate and cooperate, 5) informed participation, and 6) shared information and decision making (de Waal et al., 2010). In order to work efficiently together, both structural and behavioral components are needed which are specified as the HPP characteristics consisting of; control, trust, commitment level, coordination, interdependence, communication, conflict management, valuing diversity, similar location and management quality. These are very similar to the ten principles for the landscape approach which were mentioned under par. 2.1.

2.1 The challenges of the HPP Framework

However, the HPP framework is not without its challenges either. These are at two levels; 1) the individual organization, be it a commercial business, a farmer's association or a Savings and Credit Cooperative (SACCO), that needs to become a High Performance Organization (HPO) and 2) all the organizations within the value chain need to become HPO's. After all, if the suppliers and buyers are not HPOs, the quality of the organization will be offset in full or in part by the poorer quality of the other partners in the chain (HPO Center, 2021).

[3] Governance comprises all of the processes of governing – whether undertaken by the government of a state, by a market, or by a network – over a social system (family, tribe, formal or informal organization, a territory or across territories) and whether through the laws, norms, power or language of an organized society. It relates to the processes of interaction and decision-making among the actors involved in a collective problem that lead to the creation, reinforcement, or reproduction of social norms and institutions (Wikipedia).

This approach entails a wide range of organizational development and capacity building interventions which may range from senior management and leadership to HR management, operations, financial management and control. This orientation towards internal strengthening may very well take years, while "external" involvement and activities remain small and slow (and the need for action in the short run becomes more pressing). The HPP approach also makes partners more inter-dependent, which may cause further delays, frustrations and possibly conflict.

3. A Comparison between the Landscape Approach and HPP

Even though, as stated above, many different applications of the landscape approach can be found, covering large areas even across countries, examples that are mostly used seem to focus on specific, geographically limited ecosystems. That way, it seems that the landscape approach within CSA and the HPP framework share certain common characteristics. They both seem to be most relevant at the **meso-level, in a specific spatial** environment such as a water catchment area or a large natural forest or in agricultural value chains involving a diverse yet limited number of stakeholders. They also seem similar when it comes to factors that determine success such as building trust, continuous and effective communication, strong coordination and respecting diversity (HPO Center, 2021).

However, there are also a number of significant differences in both approaches, such as highlighted in below.

Identifiers, attributes and characteristics	Landscape approach	HPP approach
Concept or definition	Complex social-ecological system, mosaic of different land uses, boundaries discrete or fuzzy, maybe multiple overlapping boundaries	A method to measure the performance of an organization. A concrete geographic or administrative space where an authority or group of organizations shapes, influences, and controls social activities and access to resources
Ontological themes and elements	Understanding and analysis (of landscape systems)	Governance and management Ownership, entitlements rights
Epistemological purpose	Natural scientists, agrology scientists, environmental experts	Social scientists, legal and management advisors, political activists, NGO's
Core elements	Biophysical, hydrology, soils, topography, land cover, ecosystems	Legal and administrative-land use, land management systems, economic, social and cultural functions, internal and external social relations
Boundaries or limits	Differently determined by principles of different natural scientific fields. More likely determined by "purpose" of the delineation/classification system	Socially/culturally/politically Identified-although may be changeable and fluid. Usually hierarchical, Unlikely to be overlapping in principle, but often disputed.
Scale	Any; from farm to globe	Limited by controlling agents, strict common denominators as identified by human societies
Management	Multiple actor collaboration, no single entity in charge	Managed by intermediary, coordinating body such as a sectoral or product organization
Control	Control is difficult, achieved through consensus. Hidden power	Exclusion, generally accepted rules and regulations, "tradition". Visible power
Ownership	Collaboration, coordination of multiple agents (e.g., "platforms")	Single "owner"-Private, state, cooperative, OR community

Table 1. Differences between the Landscape Approach and HPP. *Source*: adapted from McCall (2016)

3.1 Towards a Successful CSA Governance Approach

While the landscape approach and HPP have a lot in common, the HPP framework seems to offer a better perspective for effective management of the natural resource base, precisely because it looks at partners' ability to contribute, control and cooperate.

As we have seen, one of the disadvantages of the landscape approach is the multi-functionality and vagueness of the concept. Involved actors need the capacity to "think" as a landscape and work collaboratively (local, regional, national and global) together at scale (Arts et al., 2017). They take a helicopter view of landscape management and then at the role of each stakeholder. This means that to accomplish effective solutions, all

actors, the local community as well as higher levels, including national political elites, are assumed to take responsibility and contribute. While there are examples where these multiple actors collaborate effectively on certain CSA interventions, such as combating illegal logging, there are very few instances where such a comprehensive and complex approach has actually led to the preservation of the natural resource base. It seems more like a delay of the inevitable demise of the natural resource base, than a turnaround, as evidenced by the increasing loss of forest and bio-diversity worldwide (World Resources Institute, 2019; WWF, 2021).
The benefit of the HPP approach lies in its focus on organizational performance. In other words; while acknowledging the urgency and need to collaborate with other stakeholders in the sustainable management of scarce natural resources, the HPP approach looks firstly at each organization's capacity to contribute and then in its relationship to other partners. This approach allows partners to remain with both feet on the ground and look at the feasibility of joint action to manage the natural resource base and address social issues such as lack of knowledge, communication, power disparity and lack of financial resources (Arts et al., 2017). In terms of governance, existing administrative and statutory bodies may be incapable of a fulfilling the conditions of a HPP (FAO, 2013). This may point to the need for a new legal body with a strong mandate in which stakeholders equitably participate, pool resources, establish rules and procedures and enforce them. Such an approach may prove to be better suited to answer the question whose territory is being managed, or who "owns" the territory (McCall, 2016).

Due to the limited access to empirical evidence of landscape approaches, more studies are required in the near future for deepening the understanding about the governance of landscape approaches (Horn & Meijer, 2015), including the application of different analytical frameworks such as HPP. At the same time, concrete monitoring and evaluation measures are needed to break up those complicated landscape approaches into simpler components and so to provide valuable insights into principles of effective landscape management and the readiness of partners to play their part. Once effectiveness can be measured, more lessons can be learnt.

Conclusion

Climate smart agriculture is a critical approach for the 21st century, integrating agriculture with forestry and other land uses to forge a comprehensive agenda for sustainable development to eradicate poverty, strengthen food and nutrition security, and promote green growth that makes cities more energy efficient and rural land use more productive and sustainable.

Governance is crucial to landscape management. Under CSA, the main concept is the landscape approach, which requires a wide range of stakeholders at different levels (local, national and even international) to effectively collaborate on the management of scare natural resources. In this approach, effective governance is rarely addressed and little knowledge exists on how this can best be done. It seems that the landscape approach is best used as a holistic strategy, a framework for more or less coordinated action by many players at many levels. This paper has sought to demonstrate that High Performance Partnerships (HPP) may offer a better framework than the landscape approach, to assess if CSA governance and management structures are actually effective in managing the natural resource base. This seems particularly true at the meso-level of agricultural value chains or geophysical spatial units with a common denominator such as large natural forests or watersheds. There are several reasons for this such as a limited number of identifiable stakeholders with a real, common interest in the preservation of the natural resources as well as manageability and control.
However, a chain is only as strong as its weakest link. Applying the HPP framework to CSA interventions means that much more attention needs to be given, and resources committed, to strengthening the organizations or actors within the CSA intervention area. This may at times be at odds with the need to "get on with it" and implement all kinds of CSA activities ranging from water management to soil fertility and livestock management, since that is often wat funders such as donors or governments wish to see, even if this is detrimental for the long-term sustainability of the CSA intervention.

How an HPP framework can be applied to CSA in different geographies and contexts and with different stakeholders needs to be the subject of further research. Some of the research questions could be:

1. What is the evidence that the landscape approach is successful in CSA and what factors determined its success?
2. What alternative approaches have been used to manage scarce natural resources under CSA? Are there examples of multi-actor partnerships, such as HPP?
3. What is the evidence that these governance and management alternatives to the landscape approach under CSA have or have not been successful?

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II Country contributions Egypt & Georgia

The need for CSA given the disastrous consequences of climate change for Egypt

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Abstract

- Climate change is a global phenomenon with local and unfair impacts, it affects weaker places, making the rich richer and the poor poorer
- Egypt is one of the countries that contributes least to greenhouse gas emissions in the world, at a rate of 0.6%,
- China, America, Russia, Canada, the European Union countries are contributing the most of climate change, but despite this, these countries are the least affected by climate change
- The impact of climate change on agriculture will lead to losses estimated for Egypt at 1.1 billion Euro by 2030, to rise to 6.4 billion by 2060 [5].
- There will be an increase in the Egyptian unemployment rate in the agricultural sector to 39%, and an increase in food prices from 16-68% by 2060 [5].
- Climate change will lead to a decrease in the agricultural productivity in field crops in Egypt between 11 to 50%.

Introduction

Climate change is an issue that is not new, as the developed world began to pay attention to it about more than 40 years ago, when it was noticed that there was a change in the climate, while the developing world did not pay attention to it until a few years ago. The reasons for this phenomenon are due to the increase in industrial human activity, which led to an increase in the concentration of certain gases in the atmosphere, and the occurrence of the so-called "global warming"; The presence of gases such as methane, nitrous monoxide, carbon dioxide, carbon monoxide and so on in the atmosphere is a natural presence to preserve the global temperature during the winter and night periods. Without the presence of these gases in their natural concentrations, the global temperature would have dropped in winter to minus 30 degrees Celsius. But with the increase in industrial activity rates - especially in the early sixties of the last century - an increase in the concentrations of these gases began to occur with it (Al-Kasan, 2020).

Therefore, climate change is a global phenomenon with local effects, as it affects places that are weaker in its composition and geographical and topographical composition, as it is an unfair issue from a human and social point of view and making the rich richer and the poor poorer.

The climate in Egypt was one of the most stable in the world throughout history, as evidenced by the existence of most civilizations around the Mediterranean basin.

Figure 1: We might faces a lot of waves of climate changes in the last hundreds of years but we still have the pyramids from 2504 BC. Years!

This region is characterized by two very clear climatic seasons, the cold winter and the hot summer, and as a result of climate change there was an increase in confusion in the climate system, and this system was subjected to "deformation", so there began to be an increase in severe climatic fluctuations, as well as quantities of rain in a limited time. What may cause floods, as happened in the Red Sea, Sinai, North Delta and

southern Upper Egypt regions, or very long heat waves, and sometimes severe heat waves occur for a day or two at an unnatural timing, as happened on 22 May 2018, when the temperature in Egypt reached 50 degrees Celsius, which was the hottest temperature on Earth on that day (Al-Kasan, 2020).

China is the largest country that contributes to greenhouse gases. Then comes America, Russia, Canada, then the European Union countries, that is, developed countries in general, due to their intense industrial activity, but despite this, these countries are the least affected by climate change.

So, the climate itself has changed, and changed in a dramatic way, and it was assumed, based on the existing models, that this change would occur within 10 to 20 years from now, but we were surprised that the change was very fast, and the dates of its occurrence were early, and this caused great problems in the main economic activities in Egypt, on mainly the agricultural activities which affects food security in Egypt (Al-Kasan, 2020).

Egypt is one of the countries most affected by the negative effects of climate change, and these damages are summarized in the rise in sea level, water poverty, and the deterioration of public health and an environmental system, which leads to economic losses estimated at billions and also affects its food security (Ministry of Water Resources and Irrigation, 2014).

Impact on Agriculture:

The agricultural sector and its activities is the sector that is affected the most by climate change in Egypt which directly affects Egypt's food security as well.

What are the reasons that agricultural activity is most affected by climate change?

There are two main reasons, namely:
1. Agriculture is the most vulnerable activity to climate change
2. The weakness of our infrastructure and lack of resistance to climate change.

Are Egyptian farmers aware of the concept of climate change?
Certainly not ... the nature of the Egyptian farmer is that it is slow in assimilation, to the extent that it is possible to absorb agricultural information in a whole season, and this slowness causes very big problems.

Was the productivity of agricultural crops affected by climate change in Egypt?

Yes, this sector was affected by the presence of a direct lack of productivity in some crops and seasons. For example, the winter of 2018 was short, which caused warm temperatures in the region. Most of the delicious fruits and olive trees did not meet their cold needs, to the point that olive productivity in most regions decreased by more than 70%, due to the effect on the rates of flowering and fruit setting, which are two important indicators of productivity levels (Al-Kasan, 2020).

Also, when in March and April of 2018 there was a significant increase in heat waves and waves carrying sand and dust, some fruit trees were in the flowering and fruit setting stage, such as mangoes and palms, which caused nodules to fall and the failure to multiply. Mangoes production decreased by 35% (Al-Kasan, 2020).

Field crops

During this heat potatoes were in the beginning of the molding stage, the first stage of the multiplication process, and a wave of very hot winds affected this stage, which contributed to reducing productivity by about 30 to 40%, wheat productivity at the country level of 2018 decreased by about 40 to 50%. As for summer crops, there were not significant differences (Al-Kasan, 2020).

Impact on Food Security

Climate change will lead to a decrease in the productivity of the main agricultural crops in Egypt, such as wheat by 18% (El-Aidy , 2021), rice by 11%, and soybeans by 28% (Fahim, 2019) as a result of the following factors:
1. High temperatures and an expected shortage of available water resources, which affect plant productivity.
2. Many of the low-lying agricultural lands in the Delta have drowned and increased salinity as a result of the rise in sea level.
3. Rising temperatures will lead to an increase in insects and diseases that cause damage to agricultural crops.

This will result in a decrease in agricultural production by 8%, an increase in the unemployment rate in the agricultural sector to 39% , and an increase in food prices from 16-68% by 2060, while the economic losses from these damages are estimated at 2.1-12.3 billion Euro (Fidele Byiringiro, 2016) (5).

Impact on Water Resources:

The Nile River supplies Egypt with the equivalent of 97% of its water needs, but despite this, Egypt has been suffering from water shortages since the 1990s. The water gap is estimated at 20 billion cubic meters, and water needs are increased by 20% on 2020, as a result of increased demand and poor water management.

Figure 2: Egyptian water recourses

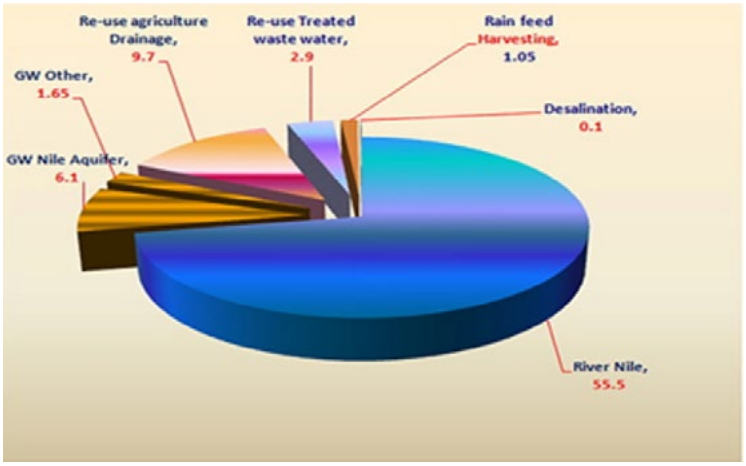
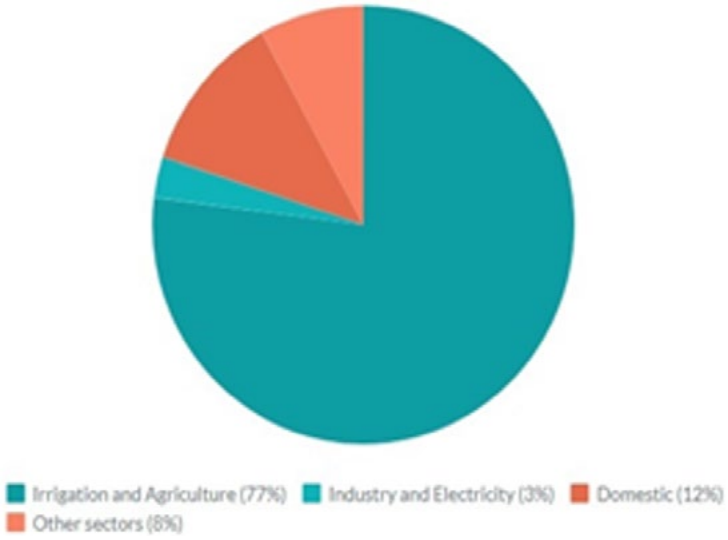


Figure 3: Egypt's Water Consumption by percentage



Climate change simulation scenarios expect a rise in the sea level due to higher temperatures. This will lead to a decrease in the surface runoff of the Nile River by 15% by 2081-2098. It is also expected, that the rate of rain in North Africa and the Arab world will also decrease by 15% (Fidele Byiringiro, 2016) (5).
The rise in sea level in the northern coasts of Egypt will lead to an increase in the salinity of the groundwater in these coastal lands up to a depth of 7 km from those coasts, according to a study was carried out by the Groundwater Research Institute in Egypt in 2011 (Fidele Byiringiro, 2016) (5). All these factors will lead to an increase in water shortage in Egypt in the medium term.

Impact on the Economy

These dangers will cause great economic losses. For example, according to a study conducted to measure the extent of the impact of climate change on the Egyptian economy, the impact of climate change on agriculture will lead to losses estimated at 1.05 billion Euro by 2030, to rise to 6.42 billion Euro by 2060, the value of financial losses resulting from facilities and roads exposed to flooding is estimated at 0.05 billion Euro annually

by 2030, to rise to 0.36 billion Euro by 2060, as a result of heat stress and respiratory problems will lead to losses of 1.26 billion Euro by 2060, and tourism income is expected to decrease to one billion Euro in 2030, to rise to 4.47 billion Euro in 2060 as a result of bleaching coral reefs and disturbance of ecosystems. These losses will reach a total of 2.73 billion Euro in 2030 and 12 billion Euro by 2060. These losses due to the dangers of climate change are approximately 3.9% of Egypt's projected GDP in 2060 (Fidele Byiringiro, 2016).
It is worth noting that there has been a significant improvement in the productivity of agricultural crops, as the index of agricultural crops productivity according to the base year 2004-2006 was about 5.21% in 1961, reaching 118% in 2014. Therefore, any negative effects are expected as a result of the climate change will cause great harm to the Egyptian economy, through increasing unemployment rates, declining GDP and increasing poverty rates. What confirms the foregoing is that the proportion of the number of poor in rural areas at the national poverty line represents about 32% of 2010 (World Bank, 2021).

The following is the evolution of the most important climate variables in Egypt:

The air temperature

During the period from 1901 to 2015, the average temperature in Egypt increased from 22.34 degrees Celsius in 1901 to 23.37 degrees Celsius in 2015, with a growth rate of 4.6%. The annual growth rate of temperature in Egypt during that period is 0.07% annually (World Bank, 2021)

The evolution of precipitation

The average precipitation in Egypt decreased from 3.91 mm in 1901 to 2.93 mm in 2015, with a negative growth rate of 25%. However, the average annual growth rate of precipitation is 25%. In Egypt, during that period, it is 4.6% annually. average rainfall in Egypt increased from 2.12 mm in 2011 to 2.93 mm in 2015, with a growth rate of 38%. From the above, it is evident that Egypt is characterized by severe fluctuations in precipitation, but the clear trend is a decrease in precipitation during this period (World Bank, 2021)

Carbon dioxide development

Carbon dioxide emissions have increased sharply from 16054.13 kilotons in 1960 to 213012.36 kilotons in 2013, with a very large growth rate of 1226.8%. However, the average annual growth rate is about 4.5% annually. In the last five years, carbon dioxide emissions have also increased from 206734.5 kilotons in 2009 to 213012.4 kilotons, with a growth rate of 3% (World Bank, 2021) which clearly shows a continuous increase of carbon dioxide emissions. From the above, it is clear that all climate variables are deteriorating significantly (El-Aidy, 2021).

Figure 4: Egypt’s climate change contribution

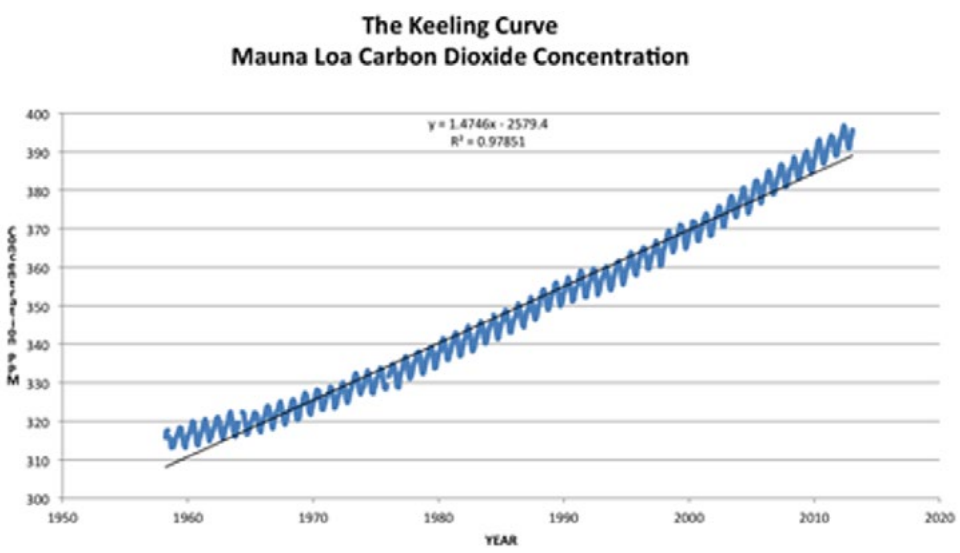


Figure 5: World Map of the global climate change risk

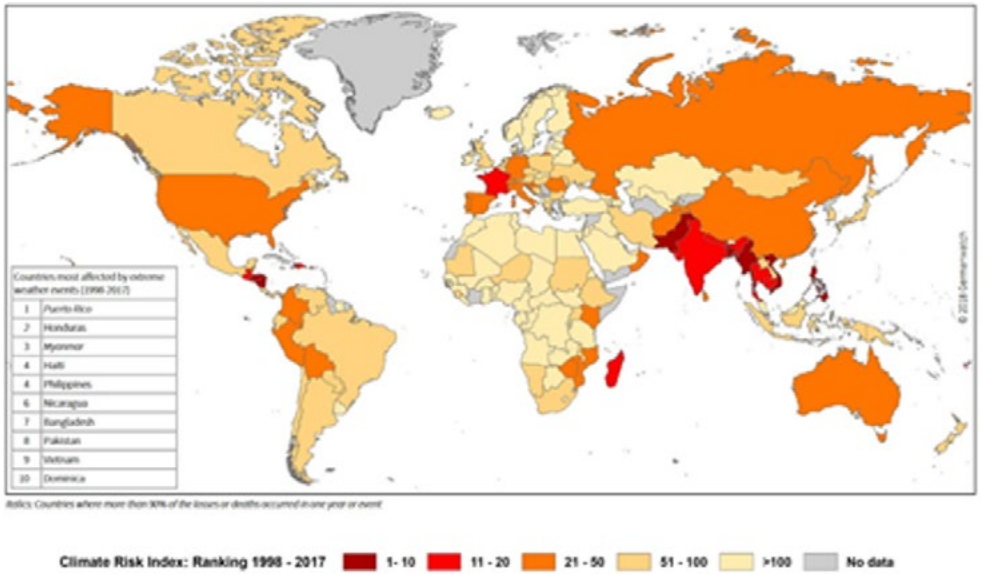
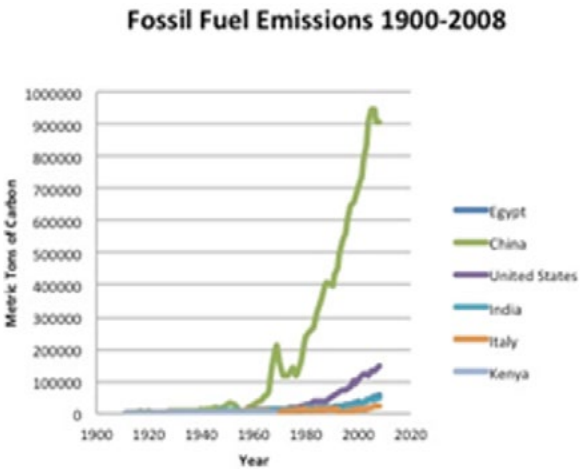


Figure 6: Egypt's climate change contribution



Other challenges

Although Egypt is one of the countries in the world that contributes least to greenhouse gas emissions in the world, at a rate of 0.6%, it is one of the countries most exposed to risks resulting from the effects of climate change, which requires international cooperation, in addition to dealing with it according to standards, objectives and policies to reduce its impact. This is in line with Vision 2030 (the Egyptian governmental vision), according to its strategic plans to achieve the goals of sustainable development.

The Environmental Affairs Agency of the Ministry of Environment, in its report on the state of the environment, identified 9 main risks of climate change to which Egypt is exposed, namely:

1. An increase or decrease in the temperature from its normal levels, as the World Bank recorded in 2017 that 2016 is the warmest year since the beginning of temperature records, as a result of the global temperature rise of 1.2 degrees Celsius above pre-industrial levels.
2. Sea level rise and its effects on coastal areas, as it is expected to increase the sea level by 100 cm until the year 2100, which will lead to saline water entering the groundwater and polluting it, salinization of soil, deterioration of crop quality and loss of productivity.

