Technical Paper

on

Strategies and Modalities for Scaling Up Implementation of Best Practices, Innovations, Technologies to Increase Resilience and Sustainable Production in Agricultural Systems in Africa

May 2020

EXECUTIVE SUMMARY

Agriculture is the largest productive sector in Africa contributing to 20-25% of the overall GDP, employing between 60 and 70% of the total labour force and a source of up to 50-70% of household incomes. Most of Africa's food is produced under rain-fed by smallholder farmers who occupy 80% of the continent's farms which however generate less than 10% of the global agricultural output. To meet the food deficit, the continent imported food worth US$ 35.4 billion in 2015, a figure projected to rise to US$ 111 billion in 2025. Despite significant idle potential that could be harnessed to produce more food, various barriers have stood in the way of achieving this goal. These include climate variability, failure to adopt and scale up proven farming technologies and practices, overused and degraded soils, poor extension services to the farmers and low commercialization of agriculture. However, food production in sub-Saharan Africa (SSA) needs to increase by 60 percent by 2030 and by 80% by 2050 to feed the growing population then. Global warming trends are already evident across the continent and the rising temperatures will amplify the existing wide-spread water stress, put further pressure on Africa's agricultural systems which are already struggling. The climate the effects will not be universally felt, as climate change will affect farmers differently depending on their gender, geography among others. Different agricultural systems will also be affected in different ways and adaptation to these impacts will need to be context-specific. To sustainably achieve the increasing food security demands across the varying climate change scenarios overlaying the multiple farming systems on the continent in the short to medium term, it will be useful to support smallholder farmers to adopt and scale up proven technologies, innovations and best-practices that have potential to deliver inclusive and climate resilient food production at scale.

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List of Acronyms

CCAFs	-	Climate Change, Agriculture and Food Security
CO_2	-	Carbon Dioxide
FAO	-	United Nations Food and Agriculture Organization
FIES	-	Food Insecurity Experience Scale
GCMs	-	General Circulation Models
IFAD	-	United Nations International Fund for Agricultural Development
IPCC	-	Intergovernmental Panel on Climate Change
IUCN	-	International Union for Conservation of Nature
LGP	-	Length of Growing Period
NRM	-	Natural Resource Management
OECD	-	Organization for Economic Co-operation and Development
SLM	-	Sustainable Land Management
SRCCL	-	Special Report on Climate Change and Land
SSA	-	Sub Saharan Africa
SWM	-	Sustainable Watershed Management
USAID	-	United States Agency for International Development.

1.0 INTRODUCTION

1.1 Background

Agriculture is the largest productive sector in Africa employing between 60 and 70% of the total labour force as well as being a source of up to 50-70% of household incomes[1]. The smallholder farmers produce over 80% of the food produced under rainfed. Women play a critical role accounting for 50-60% of the total workforce. Overall, the agriculture sector contributes about 20 - 25% of the overall GDP of the continent (AfDB, 2016). Livestock production accounts for about 30% of the gross value of agricultural production, with 92% of that coming from the production of beef and dairy cattle, goats, sheep and chickens (IFAD, 2009). Pastoralism is practiced in more than 75% of African countries by between 200 and 500 million people, including nomadic communities, transhumant herders and agro-pastoralists (Mbow *et al.*, 2019). The sector's growth since 2000 is mainly due to expansion of agricultural land (World Bank, 2013). This could be attributed to a number of factors. These include: (a) failure to scale up and out the various proven technologies, innovations and best practices; (b) failure to embed agricultural innovation within local socio-ecological structures and practices; (c) political instability in some regions; (d) unclear profitability of innovation to end-users; (e) lack of participation in technology development and decision-making; and (f) unfavourable policies and legislation such as those relating to land tenure and intellectual property ownership (James *et al.* 2015; Ajayi *et al.,* 2018). Increased food demand and changing consumption habits on the continent driven by demographic factors such as population growth and urbanization are leading to rapidly-rising net food imports, which are expected to grow from US$ 35 billion in 2015 to over US$ 110 billion by 2025 (AfDB, 2016). The food and agribusiness sector is projected to grow from $330 billion today to $1 trillion by 2030, when there will also be 2 billion people looking for food and clothing.

Most of the arable lands in Africa are highly degraded[2]. The primary cause of soil degradation is attributed to the use of unsustainable practices in expansion and intensification of agriculture in efforts to feed its growing population (Tully *et al*. 2015). Consequently, the ability of most soils to maintain the provisioning, supporting and regulating ecosystem services required by current and future generations is threatened. As a consequence, the continent experiences persistent poverty among its people that is projected to prevail beyond 2030 (see Figure 1). Similarly, the food security situation has been deteriorating in all sub-regions of Africa over the period 2014 – 2018. Table 1 shows these trends measured on the Food Insecurity Experience Scale (FIES)[3]. The number of undernourished people is hence projected to increase from about 240 million in 2015 to about 320 million by 2025 (AfDB, 2017). Table 1 compares levels and trends of undernourished in the world, Africa and its sub-regions.

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[1] https://www.iucn.org/sites/dev/files/content/documents/resilience2.pdf
[2] Africa Soil Information Service http://africasoils.net/
[3] http://www.fao.org/in-action/voices-of-the-hungry/fies/en/

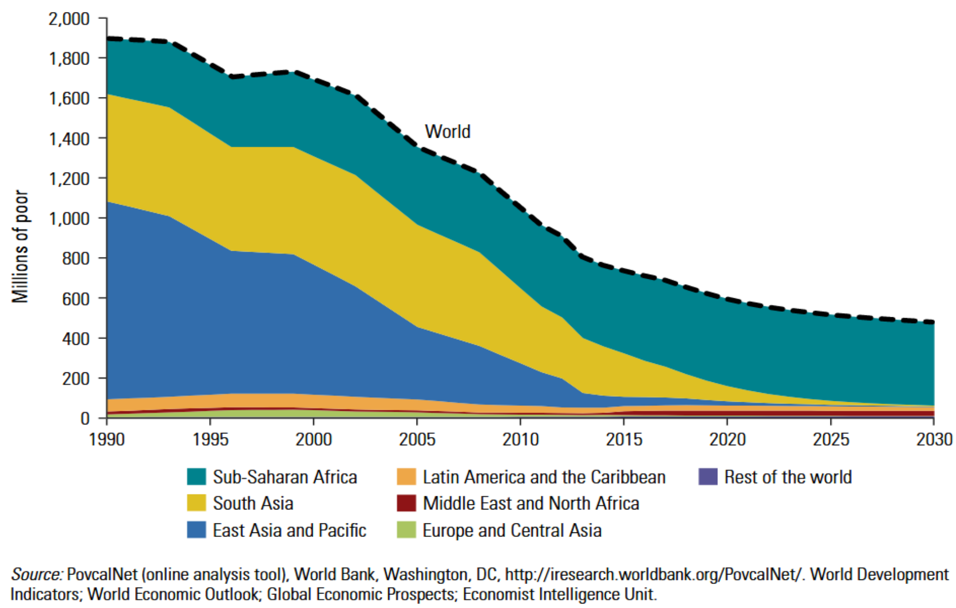

Figure 1: Trends in poverty between 1990 and 2030[4]