3. An increase in the rates of extreme weather events, such as "dust storms, heat waves, flash floods, and decreased rainfall."
4. Increasing desertification rates.
5. The deterioration of agricultural production and the impact of food security.
6. Increasing water scarcity rates, as the sensitivity of the Nile sources to the effects of climate changes has been monitored.
7. Climate change will affect the pattern of rainfall in the Nile Basin, and the rates of evaporation in waterways, especially in wetlands.
8. The deterioration of public health, as climate changes directly affect health in the event of storms or floods, and high temperatures, and indirectly through vital changes to the extent of the spread of diseases transmitted by insects, and Egypt is vulnerable due to its high temperature that exceeds its normal levels. With the spread of insect vector diseases such as: malaria, lymph nodes, dengue fever, Rift Valley fever.
9. The deterioration of ecotourism, as the rise in sea level is expected to lead to the erosion of the Egyptian coasts, and coral reefs may be affected, and environmental pressures lead to an increase in the deterioration.

Opportunities of conservation agriculture [2&3]

However, there are also opportunities for conservation agriculture (Jobbins, 2021):

- Updating cultivation dates for all crops.
- New crop pattern or agricultural cycle.
- More suitable varieties (rootstocks, new hybrids fighting biotic and abiotic stresses)
- Simple methods used to protect crops.
- Use drip irrigation and other modern irrigation methods rather surface irrigation method.
- Wastewater recycling.
- Sustainable soil management.

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CSA in Egypt: Productivity under Irrigation and water stress, Potatoes and Beans grown in the desert of Egypt

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Abstract

Limited fresh water supplies in arid and semi-arid regions are a serious problem worldwide. Town field experiments on drip irrigated Potato and Bean were executed in sandy loam soil of ESRI farm at Sadat City, Egypt. Four cultivars of potatoes were used (Sponta-Dimond-Cara and Seranto). Crops were subjected to water stress.Sponta and Seranto gave the highest yield while Dimon achieved the lowest yield and Cara was not affected. Beans (Giza 6) achieved water productivity (0.39 and 0.32 kg/m3) under irrigation and water stress. Cassava tubers under the same condition gave a tubers of 4-5 kg/tuber with total yield of 16 tons/ feddan.

Introduction

Thanks are given to Nuffic for funding and supporting Egypt with the grant OKP-ICP-EGY-103150) under the title (Enhancing water efficiency and food security through Egyptian TVETs'. Also, thanks are due to our partners implementing organizations RDB and MSM.

Egypt is turning deserts into agricultural lands using drip irrigation and new agri-technologies. Potatoes and beans are leading crops in production among desert crops and Egypt is a major exporter of ware potatoes. Potatoes and beans are the world's most economical crops and are predominantly grown on large areas in arid or semiarid regions. In most irrigated potato and bean growing regions, adequate irrigation water is becoming an important issue since both crops are shallow-rooted crop and are more susceptible than other deeper-rooted crops to soil water stress (Ati et al. 2012; Badr et al. 2012; El-Mokh et al. 2015).

Limited fresh water supplies, particularly in arid and semi-arid regions, are a serious problem worldwide. In addition, in these regions accessible supplies of fresh water are decreasing due to increased agricultural and urban development, population growth, low precipitation and competing demands from the industry (Wu et al., 1975; Al-Jamal et al., 2010; Elsayed et al., 2015). In arid and semi-arid climates, moisture stress is a major factor affecting crop growth and final productivity. Climate change and global warming lead to high evaporation rates and hence lack of freshwater resources associated with drought (Hirich et al., 2016) which is a threat to global food security (Lei et al., 2016).

The progress and development of crops is harmfully affected by water deficits. Because it reduced the growth of potatoes and resulted in a major reduction of the canopy water content, biomass fresh weight and biomass dry weight of crops and in final, it reduces yield and quality (Naz et al., 2018). Water deficits induce various morpho-physiological and biochemical adaptations that subsequently inhibit root growth, reduce photosynthesis, decrease stomatal conductance and transpiration which in turn negatively affect plant water content, growth and productivity (Elsayed et al., 2017). In this context, increasing crop productivity to meet the increased food demand requires advanced techniques of crop management (Christenson et al., 2016; Wijewardana et al., 2017) that needs deep understanding of crop response to various environmental stresses. The effect of water stress on plant growth and total yield is mainly related to the severity and the duration of stressful conditions, as well as the plant growth stage (Wijewardana et al., 2019).

1. Experimental site and conditions

Two field experiments on drip-irrigated potatoes were executed during February to May in two years 2020 and 2021 at the Research Station of the University of Sadat City, Egypt (30˚2′41.2″N and 31˚14′8.2″E). The conditions of the experimental site are characterized by a semi-arid climate with mild cold winters and warm summers. Table 1 indicates the conditions of the climate during growing seasons. The experimental site's soil texture is sandy loam, consisting of 69.8% sand, 22.3% silt, and 7.9% clay, 1.45 g cm^{-3}, bulk density and 1.15 dS m^{-1} electric conductivity. The soil at the investigated site was water field capacity of 19.2 %, wilting point of 10.1 % and the available 9.1%. The average electrical conductivity (EC) of water samples for the irrigation was 1.20 dS/m at normal standard.

For each growing season, a randomized complete block design was used with four replications and two irrigation regime treatments and four potato varieties (Seranto, Daimont, Cara and Sponta). The tubers potato and bean were planted on 3th February 2020 and 17th October 2020 as well as harvested on the 11th of May 2020 and 22th of February 2021, respectively. Both varieties were exposed to drought stress at bulking growth

stage. Each treatment was replicated four times using several rows of 30 m length, with a 0.30 m emitter spacing and 0.75 m wide between the rows. With T-shape valves installed at the beginning of each lateral line, 4 L h^{-1} discharge rate long- pass emitters were used to regulate the water flow from sub mainlines to lateral lines. The diameter of sub-mainlines and lateral lines were 50 and 16 mm, respectively. The sub-mainlines and lateral lines were 50 and 16 mm in diameter, respectively. The layout of the experimental plots design is shown in Figure 1.

Cassava stems were exported from Nigeria in order to start cultivating it in our farm as a new crop for the benefit of its flour. The stems were planted in rows at a distance of one meter between plants as well as one meter between rows and were subjected to all farm practices given to potatoes and beans.

Figure 1: Design of drip irrigation




Experimental plots obtained equal quantities of composted animal manure (75 m^3 ha^{-1}) and phosphorus (200 m^3 ha^{-1}) using single furrow-banded calcium superphosphate (15.5% P_2O_5) prior to agricultural sulphur (300 m^3 ha^{-1} SO_4) planting. At a rate of 400 kg N / ha, nitrogen fertilizer was applied four times during planting, first irrigation and 45 and 60 days after planting, respectively.

2. Irrigation water requirements

FAO CROPWAT software v.8 by Smith (1992) was used to determine the irrigation time and quantity of water to be applied to the experimental plots. This software uses the FAO Penman-Monteith method to compute the reference evapotranspiration. The weather data were collected from the nearest weather station as detailed in Table 1. The crop water requirements (ETc) and reference evapotranspiration (ETo) were calculated based on Allen et al. (1998) as follows.

ETc = ETo × Kc (1)
Where Kc is the crop coefficient

$$\mathrm{ETo} = \frac{0.408\Delta(\mathrm{Rn} - \mathrm{G}) + \gamma \frac{900}{T + 273}\ U2(es - ea)}{\Delta + \gamma(1 + 0.34\mathrm{U2})} (2)$$

Where ETo is the reference evapotranspiration in mm day^{-1}, Rn is the net radiation at the crop surface in MJm^{-2} day^{-1}, G is the soil heat flux density in MJm^{-2} day^{-1}, T is the air temperature at 2 m height in °C, U2 is the wind speed at 2 m height in m s^{-1}, e_s is the saturation vapor pressure in kPa, e_a is the actual vapor pressure in kPa, e_s- $e_a$is the saturation vapor pressure deficit in kPa, Δ is the slope of vapor pressure curve in kPa°C^{-1} , γ is the psychometric constant in kPa°C^{-1}.

2.1. Potato and bean yield

At harvest time, random samples of 5 m^2 were taken from each treatment and the final potato yield was then weighed and expressed as Mg ha^{-1} based on the harvested area.

Results

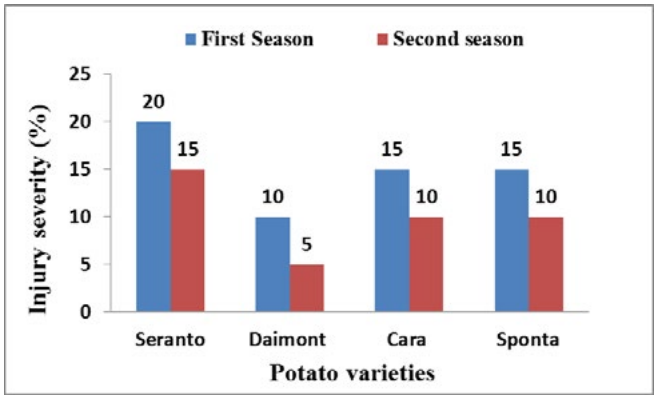

Figure 2: Injury severity (%) for Potato varieties during first and second season
It is evident from the previous figure that the injury severity present was higher in the first season than in the second season. Also, the Seranto variety was the most injury severity present potato variety during the two growing seasons with about (20 and 15%) in the first and second season respectively.

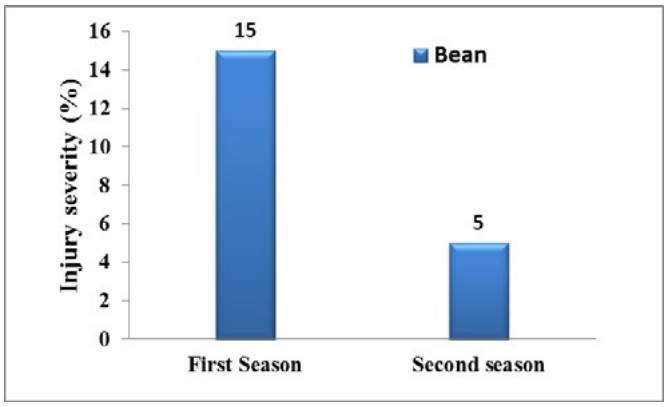

Figure 3: Injury severity (%) for Bean variety during first and second season
Moreover, for beans, it is evident from the previous figure that the injury severity presence was higher in the first season than in the second season.

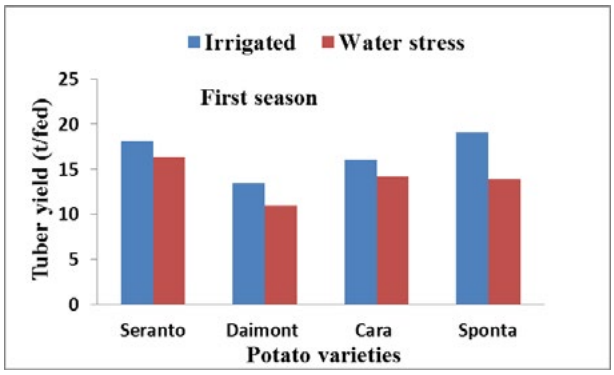

Figure 4: Tuber Yield (ton/fed) under irrigation and water stress for Potato varieties during first season

As shown above in figure (4), the results for Potato varieties tuber yield (ton/ fed) under irrigation and water stress during the first season. It can be noted that, the Sponta and Seranto varieties achieved the highest tuber yield (19.076 and 18.092 ton/fed) under irrigation, while that, the Daimont variety achieved the lowest tuber yield (13.448 and 10.985 ton/fed) under irrigation and water stress respectively during the first season. Also, we notice that there are varieties of potatoes that were not affected much by water stress, such as the Seranto and Cara.

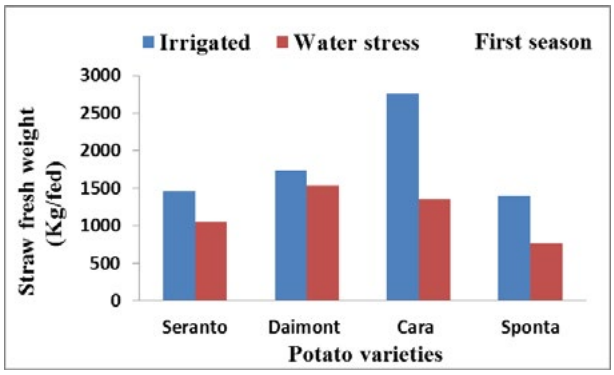

Figure 5: Straw fresh weight (kg/fed) under irrigation and water stress for Potato varieties during first season

Figure (5) shows straw fresh weight (kg/fed) under irrigation and water stress for potato varieties during the first season. It can be noted that, the Cara variety achieve the highest straw fresh weight (kg/fed) (2764.17 kg/fed) under irrigation, while the lowest straw fresh weight was achieving for Sponta variety which about (758.925 kg/fed) under water stress.

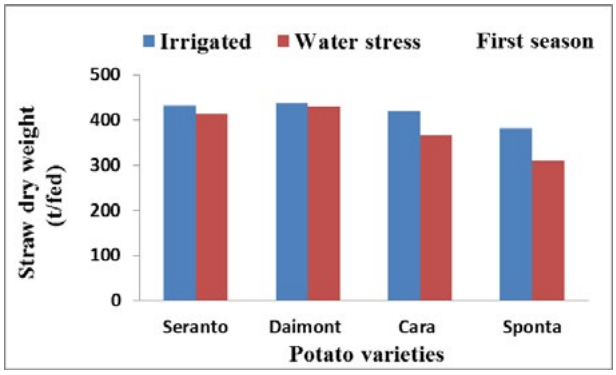

Figure 6: Straw dry weight (kg/fed) under irrigation and water stress for Potato varieties during first season

Figure (6) showed that, Straw dry weight (kg/fed) under irrigation and water stress for Potato varieties during the first season. It can be noted that, there are no significant differences between Potato varieties during first season under irrigation and water stress.

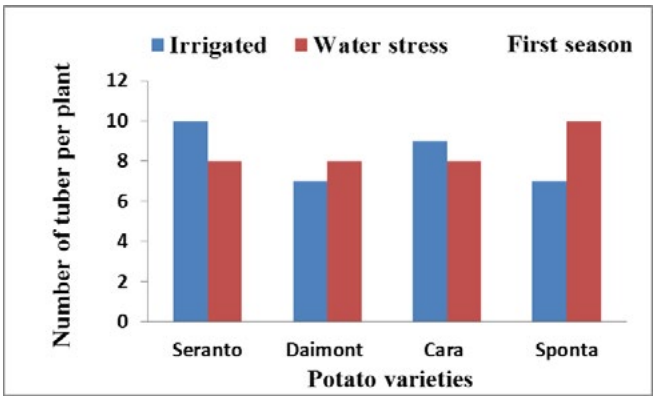

Figure 7: Number of tuber per plant under irrigation and water stress for Potato varieties during first season
Figure (7) shows that, the number of tuber per plant under irrigation and water stress for Potato varieties during the first season. The Seranto variety achieved the highest number of tuber per plant (10 tuber/plant) under irrigation. Also, Sponta variety achieved the highest number of tuber per plant (10 tuber/plant). While, the lowest number of tuber per plant was achieving under irrigation (7 tuber/plant) for Daimont and Sponta Potato varieties.

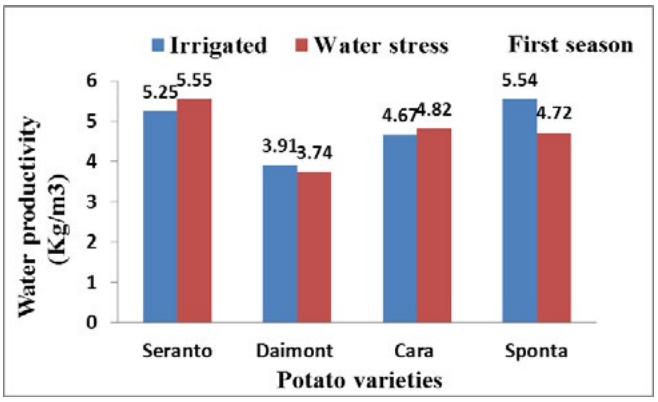

Figure 8: Water productivity (kg/m^3) under irrigation and water stress for Potato varieties during first season
Figure (8) shows that, the bean yield (kg/fed) under irrigation and water stress for bean (Giza 6) during the first season. The Giza 6 variety achieved water productivity (1510 and 1247 kg/m^3) under irrigation and water stress respectively.

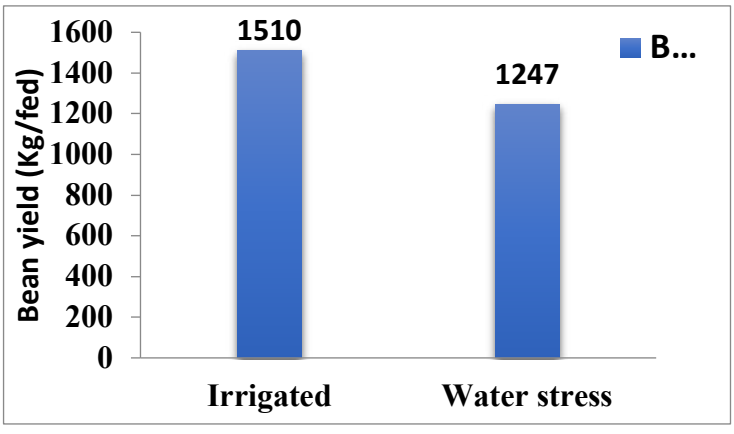

Figure (9): Bean Yield (Kg/fed) under irrigation and water stress during first season
Figure (10) shows that, the water productivity (kg/m^3) under irrigation and water stress for bean (Giza 6) during the first season. The Giza 6 variety achieved water productivity (0.39 and 0.32 kg/m^3) under irrigation and water stress respectively.

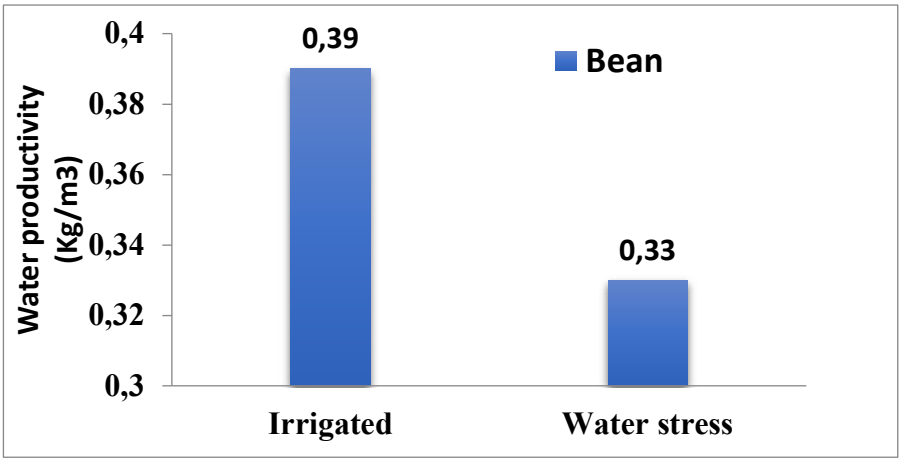

Figure (10): Water productivity (kg/m^3) under irrigation and water stress for bean variety during first season Cassava tubers when exposed to the same condition of farm practices and irrigation systems. The crop was harvested after one year of stem cultivation and the yield was calculated. The yield of 16 tonnes/feddan was recorded which shows that this crop could be grown under the Egyptian condition that can help with its flour to subsidize the wheat flour for manufacturing of bread (bread production is important to Egyptian population).

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Climate Smart Agriculture in Georgia: Status, Challenges and Opportunities for Further Development

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Abstract

This paper is focused on Climate Smart Agriculture (CSA) - a key priority action area in Georgia which is regarded as a country with much untapped agricultural potential both in traditional and non-traditional sectors. CSA, defined by the Food and Agriculture Organization (FAO, 2021) as an "approach that helps to guide actions needed to transform and reorient agricultural systems to effectively support development and ensure food security in a changing climate''. CSA aims to tackle three main objectives: sustainably increasing agricultural productivity and incomes, adapting and building resilience to climate change; and reducing and/or removing greenhouse gas emissions, where possible." While the primary food security imperatives of CSA are well acknowledged, this paper considers sustainable livelihoods more broadly and gives attention to traditional sectors experiencing revival – wine and tea – that are providing opportunities for rural entrepreneurs and, from the natural world, commercially exploitable fauna that provide better livelihoods for poor rural communities and value chain upgrading possibilities, but with a proviso that the resources are sustainably managed. The approach is guided and informed by recognized strategic directions for the implementation of CSA in Georgia.

Introduction: CSA in Georgia

Agriculture in Georgia is deeply embedded in socio-cultural and economic systems. The sector employs more than half of the total workforce in the country and is their only source of livelihood. Thus, the main objective of ensuring food security is existential. Georgian agriculture has generally supportive natural conditions and resources for production. Water resources are plentiful. There are 22 different climates in the country ranging from sub-tropical, warm and humid to cold and dry. About half of the total land area can be used for agriculture and, in particular, there are favorable conditions for grains, vegetables, fruits, nuts and sub-tropical crops. The cases considered in this paper are all from mountainous areas of western Georgia, mostly Racha-Lechkumi, which is the least developed part of the country.

The Georgian approach to CSA is based on the UN Food and Agriculture Organization (FAO, 2021) approach but is also cross-cutting and overlapping other national strategic directions. CSA in Georgia is understood to be not only directly related to climate, but also inclusively to sustainable agriculture as a whole, applying good agricultural practices and strategic agricultural choices, all seen through the prism of a changing climate. Seven strategic directions informed by the FAO's framework have been guiding the implementation of CSA:

1. Enhanced competitiveness of rural entrepreneurs
2. Institutional development
3. Amelioration and soil fertility
4. Regional, sectoral and value chain development
5. Ensuring food security
6. Developing efficient and flexible food safety system that will be consistent with EU legislation and reflecting specific features of the Georgian agricultural market
7. Climate change, environment and biodiversity

These seven directions have mostly also been included in the Strategy for Agricultural Development in Georgia (DAI, 2019). They further provide a broad conceptual framework for this research-in-progress. This paper considers the CSA strategic directions in some interesting sectors in Georgia. They provide the basis for critical comments on the current situation.

Two important specifically CSA related strategic issues - 'Disaster Risk Reduction' and the 'Role of Safety Nets' - have not. The former is critical given the increasing prevalence of natural disasters such as flash floods, landslides, mudflows and fires. The risk is increased by climate linked land degradation and bad agricultural practices, including the burning of fields. Safety nets, particularly insurance against health, crop disease, livestock disease, weather and community agricultural diversity are important in allowing both agriculture and livelihoods to survive increasing climatic risks like drought. These are crucial sub-systems in the overall strategic formulation of CSA in Georgia. In 2014 the Government of Georgia (GoG) launched the Agroinsurance project which aims to support the development of an agricultural insurance market to minimize risks, stabilize farmers' incomes, stimulate investment and increase farm production. The insurance packages cover losses caused *inter alia* by flooding, storms, hail and, in the case of citrus, autumn frost. By 2019, 49,300 farmers had purchased

insurance, however the initial high demand reduced after the GoG reduced the state subsidy from 90 percent to 70 percent. In 2018, there was a further decline due to the requirement that the insured land plot be registered in the public registry. In fact, however, most agricultural land in Georgia is not registered. Despite the GoG's efforts the penetration rate of insurance remains very low accounting for only 3.6 percent and there has actually been a decrease in the number of unique beneficiaries. The reasons for this are firstly that there is a low insurance culture among Georgian farmers who do not trust insurance companies and have very limited knowledge and experience of how insurance works; secondly, there is capacity deficit in the insurance companies, including a lack of quality professional sales agents and a shortage of branches to adequately cover the entire country; and thirdly, there is a lack of agrometeorology data. The latter includes a lack of historical data on catastrophic events, a lack of yield data and a lack of information on farmers' risk profiles (Katsia and Deisadze, 2019). All of this results in higher premiums and less affordable products. The above further illustrates the importance of effective institutional capacity as a CSA driver.

Cases from Mountainous Areas of Western Georgia: Racha-Lechkumi and Adjara

Khvanchkhara and Tvishi - wine making case studies

Khvanchkhara wine, named after a local village, is a blend of *alexandrouli* and *mujuretuli* Georgian grape varietals from a small appellation-controlled area, on the banks of the Rioni river in the Racha-Lechkumi region of Northern Georgia. Supposedly, the wine was enjoyed by Churchill, Roosevelt and Stalin at the Yalta conference in 1945. The micro-zone with is located in the foothills of the Caucasus mountain range far away from the main Kakheti wine-growing region of Georgia. The area ranges from 75 to 450 meters above sea level; it has moderately cold winters complemented by hot, dry summers, which is suitable for cultivating several unique grape varietals. Khvanchkara wine has been described as having a real sense of place (Granik, 2019). There is considerably less infrastructural development and investment than in the Kakheti region despite its potential for tourism. In statistical measures of entrepreneurial activity in Georgia, the Racha-Lechkumi region has by far the lowest output and turnover of all regions in the country – respectively 0,1 and 0,2% of total output and turnover in the country (Geostat, 2020). Restaurant and hotel turnover rates – useful indicators of tourism activity – are, tellingly, the lowest and second lowest in the country. Despite the Appellation of Origin designation, in effect a Geographical Indication in the Georgian Intellectual Property system, there is little spin-off effect on local business and tourism development. Further, there is limited cooperative organization and stimulation of related business such as hotels, restaurants and tour guiding. The Appellation of Origin for *Khvanchkhara* wine, while serving to define the geographical area and product standards, has to date brought about a limited organization of producers and aggregated knowledge to further strengthen the brand name, develop agrotourism and promote innovation.

Tvishi - another name origin wine - from the village of Tvishi in Racha-Lechkumi is similarly a unique climatic micro-zone which allows for the production of naturally sweet *tsolikauri* varietal wines with high acidity. It has virtually the same features regarding lack of cooperative organization and the positive development of the appellation for local community development. Yet Geographical Indications (GIs) are considered to be an implementation pillar for the CSA strategic direction of regional, sectoral and value chain development. The concept of the GI is itself best understood by the meaning of the French word *terroir* – the complete natural environment in which a particular commodity is found, including factors such as soil, topography and climate. Regarding the wine sector, the underlying rationale for the GI - the specific and unique characteristics that local *terroir* gives to the taste. Coping with changes in weather patterns and carbon dioxide levels impacts on grape chemistry and eventually the quality of the wine. Scientific understanding of climate change and coping with its effects are one of the broad tasks that cooperative organization, an opportunity for a holistically functioning GI, can bring. This is built into Georgia's strategic approach to CSA, but the on-the-ground implementation, especially relating to social organization and the collective pooling of knowledge and opportunity, indicates further sectoral strengthening is needed.

Georgian Tea

Tea is a commodity that is well suited to western Georgia's northerly partially sub-tropical micro regions, including parts of Racha-Lechkumi. The industry was started in Georgia in 1845 and built up in the Soviet period and at one point in the mid 1980s Georgia produced 152,000 tons of tea making it the fourth largest producer in the world at that time. The Soviet authorities, however, were not hindered by subtleties of flavor or any concern for quality standards. Not surprisingly, tea production collapsed in the aftermath of the dissolution of the Soviet Union. During the last two decades the industry has undergone a revival with the development of high yield varieties resistant to low temperatures. According to the management of the 'Okriba Tea Company' – an entrepreneurial organic tea producer in Racha-Lechkumi – the current climate positively helps the tea leaves

to naturally attain strength along with improving its natural taste. The cooler climate conditions result in a slower growth that gives the tips of Georgia's tea bushes a uniquely sweet and mellow flavor. The hills of western Georgia are particularly well-suited to producing small amounts of high-end tea. Put in another way, the climate itself naturally constitutes the taste of the tea and is naturally climate smart. A further climate advantage is that the cold winter conditions kill pests and bacteria so allowing for an organic production that is much more difficult in the tropics. On the downside, humidity in the region has decreased as a result of climate change along with an increase in the strength and frequency of winds which affects the amount harvested. The change in humidity requires climate smart responses, especially stronger irrigation systems to achieve balanced and sufficient supply during the summer periods. Progress is being made on product quality and Georgian tea, as is the case with wine, has a growing reputation. There is certainly adequate entrepreneurial drive, technical know-how and equipment, but weaknesses in institutional capacity, including producer cooperation, business-to-business networking, marketing and export promotion are constraining progress in maximizing this promising sector which exemplifies the notion of CSA and its rationale. The tea producer interviewed for this paper is a classic entrepreneur who has invested substantially in the sector. Yet he expressed frustration at the lack of follow-up support available for rural entrepreneurs. Government provides some start-up support, but then the entrepreneur is left to his or her own devices.

Trade Policy and Industrial Policy Linkages with CSA in Georgia

The first CSA strategic direction of ''enhancing the competitiveness of rural entrepreneurs" of necessity includes not only sustaining a quality product, but also support for marketing, providing opportunities for partnerships and facilitating entry into global value chains. An effectively functioning competition policy and law along with a competent competition authority should also be drivers of entrepreneurial competitiveness. The concept of fair trade undergirded by competition law is relatively new to Georgia, which is the only country in the world to have abolished competition law as a libertarian policy directive (since restored). Such measures really only served to strengthen oligopolistic business sectors, abuse of dominance and a clientelist business culture. Ease of doing business in terms of investment has been mostly positive, and Georgia has for some years occupied a high position in global rankings, but barriers to entry for small and medium sized businesses remain and these fall within the domestic policy space. Along with 'Competition' and 'Intellectual Property' (including recognition of GIs), 'Trade and Sustainable Development' is a chapter in 'The Deep and Comprehensive Free Trade Agreement'(DCFTA) between the European Union and Georgia. This agreement has brought opportunities to Georgia, but there are challenges notably compliance with standards and liberalization of sectors that require at least a period of investment and even state subsidies if they are to become competitive. In terms of the FTA Georgia is expected to reflect and practically implement multilateral environmental agreements in legislation and attain the primary goals of the UN Climate Change Framework Convention and the Kyoto Protocol. In this respect, the EU-Georgia DCFTA is a modern bilateral trade agreement which recognizes the environment, including climate change, as an integral and cross-cutting category which transcends trade.

Reflection on CSA in relation to the tea and wine sectors includes questions as to how the threats, challenges and opportunities of climate and climate change can be harnessed or mitigated. Both sectors require investment and financial support in order to become more internationally competitive. As noted above, the GoG needs trade policy space to achieve this. Industrial policy is a tool that can be used to drive trade policy and focus resources on promising sectors in the economy taking into account the CSA factors. Industrial policy is commonly associated with 'picking winners' and generally oriented more towards manufacturing, although agro-processing would offer possibilities for Georgia as a potentially competitive industrial sector. This is, however, also a value chain upgrading initiative for fruits, nuts and vegetables, in particular, and arguably requires effective government policy and CSA remedial measures. The peach sector is a case in point. Peaches are cultivated extensively in gardens and plantations in eastern Georgia in particular, but there are factors impeding production, storage, processing and sale. The findings of an EU project conducted in 2015 focused on the peach value chain noted the unstable quality of the harvest due to climatic factors, especially hail, frost and excessive precipitation. This study further pointed to farmers' lack of knowledge on climate, plant diseases and modern technologies, including drip irrigation systems. (European Union MPCD Research Enpard Support to Agriculture & Rural Development, 2016). Another impediment is the lack of an insurance culture as described earlier. The fact that the leading agro-processing company in Georgia, 'Kula', is not located in the peach growing region would seem to strengthen arguments in favor of an industrial policy in fruit sectors, which includes extension services focused on building CSA capacity.

Regarding tea, industrial policy has been used to strengthen the tea sector in India and Sri Lanka. For example, Assam State in India has its own industrial policy for tea which includes state capital investment subsidy for

micro-units, various tax exemptions, a subsidy on quality certification and technical know-how and a state capital subsidy on photo-voltaic modules up to a 20 per cent kilowattage (Government of Assam, 2019). The GoG, while not subsidizing on this scale, did start a tea program in 2015 and this has some elements of industrial policy. The steps taken have included rehabilitating over 7000 hectares of tea plantations on a phased basis, state support for small tea processing businesses, certification programs to ensure that quality standards are met and the establishment of a state program to expand tea storage facilities that will lengthen the country's tea season and allow tea products to be better stored. Furthermore, the GoG is concentrating its resources on poorer regions with lower levels of economic activity (Agenda.ge, 2015). These support efforts are modest and preliminary research for this paper tentatively suggests that a more intensive industrial policy will help a sector that at least prior to the Soviet era is historically truly climate smart.

The GoG has made use of some industrial policy tools in the wine sector, including direct and indirect subsidies. This was done not only to stimulate the industry, but also to combat Russia's boycott of Georgian wine, and more recently, to help producers manage the covid-19 economic downturn. While direct payments to farmers have been reduced, the GoG has supported state wine companies, including 'Akura', which buys grapes not bought by producers, and the National Wine Agency which controls the quality and certification processes for wine production and further does export promotion for Georgian wine in international markets. Given that the industry performed better in 2018 – 2019 when direct subsidies were not paid, and it is generally understood that subsidies are market-distorting among other problems. Nevertheless, there are alternative agricultural policies and strategies for consideration, including diversification of trading partners, ensuring food safety standards to maintain quality and providing good quality extension services to grape and wine producers (Deisadze, Gelashvili. and Katsia, 2020). The latter should include expert guidance on climate change and CSA actions to better manage anticipated problems.

Christmas Trees - the Nordmann Fir

Racha-Lechkumi is a significant part of the natural habitat for the Nordmann fir tree which occurs only south and east of the Black Sea at altitudes of 900 - 2200 meters. The Nordmann fir is the most popular Christmas tree in Europe where about 45 million are sold annually. Georgia only provides the seeds, approximately 80 percent of the total amount, which are exported to Denmark, the lead producer and supplier. The price structure is that one kilogram of seeds sells for 25 cents with 10 kilograms of cones needed for one kilogram. Each tree is sold for between 70 - 100 euros meaning that Georgian seed collectors who do the most arduous physical work in the value chain derive only a very small part of the value. Moreover, the work, entailing climbing 30 - 60 meter trees to harvest the cones, is dangerous with a high number of serious accidents and injuries. Increased publicity has brought some improvements safety standards and one Danish company, 'Fairtrees', has a fair-trade scheme approved by Fair Trade Denmark. The aim is to contribute to local living conditions in Georgia by improving working conditions for the cone pickers, paying decent wages, safety training, providing climbing equipment and trying to ensure sustainability in every link in the production chain.

Whilst sustainability standards and capacity building fall within the CSA institutional development strategic direction and no doubt has positive effects these would seem to apply only to the cone pickers in one company out of a total of more than 20 who are active in the sector. Furthermore, there are substantial arguments that the Fair-trade label is market distorting and challenges continue to exist for value chain actors who do not have the label. In the absence of research findings on this in Racha-Lechkumi firm conclusions cannot be drawn. Nevertheless, Georgia can upgrade its position in the value chain going beyond uneven corporate social responsibility actions by some Danish companies, including wage increases and improved health and safety conditions in the sector as a whole. Above all, the Nordmann fir tree is a climate-specific precious resource; it requires conservation measures and a long-term plan to manage sustainably while harnessing the resource to enhance rural livelihoods.

Snowdrops - Galanthus Woronowii

The Galanthus Woronowii or 'giant snowdrop' is a species of *Galanthus* found only in the Caucasus and Trans-Caucasus regions of Western Georgia, Eastern Turkey and Southern Russia. To date only bulbs are harvested from these areas to meet high demand for the ornamental plants in the EU in particular. The trade has clear components of CSA and highlights the importance of an integrated CSA approach to sustainable management of a limited horticultural commodity. Since 2007 Georgia has been exporting around 15 million bulbs a year to the European Union, mostly re-exported through Turkey. The plants are harvested from wild sites, although some of these are partially managed though not fully defined as artificial propagation. The high level of exports raised questions about unsustainability, noting that artificial propagation is not well-established. In CSA terms climate

and sustainable management are key factors in maximizing the benefits of the trade, not only to Georgia, but also the importing countries. The concerns resulted in a review of the trade by the Plant Committee of the Convention of the International Trade in Endangered Species of Wild Fauna and Flora (CITES, 2019) at the 14th meeting in Windhoek, Namibia, in February 2004. In a demonstration of the role of key institutions in establishing CSA, CITES Project No. S302 has proved to be a positive initiative for correct CITES implementation for *Galanthus Woronowii.* The project funded by the main importer, the Netherlands, brought together the CITES authorities in Georgia, outside experts from the Royal Botanic Gardens, Kew, and a researcher from Microsoft Research in Cambridge, the United Kingdom. The review of the trade, conservation status, distribution status, cultivation/artificial propagation sites and elaboration of a registration scheme for these sites. Based on the research the pre-cautionary export quota of 15 million bulbs from the wild was set and considered to be non-detrimental to the populations of *Galanthus Woronowii* (CITES, 2019).

The main current challenges are related to improving management systems, particularly regarding the awarding of licenses, fair and equitable value chain governance, controls to ensure compliance quotas and sustainable land use. Research conducted by McGough *et al.* (2014*)* has raised concerns about the long-term consequences of intensive harvesting of *Galanthus Woronowii* populations and the ecosystem. They argue that persistent harvesting every three years could deplete soil nutrient levels over longer timescales and, furthermore, regular disturbance is likely to alter the vegetation composition of the habitats (McGough *et al.*, 2014). It has been further suggested that a label for "sustainable harvesting", similar to a fair-trade movement label, can further buttress the protection of the mostly wild populations, but arguably this should cover the governance of the whole value chain. Over intensive harvesting could also be compounded by the effects of climate change, particularly the warmer and dryer conditions leading to an increase in flash floods and mudslides, which wash away the humus layers in the soil important to Galanthus *Woronowii.* While research is needed on climate related Galanthus *Woronowii* habitat change in Georgia, it is noted that the Kedo and Khulo municipalities in Adjara, where the plant grows in the wild on forested mountain slopes, have been significantly affected by floods and mudslides.

Conclusions

The central theme of this paper is that CSA should be cross-cutting, integrated and systematic. The case studies demonstrate that CSA implementation requires an integrated approach encompassing a coherent strategy with a combination of scientific, institutional and sectoral/regional/value chain developmental responses to the climate related threats and opportunities. The institutional domain includes international and domestic law, conservation, capacity building and technical assistance. Sectoral/regional/value chain development includes governance, policy, networking, cooperation and partnerships. A preliminary finding from this exploratory research is that, in the case of CSA, institutions do matter and these institutions function domestically and in the international domain. This is indeed how the GoG is broadly addressing the climate related challenges and opportunities. Being climate smart entails scientific understanding of the climate, its changes and the calibrations necessary to ensure food security, not only for vital agricultural crops and livestock, but also in terms of the sustainable management of natural resources such as the Nordmann Fir and Galanthus Woronowii that enhances the livelihoods of poor rural communities. The GoG has formulated wide-ranging CSA strategic directions that importantly incorporate regional, sectoral and value chain development; it further acknowledges that effectively functioning institutions are key to the achievement of overall CSA success. Within Georgia these include strengthening and further developing efficient and effective government agencies, the improved quality and quantity of extension services, improved insurance policies and farmer's knowledge of insurance, improved education, and not least, CSA linked industrial and trade policies which maximize the agricultural advantages Georgia has and provides evidence for bilateral and multilateral trade negotiating strategies. The evidence to date suggests that while CSA in Georgia agriculture, including conservation of wild resources has progressed significantly, perhaps to be expected in an emerging market country there remains a gap between the espoused strategic directions and operational reality. Wine and tea sectors discussed in this paper can benefit from industrial policy and other forms of state support, particularly for upstream marketing, business-to-business contacts and international promotions. Both wine and tea are deeply associated with climate and soil and for this reason CSA is a must. Engagement with international institutions and international economic law, as shown by the role of CITES in regulating the Galanthus*. woronowii* trade, is significantly linked to CSA considering Georgia's presence in number of global value chains.

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Developing agricultural policies and exports through CSA in Georgia, a module for a master course agro-business and agro-exports

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Abstract

Agricultural development is important for Georgia, given its farmland, rural population and current imports. The country has a huge potential for earning foreign exchange from exporting its wine and other horticultural products. It should upgrade its agriculture and intends to use climate smart agriculture and water (CSA&W) policies. MSM worked with Caucasus university with support from the Nuffic on three modules for a proposed curriculum for a master course on agro-business and agro-exports. This fitted in Georgia's policy to develop CSA&W and will help the country to develop closer relations with the EU in the framework of an association agreement. Three modules were developed. In this contribution the main ideas of the first module on agricultural policies and export promotion are summarized and its possible contribution to the development of agriculture and relations with the European Union will be assessed. Upgrading of agricultural value chains, such as wine and nuts, in a smart way is taking already place (also paper Patrick Martens). The challenge to introduce more CSA&W and Triple Helix policies to stimulate innovative thinking for agricultural innovations also in higher education and policy making circles.

Introduction

Agricultural activities are important in Georgia and have a huge potential for earning the country the foreign exchange it needs for its further development. However, this requires that a systematic effort is made to develop the agricultural sector and this requires knowledge and skills how to do this. CSA&W provides a series of suggestions how to do this (see the different chapters in these proceedings), but also requires policies and experience with formulating, implementing, monitoring and evaluating agricultural policies.
MSM worked with Caucasus university on three modules for a proposed curriculum for a master course on agro-business and agro-exports to be given at the Caucasus university in Georgia after accreditation. Modules were developed in the framework of a TMT project financed by the Nuffic. Each module has a total of 32 contact hours. The topics we dealt with are agro-policies and agricultural export promotion, agro-business development and analyzing agricultural global value chains, taking Georgia nuts sector as an example. The fist one will be discussed in some detail.
Climate smart in the Georgian context is illustrated by smart urban agriculture in Tblisi (hydroponics) and by using the opportunity of exporting to the EU in the framework of the association agreement. Also, foreign (and local) investments in horticulture are encouraged and bring new technology and markets, upgrade traditional value chains and introduce Triple Helix frameworks. The main ideas of the module agro-policies and export promotion are presented, but first the theoretical framework will be summarized.

The theoretical framework

The approach taken is explaining the policy cycle and how to do policy impact analysis (Liang et al., 2020). In particular it is important to see to it that the objectives are formulated in a participatory way, that policy alternatives are developed to achieve these objectives and the results are implemented, monitored and evaluated. In the process the use of tools like cost benefit analysis or cost effectiveness analysis are explained. The implementation needs to be well planned and the progress continuously monitored. The feedback loop serves as input for the revised and even smarter CSA&W policies.

The Agro-policies and agricultural export promotion module

The story line of the course on agro-policies and agricultural export promotion is that agricultural policies are important in Georgia since the country has a huge potential for earning foreign exchange through agro-exports. However, this requires that a systematic effort is made to develop and implement agricultural policies and this requires policy analysis to assess the effectiveness of these policies.

After explaining agricultural policies and introducing policy analysis, we will discuss the role of the government and the private sector in formulating and implementing agricultural policies. An example will be given of the systematic analysis of the effectiveness of agricultural policies. We finish with a reflection on Georgia's agricultural policies given the new challenges of the association status with the European Union (EU).
Georgia has changed its agricultural policies after independence in 1991. The government has prepared a number of visionary policy documents (GOG, 2015) and also the nature of agriculture has changed since the Soviet period. In the process of structural transformation process (Helmsing, 2013, explains this term as the

growing importance of the industrial and services sector) production for the market has become more important. This is particularly challenging for the smaller, household based farms and a process of creating bigger farming units is to be expected. The role of institutions in this process should be emphasized. Not only cooperatives play a role, but different business models (partnerships, contract farming and outgrowing schemes) should be mentioned. The previous chapter discussed a number of initiatives. Martens also made clear that appropriate policies and policy support are very important to make CSA&W a success. The agricultural sector is not yet a dynamic exporting sector making an important contribution to the gross domestic product (GDP) and contributing to the development of the rural areas. Not all agricultural policies have been successful and we need more agricultural policy analysis to determine why not and what can still be approved.

Formulating agricultural policies starts with defining the objectives and identifying the target group and stakeholders. One objective is to achieve sustainable agricultural policies, where sustainability would mean positive effects for the people, the planet and for profit (the private sector, this is the PPP concept of sustainable development, versus the Public Private Partnerships, PPPs). Georgia is also trying to achieve the Sustainable Development Goals (SDGs) formulated by the United Nations, which makes the question of sustainable policies relevant. Sustainable also has the meaning of socially acceptable, economically feasible and financially sound. Issues to consider when studying agricultural development policies:

1. What were the objectives of Georgia's agricultural policies?
2. Who are the major target groups and stakeholders?
3. Have these policies been effective in terms of achieving the objectives formulated?
4. Which policies were introduced specifically for achieving sustainable agricultural development?
5. Were they implemented?
6. To what extent did these policies result in sustainable and inclusive agricultural development?

Policies are formulated in a certain (political) context

Because of the choice of the objectives and target groups, formulating policies is a political process. The ministries concerned are inspired by a politician who has become their leader and who will present and defend the policies to parliament for approval. This does not mean the process of policy formulation, implementation and evaluation is not a process that can be scientifically sound and objective. Modern policy making starts with going through the policy cycle, where a good problem analysis is the starting point (Van Dijk, 2011). Once the issues are clear as a result of a consultation process with major actors, it is important to understand the major factors contributing to the problems. Then a distinction needs to be made between factors that the government can influence and factors which are beyond control of the national or local government. After formulating the policies, they need to be implemented, monitored and evaluated, before a new cycle of policy formulation can start. The approach of the policy cycle in policy analysis sees to it that the objectives are formulated in a participatory way, that the policy alternatives developed to achieve these objectives are analysed using tools like cost benefit analysis or cost effectiveness analysis and that the implementation is well planned and the progress continuously monitored. Issues to consider:

1. The concept of policy cycle
2. The influence of political programs on agricultural policies
3. Policies need to be formulated, implemented, monitored, evaluated and changed in the process
4. It is important to involve all the relevant stakeholders and
5. to do policy impact studies regularly

The need for CSA&W to make the sector competitive

To improve the socio-economic situation of the rural population a value chain approach could be taken (Van Dijk and Trienekens, eds, 2012). There is not yet a value chain approach in Georgia. There is a need to improve the competitiveness of different value chains and to increase the profitability of the activity for the farmers. As an example the nuts sector in Georgia will be taken.

Nuts from Georgia are competing with nuts from Turkey and other neighboring countries and it is important to assess which factors may give Georgia a competitive advantage to determine whether they are competitive? Porter (1990) introduced the competitiveness concept as a yardstick for the performance of enterprises. The competitiveness measure can be used as well at the national, the regional, the city, or even at the local cluster as at the enterprise level. Here it will be used for the whole value chain and for the different stages in the chain and could also be defined in an operational way as a strategy that manages a company (or country) to at least assure the current market share (increased competitiveness then means increasing your market share).

According to Porter (1990) national competitiveness can be created by a combination of strategic choices along the four determinants of his Diamond model, namely:

1. Factor endowments
2. Firm strategy: structure and rivalry
3. Demand conditions
4. Related supporting industries

We need to study different agricultural value chains to determine the factors influencing their competitiveness. The intra and inter chain competition is continuing, but we identified as the three main factors: the role of prices, business models and agricultural policies in different countries. Within the chain an important factor affecting the competitiveness is the agricultural business model used. Between value chains a major problem is that the price of nuts has been very volatile. The crucial elements for the competitiveness is sometimes in the producing part of the chain, sometimes it is related to the different modes of production and sometimes it depends on the cost of storing, distribution and retailing. Developments in the international context also have important implications for farmers and something like the association with the EU turned out to play an important role for investment decisions taken in the sector.
The cost of production depends on several factors, including the organizational structure chosen. Possible hypotheses concerning the current problems in the case of the agricultural value chains are listed in the following box, where in the last column we identify whether this is also a problem in the nuts value chain?

Box 1 Issues for global value chains and the nuts sector in Georgia

Issues for global value chains	Also an issue the nuts sector in Georgia?
Inputs are too expensive, or not available, or of the wrong type Extension services are too far away from the farmers, or not adapted to their needs and possibilities Small agricultural producers have no access to finance There is a lack of intermediary organizations These organizations hinder the development of export There are no adequate marketing facilities Private operators can play a role in providing inputs and extension services and organize the marketing	Not too many inputs are used currently by the family farms; considered too expensive No extension services specifically for nuts Access to finance is a problem for investing in nuts, like for all start-ups in Georgia No intermediary organization, except for the grower association & the export association Quality standards are more of a barrier But 30 to 40 companies involved in nuts trading Not yet the case in the nuts sector in Georgia

Tools for policy analysis

Policy analysis and development is important because governments want to direct the development process in their country. They want to know whether their policies have the desired effects. Modern policy making starts with going through the policy cycle, where a good problem analysis is the starting point. Once the issues are clear as a result of research with the major actors, it is important to understand the major factors contributing to the problems.

Then a distinction needs to be made between factors that the government can influence and factors which are beyond control of the national or local government. Such factors are for example the process of globalization, the increasing presence of Chinese products and services, or existing barriers to access major export markets. For policy analysis a number of tools are necessary to assess the impact of proposed and implemented policies, see table 1.