Table 1: Number of moderate or severe food insecurity (measured using FIES) in the world, Africa and its sub-regions, 2014 to 2018 (million)

	Prevalence of severe food insecurity in the total population (million)					Prevalence of moderate or severe food insecurity in the total population (million)				
Region	2014	2015	2016	2017	2018	2014	2015	2016	2017	2018
World	585.0	568.2	600.4	657.6	704.3	1696.3	1712.3	1801.9	1929.6	2013.8
Africa	210.7	226.7	268.2	287.5	277.0	554.1	577.1	644.1	682.0	676.1
Northern	19.1	16.3	21.2	23.6	19.0	59.8	51.6	63.8	82.1	70.2
Sub-Saharan	191.6	210.4	246.9	263.9	258.0	494.3	525.5	580.3	599.9	605.8
Eastern	93.0	100.2	114.3	121.3	112.5	226.1	238.4	266.0	276.3	271.7
Southern	13.4	13.1	19.8	20.1	20.2	28.3	29.1	34.4	34.9	35.3
Western	44.4	50.9	59.6	66.0	67.2	149.9	159.7	171.1	177.6	182.8

SOURCE: FAO * FAO uses the M49 country and regional groupings, available at https://unstats.un.org/unsd/methodology/m49. In this report, "Central Africa" refers to the M49 "Middle Africa" grouping

[4] https://www.brookings.edu/blog/africa-in-focus/2018/11/21/figure-of-the-week-understanding-poverty-in-africa/

Table 2: The number of undernourished in the world, Africa and its sub-regions, 2000-2018 (million)

Region/sub-regions*	2000	2010	2014	2015	2016	2017	2018	Change between 2014–2018 (Million)
World	909.3	822.3	788.8	785.4	796.5	811.7	821.6	32.8
Africa	199.7	199.8	212.1	217.9	234.6	248.6	256.1	44.0
Northern Africa	9.7	8.5	15.8	15.5	16.1	16.5	17.0	1.2
Sub-Saharan Africa	190	191.2	196.2	202.5	218.5	232.1	239.1	42.9
Central Africa	37.7	36.5	36.7	37.9	41.1	43.2	44.6	7.9
Eastern Africa	112.4	118.6	116.1	119.3	126.9	129.8	133.1	17.0
Southern Africa	3.8	4.2	4.7	5.0	5.5	5.4	5.3	0.6
Western Africa	36.1	31.9	38.7	40.3	45.0	53.7	56.1	17.4

SOURCE: FAO
FAO uses the M49 country and regional groupings, available at https://unstats.un.org/unsd/methodology/m49. In this report, "Central Africa" refers to the M49 "Middle Africa" grouping.
*** The series for Northern Africa experienced a jump in 2012 due to the inclusion of the Sudan from that year onwards.*

Climate projections to 2050 point to worsening food security and livelihood situations in most parts of the African continent. The IPCC Special Report on Climate Change and Land (SRCCL) and Special Report on the Impact of global warming of 1.5°C (SR15) above pre-industrial levels both predict severe impacts on diverse sectors—including agriculture, within the decade. Warming trends are already evident across the continent, and it is likely that the change in the continent's average annual temperature will exceed +2°C by 2100. In addition, changes in precipitation patterns are also of concern: even if precipitation amounts remain constant due to rising temperatures, existing water stress will be amplified, putting further pressure on agriculture. Across the world, smallholder farmers are considered to be disproportionately vulnerable to climate change because changes in temperature, rainfall and the frequency or intensity of extreme weather events directly affect their crop and animal productivity as well as their household's food security, income and well-being (Vignola *et al*. 2015; Harvey *et al*. 2014b in Mbow *et al*, 2019). Thus, the combination of climatic and non-climatic determinants and stressors will exacerbate the vulnerability of African agricultural systems to climate change and will affect farmers differently depending on their gender, with women and other vulnerable groups being affected the most.

1.2 Rationale for Scaling Up and Out Options towards Sustainable Agriculture

Farmers in SSA practice a wide range of crop and livestock production activities varying across and within the major agro-ecological zones. Although climatic change impacts are not uniform across the African region, temperatures are expected to increase in all locations, with temperature increases in SSA projected to be higher than the global mean temperature increase at global warming of 1.5°C and at 2°C (Weber *et al*., 2018). Climate projections on precipitation have also been estimated at sub-regional level whereby sub-regions such as parts of west and southern Africa will experience rainfall decreases while east Africa will experience increased rainfall (Caminade *et al.,* 2014; Serdeczny *et al.,* 2017). These changes will have severe consequences on agricultural production systems, human health and livelihoods, making populations more vulnerable. For example, the IPCC SR1.5 predicts severe impacts on water availability and the beef industry in southern African countries of Namibia and Botswana when the 1.5-degree C threshold is reached within the decade (from 2028).

In this regard, about 80% of the Nationally Determined Contributions (NDCs) submitted by African countries have identified agriculture as one of the priority areas for intervention. African agricultural systems will need to become resilient and adapt in order to meet growing demand, contribute to the achievement of the SDG-2 in particular, whose goals include ending hunger, achieving food security and improved nutrition by 2030, and promoting sustainable agriculture. Further, the United Nations Framework Convention on Climate Change (UNFCCC) at its 23rd Conference of Parties (COP23) acknowledged (decision 4/CP.23) the central significance of the impacts of climate change on agriculture by launching the Koronivia Joint Work on Agriculture (KJWA) (UNFCCC, 2018). The KJWA roadmap set out several topics to be discussed during joint in-session workshops to be organized by both the Subsidiary Body for Scientific and Technological Advice (SBSTA) and the Subsidiary Body for Implementation (SBI). At the 50th session of the SBs subsequent to the proposal of the Government of New Zealand, both SBI and SBSTA requested the UNFCCC secretariat to organize a workshop on the following additional topics:

i. Sustainable Land and Water Management, including Integrated Watershed Management Strategies, to ensure Food Security; and
ii. Strategies and modalities to scale up implementation of best practices, innovations and technologies that increase resilience and sustainable production in agricultural systems according to national circumstances.

This technical paper was commissioned for the African Group of Negotiators Experts Group (AGNES) as part of preparations on the second topic. According to Totin (2018), intensification of agricultural production using best practices and technologies can increase food availability and rural incomes.

2.0 DEFINITIONS AND CONCEPTUAL DEVELOPMENT

2.1 Scale Up, Scaling Out

Different versions of definition for "scaling up" exist across different development agencies such as the World Bank, UNDP, USAID and scholars. Considered more generally, the scaling up processes can take many forms and involve a range of activities from a national outreach covering the entire population to a policy reform spurred by successful pilots. These can be in the form of expanding, replicating, adapting and sustaining successful policies, programmes, or projects in a geographic space and over time to reach a greater number of rural and urban poor.

According to Wigboldus and Leeuwis (2013), "scaling out" is quantitative and will mean replication, copy-paste, more of the same, expansion, extension, adoption, dissemination, technology transfer, mainstreaming, roll-out, or multiplication, while "scaling up" is qualitative, and will mean transition, institutionalization, transformation, integration, incorporation, evolution and development. In addition to this, Menter *et al*. (2004) cited in Ajayi et al. (2018) add that scaling up requires adapting knowledge and innovations to end users, be they farmers or institutions, understanding of underlying principles, capacity building of actors involved and substantially greater investment. Therefore, as programmes scale up quantitatively and functionally, they typically need to scale up politically and organizationally (Ajayi *et al*., 2018).

According to Neufelt et al. (2015) scaling up can occur horizontally (replicating promising or proven practices, technologies or models in new geographic areas or target groups), vertically (catalyzing institutional and policy change) and diagonally (adding project components, altering the project configuration or changing strategy in response to emergent reality). Scaling can occur directly, in which an organization, initiative or coalition is directly responsible for change, and indirectly, in which these actors influence others to implement key changes.

2.2 Resilient Agricultural Systems

Miranda et al. (2019) define *resilience of a farming system* as its ability to ensure the provision of system functions or maintain its productivity, in the face of increasingly complex and accumulating economic, social, environmental and institutional shocks and stresses, through capacities of robustness, adaptability and transformability. A resilient agricultural system exposed to hazards (such as climate variability) should be able to anticipate the risks they face, to respond when disaster strikes, to adapt to changing risks and situations and transform to address underlying factors and root causes of risk. The transformation could include both adaptation and mitigation actions in agriculture.

2.3 Technology, Innovation and Best Practices

According to USAID (2014), there are two main categories of technology: material technology that takes the form of a *physical product* (i.e. agricultural tools, improved plant varieties, agrochemicals) and *knowledge-based* technology such as technical knowledge, farm management skills and other processes that assist farmers' production (i.e. soil and water management practices). According to Christiansen et al. (2011) and UNFCCC (2014), *Hard technologies* or hardware refer to physical tools; *soft technologies* or software refer to the processes, knowledge and skills required using the technology; and organizational technologies or orgware refer to the ownership and institutional arrangements pertaining to a technology. In the agricultural context, hardware is exemplified by different crop varieties, software by farming practices or research on new farming varieties and orgware by local institutions that support the use of agricultural adaptation technologies.

Lattimer (2013) in Ajayi et al. (2018) defined innovation as a new approach that has not been tried or tested elsewhere that can generate learning for the stakeholders involved and that has strong potential to be scaled up to bring positive results for the people. The FAO[5] combines all the attributes in the agricultural sense to define agricultural innovation as the process whereby individuals or organizations bring new or existing products, processes or ways of organization into use for the first time in a specific context in order to increase effectiveness, competitiveness, resilience to shocks or environmental sustainability and thereby contribute to food security and nutrition, economic development or sustainable natural resource management. Innovation is essentially the result of an interactive process between many actors (innovation system).

Two other important types of technology and innovation are the *bottom-up* (farmer-generated) and *top-down* (conventional researcher-generated) technologies and innovations. The body of literature emphasizes farmers' immense capacity to innovate. This is because farmers are active, understand the impacts of their own practices and are both sources and users of knowledge and information in agriculture. Hounkonnou *et al*. (2012) note that farmers are knowledgeable, skilled, motivated and empowered to develop technologies suited to their circumstances and farming objectives.

2.4 Scalability

Scalability is an important quality characteristic for technologies and innovation. Not all innovations can be scaled up. Technologies do have certain characteristics that define the scope of scalability. Factors critical in enhancing the scalability of a technology have been proposed and include (WHO, 2010; Cooley and Kohl, 2006)

- Credibility- if the innovation has sound evidence or proven advocates
- Relevance- if the innovation adequately addresses the problems at hand
- Advantage- if the innovation has a positive edge over other alternatives
- Appropriate- if the innovation fits the needs and context of the user
  Capacity- if the user organization has a perceived need for the technology, the motivation to advocate for its introduction and has prioritized capacity-building.

Strategies are innovations and best practices that have been tested and proven at pilot scale and are being recommended for adoption at scale.

Modalities refer to the approaches or methodologies or the "how" of scaling up and out.

[5] http://www.fao.org/3/CA2460EN/ca2460en.pdf

3.0 STRATEGIES FOR SCALING UP TECHNOLOGIES, INNOVATIONS AND BEST PRACTICES

Studies have shown that successful scaling up is a function of two factors: a) the number of farmers reached and b) the number of farmers who actually adopt the new practice or technology. While information and communication technologies (ICTs) such as radios and phones have made it possible to reach large numbers of people easily and fast, the ultimate challenge lies in creating lasting impact. In addition, scaling is often accompanied by significant changes that have both positive and negative implications on society and the environment. For example, although some farmers might benefit from an irrigation project, other community members might suffer from limited water availability or high levels of pollution in the long term. It is therefore critical to find an optimum balance which ensures that the agricultural practices selected have minimum implications and long term positive impact.

A suite of proven technologies, practices and innovations that contribute to sustainable agricultural production and resilience of farming systems in a wide range of contexts in Africa include: agroforestry, improved soil management through initiatives such as conservation agriculture, improved water management for example water harvesting and drip irrigation, integrated livestock and grassland management, improved nutrient management such as micro-fertilization and improved crop varieties and animal breeds. These are elaborated in detail in the Climate-Smart Agriculture Source Book (FAO, 2013) but summarised in Table 4. Adoption of improved management practices also depends strongly on investment costs and returns on investment, as well as constraints related to time, labour, access to machinery and existing supply and value chains. Technologies referred to as climate-smart may address productivity, adaptation/resilience and mitigation to different degrees, but it is widely agreed that food security has to increase during the shift to more integrated practices (GACSA 2014).