Table 1 Tools for policy analysis

Tools	Sources: see Wikipedia or google, for example:
Cost benefit analysis Cost effectiveness Financial analysis Life cycle analysis Multi criteria analysis Stakeholder involvement tools Scenario methods Etc.	1. Manuals on cost benefit analysis 2. Liang, X. and Dijk, M.P. van (2010), Financial and economic feasibility of decentralized wastewater reuse systems in Beijing. In: Water science and technology, 61(8) pp. 1965-1974. 3. IFC (2007; digital) Stakeholder Engagement: A Good Practice Handbook for Companies Doing Business in Emerging Markets. Washington: International Finance Corporation

Also, different policies and different policy instruments need to be distinguished. We have sectoral policies, regional policies, national policies, etc. Different policy instruments are:

1. Regulation
2. Tax related, paying more tax, or tax reduction measures, or other tax incentives
3. Subsidies and Income supplements
4. Other (non-material) incentives
5. Provision of inputs, such as fertilizer, pesticides and insecticides
6. Support to agricultural infrastructure
7. Supplying agricultural loans
8. Providing technical assistance
9. Engaging in Public Private Partnerships (PPPs)
10. Involving state services or state-owned enterprises in agricultural service delivery (tilling, ploughing, etc.)
11. Supporting agricultural insurance schemes

Issues to consider:

1. Agricultural policies can take very different shapes, using a combination of the different policy instruments mentioned.
2. Different tools are available to anticipate the effects of policy instruments
3. Give examples of policies concerning wine, hazelnut and other agricultural products
4. Which agricultural policies have been very successful policies?
5. Which examples of policy analysis are available?

The cost and consequences of trade barriers

Georgia has been a member of the World Trade Organization (WTO) since 2002. It also concluded a Deep and Comprehensive Free Trade Area (DCFTA) agreement with the EU. This Agreement introduces a preferential trade regime. We know there are several trade barriers, such as tariffs, standards, environmental and health considerations, etc. The question is which barriers have been removed by WTO and DCFTA. Issues to consider:

1. The effects of import duties, but also
2. There are different types of protection: direct and indirect, tariff and non-tariff barriers
3. And regulation can work as protection
4. Imposed standards can look like protection
5. And intellectual property is another possibility to protect your market
6. What are the advantages of the DCFTA for Georgia?

A case of policy analysis: The use of tools in public policy analysis (Dunn, 2005)

An example of agricultural policy analysis is the promotion of local production of sorghum to allow beer breweries to refrain from exports in Ghana (Van Wijk and Kwakkenbos, 2012). This is an example of import substitution policies, but implemented by a private firm!

In the Georgian context the policy concerning the promotion of wine exports could be analyzed. What was the exact objective of this policy (exports, helping farmers, improve production capacity, or something else) and to what extent has the government been successful in achieving this goal/these goals? Issues to consider:

1. The need to distinguish different policy options and compare them already before implementing them
2. The use of tools to evaluate the effects of different policy options
3. Policies are often interrelated, or complementary
4. The private sector can play a role in implementing policies

The role of the government in the development process

We suggest introducing this topic not by suggesting that the government is an all-powerful entity and should take the initiative in every direction, but rather that Georgia has dynamic stakeholders who should be motivated to contribute more to the development of the society and the government should set the conditions for their functioning and see to it that they do what is agreed upon (the regulatory role of government). Issues to consider:

1. The discussion about the role of government is a political discussion
2. The trend is towards a smaller role for the government, but a role as facilitator and regulator of the private sector
3. Did public sector reforms in Georgia lead to increased agricultural production?

4. Is the government currently involved in tasks (like doing research), which the private sector is not yet ready to take on?
5. What has been the role of the government in agricultural development and in policy formulation in Georgia?
6. Do we see certain ideological points of view reflected in these policies? For example liberalization policies, but not much attention is given to the critique on these policies, or export policies without considering the food security or internal market requirements, or a more neo-classical approach, neglecting the importance of institutions in the development process?

The role of the private sector: Public private partnerships for agricultural development

In this lecture the role of the private sector (commercial and non-commercial) in agricultural development is emphasized. Stakeholders like the Chambers of commerce, NGOs, associations of wine farmers etc. can and should contribute to the development process and the development of policies. In Georgia the private sector is not yet fully developed, but does get a lot of opportunities to contribute to agricultural development. Different business models are possible if the private sector is involved: public private partnerships, business-farmer partnerships, outsourcing schemes and contract farming. Issues to consider:

1. What is the role of the private sector in agricultural development in general and specifically in Georgia?
2. Can agro-exports be promoted through public private partnerships (PPPs)?
3. What do we know about partnerships to achieve market access?
4. Is the private sector involved in agricultural service delivery in Georgia (distributing fertilizers, new varieties, etc.) doing a good job?

The role of the private sector (commercial and non-commercial) should be emphasized. Stakeholders like Chambers of commerce, NGOs, associations of wine farmers etc. can and should contribute to the development process of the sector. In Georgia, the private sector is not yet fully developed, but does get a lot of opportunities to contribute to agricultural development. Much depends on the choice for the development of certain business models that link small producers to the global value chain. In an increasing number of countries private firms play the role of extension service and marketing institutions and farmers even accept to pay for their services. Which business model is most promising (contract farming, plantations, or out growers via cooperatives)?
It is important to stimulate innovation in these value chains and all kinds of actors and projects may be necessary to promote value chain development. The best-known business models to achieve the positive effect of private sector involvement in agriculture were mentioned. The private sector may also be involved in agricultural service delivery (fertilizers, new varieties, etc.). This would be institutionalized if the choice is made for contract farming or outgrowing schemes, although there are also examples of support provided under a partnership arrangement. (other possible examples: blue berries or biofuels).

The effects of agricultural trade liberalization policies

We suggest doing a case study of one important agricultural policy and to analyze its impact in a systematic and scientific way. My suggestion is to take the UNDP (2013) and in particular the summary of the Georgian case and use some other papers concerning the agricultural sector and to assess which policies are mentioned in the report and what has been concluded about the effectiveness of these agricultural policies. The students can read and analyze the case and work individually or in small groups on a presentation of the policy analysis.
Issues to consider:

1. What are the consequences of foreign trade for a small country like Georgia?
2. What are the effects of a trade deficit (forced devaluation, or increased exports)?
3. What do EU trade policies mean for agricultural production and exports of Georgia?
4. What were the effects of liberalization on the agricultural sector?

Policy analysis of agricultural policies in Georgia: what have we learned?

What is the effectiveness of the current agricultural policies and programs, what have we learned? Issues to consider:

1. Why is policy analysis important?
2. What are the indicators to evaluate the success of such policies?
3. Which tools are available to help those formulating and implementing policies?
4. Have the goals been achieved because of the policy or because of other factors (the attribution problem)?
5. Why do certain policies not have the expected effects?

Critical questions about Georgia's agricultural policies on the basis of policy impact studies

Thinking critically about the topic of policy impact, can we use the tool of policy analysis to come up with better policies? Issues to be discussed:

1. How many policy impact studies are available?
2. What do the teach us about Georgia's agricultural policies?
3. Different policies are implemented simultaneously and we do not know which one has which effect: do you see policies which have been interfering?
4. Which policy analysis studies are a priority for Georgia?
5. Which agricultural policies can be recommended on the basis of these policy studies?
6. Are agricultural insurance policies effective?
7. If yes, why do not all farmers use them?

Export promotion

We now turn to the core of the course the issue of how to increase your agricultural export and benefit more from it. The issue of market access for Georgia is analyzed in UNDP & SDC (2013: 61-64). Various parts of Georgia offer opportunities for product development. However, markets are segmented (niche markets), market analysis is necessary and students should be equipped with skills of strategic market planning for efficient marketing and pricing of products. Issues to consider:

1. What can be done to step up exports?
2. How can we determine the potential benefits from exporting certain agricultural products? By using the tools like Cost benefit analysis (CBA) and Multi criteria analysis (MCA; see table 1)
3. Develop a strategy to select certain products for certain international markets and look for the necessary contacts.
4. How to find the right contacts in potential markets? Developed countries of have trade promotion agencies, which can bring you in touch with interested parties.
5. How to deal with trade restrictions and foreign standards? You should inform yourself what barriers exists and decide how you will deal with these restrictions.
6. How to get the relevant information concerning contacts in the countries you want to export to?
7. What can we learn from the UNDP & SDC (2013) study comparing agriculture in the South Caucus countries?

The role of Foreign direct investment

Foreign direct investment (FDI) can sometimes help to develop CSA&W and explore export markets, but the multinational companies (MNCs) will also seek their own benefits. Introduce the debate about FDI and point at advantages and the cost. Georgia has opted for a liberalization policy and as such opened the doors for FDI. FDI has been very important for China's rapid economic development after the death of Mao in 1976. Issues to consider:

1. What has been the evidence so far that FDI has contributed to local value added of agricultural activities and to what extent has it contributed to more agricultural exports?
2. Stimulating FDI brings MNCs which can be very influential, bringing not only technology and markets, but also a certain style of life and mentality (UNCTAD, 2005).
3. FDI will also lead to profit repatriation, which can be painful during years of crisis
4. FDI want a positive business environment and Georgia is scoring very well in the World Bank Doing business report (World Bank, 2014)
5. Negative effects of trade liberalization should also be mentioned: land grabbing, environmental harm, destroying social structures, etc.

The importance of marketing for agro-export promotion

To do a good job in exporting agricultural products from Georgia need to be competitive and marketed internationally. A number of textbooks are available on marketing (Kotler and Keller, 2006), while some focus in particular on marketing agricultural products (Norwood and Lusk, 2007). Issues to deal with:

1. Tools to be used: fairs, publicity, traditional advertisements, TV commercials, etc.
2. Material to be used: samples, pictures, stories
3. Skills: how to identify a market, how to explore it and how to conquer it.
4. Use the international organizations that have been created to promote export: The United Nations Commission on Trade and Development (UNCTAD) and the World Trade Organization (WTO) in Switzerland and the Centre for import promotion from developing countries (the CBI) in the Netherlands.
5. How to choose: Do we promote a product in general (hazelnuts) or a product of a specific country (Georgian wine)?

An example could be biofuels. Huber and Dale (2009) distinguish first and second generation biofuels. The latter are produced from the inedible parts of plants and are the most environmentally friendly and technologically promising near-term alternative to oil. They claim that the US could grow enough of these feedstock to replace about half of the country's total consumption of oil without affecting food supplies. With first generation biofuels there is not enough farmland to provide more than about 10 percent of the developed countries' liquid-fuel needs. Feedstock supply can be supplemented by production from small scale farmers out-grower schemes. This is a common feature in emerging economies for the following reasons:

1. To keep costs low
2. To mitigate against competition for land with local people
3. Provide job opportunities/input support for the local people
4. A social strategy to enhance project acceptability among the local people

Table 3 Global biofuel value chain: functions, actors and examples in Tanzania
Table 3 gives some examples of global biofuel value chain actors, and the functions they have and some examples of existing companies in Tanzania.

Functions	Actors	Examples of firms involved
Selection of seeds	Biotech firms	Monsanto, Sengta, Dupont
Feed stock production	Agri companies	Farmers across Europe, USA, South America, Brazil
Supply of feedstock	Agri companies	Bunge
Conversion processing	Processors	Cargil, Abengoa, British sugar
Blending distribution	Oil majors	BP, Shell, Total, Chevron
Consumption	Final consumers	Boeing

Source: adapted from Karlsson and Banda (2009).
Biofuels are a recent chain and we must be careful not to be overoptimistic. Many researchers are interested in a value chain study of biofuels; some focus on fuels based on sugar, or maize or other natural oil products.

What about the competition for the nuts chain in Georgia?

Global value chains are facing, inter and intra chain competition (pistachio nuts from Georgia and from Iran), within and between value chains within and between value chains (customers may eat hazelnuts or wall nuts). In the literature competition within and between value chains is distinguished. The following table provides a list of factors influencing the competitiveness of biofuels.

Table 4 Factors influencing the competition within and between bio-fuel value chains

	Internal factors	External factors
Between value chains	1. Policies with respect to different value chains 2. National and international regulation 3. The profitability of one type of biofuel chain affects the development of others**	1. Innovations in plants or production methods 2. The price of petrol and of competing products, close substitutes of possible replacements*. 3. Technological abilities to mix different biofuels with conventional fuel 4. Products that could benefit more from liberalization of agricultural imports in Europe
Within value chains	1. The policy of the government with respect to this chain 2. The business model chosen (the organizational structure chosen) 3. The cost of production and transportation	1. The price of national and international transportation 2. The plans of neighboring countries with respect to biofuels

***** *This concerns a large number of prices, ranging from crude oil to the cost of generating a kilowatt of electricity through windmills.*

*** Cross-elasticities and substitution effects should be determined to get a good impression of the importance of these fluctuations.*
Source: Van Dijk (2010).

Discussion, relating the findings to the theory

Unfortunately, we had no opportunity to see the results: has the master started, were the modules used and useful? However, Nuffic could help with a relatively small amount (through a TMT project) to direct universities in Georgia to the ideas of Climate smart agriculture & water and a more global agricultural sector. MSM emphasized that CSA&W is not just technology, but also policies, technology management (Triple Helix Structure) and that it is necessary to create governance structures for consultation with stakeholders. We emphasized the need for sustainable production for export to the EU.

Conclusions

What is the contribution of these modules/course to the development of relations with the European Union? Also, what does a value chain perspective add to understanding the nuts sector? Further integration in international value chains is the future for many agricultural products. It raises the question what is necessary to upgrade these agricultural value chains and allow them to export, for example to the EU? The course developed with support of the Nuffic and MSM may facilitate the integration process by raising awareness of all the issues involved.

Five conclusions can be drawn:

1. Agribusiness is a key priority for Georgia
2. Exporting to the EU is a unique opportunity
3. Currently local customers prefer imported agricultural products!
4. International markets are more demanding
5. EU requirements can make the agricultural sector more competitive

Recommendations

The following recommendations can be made:

- Help Georgia to put Georgia's agriculture in its ecological, environmental, social and historical context
- Increase the competitiveness of the agricultural sector by formulating CSA&W policies in Georgia
- Benefit more from FDI in the agricultural sector, bringing CSA&W ideas and export markets
- Use CSA&W ideas smartly
- Develop knowledge and skills locally, develop innovation in a Triple Helix Framework

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III Examples of CSA&W

Promoting smart agriculture in agricultural colleges; the contributions of the NICHE-GHA-270 project

Ishak Shaibu, Coordinator: NICHE-GHA-270 Project, Kwadaso, Ghana

Background

According to FAO (2010), Climate Smart Agriculture (CSA) is "Agriculture that sustainably increases productivity, resilience (to climate change), reduces/removes greenhouse gases (mitigation), and enhances achievement of national food security and development goals. The rapid population growth with its corresponding demand for food and shelter is seriously challenged by the sharp decline in arable farmlands, air and water pollution. The situation poses a severe threat to food security, not just for Ghana but the world at large.

The Nuffic OKP project 'Capacity Building of Four Agricultural Colleges' is designed to strengthen the four main Agricultural Colleges in Ghana: Kwadaso, Damongo, Ejura, and Ohawu. Kwadaso is the lead Agricultural College for the project, which is also supported through collaboration with CINOP (Lead Partner), Q-point and University of Applied Sciences (HAS) from the Netherlands, and Kwame Nkrumah University of Science and Technology (KNUST), Quente Africa, and the University of Cape Coast (UCC), in Ghana.

The project has resulted in the successful revision of the Diploma program's curriculum from a more theory-based curriculum to a more gender-sensitive, practical, and Competency-Based Education and Training (CBET) curriculum changing the face of the agricultural colleges in Ghana (Ishak, 2020). Therefore, the colleges' current programs can be described as a 'blend' of CBET and traditional theory-based education while making efforts to fully becoming CBET institutions. The approaches adopted in implementing the curriculum and other project components, such as CBET, value chain, and entrepreneurship, have contributed significantly to promoting a culture of climate smartness among the beneficiaries in the colleges.

Competency-Based Education and Training (CBET)

CBET application implies that the acquisition of competencies required by companies and industry to function effectively is taken into account (Deissinger, 2011). Also, Boahen (2014) asserts that among the reasons for establishing a Council for Technical and Vocational Education and Training (COTVET) in Ghana in 2006, among other things, was to ensure the introduction of an industry-driven CBET in the TVET systems in Ghana. In line with this, the NICHE-GHA-270 project embarked on a revision of the Diploma curriculum from a more theory-based curriculum to a more gender-sensitive, practical, and competency-based education and training (CBET). As a result of the curriculum revision and staff capacity strengthening, teaching and learning in the Colleges are now more practical and hands-on than before (Ishak, 2020). More and more tutors and students alike are increasingly getting interested in learning by doing.

Figure 1: Demonstrating grafting to students

Figure 2: Precision agriculture in the greenhouse

The confidence, competence, and efficiency achieved during a CBET application is a significant contributory factor towards adopting and practicing innovative agriculture principles at the individual level.

Entrepreneurship Trainings

The project has also turned the Colleges into an entrepreneurial center, with support offered in training and finance, leading to establishing on-campus income-generating such as aquaculture, poultry, and other agro-processing businesses. These income-generating activities generate extra cash for the College and serve as an inspiration and helpful training avenues. Students are fully involved in all operations of these campus businesses. For instance, at Kwadaso Agricultural College, the project has supported the College to raise 1,000 poultry layers. The College collects no less than 20 crates of eggs per day and generates a revenue equivalent to about 1,300 Euros per month. Additionally, a mini concrete pond with a capacity of some 1,000 catfish also generates income.

To make full use of the Home Science Department at Kwadaso and the staff who attended the Food Processing internship at CSIR/FRI, food processing equipment has been procured for the College, including juice extractors. The intention is to pay more attention to the agro-processing aspects of the value chain, which is also vital for curriculum implementation. It is also essential if smart agriculture principles are to be achieved to the fullest. To facilitate sales of the College-produced agro-products (eggs, fish, fruit juice and vegetables), the project has also funded the construction of a "Green Market" – a container shop located at the College entrance. In all these enterprises, students are actively involved in production operations (feeding, medication, records keeping, and other routine procedures).

Figure 3: Commercial/sales activities in and outside the green-market respectively

Value Chain Capacity Building

The Colleges' participants had their capacities built in value chain analysis and development in the Agricultural sector. The training introduced participants to the Net-chain Improvement Framework (NIMPF) tool in value chain analysis. The training focuses on value chain analysis tools and skills, allowing participants to diagnose bottlenecks and improvement opportunities.

Sustainable food value chains for climate-smart agriculture interventions should be selected on the basis of their vulnerability to climate change, their potential contribution to climate change adaptation and mitigation, and their ability to improve the resilience of producers and other value chain actors (IFAD, 2015). The threats and risks to agriculture posed in climate change projections can be reduced by building producers' adaptive capacity, increasing the resilience of agricultural production systems at the farm level and beyond, and improving resource use efficiency (Lipper *et al*., 2014). After disposal, the decay of food waste, though relatively small compared to the stages from production to consumption, also directly contributes to greenhouse gas emissions (FAO, 2013).

Understanding food value chains and food systems in terms of the risks and the potential impacts of climate change in the core value chain stages, the extended value chain and the enabling environment in which it is embedded, as well as the behavior of the diverse stakeholders involved, can help identify the most impactful food system interventions to support climate-smart agriculture (FAO, 2021).

The story of Kwadaso Agricultural College

The approach to the training at Kwadaso Agricultural college is witnessing some improvement in line with Smart Agriculture due to the interventions of the NICHE-GHA-270 project. This can be ascertained in the following intervention areas:

i. Installation of Solar-powered water pumps: Solar-powered water pumps have been installed to replace the existing electric pumps powered from the national electricity grid. This initiative does not only significantly take away the unsustainable electricity cost that the College was already battling to address but will also serve as a cheap source of energy to power the water pumps. It also ensures all year-round crops and vegetable production at the College's vegetable garden without having to rely upon the natural rainfall pattern, which had recently become irregular due to climate change challenges, as noted by Ibrahim et al. (2018) when they indicated that the impact of climate change is often demonstrated by rainfall and its corresponding characteristics.

Figure 4: Solar irrigation system at Kwadaso

Figure 5: Dry season vegetables production

The all-year-round production ensures a green and serene environment that is suitable for sustainable ecosystem management. It is also interesting to note that the entire water requirements for use in the greenhouse and the whole vegetable garden are supplied by the solar-powered irrigation facility supplied from a single borehole.

ii. Greenhouse vegetable production: The acquisition and installation of a greenhouse system for vegetable production do not only modernize the agricultural production systems in Ghana to entice and attract the youth to embrace agriculture but, to a large extent, also serves as a sure means to saving the environment. This is evident in the precision achieved in the use of fertilizers, herbicides/weedicides, and irrigation water. Greenhouses can help farmers reduce spoilage, increase yields, and improve their livelihoods (Czyzyk et al., 2014).

Figure 6: Greenhouse vegetables production at Kwadaso

iii. Organic vegetables production in sacks: Another interesting lesson learned from the value chain lessons is how to turn a challenge around into an opportunity. In line with this, the College saw the need to address nutrition and environmental challenges by promoting organic agriculture production. An exciting addition to the organic concept is adopting the sack and medium system of vegetable production. In this system, an organic medium made up of rice husks, poultry, and other organic manure which are readily available as waste and could easily pose an environmental threat is filled in nylon sacks for vegetable production purposes.

Figure 7: Organic vegetables production in sacks at Kwadaso

This system ensures intensive cultivation of vegetables in a relatively small land area, thereby saving land for conservation and other productive purposes. In this system, the right amount of nutrients and water required by the plants are supplied to a precise level through adoption of drip irrigation systems. This significantly reduces wastage of inputs and its attendant effects on the environment. According to Deveza and Holmer (2002), with the rapid urbanization rate, when there is not much space to grow crops in the city, we are challenged to find alternative, practical means for growing crops.

iv. Zero tolerance for the waste initiative: The NICHE-GHA-270 project has supported the College to undertake poultry for egg production and catfish production. These initiatives are in line with some of the food security commodities promoted in the revised curriculum. These investments serve as an income-generating activity to generate additional cash to support the running the college programs.

Waste from the poultry and the catfish through droppings and cage /pond cleaning are used as organic manure on the vegetable farms for organic manure. Left-over leaves, stems, and other remains of crops harvested are either used as organic mature by incorporating into the soil or used as livestock feed to feed cattle and sheep belonging to the College. In a similar vein, waste from this livestock is collected and used as manure on the crop's fields. This integrated system is a significant contributor to environmental sustainability. The College, with support of the NICHE-GHA-270 project is making efforts to promote smart agriculture at the micro-level through low or no-cost initiatives.

Figure 8: Some NICHE-270 interventions contributing to income generation and integrated agriculture

It also enhances the application of CBET in the training as it offers opportunities for students to carry out the hands-on practice of lessons learned in the college environment.

In all these initiatives, students are taught the Agribusiness principles of effectiveness and the need to achieve efficiency to maximize profit. These principles significantly contribute to reduced input use to the possible minimum, leading to environmental sustainability. Rubén & Lara (2017) asserts that, one way to achieve ecological sustainability is to arrive at the final fixed objective efficiently.

v. Green-market: One of the dispiriting factors for the colleges in the past was the lack of a ready market for products from the college farms/fields. With the green market provision, poultry products, eggs, fruits, and other vegetables produced in the College can now be readily off-taken, preserved, and packaged for sale at the green markets.

Figure 9: Green-market at Kwadaso

Figure 10: Fruit processing for to be sold at Green-market

Besides providing a ready market source for the products from the college fields, the many postharvest losses usually experienced in the past with its attendant threat to the environment are also significantly reduced. The home science department and other departments in the colleges are increasingly becoming busy to produce a product or render a service to the green market, which eventually ends up raising funds to supports the college operations, whilst also ensuring minimal waste as much as possible.

vi. Tractor & equipment services: through the NICHE-GHA-270 project, the colleges can now boast of brand-new tractors, planters, ploughs, and harrows etc. The purpose is to support the practical and CBET training objectives of the revised curriculum. It will also facilitate the commercial farming/production of the colleges by making it relatively easy and cheaper to till and prepare the land for production. The colleges are also encouraged to render commercial mechanization services to neighboring farmers to enhance their productivity while also generating additional income to sustain the machinery /equipment and raise funds for supporting the College's operations.

Figure 11: Tractor and equipment procured for the 4-colleges

In the absence of these tractors/equipment and services readily rendered, farmers and potential farmers are highly likely to slash and burn the bush for production purposes. Apart from the reduced production scale due to exertion, bush burning is a serious threat to environmental sustainability (Hamid et al., 2010; Nigerian Conservation Foundation, 2012; Nsiah-Gyabah, 1996).

This machinery and equipment and the associated services rendered promote innovative agriculture initiatives as farmers can practice drip irrigation and other smart agriculture initiatives for enhanced productivity in an environmentally friendly manner.

The story of Ishak Shaibu

Ishak Shaibu, the coordinator of the NICHE-GHA-270 project, is also a tutor and head of the department for Agribusiness and Economics at Kwadaso Agricultural College. Coordinating the NICHE-270 project had offered the opportunity to be part of all entrepreneurship, value chain, gender, and other capacity-building initiatives of the project. The many lessons also drew inspiration thought and learned through the implementation of the project. So, in the second year of the project (2018), I took the initiative to put my home backyard into agricultural production as innovatively and efficiently as possible. I started with a few chickens, rabbits, and vegetables. With time and the success stories of the initial investments in chickens for meat, other production ventures including goats, catfish, snails, and poultry for egg production were also included.

Figure 12: Some agro enterprises embarked upon by Ishak with lessons learned from NICHE-GHA-270

Currently, the scale of production has significantly improved. For instance, further steps were taken to develop other aspects of the poultry value chain by the inclusion of breeder poultry birds for breeding eggs production, hatching of breeder poultry eggs, provision of hatchery services for other interested farmers, brooding of hatched day-old chicks for a later sale to farmers and prospective poultry farmers. The initiative and the initiative's innovation have contributed to a national award-winning as the Best Municipal Farmer, Kwadaso, in December 2020. This prestigious recognition came two years after this initiative.

The exciting innovation regarding how the farm unit re-uses waste materials generated on the farm ensures production efficiency while reducing the obnoxious gasses and stench usually characterized by many backyard farming and poultry production. A system is invented to ensure that droppings / fecal matter from the poultry is used to produce maggots. These maggots serve as an excellent protein source to the catfishes, as well as the birds themselves. This initiative has significantly reduced the feeding cost associated with raising catfishes in concrete ponds, a challenge many fish farmers are seriously grappling with. The maggots' production process is carried in a simple but controlled environment. The method also naturally addresses the stench issue that otherwise will have been a nuisance to neighbors and cause environmental pollution. After the harvesting of the maggots to feed the poultry and fishes, the remaining debris is a relatively decomposed manure with no stench that serves as a great source of growth medium and nutrients for crop production. This is then deposited and or packaged into nylon sacks for organic vegetable production.

Drinking water provision for the poultry, rabbits, and catfishes, snails, and vegetables is semi-automated. The purpose is to ensure minimal water waste while ensuring that just sufficient water is supplied for the animals and crops. The center has some other agro initiatives that may not be present or available in the College, such as the snails, goats, incubators for eggs hatchery. Many students and even people from outside the College premises visit to study and learn from my best practices.

Conclusions

Environmental sustainability is a shared responsibility, and the NICHE-GHA-270 project is playing its quota towards achieving this objective. Agriculturists have an enormous responsibility to lead the crusade for ecological conservation and sustainability by adopting smart and innovative agricultural practices since they need a safer environment for enhanced productivity.

Smart and conservation agriculture should not entirely be viewed as investment and procurement of sophisticated equipment to ensure strict and precise input application in Agriculture to safeguard the environment, but also an objective that can be achieved through disciplined and responsible production methods at the primary and individual levels, at relatively little or no cost.

Therefore, it is recommended that education for environmental sustainability through innovative and responsible agricultural practices be strengthened and start at all educational sector levels to create awareness of wrong Agro-practices' implications on the environment and man's existence. Again, individuals, groups and organizations be encouraged to adopt smart agricultural practices through responsible agricultural practices.

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Hybrid maize as the next step to a green revolution, The importance of the ecosystem, frugal innovation and a Triple Helix model in Tanzania

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Abstract

Climate change and the resulting increased drought periods contribute to farmers' problems in Tanzania, but their core problem is low agricultural productivity. Between 2011 and 2014, the Swiss Capacity Building Facility (SCBF), a non-governmental organization (NGO) financed by ten private Swiss insurance companies, funded four projects in Tanzania aiming to introduce crop insurances for maize farmers in the Iringa, Mwanza and Arusha regions to help them to move from using traditional maize seeds, which they would save each year, to hybrid seeds sold by commercial companies. These seeds require expenditure on additional inputs, which means the farmers risk losing the investments if the harvest is lower than expected. The hybrid seed is available, but it requires other actors and instruments to give small-scale farmers access to these innovations. This helps to develop the necessary ecosystem for Climate Smart Agriculture and Water (CSA&W).

To assess the impact of this Weather Index based crop insurance for Tanzanian maize farmers, which intended to mitigate this risk, a survey has been undertaken by the author. In total 200 farmers were interviewed, using cluster sampling. The objective is to analyze the impact of the crop insurance introduced with the support of SCBF and its effect on household's income and assets and on agricultural productivity. In this paper we also analyze to what extent the ecosystem used to introduce crop insurance was optimal and what the needs of the farmers are concerning this ecosystem. Finally, the question is asked whether this is an example of introducing Climate smart agriculture and water, using frugal innovation in a Triple Helix construction?

Introduction

Low agricultural productivity is a big problem in Tanzania, but climate change and the resulting increased drought periods contribute to problems of farmers. Tanzanian farmers need to move from traditional to hybrid seeds to assure food security. A non-commercial private sector initiative is helping the farmers by providing crop insurance, which can help them to take the risks they run by buying hybrid seeds instead of using traditional seeds and by using complementary inputs, such as fertilizer and sometimes water. Local extension services are not functioning properly, while farmers need to move from traditional to hybrid seeds to assure food security (Lamek, 2016). A non-commercial private sector initiative is helping them by providing crop insurance. Between 2011 and 2014, the Swiss Capacity Building Facility (SCBF), a non-governmental organization (NGO), financed by ten private Swiss insurance companies, funded four projects in Tanzania aiming to introduce crop insurances for maize farmers in the Iringa, Mwanza and Arusha regions (ACRE Africa, 2014). What is it all about? Crop insurance, an innovation in the Tanzanian context, is introduced in a Triple Helix way (Van Winden and De Carvalho, 2015), where the private sector supplies the innovation, the NGO sector delivers the insurance with technical advice and inputs to the farmers and the national and local governments allow the use of these new technologies to serve the farmers and regulate the insurance and the mobile telephone sector.

What is the project to be evaluated all about?

The Swiss Capacity Building Facility (SCBF; an international NGO) introduced crop insurance through local NGOs. Crop insurance is a frugal innovation (using existing technology), helping small maize farmers in Tanzania to make a step towards a green revolution. Not only additional agricultural services were provided through this program, also new technological options were used to reach as many farmers as possible at minimum cost. The project used a Weather Index Insurance (WII) based on satellite images (which are also available), to determine whether drought prevailed in the area concerned during the seeding, germination, or ripening period. If the signal is less rain than normal, the farmers are compensated for the damage.

Farmers can insure as little as one bag of hybrid seed (which is also not the innovation, because locally available), bought from the seed company (SeedCo, covering only the germination period), or through signing up for a package for one acre of land through an NGO, or a commercial intermediary working together with a local NGO. The training projects were carried out by Acre Africa (AA), an international NGO, with a local affiliate (One Acre Fund in Tanzania, or the 1AF). The project contributed to the training of thousands of farmers in the three regions studied. In total more than 20,000 farmers have been insured in the Iringa region and more than 10,000 in the Mwanza and Arusha regions taken together. The research also identified the importance of land

for the success of crop insurance for maize farmers in Tanzania (Van Dijk, 2019). Is this the development the first step to the long expected green revolution in Africa?

An innovation: different ways of involving the private sector

There are three ways (modalities) to involve private companies to provide crop insurance for maize farming:

a. Selling crop insurance policies directly to the farmers
b. Benefitting from the seed company, which provides this service when you buy a bag of hybrid seed, or
c. Working through a local NGO, which functions as intermediary between the farmer and the insurance company and offers the insurance as part of a package of inputs and technical advice.

Ad a In one of the study areas a local insurance company was selling crop insurance policies directly to the farmers, without providing too much explanation, or technical advice on the inputs to be used.
Ad b Seedco, one of the biggest seed companies provided an insurance with a bag of hybrid seed. The farmers would find a card inviting them to send a message through their mobile phone about their interest to be insured during the germination period. The insurance covers a lack of rain during the germination period. If no proper germination, the farmer can get a new bag with hybrid seeds.

Ad c Under this modality the One Acre Fund (OAF) allows farmers to insure as little as one acre planted with hybrid seed. They sign up for a package of inputs for one or several acres of land through a local NGO. The training of the staff of this local NGO was carried out by Acre Africa (AA), an international NGO based in Nairobi, with as local affiliate Acre Tanzania. The staff of the OAF benefited in a big way of these training sessions.

Theoretical section: frugal innovations and Triple Helix

In the innovation management literature, there is an increasing interest in frugal innovation (Onsongo and Knorringa, 2020). Frugal innovation is usually discussed in the context of emerging economies. It provides poor consumers opportunities to consume affordable products and services suited to their income and needs. Weyrauch and Herstatt (2017) suggest criteria that make it possible to determine what frugal innovation is. They suggest three criteria for frugal innovation:

1. A substantial cost reduction,
2. A concentration on core functionalities, and
3. An optimized performance level.

In Tanzania, the technologies used are a Satellite based Weather Crop Insurance, which can be obtained by the farmers by using a mobile telephone. The policy cover is paying out by informing the customer through the mobile telephone about the pay-out, or how much their debts have been decreased because of a period of drought. Crop insurance was relatively new in Tanzania but was used already in the Netherlands before World War II to stimulate farmers to grow strawberries. Hence it is an existing technology. In the same way farmers usually have a mobile telephone (80% of the Africans), although only a minority has a smart phone. However, so far farmers did not use their phone to take an insurance or to receive information about the pay-outs.
Crop insurance may also be smart agriculture and an example of a frugal innovation introduced through a Triple Helix approach. In the Triple Helix model of desirable university-industry-government relations frugal innovation has become a popular innovation model and Triple Helix forces us to specify the role of each partner.

Satellite images are used to determine whether drought prevailed in the area concerned during the seeding, germination, or ripening period. This crop insurance is helping small maize farmers in Tanzania to make a step towards a green revolution. What is the problem? To use hybrid seeds, farmers must spend money and run the risk that their investments turn sour, for example if there is not enough rain due to climate change leading to less rain and more variability.

If the satellite signals less rain than normal, the farmers are compensated for the damage accordingly. The agricultural insurance sector is nascent in Tanzania: no agri-insurance products at all were reported in the microinsurance landscape in Africa in 2015 (Micro Insurance Center, 2016). However, with strong life, credit life and health, Tanzania sees the largest proportion of its gross written premium coming from micro insurance with 6.4% in the region. This gives the country a promising potential. In 2013 the supervisor for the insurance sector (Tanzania Insurance Regulatory Authority) issued a microinsurance regulation to boost the sector.

The results of introducing the crop insurance will be studied, but the international NGO One Acre Fund, with support from SBCF, is clearly a first mover in this market with only some competition coming from Kenya with

PULA (a Kenyan insurtech start-up that specializes in digital and agricultural insurance to de-risk millions of smallholder farmers across Africa by developing insurance products and distributing them to farmers). As in many Sub-Saharan countries the regulator faces resources constraints that translate in time consuming license processes. Recent market intelligence also revealed that the insurance industry is in the process of setting up an agriculture pool that would allow a central underwriting and spreading of risk. The main shortage clearly remains know-how and the ability to develop scalable products that will be sustainable when subsidies dry out. In the meantime, the regulator is looking to public-private partnerships on the grounds that premium cannot otherwise be affordable. In this context a weather index insurance provides an innovative approach using satellites and mobile telephones to reduce transaction costs, however the mass distribution challenge has not yet been fully solved.

Theoretical framework, definitions of CSA&W, frugal innovation and Triple Helix

Van Dijk et al. (2020) provide several definitions of CSA&W. Climate smart agriculture (or Precision agriculture, or Smart Farming, or Conservation agriculture) means that crops (or animals) get precisely the treatment they require, determined with great accuracy thanks to the latest technology. Successful introduction of climate smart agriculture is based on introducing and using new, precise and water-smart technologies. A drive to reach optimum cost-benefit in production methods and an ability to build governance (partnership) structures. are also important. The definitions of the Food and Agriculture Organization (FAO) and the World Bank are provided, but the authors try to identify the special role of a business school, when studying CSA&W (this will be discussed in the final paper of this volume). The definition is summarized in table 1.

Table 1 The proposed operational definition of CSA&W

Organization, source	Main defining criterion
FAO	Transforming agricultural systems to ensure food security in a changing climate
Literature	Precision agriculture, smart farming, or conservation agriculture
MSM (Van Dijk et al., 2020)	Non-technical aspects, requiring management and governance structure
My additional criteria	Need for a combination of factors & making use of existing, advanced technology

The scientific definitions emphasize the goals (sustainable development, food security or adapting to climate change), or refer to technical aspects: precision, smart or conservation. Van Dijk et al. (2020) conclude the operational definition CSA&W should include two elements, where business schools can contribute: it requires management of innovation and a governance structure. My own additional two elements of the operational definition of CSA&W are that there is always a combination of inputs (that needs to be managed) and that some of these inputs are new and technologically advanced. In this study that concerns the crop insurance, the use of mobile telephones to insure the crop and to receive the pay-out. In this research we will check to what extent introducing crop insurance is indeed leading to CSA&W.

Methodology

The original research questions were:

1. What is the best way to help traditional maize farmers?
2. Does crop insurance help small maize farmers in Tanzania to make a step towards a green revolution?

For a conference in Washington we added: what is the role of land and modern inputs to increase agricultural production? (Van Dijk, 2019). During the research, it became clear that we were answering three other research questions:

3. What is the best ecosystem for upgrading traditional maize farmers in two regions of Tanzania?
4. What are the ecosystem needs among small-scale farmers in Tanzania?
5. Is this project trying to introduce crop insurance an example of introducing Climate Smart Agriculture and Water (CSA&W) in Tanzania?

To assess the impact of a Weather Index Insurance for Tanzanian maize farmers a survey has been undertaken by the author and three local researchers in the Iringa region and by three colleagues in the Arusha and Mwanza regions. In total 200 farmers were interviewed, using a pre-coded questionnaire and cluster sampling with the villages as sampling unit and then selecting farmers' households per village as random as possible. Part of the questionnaire is based on the PACE client satisfaction and value assessment (ILO, 2012), which helps to

get an impression of behavioral changes and indications of impact, customer satisfaction and reasons for purchasing this product. Questions about the perceived value for money for crop insurance were also asked to identify factors that drive the up-take of the product.

Analysis of the impact

RQ1 Data were analyzed to understand the problems & assess the impact of crop insurance The objective is to analyze the impact of the crop insurance introduced with the support of SCBF and its effect on household's income and assets and on agricultural productivity. The results of the survey are analyzed to better understand the problems of the farmers using hybrid seeds and the know the effects of introducing crop insurance. Positive effects were found comparing data for the first and the second year (Van Dijk 2018). The project is successful and had impact, which can partially be attributed to the availability of hybrid seeds, additional inputs, technical advice, crop insurance and an emerging land market. Farmers used more land and inputs and produced more maize, despite poorer rains and lower maize prices in the second year for which data were collected. Besides indicators of the impact, also the outreach, efficiency and effectiveness of the interventions are analyzed, and positive evidence is found.

We also looked at the role of different inputs. The main inputs, besides the crop insurance were water, land, technical advice, hybrid seeds and fertilizers. In many locations there is also a need for additional water supply, while irrigation opportunities are often not available. In the 1AF NGO case the farmers pay for the package of fertilizer, hybrid seeds, technical advice, and the crop insurance. 1AF charges 235,000 Tanzanian shillings (around 100 euros) for a package for 1 acre in the form of a loan to be repaid in a period of ten months. However, the key is that these inputs were largely combined in a package provided by the local NGO and together they provided the positive results.

The impact of the size of the land for maize farmers was analyzed. There is a land market in Tanzania. Successful farmers obtained additional land. Bigger farmers benefit relatively more of the opportunity to get inputs & to insure their maize. Land laws and regulations in Tanzania grant customary rights of occupancy equal status to other property rights, or de facto ownership. The farmers interviewed owned at the average 4.98 acres during the first year and 5.22 acres during the second year. Table 2 provides a summary of the role of land when moving from traditional to hybrid maize (Van Dijk, 2019).

Table 2 A summary of the role of land when growing hybrid maize

Situation first year (2016)	Situation second year (2017)
• 45 farmers have leased land • 28 farmers had no land during the first year (but leased) and only leased • and 17 added leased land to the land they own • In the first year the average size of leased land for 41 farmers was 6.78 acres	• In second year 27 had no land, some farmers had bought land, or leased it • Average leased land for 46 farmers 10.39 acres • **Conclusions**: An increase in the number of farmers leasing and in the amount of land leased!

The table shows a functioning land market, which is especially important for a dynamic agricultural sector. Land is an important asset for these farmers and our study analyzed the role of land, owned, or leased and the prices paid for land. The impact of the size of the holdings was analyzed, not only showed that there is something like a land market in Tanzania but that the bigger farmers benefit relatively more of the opportunity to get inputs and tend to insure more land for rain failure.

Regional differences

The farmers in the Arusha and Mwanza region have more land, bigger families, and lower average yields than farmers in the Iringa region. In the Iringa region they spend more on inputs and, with the support received from 1AF, they comparatively get the highest average yields per acre while they cultivate less land than in other regions.

Research question 2: What is the best ecosystem for upgrading traditional maize farmers in Tanzania?

Different ways to supply insurance are compared: farmers supported by 1AF show the best results. Three ways of supplying insurance are compared, and the farmers supported by a local NGO, the One Acre Fund, shows the best results, proving that insurance is in particular useful if it is embedded in an institutional support structure that is non-commercial and close to the farmers and not by using a profit-oriented intermediary (Seedco), or a

combination of a commercial and non-commercial organization. All three modalities insure the final risks with a local commercial insurance company (UAP) and the Swiss re-insurance company. These are innovations for small-scale farmers, but it required a lead firm and a NGO to facilitate CSA&W supportive actions.

Research question 3: What are the ecosystem needs? The problems of the farmers

What do farmers no know about the ecosystem in general and about insurance in particular? Most farmers have limited knowledge about the opportunities to get support. They often do not know how much they pay for the crop insurance, but they are generally positive about it, since the insurance offers a feeling of security and the intermediary organizations reduce the loan in case of a crisis. However, some farmers were critical because no payments were made despite limited rains, or the pay-outs were too low. They want support to find better markets for their produce and more transparency concerning pay-outs.

The insurance concerns rain, but not the biggest problem in 2018: caterpillar! However, such an insurance would also be difficult to launch with similar low transaction cost. Compared to the current Weather Index Insurance the transaction cost will increase, because the caterpillar cannot be observed on the arial photography. In all cases the challenge remains how to come to scale and break-even.

Research question 4: Is this project to introduce crop insurance an example of introducing Climate Smart Agriculture and Water?

Taking the definition provided in table 1, we can provide the empirical evidence in table 3.

Table 3 The evidence for the proposed operational definition of CSA&W

19,75 mm

Organization, source	Defining criterion	Empirical evidence
FAO	Transforming agricultural systems to ensure food security in a changing climate	Certainly an issue in Tanzania
Literature	Precision agriculture, smart farming, or conservation agriculture	Improved seeds are introduced, just like information on inputs
MSM (Van Dijk et al., 2020)	Non-technical aspects, requiring management and governance structure	This is the key of the success: 1AF manages the process, provides a governance structure & contributes to developing an ecosystem
My additional criteria	Need for a combination of factors & making use of existing, advanced technology	It is the combination of elements and the use of existing technologies that make the approach affordable for the poor

Is this project to introduce crop insurance an example of introducing Climate Smart Agriculture and Water? We will take up this issue in the discussion section.

Discussion

The study confirms the importance of an ecosystem facilitated by NGOs. It was a Triple Helix construction for successfully introducing frugal innovations in the rural areas in Tanzania. In fact is could also be called a Four Helix approach, since the NGOs were involved, besides the government, the private companies and academia. The innovation is frugal because they basically use existing technologies but combined in a smart way. In terms of Weyrauch and Herstatt (2017) the innovation results in a substantial cost reduction, it is a concentration on core functionalities (drought in this case), and an optimised performance level (the hybrid seeds allow a better harvest and hence an investment in inputs and crop insurance is justified).

The role of the three pillars of the Triple Helix model can be summarized as:

a. Government provides the regulatory framework for introducing crop insurance and gives permission and monitors the situation.
b. International & local NGOs do the introduction of the technology, or in this case the combination of existing technologies.
c. Private companies provide the insurance to farmers, through the seed company or an NGO, or by selling directly the insurance cover.

In this case the role of the government could be made more important, supporting the initiatives of the farmers, NGOs and private enterprises. What is so smart about the Tanzanian experience with modernizing agriculture? Four indications can be given:

a. It is an example of frugal innovation introduced in a Four Helix framework. Commercial crop insurance existed but could never be supplied with such low transaction cost. Aerial photography existed, but the satellite images can be analysed on rain fall in a crucial period of the plant. NGOs have been active in Tanzania, but here a strategic partnership with the private sector was developed.
b. Hybrid seed is available already for some time in Tanzania, but the farmers found it risky because in case of drought they would lose their investments in seed, fertilizer and other inputs. By reducing their risk the technology became more acceptable.
c. A market for land seems to be developing. Surplus land is rented out and allows ambitious and young farmers to apply the new technology and get a relatively good return on their investment.
d. Controlling the supply of water is the next step. Farmers become more innovative, forced by climate change they search for additional sources of water to supplement what the rains offer.

Is crop insurance in a package with inputs and technical advice an example of promoting CSA&W. The secret is the combination of:

1. Hybrid seed, providing inputs, advise and a crop insurance
2. The crop insurance is high tech: satellite-based images of the weather, administered by mobile telephone
3. The technical advice received from the NGO

Does this case fit the operational definition suggested for CSA&W? Yes, because there is a new technology (or a frugal innovation), and a governance structure (the Triple Helix model) and the emerging ecosystem. Also, because the management of innovation was important (local NGO coordinating supply of inputs).

Conclusions concerning the modalities of providing crop insurance

However, the modality used to provide crop insurances to the farmers is important. Three different models were observed: (i) the NGO model with 1AF (ii) private sector limited insurance cover (SeedCo) and (iii) the efforts of 1AF to sell insurance directly in one area, with support of the insurance company in Tanzania UAP, but without the package they provided in the Iringa region. We conclude that crop insurance is most useful if it is embedded in an institutional support structure that is non-commercial and close to farmers. In this research the One Acre Fund did the best job in this respect in the Iringa region.

The alternative modality of an insurance company selling policies directly confused farmers and led to more complaints, because they did not understand the mechanism and did not get the additional inputs and technical advice.

The seed company provided a cover for the first 28 days, which may not be enough. More seriously the farmers often did not understand the meaning of the form included in the seed bag. Some thought it was just publicity and threw it away. These farmers did not register and hence missed their chance to get free seed if it did not germinate. The seed company lost interest in the insurance and did not provide it everywhere in the next year. The delivery of an all-inclusive package to farmers with regular interaction within an institutional support structure delivers the best result in terms of productivity, investment, and satisfaction.

General conclusions

Supporting the transition from using traditional to hybrid seeds is recommended to modernize agriculture, to increase rural incomes and food supply. The data show that the delivery of an all-inclusive package to farmers with regular interaction within an institutional support structure delivers the best result in terms of productivity, investment, and customer satisfaction.

For providing crop insurance it is important to select the intermediary carefully and to consider crop insurance as part of support package which should also include fertilizers and additional inputs like pesticides and access to water. There is also unsatisfied demand for insurance to be covered: from other regions, for other crops, for more land and for additional risks (like the damage due to caterpillars). More information and training should be provided to farmers and the insurance process needs to be made more transparent. The complaints of farmers should be taken seriously. SCBF should consider consultations with the government, to ensure support for crop insurances and facilitate the various steps to increase productivity of farmers, of which providing insurance is an important part. The challenge is to come to scale and break-even with this private sector initiative, which has

helped farmers to run risks and become more entrepreneurial, as shown by their behavior of buying or leasing additional land to increase their income.

We have shown a net increase in most variables, including value of assets, consumption, production maize and productivity and expenditures, due to the introduction of the crop insurance. These improvements can be partially attributed to the availability of hybrid seeds and crop insurance. Land markets also play an increasing important role and their functioning should be facilitated.

Supporting the transition from using traditional to hybrid seeds is recommended to increase rural incomes and food supply and contribute to food security in the country. It is important to select the intermediary carefully and to consider crop insurance as part of support package which should also include fertilizers and additional inputs like pesticides and access to water. There is scope for making the innovation more frugal, by really using only mobile phones for registration and pay-outs, which was currently not always the case. There is demand for this service from other regions, for other crops and risks (like caterpillars). More information and training should be provided to farmers and the insurance needs to be made more transparent.

The conclusion of this paper is that small-scale farmers have access to existing CSA innovations (drought tolerant seed), while normally the risk to purchase such seed is too high. An innovation (crop insurance for small-farmers) as an add-on to the existing innovation (hybrid seeds) makes small scale farmers adopt the innovation. This can only be done by involving an NGO (or in theory the government) to develop the ecosystem necessary for this. The questions is of course: what happens when NGO pulls out? As argued in chapter 7 policies are required to institutionalize these initiatives. They can be continued with Government support, or support from the Tanzanian Agriculture Development Bank, which should then embrace the approach and take it over from 1AF.

It is recommended to continue to modernize agriculture, to increase rural incomes and food supply and hence improve food security. For providing crop insurance it is important to select the intermediary carefully and to consider crop insurance as part of support package which should also include fertilizers and additional inputs like pesticides and access to water. There is also unsatisfied demand for insurance to be covered: from other regions, for other crops, for more land and for additional risks (like the damage due to caterpillars). More information and training should be provided to farmers and the insurance process needs to be made more transparent. However, crop insurance helped farmers to run risks when starting to use hybrid seeds and to become more entrepreneurial, buying or leasing additional land to increase their income.