Table 3: Categories of innovations, technologies and practices and their benefits

Examples of technologies and practices	Examples of benefits
Soil Management	
• Zero-tillage, minimum-tillage or conservation tillage • Erosion control (such as reducing the degree and length of slopes through progressive and bench terracing) • Protective soil cover from mulch, crop residues or cover crops • Soil compaction management • Restoration of degraded soils • Fallowing	• Practices that increase soil organic carbon maintain productive soils, require fewer chemical inputs and support important ecosystem functions such as nutrient cycling, contributing to enhanced productivity, adaptation, mitigation and building resilience to climate change
Nutrient Management	
• Integrated soil fertility management using inorganic and organic fertilizers; management of nitrogen fertilizer; using mulch, compost, manure or green manure in place of inorganic fertilizers	• Integrated nutrient management such as green manures can contribute to adaptation and reduce costs to farmers

Crop Management	
• Crop diversification • Crop rotation • Intercropping (e.g. with leguminous plants) • Increasing the use of perennial crops and grasses • Growing nutrient-use efficient crop varieties • Integrated pest and/or weed management • Breeding and using crop varieties with increased resistance to extreme conditions such as droughts • Mulch or cover cropping • Rice intensification and improved cultivation techniques • Landscape-level pollination management	• Pollination management can improve landscape level ecosystem resilience • Planting nitrogen-fixing crops can contribute to adaptation and reduce costs to farmers
Water management	
• Water harvesting • Groundwater development • Construction or enhancement of dams • Irrigation (e.g. modern technology, accurate scheduling) • Drainage and flood management • Restoration of riparian habitat or creation of rivers • Improved hydrological monitoring and weather forecasting capacity	• Irrigation improvements can reduce GHG emissions, contributing to mitigation; increase crop and grassland productivity; and support adaptation
Livestock Management	
• Grazing management on pastures or rangelands (such as rotational grazing, adjusting stocking densities to feed availability, and altering plant species) • Feed management (such as improved feed quality, diet, supplementation, using improved grass species and forage legumes, and low cost fodder conservation technologies such as baling and silage) • Assisted natural regeneration and/or fire management of grazing systems • Manure management (such as recycling and bio-digestion, composting, and improved	• Diversification of incomes from livestock management can increase adaptation • Incorporating livestock manures can support adaptation and reduce costs to farmers • Improved pasture and grassland management, including rotational grazing can boost resilience, contribute to mitigation and increase productivity and food security.

storage) • Animal breeding (such as for heat-tolerant and locally adapted breeds) • Disease surveillance and control • Vaccines • Weather warning systems and weather-indexed insurance • Infrastructure (such as housing and shade) • Temperature control systems	
Integrated Systems	
• Agroforestry • Crop-livestock-tree systems • Rice-fish systems • Land fragmentation (riparian areas and forest land within the agricultural landscape) • Integrated food-energy systems (IFES)	• Integrated soil-crop-water management improves the soil's capacity to retain nutrients, improving productivity • More integrated systems often have important biophysical and socioeconomic benefits when compared to conventional systems (e.g., without the integration of trees, etc.)
Energy Management	
• Wind energy (such as windmills) • Solar power (such as photovoltaic panels) • Energy-efficient cook stoves • Equipment for bio-oil extraction and purification • Fermentation and distillation facilities for ethanol production • Solar-, wind- or bioenergy-operated water pumps • Renewable energy-powered vehicles • Heat generation and recovery systems (such as heat pumps, geothermal energy, insulation) • Dedicated energy crops	• Energy technologies can improve energy efficiency, increase the use and production of renewable energy, and broaden access to modern energy services • Developing and using local energy sources can increase incomes and expand the diversity of energy sources, increasing resilience to climate change
Conservation and management of genetic resources	
• Use of genetically diverse varieties and breeds • Using grazing animals to manage landscapes and wildlife habitats • In situ conservation of wild relatives (for	• Diversity on farms can contribute to risk management, adaptation and resilience

example protecting important species by designating sites as genetic reserves)

- Ex situ conservation (for example, conserving species in gene banks)

4.0 MODALITIES FOR SCALING UP AND OUT CLIMATE RESILIENT OPTIONS

4.1 Barriers to Scaling Up and Out

Barriers to scaling up and out climate resilient agricultural technologies and innovation differ between contexts and over time (James *et al*, 2015; Thomas *et al*, 2017). Identifying the main barriers or drivers in any particular context from an array of contributing factors is a key first step for the scaling process. Scaling may also be challenging in particularly diverse or unique agro-ecosystems and socio-cultural settings where climate smart technologies and innovations have to be significantly adapted to work in each setting. Key barriers to scaling up and out include: transaction costs, farmers' attitudes and objectives and political, institutional and economic barriers.

4.1.1 Transaction costs

The need to reach individual farmers or create structures to reach groups of farmers often leads to high transaction costs. Poor infrastructure makes the process of reaching farmers in remote areas very costly thus limiting their access to best practices, technologies and innovations. As governments work to increase their national budget allocation to the agriculture sector to the recommended 10% of the public expenditure (Maputo Declaration, 2003), it is necessary to unlock the potential of the private sector investments into the agriculture sector. Overall, it is generally difficult to estimate the costs and benefits of scaling activities which makes it hard to gauge their economic efficiency.

4.1.2 Farmers' attitudes and objectives

Adequate understanding of farmers' priorities is important not only for scaling up processes but also for uptake of new technologies and practices. In some situations, there may be costs associated with transition to a new practice or high labor demand. It is thus important to put in place options to cover these up-front costs through targeted subsidies or support. In addition, many smallholder farmers are usually interested in minimizing risks to the best possible extent while maximizing returns on minimum inputs (Westermann et al., 2015).

4.1.3 Political, institutional and economic barriers

The policy and regulatory framework and its enforcement are critical in providing a good enabling environment for effective scaling up. Some of the most important policies are those relating to land ownership rights, extension services, taxes or subsidies on agricultural inputs, credit and insurance schemes as they provide the rules and incentives (or disincentives) for adoption of innovation (Westermann et al., 2015). Institutions and their capacities also play a critical in the scaling up process.

4.2 Success Factors in Scaling Up and Out

Numerous frameworks have been developed for effectively scaling up and out agricultural technologies and innovations by different organisations working directly with farmers and other stakeholders. Designed to facilitate scaling up and out on the ground, these frameworks are informed more by experiential knowledge and they resonate well with the theoretical literature. An evaluation of some of these frameworks by Thomas *et al* (2017) and Neufelt *et al*. (2015) reveals that, despite broad structural differences as well as the number of steps in each and the order in which they are presented, the different modalities or operational frameworks had much in common with each other and the theoretical literature (Box 1).

Box 1: Common elements of frameworks on successful scaling up climate smart technologies, innovations and practices

- Draw on diffusion theory, and reflect the external, contextual factors identified elsewhere in the literature as being important in determining the adoption of innovations.
- Identify a successful intervention, defining what is to be scaled up, which is usually either a technology, a process or organizational innovation.
- Select a scaling up method from the range available.
- Develop a vision and assessment of the scalability of the intervention or innovation through a thorough diagnosis that includes all actors or stakeholders, is interactive, multi-disciplinary, and multi-sectoral.
- Identify barriers or constraints to scaling and solutions to remove them, perhaps using a theory of change process that results in a favorable enabling environment.
- Develop a communication and constituency building process for increasing public and stakeholder awareness.
- Track performance through a monitoring and evaluation process that also helps to quickly identify bottlenecks and can suggests course changes in the process and provide feedback for modifications, innovations.

Source: Thomas et al (2017) and Neufelt et al. (2015)

4.3 Proposed Modalities and Operational Framework

Using the common elements as building blocks for scaling up climate smart technologies, innovations and practices in Africa, the conceptual framework in Figure 5 is proposed. The framework has seven steps.

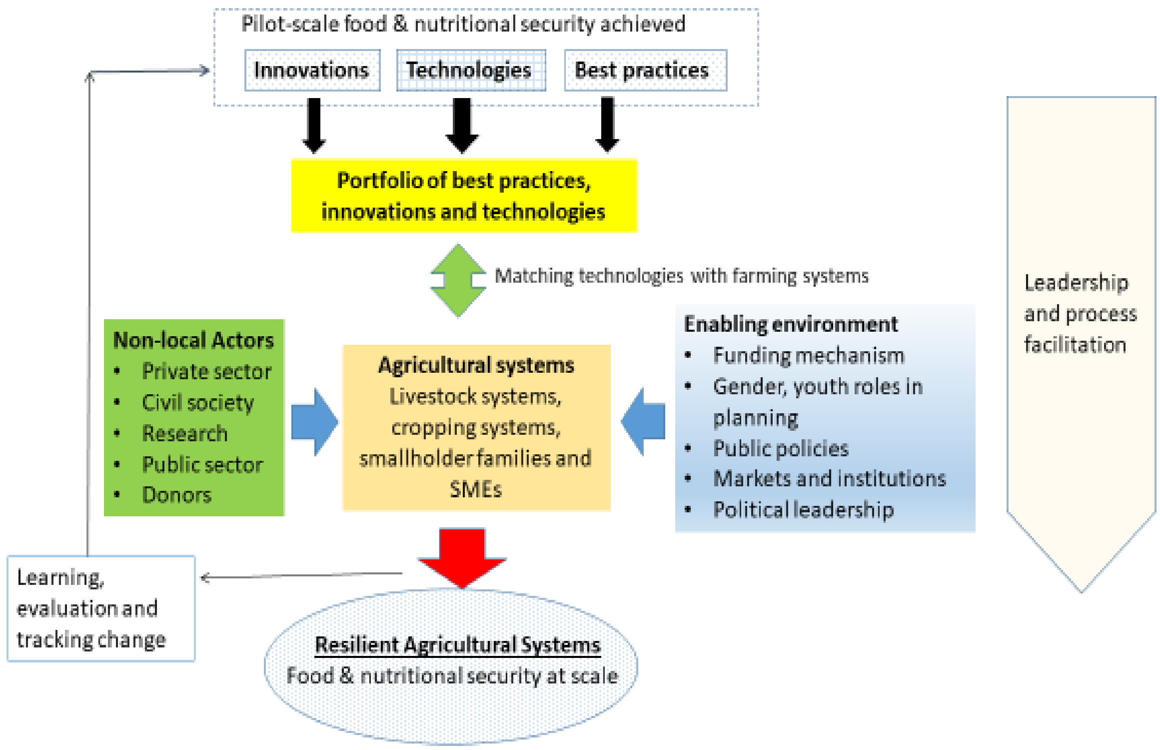

Figure 2: Conceptual framework for scaling up agricultural technologies, innovations and practices

Step 1: Planning Adaptively for the Scaling Process

Proper planning of the scaling up from the outset is very important using approaches such as Logical Framework Analysis, Theory of Change and Impact Pathway (Neufelt *et al.*, 2015; Reed, 2016). Thus, setting clear milestones that relate to scaling through a well-defined theory of change and impact pathway helps to bring divergent views and options together, cementing a joint understanding and vision of the rationale for scaling up and out. Table 5 shows a sample theory of change for scaling up. Potential partnerships for scaling up should be identified during the planning process as they are crucial for maintaining focus and momentum. Partnerships can help in overcoming challenges such as the high costs associated with initial transition to a best practice, technology or innovation. For instance, although extension and participatory measures such as demonstrations are critical tools to explain complex technologies, they are expensive, requiring large inputs of trained labour. Public-private partnerships may be useful when it comes to scaling up of climate smart technologies, innovations and practices. .

Table 4: Sample Theory of Change for Scale-Up

Sphere of Control			Sphere of Influence	Sphere of Interest
Input	**Activities**	**Outputs**	**Outcomes**	**Development Goals**
• **Institutional partnerships and networks** • **Enabling environment** • **Portfolio of scalable technologies innovations and best practices,** • **Organizational leadership/facilitator**	• Participatory context-framing research; identify barriers to scaling up; value chain analysis • Learning events and dissemination of research findings • Capacity strengthening of different value chain actors and thought leaders • Multi-Stakeholder planning • Policy engagement • Roll-out of best-practice projects and process documentation; support extension services	• Locally viable portfolios of best practices, innovations, technologies produced, matched with appropriate farming systems • Trained individuals • Meetings held	• Institutionalization: Increased individual and institutional capacity to adjust tech practices and innovate in response to environmental change • Policies and plans from Innovation Platform for promoting scale up are continuously implemented ensuring sustainability • Increased spatial gains from scaling out	• Food and nutritional security at scale • SDG 1,2,13 achieved • CAADP/Malabo • National Development Plans implemented.

Step 2: Selection of Technologies and Innovations based on Best-Available Evidence

While economics can drive key decisions, the social and cultural dimensions around changes in farming systems should not be overlooked when introducing new climate innovations (Thomas *et al*. 2017) and participatory techniques for considering multiple perspectives and dimensions of value are available. Below are three stage process proposed for the identification of technologies, innovations and best practices for scaling up and out.

Box 2: Case Study—Selection and adoption of climate technologies in the agrifood sector

The methodology is organized in a four-step approach, as can be seen from the figure below:

a.) identify relevant GHG emissions in the agrifood sector by activities carried out both on-farm and during food processing;
b.) analyse the markets for selected agrifood climate technologies and practices and evaluate their potential;
c.) consider other sustainability issues for a more comprehensive assessment of the technologies and
d.) identify obstacles to increased adoption, policy areas that warrant reform and measures to encourage market penetration of appropriate climate technologies and practices.