Recommendations

Crop insurance is an innovation that stimulates other innovations. Is this the way to go to support the transition from using traditional to hybrid seeds to CSA&W? Introducing crop insurance certainly helped to modernize agriculture, to increase rural incomes and food supply. It is important to select the intermediary carefully and to consider crop insurance as part of support package, which should also include fertilizers and additional inputs like pesticides and improved access to irrigation water.

The development of ecosystems should always be farmer-driven. Larger farmers just make that happen themselves, since they are more dynamic and the development is spontaneous by private parties. NGOs or academics or others might just hobby around with small-scale farmers and forget the business model of the farmer - no matter how small the CSA farm operation. Start with better listening to the famers. The complaints of farmers about the ecosystem should be taken seriously. SCBF should consider consultations with the government, to ensure more support for crop insurances and to facilitate the various steps necessary to increase productivity of farmers, of which providing insurance is an important part. The challenge is to come to scale and break-even with the introduction of crop insurances. There are now many Agricultural Development Banks, some also government owned, who can help to reach SDGs. They can and will step in, as long as the sales of the farmers are secured and farmers are grouped into private groups (AMCOS in Tanzania). This means better clustering with cluster actors in an ecosystem: seed suppliers, AMCOS, crop buyers, 1AF, etc. That may also be enough to be able to access funds more easily.

Another recommendation is to develop the link with agrarian credit and micro-finance institutions (Bannerjee and Duflou, 2013). They are part of the ecosystem and could institutionalize the loan part. Given the distribution model is important this would require a new way of working together between the Triple Helix organizations. The academic partners can be used to fine tune the instruments and to monitor the results.

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IV Examples of ecosystem analysis

CSA in Eastern Africa - perceptions and practices

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Introduction

Agriculture and its productivity are at the heart of feeding and sustaining the ever-growing world population. The Food and Agriculture Organization (FAO, 2009) estimates a 9.7 billion world population by 2050, which will require a 70% increase in agriculture production. At the same time, the world is faced by the challenges of climate change. The Fifth Assessment of the Intergovernmental Panel on Climate Change (IPCC) has shown that global climate change is already damaging crops and undermining food production capacity, particularly in poorer countries (IPCC, 2014).

For Africa, agriculture plays a particularly crucial role as a significant contributor to GDP and also the biggest employer (ACET, 2017). Agriculture also plays a crucial role in supporting other sectors of the economy, for example, in Kenya, while agriculture directly contributes 32.6 percent of national GDP and it further contributes about 27.0 per cent indirectly through linkages with other sectors (KER, 2017). Indeed the prospect for transforming African economies largely hinges on how well agriculture is upgraded and leveraged to support other sectors of the economy (ACET, 2017). However, this prospect is under significant risk. African countries are particularly vulnerable to climate change due to strong dependence on rain-fed agriculture and natural resources; high levels of poverty; low levels of human capital; low levels of preparedness for climate events; and poor infrastructure in rural areas, indeed impacts of climate change are already being felt across Eastern and Southern Africa (FANRPAN, 2017). As such, agriculture and food systems must undergo a substantial transformation in order to meet the challenges of climate change and food security.

A key adaption and mitigation mechanism is Climate Smart Agriculture (CSA). CSA is defined as agricultural practices that sustainably increase productivity and system resilience, while reducing greenhouse gas (GHG) emissions. It is not a single specific agricultural technology or practice that can be universally applied; it is a combination of policy, technology, and finance options that involves the direct incorporation of climate change adaptation and mitigation into agricultural development planning and implementation (FAO, 2010). CSA seeks to answer what steps can be taken now to move towards a more sustainable future in agriculture under climate change.

CSA AND SDGs

Given that CSA is about sustainable farming, it dovetails well with the SDGs as it addresses many of the SDG goals. The SDGs address by CSA include: No poverty goal number 1; Zero hunger goal number 2; Clean water goal number 6; Decent work and economic growth goal number 8; Responsible consumption and production goal number 12; Climate action goal number 13; Life below water goal number 14; Life on Land goal number 15. Given that CSA has a very broad definition that encompasses many sets of actions, there is bound to be difference in what the term means to various stakeholders and also the fact that agriculture takes place in very diverse ecosystems CSA practices are like to vary. The potential for confusion or sub-optimal action is huge. Therefore, there is need to assess how different stakeholders perceive CSA, the potential gaps they see and what is happening in the ground. This can then provide insights into how to craft support for better CSA policies and practices. This contribution seeks to do that through a survey of key stakeholders. The next section describes the survey, section three discuss the results of the survey, section 4 reflects on the insights gained and what they imply in terms of support, section 5 concludes.

1. Survey Approach

Research methodology

A survey was administered to key stakeholders involved in implementing CSA. The survey was collected using a structured questionnaire (see appendix). The targeted stakeholders were Development Partners/Actors, Policymakers, Private sectors and Academics/ Researchers within the MSM networks.

Survey objectives

- To explore the understanding of CSA among various stakeholders and their perceptions of the level of understanding of various stakeholders

• Get insight in the level of preparation for CSA (policies, institutions, support systems)
• Get insight in CSA practice being applied and the gaps in the potential for greater application
• Get insights in innovations needed to improve CSA adoption

The survey was administered by MSM teams in four countries namely Kenya, Ethiopia, Tanzania and Mozambique. Data collection was done in March 2021. The survey was also complemented by a survey of literature to gather more insights on policies and actions being pursued by various countries.

Findings

A total of 29 respondents was achieved. Of these respondents the majority (39.3%) were development actors while 10.7% were from the private sector.

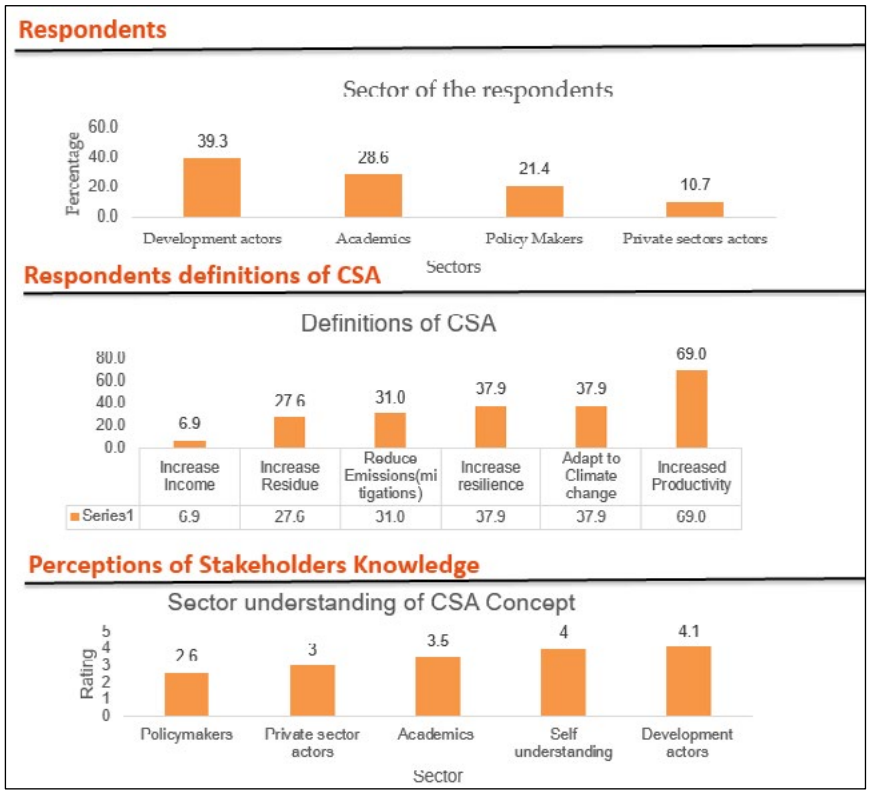
a) Definition and perception of understanding of CSA

In terms of the definition of CSA, very few of the respondents could capture all the dimensions of the CSA definition (only one captured all the 5 elements). An increase in productivity and adaption to climate change were the most captured aspects of CSA. An increase in incomes received little attention, yet without impact on incomes, farmers are unlikely to adopt CSA.

Regarding the understanding of the CSA concept. On average, most of the respondents rated their self-knowledge as High, and the development sectors were most highly rated (which can be explained by the fact that most of the respondents were from the development sector) while the policymakers were rated as low to moderate knowledge.

The fact that the concept of CSA is not yet fully appreciated and that policymakers are perceived as the most lacking in understanding means that the potential of missing the range of opportunities offered is high as policies might not address the range of issues and uptake likely to be low due to low levels of knowledge. More crucially, if the economic aspects of CSA are not addressed, farmers are not likely to take up CSA. The implication here is that more efforts are needed to increase awareness of what CSA is and also to build the capacity of policymakers so that the right policies are put in place.

Figure 1: Definition and perception of other understanding of CSA

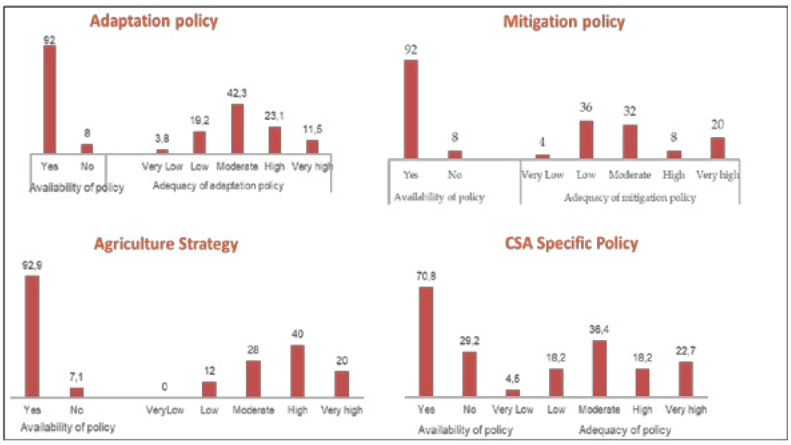


Rating 1 -5 where: 1 = Very Low, 2= Low; 3= Moderate; 4= High; 5= Very high

b) CSA Enabling Environment

Achieving CSA will requires policies, institutions, coordination and support and dissemination of practices and catalyzing innovations. Supportive policies, institutions and financing together create an enabling environment for climate-smart agriculture. To understand the CSA enabling environment we looked at four main policies that affect CSA namely climate adaptation, climate mitigation, agriculture policy and Climate smart specific policy. The findings are summarized in figure 2. Basically, the policies to support CSA are there, however, the adequacy of the policy was rated between low to moderate. The mitigation policy is seen as least adequate and the agriculture policy was rated more adequate than the others. While policies are there, they need strengthening. As we saw policy making are seen as least informed on CSA and this might explain the weakness of policies. This calls for building capacity of policy makers. This can be through training programs, attaching them to other development actors well versed in CSA practices.

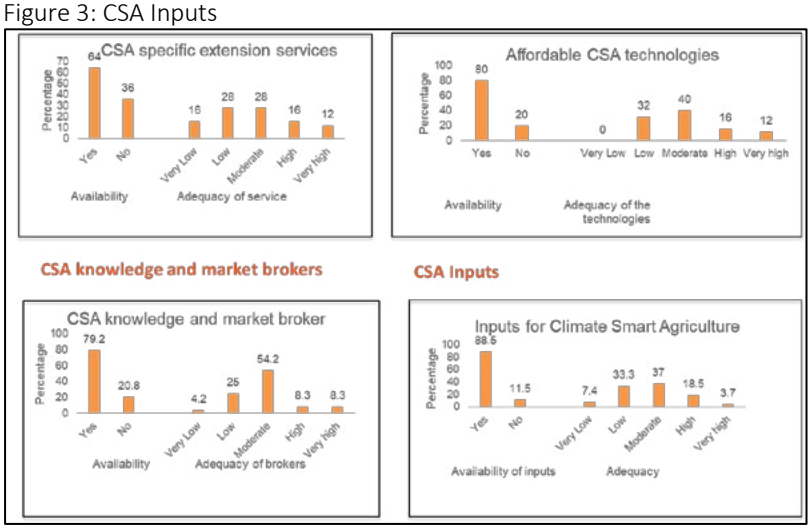
Figure 2: CSA enabling environment



c) CSA Supportive Environment

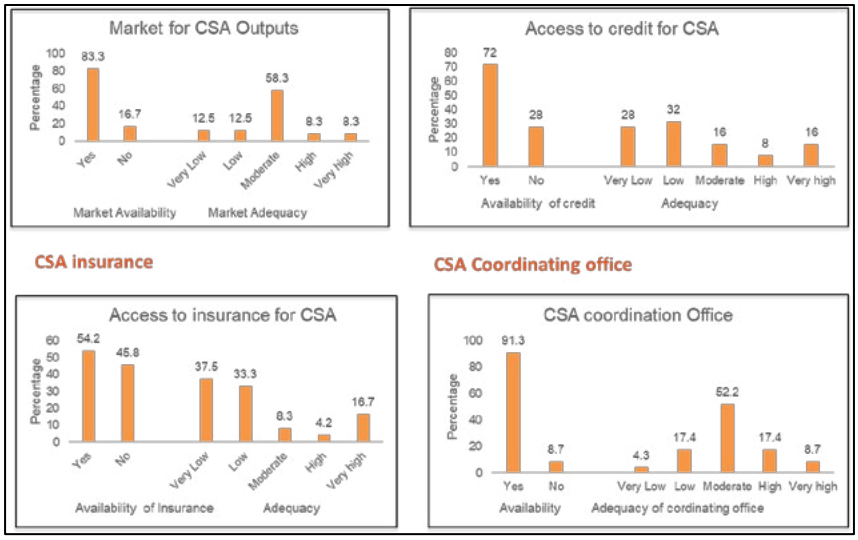
CSA needs inputs and know-how. To understand the status of these key ingredients, we explored CSA extension services, availability of affordable CSA technologies, the availability of knowledge and knowledge brokers, and the inputs specific to CSA practices. The needed inputs were largely available though the extension was somewhat less available. Adequacy however, tended to be mostly moderate, with CSA inputs less adequate than the other inputs.

Figure 3: CSA Inputs



Beyond inputs, supportive services are crucial to supporting uptake. These include access to markets, access to credits, access to insurance and CSA coordinating. The survey found that **s**upport services were generally available; however, the adequacy was low to moderate. Access to financing and insurance was especially rated low.

Figure 4: CSA support services

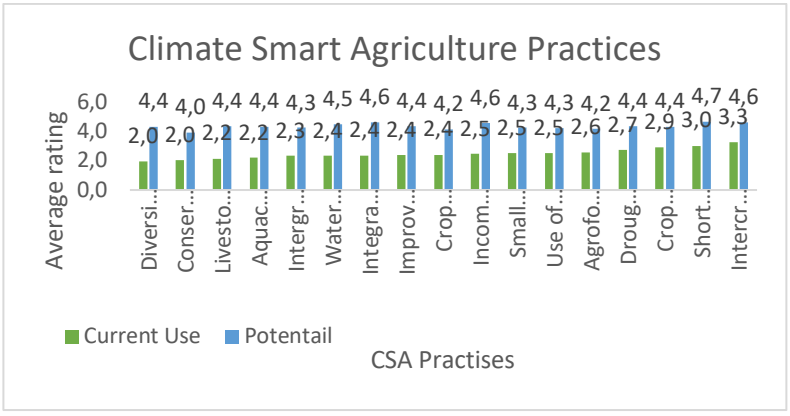


The CSA supportive environment can be strengthened. Access to insurance is particularly key given the risk that climate change has posed in agriculture. Financing is also crucial and has been a challenge to agriculture for a long time due to lack of understanding of the risk by financiers. An approach that combines financing and insurance in one product can help improve the CSA uptake. This will need to be incorporated with greater efforts to increase CSA knowledge to farmers and other actors, including researchers, to increase supply of innovative inputs, financing actors to increase their understanding, and support CSA financial product development. Government and other development actors should also enhance efforts to build extension workers' capacity to boost CSA extension services.

d) Current Practices of CSA

Climate-Smart Agriculture (CSA) encompasses many practices. Given the range of agro-ecological conditions and many diverse livelihoods, we would expect many practices to be implemented. Therefore, we sought to explore the knowledge on a range of CSA practices being implemented to get further insights on CSA knowledge but, more importantly, to understand to what extent the practices are being used to the fullest potential. The widely used CSA practices are intercropping, planting short season crops, crop rotation, and drought-tolerant crops, respectively. The practices of intercropping and planting short-season crops were also among the highest-rated in terms of their potential and integrated soil fertility management (ISFM), income diversification and water efficiency management. There was a significant gap between the current use and potential of the CSA practices, with the biggest gaps seen in conservation agriculture, water efficiency, livestock supplementation and diversification to new energy sources.

Figure 5: CSA practices: Current Use Vs Potential



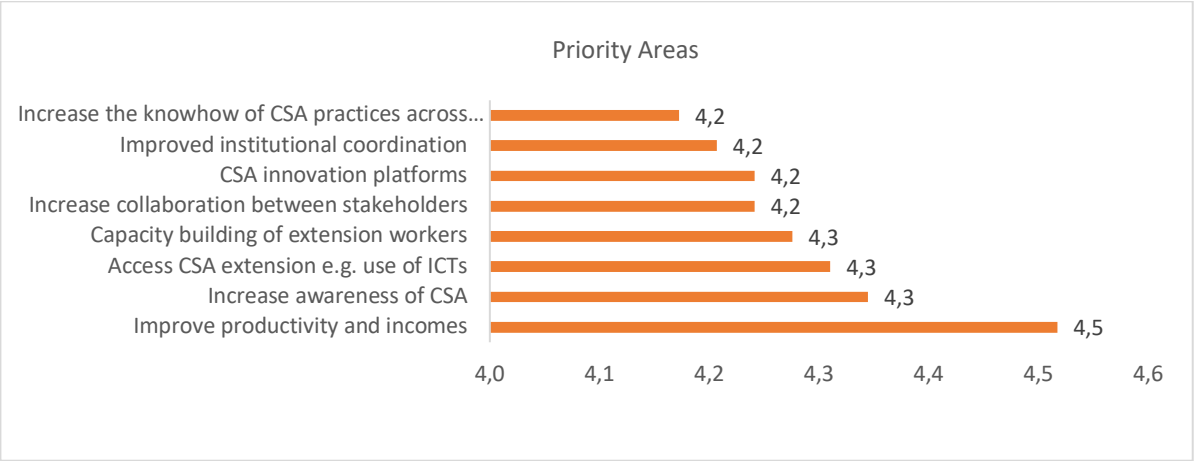
Rating 1 -5 where: 1 = Very Low, 2= Low; 3= Moderate; 4= High; 5= Very high

From the observation, we see that most CSA practices are implemented, underscoring that awareness of CSA is somewhat high. However, in line with the observation earlier, CSA's significant potential is yet to be unlocked, thus reinforcing the previous observation of the need for capacity building and increase supporting services.

e) Prioritizing CSA Actions

While many actions are needed to improve CSA uptake, not all can be taken together, and prioritization is needed. Also, it is important to understand what aspects of CSA stakeholders consider important so that we craft strategies that are more likely to be taken up. From the stakeholder perspectives, their prioritization is shown in figure 6.

Figure 6: Priority actions for CSA



*Rating was done on a scale of 1 -5 where: 1 = Very Low, 2= Low; 3= Moderate; 4= High; 5= Very high

Increasing farmers' incomes and productivity are seen as areas that should be given the highest priority followed by increasing awareness of CSA, a mechanism to help farmers access CSA opportunities. This shows the importance of putting farmer at the center of CSA. Without helping farmers increase incomes, there is no likely uptake. Increased awareness and extension are the first steps in helping to make CSA worthwhile for farmers. Equally important is having the innovations needed for CSA.

f) Innovations

CSA is an evolving area and requires innovative thinking and solutions. To get an insight on the innovation needed to enhance CSA further we asked the stakeholders to list innovations needed. Some of the innovations proposed by the respondents are shown in table 1.

Table 1: Innovations

Innovations Needed
Use of drones to survey soil fertility, water stress, diseases and pests, crop health and enable precision advisory as well as variable-rate fertilization
Use of innovative virtual platforms e.g. eGRANARY to give services to the farmers, such as increase access to financial services (credit and insurance), access to extension and advisory services, access to inputs and output markets, etc.
Breeding for short life cycle crop varieties that suit different environments
Improved seeds, disseminating drought resistant seeds to farmers at lower price.
Rainwater harvesting technologies for ASAL regions
Use of internet apps to forecast/predict possible cases of invasion by certain migratory pests
Farmer-To-Farmer Extension- Farmer Field Schools
Use of crop models such as Decision Support Systems for Agrotechnology Transfer (DSSAT),
Use of meteorological information for decision making and planning and Using ICT to pass weather information on daily bases
Index-based insurance
Micro-insurance targeting crops that have good resilience and have lucrative markets
Linking smallholder farmers with agribusiness firms to increase access to CSA and improve productivity
Biogas technology and usage of manure for fertilization

Catalyzing and scaling CSA innovations will be critical. Subsidizing innovations of CSA inputs (through, say, having an R&D fund to support a CSA innovation platform). A triple helix platform that brings policymakers, academics, and the private sector together to co-create solutions and implement many of the innovations proposed by stakeholders can also help.

Increasing CSA uptake - Way Forward and Conclusion

The case study points to the need for enhancing CSA to capture the potential it offers fully. The significant potential of CSA remains unlocked. This can be attributed to many things, with a lack of adequate policies and a supportive environment being the key culprits. Unlocking the potential of CSA will require a multi-pronged effort that will include:

- Increasing the understanding of what CSA is across stakeholders and especially among the policymakers
- Improving the adequacy of policies needed to support CSA. This will require effective advocacy of the right policies and also building the capacity of policymakers to make the right policies
- Improving supply of CSA inputs. This will require increased awareness, improving the market for CSA products to stimulate farmers to adopt CSA practices. Incentives that could help include subsidizing credit for farmers to help them purchase and enhance the private sector's capacity to supply the needed CSA inputs. Building their capacity and also supporting access to financing can help.
- Improving the supportive services. This will need to build the capacity of value chain actors, especially finance actors, to build CSA target financial products. One way to support this is subsidizing risk so that they can participate and thus improve their understanding of the sector. Over time this understanding will help improve perception of risk and also how the sector works and thus help them innovate product and services targeting CSA
- Building innovation platforms to support CSA will also be key. Effort should be made to help catalyse a localized triple helix platform to support innovations that respond to specific contexts.

CSA promotion and adoption will require concerted action from multiple actors to allow for context-specific approaches to be designed, implemented, and monitored. Ideally, climate-smart technologies should provide the farmers with essential clean air, water, food essential materials, ideally, maintain the ecosystem, should be individualized to the location and be context-specific and importantly, be gender inclusive.

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APPENDIX Climate-Smart Agriculture (CSA) Survey

1. Exploring understanding of CSA

a) Please indicate the sector you are in

Stakeholder	Tick as applies
Policymakers	
Development actors	
Private sector actors	
Academics	

b) Please rate your own understanding and that of other stakeholders of the CSA concept

Stakeholder	Rate (1-5)*	Comment
Self-understanding		
Policymakers		
Development actors		
Private sector actors		
Academics		

*1 = Very Low, 2= Low; 3= Moderate; 4= High; 5= Very high

c) In your own words, please write define what your understanding of CSA is

2. Exploring a CSA-favourable environment

Supportive Policies/Actions	Yes/No	Adequacy* (1-5)	Comment on Gaps
Polices			
Adaptation Policy			
Mitigation Policy			
Agricultural strategy			
CSA specific policy			
Institutions			
CSA coordinating office			
Others			
Supporting Services			
Extension			
CSA specific extension services			
Affordable CSA technology			
CSA Knowledge & Network broker(s)			

*1 = Very Low, 2= Low; 3= Moderate; 4= High; 5= Very high

3. Please indicate the extent of the current use of the following CSA practices and your assessment of the practice's potential. (For MSM project managers indicate if MSM is addressing the practices)

Practice	Current Use (1-5)*	Potential (1-5)*	MSM Active (Y/N)	Comment
Water efficiency Management				
Integrated Soil Fertility Management (ISFM)				
Drought-tolerant seed/cropping				
Short season crops				
Integrated Pest Management				
Intercropping				
Crop Rotation				
Organic inputs				
Crop residue management				
Conservation agriculture/ Low or No-tillage				
Aquaculture				
Agroforestry				
Improved livestock breeds				
Livestock supplementary feeding				
Small livestock, e.g. goats				
Diversification to new energy sources				
Income diversification				

*1 = Very Low, 2= Low; 3= Moderate; 4= High; 5= Very high

4. To increase the uptake of CSA practices, please give your assessment of the importance of the following actions. For MSM project managers, also indicate how the project is addressing the actions

Actions	Priority (1-5)*	MSM Addressing (Y/N)	Comment on key actors needed
Improve productivity and incomes			
Capacity building of extension workers			
Improved institutional coordination			
Increase awareness of CSA			
Increase the knowhow of CSA practices across stakeholders			
A mechanism to help farmers access CSA extension e.g. use of ICTs			
Increase collaboration between stakeholders			
CSA innovation platforms			

*1 = Very Low, 2= Low; 3= Moderate; 4= High; 5= Very high

5. Innovations needed

Please indicate any innovations that you think could support CSA adoption, e.g. use of drones to detect water stress, micro-insurance targeting crops.

6. CSA Initiatives

Please list some of the ongoing CSA initiatives

Initiative	Sponsor	Briefly describe including the CSA practices targeted

The existing and desired agricultural ecosystem for medium size farmers in Kenya

Meine Pieter van Dijk, Maastricht School of Management

Abstract

Medium-size telephone farmers benefit from and have the potential to support a thriving agricultural ecosystem, making use of it, but also by providing agricultural services and modern technology themselves, training their workers and helping them by subcontracting certain activities to smaller farmers and obtain contracts to sell large quantities regularly themselves. This paper analyzes the presence of an ecosystem for medium size farmers based on interviews with 50 medium size farmers and indicates the expectations of these farmers with respect to such a system.

Introduction

The World Bank and the Food and Agriculture Organization of the UN (FAO) estimate that 95 percent of the world's farmers are smallholders. In Africa they are often stuck in a low productivity trap. The challenge is to unlock domestic productivity by spreading the ideas of smart agriculture and the smart use of the most important input, water. We proposed to use certain definitions for smart agriculture and water and pointed at the importance of an agricultural ecosystem, delivering all kind of services to farmers. In this paper we provide examples from our research in Kenya among medium size farmers to show the importance of an emerging ecosystem for the development of smart agriculture and water. The idea is that the ecosystem, developed for medium size farmers, can also be used for unlocking the low productivity of the small holders. Secondly, we identified what medium-size farmers expect from the ecosystem.

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In Kenya the Maastricht School of Management (MSM) did research on the Telephone farmers project financed by the government of the Netherlands (Leenstra, 2014). Telephone farmers are considered as medium size farmers, in between the small-scale, semi-subsistence farmers and large-scale farmers.
MSM executed a project, financed by the Netherlands government, which contributed to building up an ecosystem for farmers in Kenya by supporting telephone farmers. The consortium worked with Latia Resource Centre, an important player in the Kenyan agricultural ecosystem. The Latia Resource Centre (LRC) offers a selected group of telephone farmers guidance in the form of technical, social and business skills (Nijhoff, 2017). The goal was to ensure that both the telephone farmers and their employees are capable of efficiently operating the farm, using smart agriculture ideas. Van Dijk et al. (forthcoming) argue they can be the missing middle and play a role in catalyzing agricultural development in Kenya, if a proper ecosystem develops further.

Theoretical section

The MSM definition of Climate Smart Agriculture and Water (CSA&W) is: 'a combination of inputs and using modern technology, with management of the innovation and a governance structure'. I added that usually different existing (or frugal) technologies are combined and that there should be some management or governance structure for their use. It is clear that an ecosystem is important for CSA&W and hence the question: can we measure the presence of such a system. An index could indicate to what extent Kenya is an example of a developed ecosystem for CSA&W development (compare World Bank (2016) effort to measure CSA&W policies). The following criteria are suggested to use for classifying agriculture as smart agriculture and guide the analysis of the data collected at the farmers level in Kenya. On the basis of all available information the author tried to make an estimate for the score on each criterion.

Box 1 Criteria for the development of an ecosystem as part of smart agriculture in Kenya (total score should be above 70%)

Criterion	Indicators	Expressed need/ Score in your country
1. Use of modern **technology,** for example a. For data collection & analysis b. Improved seeds c. Additional inputs d. Use greenhouses e. Other equipment	A1 Quality of the soil, temperature, humidity, diseases, etc. B1 Use HYV seed/seedlings C1 Use of fertilizer C2 Pesticides & Insecticides D number of greenhouses E Use of other equipment	Desired by many farmers and often used by the medium size telephone farmers (see table 1) Score : 60%
2. **Water** availability & use of irrigation techniques	1 Quantity of water 2 Quality of the water 3 Cost of water supply 4. Irrigation system: tanks 5. Drip irrigation 6. Borehole 7. Other	A big issue, more than half of the farmers interviewed have a possibility to add water (some kind of irrigation) Score: 60%
3. Use of mobile smart **telephone**, for a. extension services b. agricultural dates c. prices of commodities d. payment	Type of phone & provider A1 Yes/no, name? B1 Yes/no, how often? C1 from friends & family C2 from other sources D Payment transactions	By definition telephone farmers use a mobile telephone, a smaller number is using smart phones Score: 60%
4. Use of **radio** or television for a. extension services b. agricultural dates c. price information	A1 Yes/no, name? B1 Yes/no, how often? C1 from friends & family C2 from whatever source	Radio and television are not very relevant, but some basic agricultural information is disseminated Score: 50%
5. A well-functioning **value chain** a. Efforts to upgrade the chain b. Major players c. Linked to the world market	Available traders Possibilities for storing Processing opportunities Adding value/processing Export requirements	Value chains are there but not all farmers have managed to link up to modern chains and benefit from new opportunities to sell their produce Score: 60%
6. Use of external **finance**	A Formal credit B Informal credit C Micro finance: loans, savings, other financial services? D Family & other sources E Crop insurance	External finance plays a very important role for medium size farmers in their success. Score :70%
7. **A** functioning **land market**	Possibility to buy or lease additional agricultural land Possibility to use it for lending	Some buying and leasing, mortgaging land, all takes place Score: 60%
8. Training opportunities	TVET, informal or formal education institutions Acquiring ICT skills Entrepreneurial training, Other important skill/training	Many opportunities, but not yet enough Score: 70%
9. Financial and other private sector **consultants**	Use accounting system Assistance to obtain loan Soil quality services Water detection services Bore holes companies	Many services are available already Score: 65%
10. An **integrated approach** to these issues?	Specialization/diversification Project provides advice Collaboration among farmers Contract farming Certification Organic farming Adding value/processing Export requirements	Latia certainly tried to implement these ideas in an integrated way Score: 60%
Total score on the presence of an ecosystem in Kenya	Calculated as the sum 10 scores between 1-100	Score: 61.5%

Scoring: an estimate by the author of the relative importance of this indicator.

Research questions

Three theoretical issues were addressed in different papers for this seminar:

a. What is a good operational definition of CSA&W, what are the defining characteristics from a business school point of view. This question is dealt with in the Tanzania chapter
b. What can be done at the national or policy level to promote CSA&W, in chapter 8.
c. How can we assess the importance of the ecosystem for medium-size farmers? This is discussed in this paper.

We will also pay attention to the ecosystem desired by these farmers. The main research question is: what does research tell us about the existence of an ecosystem for the development of agriculture in general and for medium scale Telephone farmers in Kenya in particular? The following sub-questions were formulated:

- Which elements of the ecosystem are being used at the farm level?
- Why are medium size farmers successful?
- What do these medium size farmers desire as far as the ecosystem is concerned?

Methodology

We used mixed methods, partially quantitative through a survey of 50 farm owners and managers. However, partially also a qualitative study, because we were interviewing resource persons, key informants and doing a number of in-depth interviews with other stakeholders. We interviewed 20 Telephone farmers, also 20 aspiring farmers (who want to become customers of Latia) and 10 hortimpact farmers, benefiting from training provided by Latia how to run a greenhouse, but financed through another project.

Our population of smart farmers is defined through their relation with Latia. The interviewed farmers are medium size farmers and more open to investment and modernization than the more traditional small farmers in Kenya. They are using external advice and not only from Latia. Below I will analyze the cases indicating which ecosystem services are being used to become a climate smart farmer, based on the definition of the ecosystem given in box 1. In our study farmers had three main activities: horticultural activities, maize farming (but usually trying to diversify), or raising cattle. Some cattle farmers are paying more attention to dairy than meat and go for mixed farming, by growing their own feedstuff.

The evidence on the presence of an ecosystem for medium size farmers in Kenya

The majority of farmers interviewed were men (Limpens et al., 2018). However, there are some interesting exceptions of women making a career in vegetable growing using greenhouses (for example farmer 5a). Another woman owns a mango farm of 70 acres (number 14), and uses water from the river for irrigation. The first women has land close to Nairobi and benefits from a contract with a supermarket. She has a number of greenhouses. The owner of the mango farm is a woman and she works on the certification of her products to facilitate exports to more paying markets. Partially she exports to Middle Eastern markets, partially she exports to Europe. The owner was actively promoting social activities in the nearby village. When calling her later we learned that:

1. Some land is available for the workers to grow some vegetables
2. She has inspired two other people to start a mango plantation in this relatively isolated part of the country
3. They agreed to embark on some collective action, like driving the harvest together to town and trying to find a buyer interested in bigger quantities for more lucrative markets
4. They are also working on the certification process. We took a soil sample with us. Testing it is one of the requirements for certification. Latia helped them with it.
5. They employ local people and introduce notions like quality control and certification.

Their problems are the proper feeding of the trees, crop diseases and water supply (the pipes did not have the right dimensions). They had to invest in a new pump and a building along the river, after the previous pump had been washed away. They are satisfied with the Latia support, in particular the training, the certification and the advice on crop protection.

1. Use of modern technology

The use of modern technology is becoming more and more common. Farm manager (11) discussed the business plan established by Latia with the farm owner to agree on what needs to be done first. He uses a mobile phone to provide daily updates what has happened on the farm. He has a good relation with the farm owner. They trust each other and he would give the relation a ten out of ten. This makes the introduction of CSA&W ideas much easier. According to this farmer the availability of modern seeds and other complementary inputs, irrigation and other agricultural equipment is no problem and many people seem to have the necessary money.

Table 1 summarizes some of the technologies observed during the survey. Often technological consultants are used to identify the needs, but once the farmer has decided, the technology is usually bought very soon.

Table 1 Agricultural technologies observed, sometimes provided by consultants

Mechanical equipment	Electric and electronic equipment
Pump (diesel, solar, or electric) Buying tractors, and Tractor hire services Solar panels for pumping Installation and use of borehole Use of green houses Mechanical drip irrigation Consultants taking soil samples Consultants identifying ground water Egerton university agricultural faculty provides agricultural advise	Two and three phase electricity connection Mobile telephones Internet connection Digital accounting program Mechanized irrigation techniques, ranging from pumping to computer monitored drip irrigation Electric pumping Milking equipment Cooled storage Slaughter house

We have visited some farms which were very traditional, producing maize or livestock for example, however, for many the challenge now is to specialize and find more rewarding activities like horticultural activities, or focusing on dairy products. (10). Other farmers just diversify and produce for example more food crops for their animals. Examples of other types of specialization are growing of onions (in the dessert), mangos (close to a river), tomatoes (in a greenhouse), etc. We also met a farmer who is growing trees (10).
The opposite of specialization is diversification and we often found farmers trying to diversify and move into more rewarding crops in this way (like number 13). Many added animal husbandry to their activity because they had land available and leftovers of their horticulture to feed the animals. Climate smart agriculture in their case means using insemination techniques, buying animal feed and using veterinary services.

Specialization is the real issue for medium size farmers. What are the rewarding activities and what are the strong and weak points of alternative options. Typically, in 2019 going into spices was a big thing. There were also rumors that bamboo would be very lucrative and some farmers wanted to go into multiplication of seedlings for potatoes or other crops. Having a contract to sell the output is very important for the success of a modern medium size farmer and many asked Latia how they could become a contract farmer. However, contract farming requires discipline on both sides. The farmer has to produce a certain quantity and quality and the buyer has to take up the supply and pay the agreed price.

An example of a specialized farm is the seed multiplication farm. The farmer is also working as a contract farmer. Some farmers are real entrepreneurs. Some even go for a master in agro-entrepreneurship and are now looking for activities with higher value added, by adding value to their production. Some farmers are trying to add value by processing their products. Farmer 11 bought equipment to make yogurt and cheese from his milk. In a number of cases we found mixed farming. Farmer number 13 has 40 acres, of which 10 acres are leased. Besides growing onions he has two cows and 30 sheep. Others are starting a dairy farm, requiring the building of stables and a place to store the feed. We interviewed the farm manager of this dairy farm, who is responsible, while the farm owner is a woman living in the capital, but her brother lives nearby and was around the first time we visited the farm. During the second visit in 2018 there was clearly progress, a gradual growth of the number of cows and the production, better organization of sales (the cooperative comes to collect the milk), there were more cows and they reached a higher level of productivity per cow in 2018. They imported second-hand equipment from the Netherlands.

2. Water availability and use

MSM is involved in a number of Climate Smart Agriculture and Water projects, where water is often a crucial input, but a scarce resource. The choice needs to be made between growing more drought resistant crops or supplying irrigation water, using the modern technologies available, ranging from drip irrigation to using hydroponics. Water is often an issue in Kenyan agriculture. Relations between interviewed farmers and their neighbors are not always good. Cattle may invade their land, or other farmers may want to use the water of the modern farmer and steal some of its products (see farmer number 11).

One of the most important problems with the water supply is that the boreholes do not produce enough, while neighboring villages come to claim water from the farmers. Sometimes the borehole does not produce enough

water (14) and some farmers (for example farmer 16) also face water problems, despite dams and a borehole. Since they leased another 10 acres, they need a second borehole. A new borehole would be a considerable investment. The investment may not be economically justified for the quantity of land he is managing. However, it would bring the farm at a different production level (the case of farmer number 2).

Farmer number 2 mentions that the climate is somewhat drier in the southwest of Kenya. It means they suffer less from certain fungus. The price of water from the borehole is OK, compared to for example what he has to pay for a lorry bringing water. However, again there is not enough water. In 2018 we saw several onion fields suffering from water stress (Van Dijk, 2018). Farmer number 4 is also suffering from a water shortage. They need to execute their plans for a borehole with an electric pump more rapidly. However, this requires a three phase connection, which is not yet in place. In a big horticultural farm they used to work with boreholes, but the water ran out and they are now getting it from the river, which does not sound like sustainable. April 2017 they were spending a lot of money on pumping, because the rains were late. The pump works 8 hours a day producing 40.000 liters per hour. They pay the Kenyan government less than 10 K. Sh. per m^3. They also harvest water from the greenhouses and lead it to a big open air reservoir.

Climate change may play a role. One farmer (13) had serious problems with the floods in April 2018. Her pump station next to the river washed away! One farm manager (2a) is considering to give up. Their problem is that the deep well does not produce enough water and so they have to buy expensive water from a tanker. The owner is a woman who works for a nongovernmental organization (NGO) in Nairobi and who does not like to give up. The farm manager is a simple man and his wife lives with him on the farm and she helps him. It is a relatively small farm, where a new borehole would be a considerable investment and may not be economically justified for the quantity of land he is managing. However, it would bring the farm at a different production level.

Number 19 mentions that his solar power pump is no longer sufficient to pump up the necessary water and he has installed a generator for electric pumping. The borehole is 130 meters deep, while he is close to the lake. He stores the water in a reservoir and some of it is available for the neighbors. The meter registers what he has to pay to the government, but some of the water comes up spontaneously and outside the meter.

A horticultural farm near Latia also gets water from a borehole, but the irrigation is partially manual. The well is reclining. Water supply is not a field of expertise of Latia, irrigation is. Currently the farmer can obtain 20 cubic feet per day, but the quantity is less during the dry season.

Number 21's farm is totally depends on drip irrigation, but she has to buy the water because she did invest in a borehole but needs a transformer to pump the water and there is no three pulse electricity yet. There is no water coming out if you use normal pumps. You need a very strong one. She is also not yet certified and she would like to do organic farming, but uses chemicals at the moment. Half her harvest is sold to traders and the other half to grocery shops.

There is clearly the risk of over exploitation of underground water and the current control system is not functioning properly. Many use private companies to dig boreholes and there seems to be limited control (16).

3. Use of mobile telephone

80% of the Kenyans have mobile telephone, while the use of smart phones is up from 18 to 50%. We showed that with technology farmers can solve some of their problems. The problem is that we have not yet fully digitized agriculture to allow Kenyan farmers to fully benefit from existing low-cost technologies, such as smart phones. They would allow farmers to make payments, receive money transfers and get crucial information about traders coming and prices being paid. It becomes easier to order farm inputs and to sell their production. Latia uses the phones to stay in touch with their customers and can send or receive information in this way, if there is no internet connection.

Tingo mobile advertises in the Financial Times (African farming and the world, 22-10-2020) that they support farmers in Nigeria with the latest technology to allow their farms to generate higher yields and reduce post-harvest losses. They put apps on the phones allowing farmers to access information that will help them to unlock productivity. According to the advertisement they can ask for example which areas are more flood prone, or which ones will suffer from drought. We did not find evidence of this technology being used in Kenya.

4. Use of radios and television

Radios and television can be used for simple information like the weather, the prices of agricultural produce and the optimal sowing or harvesting dates. In many countries television is used to provide agricultural extension services. However, in Kenya the use of radio and television for this purpose seems limited.

5. A well-functioning value chain

The Financial Times (African farming and the world, 22-10-2020) notes that fintech and agritech initiatives are jumping on the agro value chains and bring digital services to small holder farmers and their customers, including local traders and processors. Most farmers still sell to traders, who know to find them. However, the more successful ones have managed a contract for continuous supply of a certain quantity and quality during a period of the year. Many see this as the next step and hope organizations like Latia can help them to obtain such contracts (for example farmer number 11) linking them to (inter)national value chains.

Quite a few farmers are active in special value chains like fruits and vegetables for export, or local chains for meat, or diary. However, some are linked to modern local value chains like supplying supermarkets, or food processing units. There is a need to integrate local value chains, in national and international ones. These value chains become increasingly digitized, so we need to ensure they remain inclusive. International players in food chains are more and more aware that their market share depends on fair trade and requires transparency all the way to the producer and consumer level, to assure sustainable production (Van Dijk, 2012).
Some markets for Kenyan agricultural products are in East Africa. In certain years maize from Uganda and Tanzania may hit the Kenyan market and bring the prices down. Other examples are onions and tomatoes from Tanzania, which can make growing them in Kenya not profitable. On farm number 12 the new farm manager complains that there is unexpected competition in horticulture. When he wants to sell his onions or tomatoes, there is often a truck load of onions from Tanzania and the prices collapse. He wonders how they can grow onions for 30 KSh., while they need in Kenya at least 50 KSh. per kilo. The same with the maize from Uganda, some of which was imported fraudulently last year and sold as Kenyan maize to the government for a much higher price. This has to do with comparative and competitive advantages. Also the opposite happens. In Tanzania the only affordable vegetable oil is Kenyan vegetable oil!

6. The use of external finance

Many farmers interviewed used an external source of finance. They may be member of a Sacos (10), (saving associations, popular in the transport sector: the Matoto busses). Some get loans from formal banking institutions (10). One farm owner used to work for a bank and she could get a loan relatively easy (5a). They often borrow from family members.

One female horticultural farmer uses MPesa (mobile telephone paying) for paying for the inputs she uses, which may imply a small loan, but this is not enough. The problem is any way how to repay given the high rates of interest in Kenya. There are agent banks and micro credit institutions but she is not using them. There are also Sacos, but she has not tried them to obtain a loan. Latia can play a more important role by not just helping to make a business plan, but by making CSA-driven plans with linkages to CSA-minded financial institutions.

7. A functioning land market

The problem of modern farmers is not the size of their land. With modern technology and a secure source of water we have seen very small farms (as of one acre) to be able to generate half a million or more shillings per year, using modern greenhouses. However, one needs a piece of land and opportunities to extend the land surface, if necessary that is why a functioning land market is important.
Number 13 leases additional land (10 acres) and now also needs additional water. He considers installing a diesel pump which would allow to grow more vegetables. One farmer leases as much as 150 acres for seed multiplication on top of the 527 acres they own themselves.

We interviewed one farmer who is leasing land and buying water (3a). This is a young, relatively modern and educated horticultural farmer. He needs to calculate carefully, since he is paying for the land and the water. The price of onions is crucial and the problem is that sometimes lorries come from Tanzania with loads of onions sold at 50 or even 35 KSh., which makes his business vulnerable. However, he can store the onions and sell them when the prices are better.

In this case there is not enough water. In 2018 we saw several onion fields suffering from water stress. His income is totally dependent on the price of onions. Furthermore, leasing this land means he is not motivated to

keep up the quality of the soil. The model risks that he will move after two or three years to another piece of land, once he has exhausted the soil.

8. Training opportunities

Skills are extremely important in smart agriculture and most farmers interviewed had a combination of skills, which made them unique. They often followed training courses at Latia introducing CSA&W ideas, or hired trained people, for example as farm managers.
Sometimes the interviewed farmers have problems with their labor. Farmer number 16 mentioned that he is involved in a number of activities, but it is not clear which ones he really spends his time on. They needed additional labor; he has now two permanent workers. These are relatively expensive because of the travelling required (2250 KSh. wage per week and 800 KSh. for daily workers, plus feeding and transport). He mentions the following challenges for the farm:

1. Lack of skilled labor, they are just 'farm hands'
2. Available labor is not business minded, has no commercial approach
3. They are not properly trained, for example no knowledge about soil testing, crop protection, planning the work, etc.

Some farmers are very ambitious and engage in a number of projects. In certain cases this means they are not doing their core business well, while losing time and money on all these projects (for example farmer number 10). One of the problems smart farmers are facing is that many of their trained workers leave, to start their own business, or to earn more on another farm. On the one hand this is a loss for the farmer concerned, but on the other hand, from a national point of view this is how innovation diffusion takes place.

Some farm managers are very specialized. The mango farm employs for example a spraying expert, which is important for the fruits. The relation between the farm owner and manager is not always good. In the case of number 15 the owner works for television is Nairobi and the farm manager complains that he does not get enough clear directions from the owner what to do on the horticultural farm. This was very frustrating in the beginning. He now has a good relationship with the farm owner, although he is only coming a weekend twice a month. The farm owner had two other farm managers before him. The owner expected him to do all the work, but in reality there was too much work just for him. He identified the need for additional labor, but it is hard to get people's attention at this place.

Not all farmers are using the accounting system pushed by Latia (quick book). Sometimes they do not have electricity or internet, sometimes it is just too much work. The introduction of the accounting program Quick book did not go as fast as desired, although it would eventually allow distant management advice for the farm, for example from Latia.

There is clearly a shortage of trained labor for these kinds of modern farms: staff knowing what to spray, how much and when to irrigate and when to weed. Latia has helped many medium size farmers with a cropping plan, including planting schedules (10). They also trained farm owners, farm managers and farm workers. They expressed the following needs:

1. Plant protection material
2. Propagation/multiplication
3. Use of a business plan
4. Skilled farm managers
5. Use the digital accounting system
6. Develop ICT skills &
7. Entrepreneurial skills and
8. Other important skill/training

9. Financial and other private sector consultants

All of the interviewed farmers received advise from Latia, however some get advice from other sources as well, for example a pool of consultants of the Egerton university agricultural faculty. During our first visit one of the cows had an infection producing spoilt milk. The farm manager called a guy on a motor bike providing veterinary services. He gave an injection. He used to work for the public extension services, but had gone private. It had cost 2000 KSh. (2 dollar). They have plans for 2019 to process the milk and sell in Nairobi.
Internet requires electricity, which is not everywhere available (10). Farmer number 12 can get new knowledge in different ways. On internet he found how to do silage with sorghum rather than with maize to improve the

nutritious content of the animal feed. He wants to know how to export capsicum (red peppers or paprika). We explain that for export you need standard quality, sufficient numbers and regular supply. Red peppers are often cut and put in bottles for the European market.

Some farmers ask independent firms to do a soil study (10 & 11), to help them to find water (several examples) or to identify plant or animal diseases. Farmer number 16 used a company to drill a bore hole for his farm. Farmer 11 found out that for the fertility of the soil he needs fertilizer, but also additional gypsum is required to produce more. Technical advice can help to put a brake on soil depletion and these services are available in the private sector in Kenya.

10. An integrated approach to these issues?

Donors, government organizations and Latia all advocate an integrated approach to climate smart agriculture and water and consider ecosystem development as part of it. In practice there is not one party leading the process of developing the agro ecosystem, but rather a lot of initiatives which together have the expected result.

We conclude that access to the ecosystem for the farmers is important and Latia helps by organizing training sessions or seminars, planning field visits and visits to Latia headquarters. However, the telephone and internet also allows farmers to ask questions and even makes management from a distance possible as Latia is currently doing in the case of one farm. Latia should focus their business model on medium size farmers who have the potential to benefit from CSA&W ideas.

Latia has helped to develop an ecosystem for modern Kenyan farmers and more and more supporting services are available, as long as you are willing to pay for it. Latia has also been quite successful in recruiting farm managers for telephone farmers. They have developed a market for dynamic specialists! Telephone farmers may have the capital to develop their farms; they do not have the required skills and usually not the data base to recruit a farm manager. Modern farmers can choose such a farm manager and draw up a contract specifying the responsibilities and incentives. Finally, Latia may refer their customers to other players in the ecosystem.

Research question 1

Which elements of the ecosystem are found at the farm level?