This step-by-step methodology seeks to reduce emissions from the agrifood sector while maximising co-benefits. Climate change mitigation is therefore just one criterion that impacts the classification of technologies, together with other sustainability considerations, based primarily on an assessment of technical, market and economic criteria. Such an approach may aid policymakers to screen technologies and attract international climate financing to mitigate emissions, while maximising co-benefits. However it is less suitable if the local priority is to adapt to climate change. For this reason, technologies such as small dams, biogas from agri-residues or grazing management, which may have an important value in making agriculture more resilient to climate change, rank relatively low compared to other technologies. A different analysis where adaptation co-benefits are preferentially weighted can nonetheless be performed.

http://www.fao.org/3/a-i7022e.pdf

- ***Identifying a portfolio of best practices, technologies and innovations:*** By the time one arrives to the scaling up, one already has a technology, innovation or best practice[6] that has worked well at local scale and would like to disseminate it wider. At this point, it is important to understand that there is no "one-size-fits-all" solution for increasing resilience of any farming system. Therefore, it is critical that scalability assessment tools are employed in selecting the appropriate technology or practice or a combination of them.
- ***Framing the Context:*** The next step involves framing the context for scaling up and out in order to understand the circumstances under which the proposed innovation, technology or best

[6] "Best" implies those practices that increase production and are profitable, are cost-efficient with primarily rapid but also long-term payback, are easy to learn, are socially and culturally accepted, effectively adopted and taken up, are environmentally friendly and are appropriate for all stakeholders including socially marginalised groups http://www.fao.org/3/i1861e/i1861e14.pdf

practice worked at one level and the needs and limits of the level to which it is to be scaled up and out. In particular, this step clarifies the geographical, historical and cultural contexts within which people's priorities and the possibilities for innovation are set and bounded (Carter and Currie-Alder, 2006). The boundaries for scaling up and out are determined by biophysical, institutional and economic considerations and may be modified to accommodate emerging practical issues such as costs. Temporal limits also must be set to enable development of realistic work plans.

- ***Matching best technologies and practices with farming systems:*** Once the geographical and social context as well as institutional, administrative boundaries have been determined, the portfolio of climate-smart technologies, innovations and best practices identified can now be assessed against these boundaries to determine their suitability of adoption. Agro-ecological zones and farming systems are extremely diverse but must be taken into account when deciding the appropriateness of a particular climate smart technologies, innovations and practices under consideration. Whereas trade-offs and synergies among the different for scaling up, the focus should ultimately be on maximizing synergies (Dinesh and Vermeulen, 2016).

Step 3 Mobilise Innovation Platform and Build Capacities

The agricultural innovation system or innovation platform is a network of individuals, organizations and enterprises, together with supporting institutions and policies in the agricultural and related sectors that bring existing or new products, processes and forms of organization into social and economic use. Policies and institutions (formal and informal) shape the way that these actors interact, generate, share and use knowledge as well as jointly learn. The main actors in scaling up are local and non-local stakeholders.

- ***Establishing Innovation Platform/s:*** Innovation platforms are important for facilitating exchange of information and best practices among the different stakeholders involved in the scaling up process. Appendix 1 presents general descriptions of the roles likely to be played by six major stakeholder groups in climate smart agriculture projects (Neufelt *et al*. 2015) who are broadly classified here as local and non-local stakeholders. *Local Stakeholders* are the key beneficiaries in a scale-up undertaking. They possess indigenous knowledge characteristic of their respective farming systems and Agro-Ecological Zones (AEZ). *Non-local stakeholders* include donors, government, researchers, civil society and private sector actors. Each of these stakeholders play uniquely diverse roles within an innovation system and especially in supporting scaling up of climate smart technologies, innovations and practices.

- ***Capacity Building:*** Scaling up climate smart practices requires capacity building across all scales and among various stakeholders. The strengthened capacity would coupled with appropriate incentives is an essential component of scaling up and out. Capacity building at grass roots level via farmer-to-farmer visits, peer-to-peer training, training of trainers, development of community-based institutions and best practice competitions have proven to be very successful (James *et al*., 2015). Unlike 'traditional' extension services that have transferred outside solutions to farmers, new approaches need to be farmer-based, driven by local needs, participatory and considerate of groups such as women, young people and the very poor. Several extension approaches can help spread innovation when technical solutions are not enough (Neufelt et al. 2015):

- *Farmer-to-farmer extension*: The volunteer farmer trainer approach uses farmer trainers to train their peers, mobilizing people to disseminate information and promote the adoption of innovations.
- *Community nurseries and farmer field schools*: A widespread approach for enabling a process of structured, field-level learning and problem solving among farmers by bringing them together on experimental farms or other field-level examples of successful innovation.
- *Innovation platforms*: These are spaces for fostering learning and creating change by bringing diverse actors (e.g., farmers, researchers, local authorities, conservation officials, extension officers, supply chain actors financiers) together to share knowledge and find solutions to common problems in an equitable and dynamic space.
- *Rural Resource Centre*: These are community-based hubs for information access, interactive learning, training and networking that values local knowledge and priorities and encourages researchers, extension workers and farmers to learn.

Step 4 Create the Enabling Environment for Successful Scaling Up and Out

An enabling environment is necessary for successful innovation and scaling up and out. This may include adequate finance and the issues of gender and youth.

- ***Adequate and predictable funding:*** How well Africa's agriculture deals with climate impacts now and in the future will largely depend on the funding it receives or sets aside for adaptation measures. Meeting resource in Africa's investments in the agriculture sector calls for innovations, cooperative actions and political will. This could be achieved by targeting multiple funding sources, including public, private and other innovative sources such as green bonds, crowd-funding and bank guarantees. The approach to scaling up and out will typically need to be adapted to the funding model. De-risking investments remains a critical issue especially for the private sector no matter what their objectives are (Cornell et al. 2016). Some of the financing sources are:
  - *Multilateral Climate Finance:* Climate finance landscape is highly fragmented with finance to support climate action and to implement the Paris Agreement coming from multiple sources and is not always be labelled or clearly recognizable as climate finance. Finding the right source of finance for a country or project is important as there is *'no one size fits all.'* The international climate funds include the Global Environment Facility (GEF), the Green Climate Fund (GCF), the Adaptation Fund (AF) and the funds led by the multilateral development banks (MDBs) such as the Climate Investment Funds and bilateral funds specializing in climate. As a result, the climate finance landscape is diffuse which increases the challenges associated with accessing finance and reduces overall efficiencies. This is why country ownership is essential, to guide resources to where they are most needed and

to target the funds best suited to a country's needs. To integrate private sector, GCF recognizes the value of incorporating results-based financing, in particular for incentivizing mitigation action. Current guidance on the fund's Private Sector Facility mentions the clean development mechanism-like (CDM) mechanism as one of the mechanism through which private investment into mitigation actions in developing countries can be incentivized. Currently, there are negotiations to establish rules to operationalize Article 6 of the PA that provides for market and non-market mechanisms.

- *Regional funds in Africa* such as from AfDB also provide an additional source of climate finance.
- *Domestic sources***.** These include from: national budgets through parliamentary appropriation; remittances from the diaspora, which have fast gained a leading position as key foreign exchange earner for most sub-Saharan African countries; NGO funds—this sector controls a significant chunk of donor funds towards climate action; and the private sector.
- *Private sector, microfinance institutions, merry-go-round and credit groups* may also provide the much-needed funding to support scaling up of climate smart solutions.
- *Decentralized Climate Finance (DCF)* is becoming increasingly important, examples being the County Climate Change Fund (CCCF) in Kenya (**see Box 3**) that is currently being scaled up to more regions in Kenya by the NDMA after institutionalizing the pilot phase.

Box 3: Case Study-Delivering climate finance at the local level to support adaptation: experiences of County Climate Change Funds in Kenya

The Kenya County Climate Change Fund (CCCF) mechanism, initially piloted as the Climate Adaptation Fund in Isiolo and subsequently scaled out to Garissa, Kitui, Makueni and Wajir Counties over the period 2011-2018, is a pioneering mechanism to facilitate the flow of climate finance to county governments and simultaneously empower local communities, through strengthening public participation in the management and use of those funds, to build their resilience to a changing climate. It is a practical example of how climate finance can support climate-resilient development and effective adaptation as set out in the Paris Agreement. It has been piloted successfully in five counties, and its expansion is one of the priorities in the National Climate Change Action Plan, 2018-2022. The CCCF is being scaled out to new areas, including Kenya's lake and coastal regions. This tested and trusted mechanism facilitates the flow of climate finance to county governments and empowers local communities. Recognizing that adaptation action is best planned locally and informed by local experiences and perspectives, CCCF strengthens public participation in managing and spending climate finance and making decisions about adaptation priorities to build their resilience. The pilot invested GBP£1.91 million into 99 community-prioritised resilience-building projects across the five counties, directly benefiting more than 500,000 people.

https://www.adaconsortium.org/index.php/component/k2/item/381-assessing-the-effectiveness-of-the-cccf-mechanism-on-rural-livelihoods-and-institutions-in-kenya

- ***Gender and Youth Considerations in Planning.*** Climate change impacts are not gender-neutral. Women, children, the youth and the poor are particularly more vulnerable as they often have limited resources, receive less education and are not involved in political and household decision-making processes at different levels. Women in Africa are vulnerable to the effects of climate change as a result of their critical and differentiated roles and responsibilities in agriculture and dependence on natural resources in their livelihood strategies. For example, women provide more than 60% of the labor force engaged in agriculture, and with increasing impacts of climate change this makes women at greater risk of livelihood insecurity. Gender considerations will be necessary in the design and implementation of scaling up climate smart technologies, innovations and practices.

- **Public Policies and Political Support.** The policy framework, laws, regulations and norms in a given country and region have to be supportive if scaling up of climate smart technologies, innovations and practices is to succeed[7]. Similarly, scaling up productive technologies can be severely constrained or rapidly advanced by the policy environment (USAID, 2014). Examples of policies that could constrain or advance scaling are those related to farm inputs, regulations regarding food safety and product quality, output markets and trade (Ajayi *et al*., 2018). For example, a systematic review of published research suggests tenure reform in Africa produces relatively modest agricultural productivity gains[8]. In addition, decentralized governance where local stakeholders determine key planning decisions and can incorporate local needs and priorities into the local level planning processes can facilitate scaling up of climate smart technologies, innovations and practices (**Box 4)**.

Box 4: Case Study—A case study on policy action gaps in Rakai District, Uganda

Rakai was a National Adaptation Plan of Action (NAPA) pilot district but many stakeholders were not aware of the existence of such activities (policy engagement). Discussions held with key informants in Rakai district indicated that district level policy actors are inadequately involved in national level policy formulation processes. Usually a few district representatives are invited to attend national level consultative workshops. Most NGOs alluded to the same claim that they were not adequately included, and felt that the consultative approach used only allowed them to "rubber stamp" the policy documents but not to contribute to their development.

As highlighted, having policies formulated does not guarantee implementation of adaptation practices at farm level. The Rakai case shows that ineffective implementation of policies at national and district levels results in a lack of enabling strategies at lower levels. Yet lack of functional by-laws and enforcement structures at lower levels results in constrained access to resources that would reduce smallholders' vulnerability to climate change impacts.

https://www.sciencedirect.com/science/article/pii/S146290111630716X

[7] https://www.brookings.edu/research/scaling-up-a-framework-and-lessons-for-development-effectiveness-from-literature-and-practice/

[8] https://forestsnews.cifor.org/26908/land-tenure-reforms-africa-review?fnl=en

One key way to ensure that leaders and institutions continue to pay attention to scaling up is to create an effective demand for it through the political system[9]. Social change needs to be embedded in the process as that will ensure that those involved are actively engaged and leaders are constantly reminded of the significance of the process and the consequences it might have on their political agenda. Cooley and Kohl, 2006) indicated that for field programmes to be expanded and sustained, political support needs to be secured through explicit strategies of advocacy that are built early on into the scaling up process. Advocacy often needs to be built around individual champions but should aim to form broader coalitions down the line.

Step 5 Provide tangible early Benefits and Incentives to Stakeholders

Scaling up and out processes require sustained inputs from a range of stakeholders including farmers, NGOs, research and business communities, development partners and policy makers who can facilitate or hinder attempts to scale up. Therefore, to both mobilize and retain stakeholder engagement, it is necessary to provide tangible, early benefits that generate meaningful value for those involved (Reed, 2016). For example ensuring prompt payment of farmers upon delivery of the produce would entice and win new additional farmers. Besides incentivizing the process of scaling climate smart solutions up and out, it is important to identify disincentives or perverse incentives that may affect scaling up and out. It is important to avoid raising false expectations of the degree and speed with which benefits may accrue and to constantly manage expectations during the process of scaling up and out.

Step 6 Monitor, Evaluate, Learn and Communicate

Successful scaling up requires regular feedback from monitoring and evaluation systems. It is essential to learn from success and failure alike in order to develop best-practice in scaling up and out (Thomas et al. 2017). It requires a “learning by doing” culture, one that values adaptation, flexibility and openness to change. While a solid process needs to be laid out, scaling processes need to be adjusted regularly. Therefore, regular monitoring and evaluation as well as feedback from beneficiaries, communities, and field-based staff are important for learning and adjustment to take place. Two types of evaluation are relevant to scaling up. First is the evaluation of the pilot programme to establish whether or not the innovation tested has been successful and what lessons can be gleaned from it. Second, is M&E of the scaling up process (IFAD, 2017). It is necessary to monitor progress towards agreed sustainability targets and evaluate the impacts of climate smart technologies, innovations and practices against measures of sustainability, including sustainable livelihoods (Thomas et al. 2017). Facilitating learning between different stakeholder groups across scales is critical—designed and implemented in collaboration with stakeholders to enable continuous learning—will improve climate- smart practices and ensure effective scaling up and out.