Medium size farmers are eager to benefit from available technological opportunities. Telephone farmers are more prone to have training and get access to new technologies. They learned from Latia and other actors in the ecosystem to produce different products, which link them up to value chains and may generate foreign exchange allowing Kenya to buy cheap grain products in the world market to deal with food security.
Medium size farmers also train their farm workers to use more modern methods of cultivation and through this and subcontracting they become part of the ecosystem. The combination of elements makes the ecosystem tick and contributes to CSA&W use. The research showed:

- Many farmers use ***mobile phones*** to transfer money and pay taxes and instruct farm managers
- New forms of finance are available, even ***agency banking***: shopkeeper knowing people collects savings and provides loans, on behalf of a bank to which it is connected through internet
- The emerging ecosystem helps farmers with access to markets, supported telephone farmers are for example more often involved in ***contract farming*** than the prospective and hortimpact farmers group
- Being a successful agro-entrepreneur is not a part-time job, when doing investments one has to be there, to be sure things go right, unless you have a very ***good farm manager***, while using modern technology to monitor her

Contract farming has become very important. The telephone farmers often have a contract with an exporting firm or a food processing firm and want similar relations with the small farmers around them. The impression is that the approach is effective (the production and productivity of the farmers increases). The importance of out contracting out should not be underestimated. Contract farming can be repeated between the medium size farmers and the smaller local farmers, which increases the positive impact of the project. Latia can play a role of bringing together different groups. It should look into the contracting potential of the farms and through contracting focusing on medium size farmers one can still reach the smaller farmers by outsourcing. The visit of the original 17 telephone farmers to the Netherlands was a good opportunity for more knowledge exchange between them and with international value chain operators.

Some farmers advise other farmers to apply what they have learned in the framework of this project. One trains small farmers and buys their pigs; others buy potatoes or vegetables from small scale farmers, who learn from them while working for them. Medium size farmers have become part of the ecosystem.

Research question 2
Which factors determine the success of medium size farmers?

Success factors are: being on the farm regularly, having a good farm manager, being entrepreneurial, being sure to sell the harvest at a reasonable price, etc. Part-time farmers are not always a success, because they cannot devote enough time to their business and so far farm managers were not always reliable. Quite a number of medium size farmers have realized this and have chosen to live on the farm, which usually means a more limited role for the farm manager! Undertaking too many activities makes it difficult to turn them into profitable production lines. There is currently a wave of young, well trained farm managers, who are happy to start, but eventually want to share in the results.

The original 17 telephone farmers have been treated in a very luxury way because they did not have to pay for the services provided by Latia. Now they think that is normal. Some of the paying customers of Latia are jealous about it and also do not pay because they think it is all development cooperation. Other success factors are:

- A contract for selling their products, and outsourcing production if they do not produce enough
- The availability of enough water
- Well managed green houses
- Find niche market and deliver quality products
- Taking the market as point of departure for production decisions
- Using the emerging ecosystem!

According to the research good farm managers are an asset for these farms and should have the following qualities (formulated by farmer number 11):

1. Qualified for the job (having the agricultural skills)
2. Good relationship with the farm owner
3. Good at book keeping
4. Good relation with the market
5. A good relation with the neighboring villages, some develop Corporate Social Responsibility (CSR) type of activities, such as sponsoring a primary school (17)
6. Score on the indicators for sustainability that were included in the questionnaire.

Research question 3
What do these medium size farmers desire as far as the ecosystem is concerned?

What kind of support do medium size farmers get and what do they want? Farmer number 11 states that the priority services for his farm are:

1. Marketing assistance, they have no contract with a buyer
2. An updated Business Plan
3. Training, but some people trained have left the farm
4. Soil tests

They also mentioned:

- GVC development, value addition
- Help with contracts in legal terms
- Arrange for financing
- Deal with water & animal diseases
- Breeding & artificial insemination
- Certification & logistical issues
- Advanced computer programs
- Standards for export, supermarkets
- Advice on different technologies to be used for modernization
- Tractor hire services

Others express the need for more water, skilled labor, training for spraying against diseases, modern plant growing techniques, fodder management, dealing with health issues, certification and increasing their efficiency. The feedback concerning Latia's interventions is generally positive:

a. Information is crucial and should be available in different ways
b. Training is practical and hands-on
c. It is specialized
d. It helps to build up a network
e. The training for farm managers is good
f. The coaching visits are very useful

Weak points mentioned are:
a. The courses are given far away at headquarters of Latia in Isunya
b. They are sometimes expensive
c. They are not given all year through
d. Broaden the scope of certain courses, make them all-rounder, instead of spraying specialists
e. Certification takes a long time
f. Sometimes the training takes too much time
g. The relations with market parties are not always successful
h. Sometimes the BP is not about the right product and implementation may be difficult
i. The software assumes electricity and internet
j. After signing the agreement there is not always a good follow up to implement the agreed ideas

Concerning the other actors, the seed companies do a good job, the firms selling chemicals often do not provide good information, you can get a bore hole, although they tend to be expensive, the road infrastructure is improving. For the development of competitiveness a well-functioning ecosystem organizations like Latia are a necessary, but not a sufficient condition. Next to the availability of agri-entrepreneurship it is important to have positive policies in place, which stimulate the modernization of the agricultural sector in Kenya.

Theoretical conclusions

Kenya needs a dynamic agricultural sector to produce surpluses for the market and the Telephone farmers' project has supported development of an agricultural ecosystem. Now this emerging ecosystem plays an important role in Kenya's agricultural development. It is Triple Helix, where in Latia Resource Centre, governments, NGOs and the private sector work together. The ecosystem development process is largely spontaneous and should be catalyzed and not taken over by a donor or government institution.
A total score could be calculated for the indicators in box 1, by estimating the importance on a range of 1 & 100, but the macro economic environment is also important. Maize farming is for example not considered very lucrative given the role of the government, which may pay a fixed price but often pays very late. Its production may be very important from the food security point of view, but would require other incentives.
The framework given in box 1 can be used to give an impression of the presence of elements of the ecosystem. There are two big problems, however:
- the scoring is a problem we have not yet solved: should it be through observation or measurement, or should we use the opinion of experts or farmers? There is a need to continue the research in this respect.
- the ecosystem is not available everywhere in Kenya and hence the data have a different meaning at different levels: the national policy level, where the World Bank tried to measure it, the meso ecosystem level, which could be measured by asking stakeholders about the ecosystem and at the farmer's micro level, where we did our observations.

Conclusions on food security

Water supply is a constant problem at the farm level and an environmental issue at the regional and national level in Kenya. Food security based on maize produced by small farmers is not going to do the trick in Kenya. According to an article in the Daily Nation maize production has declined during the past years despite all the efforts made by the government. A big maize telephone farmer explained that the government is killing the maize market because they only paid last year's harvest at the end of 2018 and at a too low a price. He is going to sell to private traders this year, even if they pay a lower price! Furthermore, people misused the system by buying maize cheap in Uganda and selling it at the official Kenyan price to the Kenyan government. This meant that in 2017 the money available for buying maize was finished before all Kenyan maize had been bought up.
In the framework of this project farmers learned to produce different products which generate foreign exchange allowing Kenya to buy cheap grain products in the world market to assure food security. Also the modern medium size farmers train their farm workers more modern methods of cultivation, which they may also use for their small plots, contributing indirectly to food security.

Conclusions about Latia's approach

Services provided by Latia need to be focused, to be effective. Latia is doing a good job when preparing business plans, providing advice and training, when visiting the farms and writing reports on what needs to happen next, or when they function as a broker for the medium size modern farmers. The focus is on improving farm management practices and helping the farmers to find a sales outlet. Latia's activities have also helped to develop an ecosystem for Kenyan farmers: more and more supporting services are available, as long as you are willing to pay for it. Latia wants to become more commercial, but they will have a hard time to become a financially viable and sustainable institution.

However, the impression is also that the project has tried too many different interventions. Sometimes there is not enough focus on implementing one of these suggestions (the Business plan, the marketing plan, the crop plan, the planting plan, the dairy development plan, etc.).
From this project we learned that it took time to gain the confidence of the original 17 farmers and now they feel privileged and not willing to give up their favorable position of receiving assistance without having to pay for Latia's services. Latia now employs someone to see to it that farmers pay, however this is not easy. A system of subscribing to Latia services and to pay in advance may be better.

The Latia Foundation is supposed to generate more funds for LBS, but has not been very successful in 2018 in acquiring new externally financed projects. LBS may have to continue with the serious 70 (minus the original 17 customers who ar not willing to pay), who came to Latia for support and are willing to pay for specific services. A quick calculation shows they need ten new customers per month to pay the 1 million KSH plus in salaries each month. The 53 new paying clients during the last year, who often have bills still of previous years to pay, are not enough to sustain the ongoing operations.
For the future it is important to have a clear business model for Latia Business Solutions, taking into account their strong points (crop and dairy advise for example) and weak points (advice on the use of water resources for example). An emerging business support system is available for all farmers, in Kenya. What is new is that this is no longer the traditional extension system, which used to be geared towards the smaller farmers, but has been generally considered ineffective.

The LRC has become one of the players in the eco system, providing a number of services. The telephone farmers' project has supported the development of such an eco-system in different ways:

a. It developed a support system for modern medium size farmers, introducing new forms of support which hardly existed in Kenya (such as a market for farm managers)
b. Latia has taken the role of a broker by connecting farmers to relevant parties if LBS cannot provide the service itself (for example connecting farmers to banks, soil testing organizations and agro-industries)
c. A number of their former employees started their own companies for providing that type of support

Table 2 Strong claims for Latia versus what to leave to other players in the eco system

Strong claims to become a CSA&W supportive ecosystem	Important CSA&W support services delivered by other ecosystem stakeholders
1. As an intermediary which can put the farmers in touch with others 2. Providing management advise and common services 3. Providing crop related advise 4. Providing advise concerning dairy and animal husbandry 5. Human resources development or hiring of staff and management 6. Providing farmers with a good accounting system 7. To advise on greenhouses and the necessary irrigation layouts 8. Training and coaching 9. Providing common services (see below) 10. Feasibility studies 11. Helping farmers to come to scale 12. Setting standards for depreciation 13. Contacts with commercial parties 14. Developing a bonus system for farm managers 15. Managing farms through internet using Quick book	1. If the marketing channels need to be developed further (GVC development) 2. If a contract needs to be established in legal terms 3. To arrange for financing 4. To deal with water supply issues 5. Animal diseases 6. Breeding and artificial insemination 7. Certification 8. Logistical issues 9. Advanced computer programs & skills for complete climate control and growing plants by supplying the nutrients 10. Dealing with standards for exports, supermarkets and food processing 11. Value addition activities 12. Advice on different technologies to be used in the modernization process 13. Tractor hire services

Source Van Dijk (2017)

We suggested selecting a limited number of core activities. Latia has strong claims to intervene in some areas, but others may be better in other fields. Table 2 suggests that Latia needs to think in a systematic way on which interventions it should focus in the future. The table gives some suggestions where Latia seems to be strong and should have capacity and where it may leave certain activities to other players in the ecosystem in Kenya. Latia could play a more important role in spreading the CSA&W ideas mentioned in the first column of table 2. Farmers can benefit for example from common services such as buying inputs together or marketing certain products collectively. Latia could provide such collective services: access to financial partners, to land, insurances, marketing efforts, processing, transport or water and energy, shared equipment, storage and sales efforts. Buying inputs collectively (seeds, fertilizers, pesticides and insecticides) is relatively easy, although distribution over the country may be a problem.

Latia may help farmers to design a system of bonuses, to allow farmer managers to receive incentives to farm better. This is typically something that could be developed collectively and used by individual farm owners, facing the same issue of motivating their farm manager.

The distinction between the original 17 and the 53 'paying' clients of Latia is a pity. The original 17 telephone farmers never had to pay in the past and do not want to pay in the future, while the aspiring customers will only pay if they think it is worth doing so. They may also go for other service providers.

Some suggestions can be made concerning the fee structure of LBS. It could be based on the number of hours, but this would make the support very costly for the farmers living far away. Latia could also go for a certain percentage of the additional turnover achieved after its intervention. A profit-sharing formula (percentage of turnover, of profit, of cost reduced, etc.), is an alternative for the fee per consult. Latia already asks for a management fee if the whole farm is managed. This can still be combined with specific service fees.

Conclusions

CSA&W is crucial for increasing food production and for achieving Kenya's agricultural export potential. There is an ecosystem for modernizing farmers developing in Kenya. All kinds of support activities are available, ranging from government extension services to private sector advice on how to keep records for a medium size farm. Latia has become a service center for the middle size modern farmers in the agricultural sector of Kenya. There are however other suppliers of services and there are competitors. One finds traditional development cooperation activities, focusing on the poorest farmers, However, also support is given through agro-processing companies, for example a potatoes processing plant encouraging farmers to supply a certain type and quality of potatoes. We observed that even medium size farmers have become part of the ecosystem, which is a positive development for Kenya's agriculture.

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V Conclusions

Climate smart agriculture & Water efficiency in agriculture in MSM projects: final observations

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Abstract

The final chapter brings together some insights from the case studies of climate smart agriculture & water (CSA&W) in different countries presented during the MSM research seminar. We review the definitions of CSA&W and argue that different disciplines (agronomy, agricultural economics and management science) are relevant, but have different definitions and that CSA&W has a different meaning at different levels. We distinguish the macro (national), the meso (the level of the ecosystem) and the micro level of the farmers. Examples of each discipline and each level are provided to draw four conclusions:

1. CSA&W has a different meaning in different disciplines and at the macro, meso and micro level. The common element is that CSA&W has a signaling function, drawing attention to the technology that can modernize agricultural production
2. A Business school has its own contribution to make to the CSA&W debate
3. As MSM, we looked at one type of governance in CSA&W interventions in particular, the use of partnerships to introduce and exploit innovation
4. An index developed in the previous chapter for CSA&W or the presence of an ecosystem is sensitive to the indicators chosen and the method used to come up with a score.

Introduction

This chapter discusses some of the issues that came up during the presentation of the case studies of climate smart agriculture & water (CSA&W) in different countries during the seminar at MSM on March 25, 2021. The projects are usually financed by the Nuffic, the simple (but not exhaustive) definition of CSA&W is 'Interventions in agriculture that want to develop the most effective crop rotation systems, through policies, infrastructure and training'. In this final chapter we first look back why it was useful to bring together the experiences with promoting CSA in about 15 countries in Africa and the Mena region. Then we review the definitions used to conclude that CSA&W has a signaling function, it points to an important phenomenon, a way of looking at agricultural development from a technological opportunities point of view, according to specialists trained in different disciplines. From a researchers' point a view we can ask the following question after this seminar, which will be discussed in this chapter:

1. Is there one definition of CSA&W, given different disciplines put the emphasis differently in the case of defining and promoting CSA&W?
2. What are the major issues to be studied?
3. What is the contribution of a business school to this topic, which is usually discussed by agronomists, veterinarians and agro-economists?
4. Can we develop an index with a score for the progress with implementing CSA&W ideas in different countries, or for the development of an ecosystem?

After discussing these topics we review what we have learned from the 15 contributions to our seminar and draw some conclusions.

Why pull together our experiences with CSA&W?

MSM has initiated this event and you may ask why did you pull together your experiences with CSA&W? As a business school, involved in a large number of agricultural development projects in the Global South, we noticed that many project documents want us to document our experiences. Secondly, we are often doing the same things, developing for example certain learning outputs, but then we can learn from each other if we have a good picture what the others are doing in the field of CSA&W. Finally, we want to learn from project and research done and create a body of knowledge and track record around the management niche of CSA for future work and we hoped to promote some reflection upon our work: is this the way to support the agricultural development processes in these countries?

What is the definition of CSA&W? Technical, policy oriented or in terms of objectives?

In Van Dijk et al. (2020) three definitions of CSA were provided. First the one coined by agronomists: Precision agriculture, Smart Farming, or Conservation agriculture, means that crops (or animals) get precisely the

treatment they require, determined with great accuracy thanks to the latest technology, success is based on using precise and water-smart technologies. According to the FAO, CSA is an approach "that helps to guide actions needed to transform and reorient agricultural systems to effectively support development and ensure food security in a changing climate"

Finally, CSA can be defined by its aims, namely to tackle three main objectives:
1. increasing agricultural productivity and incomes in a sustainable way,
2. adapting and building resilience of the production systems to climate change; and
3. reducing and/or removing greenhouse gas emissions, where possible

Another approach would be to come up with an operational definition for CSA&W. This has been tried in the chapter on crop insurance in Tanzania (Van Dijk, 2021c). After showing that CSA&W is defined differently in different disciplines and at different levels (macro, meso and micro, see table 1), we conclude that CSA&W has a signaling function. It points to an important phenomenon, a way of looking at agricultural development from a technological opportunities point of view and specifies what needs to be done to achieve certain goals. Let us start with the questions CSA&W raises from a researchers point of view.

1. Different disciplines emphasize other aspects and use different theoretical frameworks
We have provided three definitions of CSA (Van Dijk et al. 2021), the FAO definition, the one used by agronomists and the one specifying three goals. All three are quite general, hence our effort to come up with an operational definition of the CSA&W concept (table 1 in the chapter on Tanzania). The definitions mentioned emphasize the following objectives: 19,75 mm
- Increasing productivity
- Achieving food security
- Taking climate change into account by becoming more resilient
- Achieving sustainable development

The agronomist emphasizes the need to be precise in creating the optimal conditions for the plant or an animal to grow (precision agriculture), or they call it being smart (the optimum should also be the best combination in economic terms), or conservation agriculture (defined as a farming system that can prevent losses of arable land while regenerating degraded lands; it promotes maintenance of a permanent soil cover, minimum soil disturbance, and diversification of plant species)

For the operational definition we suggested that management science can contribute to agriculture because:
- CSA&W is often using a combination of different and sometimes frugal innovations, and the success is the combination of these existing technologies and its management
- Innovation management in the rural areas is required
- Developing governance structures to promote the institutional sustainability of agricultural innovations is desirable for the success of the initiatives

The following table summarizes theoretical frameworks used by different disciplines at different levels: the national, the meso and the level of the farmers. In table 2 we will put the papers presented in these different categories, to put them in a perspective.

Table 1 Theoretical frameworks used by different disciplines at different levels

Discipline/level	Macro level, national policies	Meso ecosystem level	Micro level of the farmer
Agronomy	Agricultural technology development policies	Availability of inputs and their level of use (agronomic theories)	Theories concerning the effects of extension services
Agricultural economics	Role of incentives & taxes (Dubner & Levitt, 2008) Landscape approach	The economics of growing crops and animal raising	Economic behavior of farmers, optimal use of inputs
Business school	Policy impact analysis Technology management & Triple Helix approach	Governance theories, the role of finance in ecosystem theories	Innovation management & functioning partnerships

In the table we distinguish the three major disciplines working on this topic and the macro level of the national policies with respect to CSA&W, the meso level of the sector and markets and the ecosystem and the microlevel of the farmers. One consequence of this subdivision is that the defining characteristics of CSA&W could be different at these different levels and hence the impact of CSA&W policies, incentives and taxes would need to take into account the disciplinary background and level that one want to reach.

Different themes were discussed in the contributions to the seminar, ranging from growing crops in the dessert in Egypt to upgrading horticulture in Kenya. The papers can be ordered in terms of disciplines and level in table 2, following the definition suggested in table 1.

Table 2 Contributions of the papers in terms of discipline and at the different levels

Discipline/level	Macro	Meso	Micro
Agronomy	Farouk (2021) on Egypt and Murene (2021)	Martens (2021) on Georgia	Alam (2021) on growing beans in the dessert
Agricultural economics	Martens (2021) and Van Dijk (2021c on Tanzania and 2021a on Georgia)	Shaibu (2021) on Ghana and Van Dijk (2021b) on Kenya	Kariuki's presentation on indicators for CSA&W
Business school	De Boer (2021), Dellevoet et al. (2021) and Van Dijk (2021a)	Nijhoff et al. (2021), Limpens (2021)	Van Dijk(2021c) on crop insurance in Tanzania

The macro level: the link between Smart agriculture & Triple Helix innovation

CSA collaborations aims at being funded by the same partners, as well as mobilizing additional funding from external sources brought in through this partnership. In CSA, collaboration at planning and implementation level preferably includes Industry, institutions, commodity organizations, private companies, and Government. It is these forms of collaboration and partnership building, including through a Triple helix approach (government, private sector and academia), where MSM can contribute to the overall research on success and failure factors of CSA&W strategies.

The meso level, the role of the agricultural eco-system

We defined smart agriculture in terms of using of modern technology. The chances to make this a success at the farm level depend very much on the eco-system, as we learned in Kenya with the Latia Resource Centre. Such a system can be defined as the total of available agriculture-related services and services suppliers.
The importance of the eco system was assessed in the chapter on Kenya (Van Dijk, 2021b) and in the paper on ecosystem needs (Nijhoff et al. 2021). Julius Kariuki and Van Dijk separately tried to identify a list of indicators for the definition of CSA&W and for the presence of an ecosystem and tried you to come up with a score: what is important for CSA&W and the ecosystem services available and do they play a role in the agricultural modernisation process? Other examples of the macro level were the technology or innovation management practices, playing an important role are in the Tanzania paper (Van Dijk, 2021c) and the importance of climate change for Egypt (Farouk, 2021).

The importance of a governance structure, for example in the form of a Triple Helix structure also came up in several papers. Finally, the importance of policies was shown in the Georgia papers.

The micro level: what does CSA&W mean for the farmers?

What is the definition and how does CSA&W look in practice? Examples of this were given in the chapters on CSA in Ghana, the one on growing beans in the dessert (Alam, 2021) and chapter 9 on introducing hybrid maize with a crop insurance in Tanzania (Van Dijk, 2021c).

2. What are some of the major issues to be studied?

Very different themes have been presented during the seminar, ranging from the effects of climate change desert in Egypt to upgrading the maize production in Tanzania by introducing hybrid maize. The Telephone Farmers project in Kenya brought out dilemmas like

- Do we go for small, medium or large-scale farmers?
- Are Telephone farmers smart farmers
- What is the role of an appropriate eco system for farm development?
- Do we support food security via local food production or production of more rewarding products for export?

3. What is special for a business school like MSM in this field?

Asa Business school, we are interested in non-technical success factors of introducing and operating CSA at farm level:

- This requires the ***management of innovation***
- A drive to reach ***optimum cost-benefit relation*** in production methods and
- An ability to build ***governance structures*** is important

A Business school has its own contribution to make to the CSA&W debate. We have shown that managers formulate the issues in terms of innovation management (or change management or transition management). Managers look at the process and create governance structures to use the existing innovations in a more sustainable way. They formulate the issues in terms of innovation management (or change management or transition management), which points to the needs to manage the process and to create governance structures to make the innovations sustainable.

Finally, a business school underlines the importance of the economics of CSA&W and stresses that one needs to be an entrepreneur to see the opportunities and make a profit from the smart combination of available (frugal) innovations. We also look at the economics of CSA&W and stresses that one needs to be an entrepreneur to see the opportunities and make a profit from the smart combination of available (frugal) innovations. At MSM, we looked at one type of governance in CSA&W interventions in particular, the use of partnerships to introduce and exploit innovation.

However, other parts of the Business school curriculum are important, for example entrepreneurship development, managing partnerships and Business schools are used to providing on the job training and to do research into the specific factors explaining success in a given country and sector.

4. Can we develop a score for the degree of CSA&W in different countries, or the development of an ecosystem?

Kariuki and Munene in chapter 10 used a survey to find out what people know about CSA&W, while in chapter 12 Van Dijk tried through an index to measure to what extent Kenya has developed an ecosystem for CSA&W development. The World Bank (2016) makes an inventory of relevant policies and scores a number of countries to what extent they promote CSA&W.

Van Dijk's Kenya paper used ten criteria and a number of sub-criteria for classifying whether farmers were using the ecosystem. These criteria guided the analysis of the data collected at the farmers level in Kenya. The research question was: How can we assess the importance of the ecosystem for medium size farmers and the answer was: we can determine a score, but what does it mean exactly?

There are two unsolved problems: which indicators to use and how to score them and secondly the indicators may have a different score at the national, the regional and the local level. Three methods for scoring were suggested: through observation, or by measurement, or by using the opinion of the stakeholders. Then of course the question is raised who are the stakeholders: the experts, the participants in the value chain or farmers? It is found that the ecosystem is not developed everywhere in Kenya and hence the data have a different meaning at different levels: the national policy level, where the World Bank tried to measure it, the meso ecosystem level, which could be measured by asking stakeholders about the ecosystem and at the farmer's micro level, where Van Dijk made his observations, using surveys and interviews at the farmers' level. The conclusion is that the index measures what you want it to measure, and the score depends on the way you score. Overall scores are only interesting if they can be compared with other cases or over time.

Conclusions

Different disciplines (agronomy, agricultural economics and management science have different definitions of CSA&W and that CSA&W has a different meaning at different levels. We distinguished the macro (national), the meso (the level of the ecosystem) and the micro level of the farmers. Examples of each discipline were provided and we showed that at each level the terminology has a different meaning. This leads to the conclusion that the common element in all definitions is that CSA&W has a signaling function. It is drawing attention to the role of modern technology in agricultural development. Technology can help to modernize agricultural production and increase productivity, but it needs to be managed properly and to be embedded in a governance structure. MSM wants to contribute to this!

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