[9] https://www.brookings.edu/research/scaling-up-a-framework-and-lessons-for-development-effectiveness-from-literature-and-practice/

Local stakeholders require building of their confidence and skills to enable them to share, learn, develop, adapt and apply appropriate knowledge, ideas, methods and tools within a given context. Non-local stakeholders can foster learning among local stakeholders by providing necessary interdisciplinary research and forums for knowledge sharing. Scaling up also implies learning empirically how to facilitate multi-stakeholder processes on a larger scale. To be able to modify issues of their concern or meet their priorities effectively, local stakeholders need to be aware of the complexities and interconnectivity of the systems on which they depend for their livelihoods. Employees of non-local agencies (donors, NGOs, government NRM agencies, etc.) need to learn how to support and empower local stakeholders by providing the required training, research and opportunities for knowledge sharing. Where good practices are identified, these need to be communicated globally to build expertise in scaling up across different contexts.

Scaling up local climate innovations depends on demonstrating their success and convincing non-local stakeholders to learn from these experiences. Donors and research organizations have a role in disseminating local innovations and changing their own behavior to facilitate further scaling up of local innovations. Training programmes by international institutions and universities represent an important channel for disseminating knowledge on how to use innovations, the principles on which they are based and their potential applications.

Step 7 Foster Institutional Leadership to Support the Scaling Process

Scaling up cannot happen in a vacuum and requires leadership and process facilitation. There is the need to engage a champion from one or more of the actor groups who can lead and link different interests. This may be an enthusiastic NGO leader, member of a farmer group, politician, financier, or a research team leader (Thomas et al. 2017). It is possible to work with champions to develop an influencing/engagement strategy with key stakeholders, working where necessary with influential intermediaries, to build momentum for changes in policy or practice. Key roles of the champions include inter-level coordination, (Ajayi et al. 2018) mobilizing key stakeholders involved in the scale-up and out program, coordination of the decentralized scale up governance framework and can also serve as an intermediary organization between the innovation “originating” and the innovation “adopting” organization to drive the scaling up process (Cooley and Kohl, 2005).

Organizational leadership could be provided by the process facilitator. The facilitator to mobilize participation by different stakeholders through the agricultural innovation system/platform. This would strengthen promoters of the climate smart solutions, government and farmers thus enhancing synergies between scientific and indigenous knowledge but also inter-level coordination (Ajayi et al. 2018). In some instances, there may be need for innovation intermediaries. Innovation Intermediaries (brokers) would facilitate interaction among isolated innovation networks, and between farmers and researchers, policy makers and other industry actors. Intermediation is presented as a formal professional role in development where intermediaries are hired consultants or web-based platforms for brokering exchange among actors in agriculture and food systems. Examples include AFIDEP which specializes in knowledge translation in the health sector—linking health researchers and ministries of health across Africa.

4.4 Incentives for Scaling Up

Incentives aimed at scaling up and out climate smart technologies and innovations need to be designed based on a thorough assessment of stakeholder needs, their local or traditional knowledge and a critical appraisal of existing incentives and their impacts.

- **Private sector incentives:** A number of opportunities exist which the private sector could exploit towards climate resilient smallholder production with the right incentives in place. Opportunities identified by Thomas et al. (2017) include:
  - Provision of input supplies, technologies, market chains, and other products and services for climate smart innovations on smallholder farms despite this sector producing 70-80% of all food in Africa and Asia (IFAD 2011) and will need to continue feeding the growing population.
  - New technology services and payment schemes e.g. more accurate location analyses via new geographical information systems, cellular phone coverage, internet presence, distance to financial institutions, and electricity connectivity—all of which can help target climate smart solutions.
  - New information and communication technologies (ICT) such as advanced soil and water sensors and monitoring equipment that will allow farmers to monitor soils and crops more accurately. Most of these are mobile phone-based and are already appealing to the youth who use mobile phones.
  - Targeting existing retailers rather than smallholders directly to not only sell products but also offer advisory services that government departments are unable to, hence providing growth opportunities in areas where digital and advisory capacities are low.
  - Innovative payment methods designed for cash-poor consumers without access to banks, including mobile money, escrow services, small loans and mobile vouchers. Mobile banking will also help better use of the vast amounts of remittances from abroad avoiding high interest rates on international transfer by other means.

  To realize these opportunities, the private sector needs incentives and co-financing for large-scale public-private partnerships (Thomas et al. 2017). These could include de-risking investments in land-based projects via state guarantees if projects fail and tax allowances for investing in restoration projects (Cornell et al. 2016). Secondly, these futuristic opportunities will require innovative partnerships, greater collaboration and connectivity amongst stakeholders riding on technological innovations along agricultural value chains.

- **Incentives for farmers and communities:** Incentives to encourage farmers should be designed in ways that encourage innovation and testing of interventions by farmers themselves. Examples include Farmer Field Schools (FAO 2015) and farmer competitions which bring prestige to farmers and can strengthen cultural identities, greater knowledge exchange and learning. Further, resource-poor farmers are unlikely to switch to climate smart solutions unless they can see tangible returns to their investments—usually within one growing season. Government support in provision of infrastructure and other services is essential.

- **Incentives for policymakers:** Policymakers will likely to respond more readily to evidence that the implementation and scaling up and out of climate smart solutions will address some of the immediate challenges being faced such as unemployment and food insecurity. Linking these efforts with some of the international commitments that the country has entered into such SDGs and the Sendai Framework on DRR is likely to be received favourably by the policy makers.

4 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Climate Chang's negative impacts on Africa's agriculture is already being felt, in the form of reduced yields and more frequent extreme weather events, affecting crop and livestock alike. Over the years, significant investments in research and innovation have led to the development and testing of a wide range of agricultural technologies and innovations that could potentially be scaled up and out so as to achieve the region's food security. These include improved crop varieties and livestock breeds, use of apps and drones, solar-powered irrigation and soil health management. Substantial investments in scaling up climate smart technologies, innovations and practices will be required to maintain current yields and to achieve the required production increases in a changing climate as well as in transitioning Africa's agriculture sector into low carbon, climate resilient development pathway.

5.2 Recommendations

The following recommendations are made in respecting to scaling up of best practices, technologies and innovations:

1. Create the enabling environment, including incentives to support and catalyse successful scale up and out of climate smart technologies, innovations and practices..
2. Select climate smart technologies, innovations and practices based on best-available evidence recognizing there is no "one-size-fits-all".
3. Set clear milestones and indicators to track progress in the scaling up efforts, including a well-defined theory of change and impact pathway.
4. Support agricultural innovation platforms to facilitate and enhance knowledge sharing and learning (including indigenous knowledge).

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