Food Agriculture, Natural Resources Policy Analysis Network

FANRPAN




POLICIES AND PRACTICES FOR CLIMATE-SMART AGRICULTURE IN SUB-SAHARAN AFRICA

A Comparative Assessment of Challenges and Opportunities across 15 countries

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Synthesis Report

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The Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN) is an autonomous regional stakeholder driven policy research, analysis and implementation network that was formally established by Ministers of Agriculture from Eastern and Southern Africa in 1997. FANRPAN was borne out of the need for comprehensive policies and strategies required to resuscitate agriculture. FANRPAN is mandated to work in all African countries and currently has activities in 17 countries namely Angola, Benin, Botswana, Democratic Republic of Congo, Kenya, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Uganda, Zambia and Zimbabwe.

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This report synthesizes the findings of 15 scoping studies conducted by national consultants across Eastern and Southern Africa.

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2. Executive Summary

Climate change is already a reality. The latest assessment of the Intergovernmental Panel on Climate Change (IPCC) shows that global climate change is already damaging crops and undermining food production capacity in much of the world, particularly in poor countries. Negative impacts on crop yields have been more prevalent than positive ones; and even worse, that is often the case for staple foods such as wheat and maize, which feed much of the global population.

Sub-Saharan Africa is particularly vulnerable to climate change. The region is marked by strong dependence on rain-fed agriculture and natural resources, limited infrastructure in rural areas, and high levels of poverty. The region is projected to suffer further water stress, more frequent droughts, floods, and other alteration in rainfall patterns, leading to lower agriculture yields unless adaptation measures are taken. Furthermore, climate change is likely to reduce the land suitable for agriculture, potentially leading to increases in clearing of native forest and pasturelands for crop cultivation, with a consequent significant increase in carbon release. The effects of climate change on African agriculture thus are severe and a major challenge to household livelihoods.

In this context, this study has set out to analyze the barriers and opportunities for promoting climate-smart agriculture (CSA) in sub-Saharan Africa. CSA means agriculture that: (i) increases productivity and income, (ii) adapts and builds resilience to climate change and variability, and (iii) reduces greenhouse gas emissions where possible. This synthesis is based on national scoping studies conducted by local consultants in 15 Eastern and Southern African countries: Botswana, Democratic Republic of Congo, Kenya, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, South Africa, Swaziland, Uganda, Tanzania, Zambia and Zimbabwe. Those studies, in turn, were based on literature reviews, policy reviews, and key-informant interviews with multiple stakeholders to assess practices and policies on CSA. This report now analyzes and synthesizes their findings on a regional scale.

A comparative assessment reveals that the onset impacts of climate change (particularly droughts, floods, and other alterations in rainfall patterns, with their associated impacts on crop yields and livestock) are already being perceived both by formal experts and by rural populations across Eastern and Southern Africa. Yet, the promotion and uptake of CSA practices remain limited. All countries have examples of both traditional and research-based agricultural practices that can be deemed climate-smart, but they are not mainstreamed and still receive limited support. Such practices include both agroecological techniques (e.g. mulching, intercropping, agroforestry, mixed farming) and agricultural biotechnology, such as high-yield and/or drought-tolerant crop varieties and livestock breeds.

Similarly, Eastern and Southern African countries generally have policies on agriculture and climate change – and do recognize the impacts of the latter on the former. Some countries have developed National Climate Change Policies (e.g. Madagascar, Malawi, Uganda and Zambia), while others countries have National Adaptation Programmes of Action (NAPA) in place (e.g. DRC, Tanzania, Uganda), and/or National Climate Change Response Strategies (Kenya, Tanzania, and Zimbabwe).

However, such policies often lack adequate instruments to achieve the goals they set. Furthermore, they are not sufficiently connected across sectors. There is a clear **need for greater policy coherence** to avoid conflicts and create synergies. Furthermore, perverse incentives that hinder CSA implementation (i.e. larger subsidies or other policy incentives for practices that are *not* CSA) remain in place and need revision.

Other challenges include limited material (including human resource) capacity, insufficient smallholder participation in governance, and persistent gender imbalances. There are not only financial constraints but also limited access to technology for scaling up CSA practices. Many CSA practices – notably those based on biotechnology, but also suitable machinery for conservation agriculture or small-scale farming – remain expensive and dependent on foreign actors. This situation reveals an **urgent need for South-South and North-South cooperation that promotes the *endogenous* technological development of Africa**.

For greater CSA uptake, it is also **fundamental that smallholder farmers, particularly women and the youth, have greater participation in policy- and decision-making**. Currently, most agricultural and climate change policies have been top-down and carried out through "one-way" extension services that tell farmers what to do not sufficiently listen to them. As a result, not only is there a governance participation deficit, but also difficult implementation. It is essential that institutions be revised to eliminate gender imbalances (e.g. ensuring the participation of women in decision-making and equal rights over land). Similarly, there is a need to incorporate the views, needs, interests and concerns of smallholders, who make up the majority of farmers in Africa. (The table below summarizes the key challenges and ways forward identified).

All in all, Eastern and Southern Africa hold great potential for CSA, but this potential needs to be further explored. The region has a large number of traditional agricultural practices as well as research-based programmes and techniques that have CSA qualities. CSA promotion requires concerted action from multiple actors, perhaps most notably from governments themselves, as from non-state actors who can work as CSA advocates. To the same extent that climate change poses an enormous challenge to African agriculture, it may bring about an opportunity to transform it – not simply an opportunity to change its material basis, but one to shift its policies, institutions, and development strategies in the direction of sustainability and of a food-secure future free from poverty.

Challenges and recommendations for CSA promotion in Eastern and Southern Africa

Main challenges	Specific challenges	Recommendations
Limited Material Capacity and Human Resources	Financial constraints	Public and private investments through greater budgetary allocation and North-South and South-South cooperation on CSA; value-addition wherever possible, to improve economic development
	Technological constraints	Focus on endogenous human, scientific and technological development in Africa; transfer of technology know-how, not just products
	Limited human resources (e.g. extension staff)	Training of scientists, technicians, and extension staff on CSA, with adequate investments in material means and personnel
Poor Policy Coherence	Lack of adequate policy incentives	Create regulatory and economic incentives that give "teeth" to climate and agricultural policies to effectively promote CSA
	Insufficient cross-sectoral coordination	Promote synergies among different ministries, departments and stakeholders through the creation of think-tanks, intersectoral committees, and/or multistakeholder communities of practice
	Perverse incentives	Revise existing policies to eliminate perverse incentives that hinder CSA
Weak participation of smallholders (notably women)	Top-down policy-making	Create and strengthen smallholder farmer associations, and bring them on board in governance for CSA
	One-way extension services	Ensure two-way extension services to benefit both from scientific, research-based and traditional knowledge
	Gender imbalances	Revise existing policies and institutions that put women in disadvantage, notably in their rights over land and of access to decision-making

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1. Introduction

Climate change is already a reality. 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 in much of the world, particularly in poorer countries. Negative impacts on crop yields have been more prevalent than positive ones; and worse, that is often the case for staple foods such as wheat and maize, which feed much of the global population (IPCC 2014).

Sub-Saharan Africa is particularly vulnerable to the impacts of climate change. The region is marked by strong dependence on rain-fed agriculture and natural resources, little infrastructure in rural areas, and high levels of poverty. Projections suggest this region will suffer greatly from further water stress, more frequent droughts, floods, and alteration in rainfall patterns. This leads to lower agriculture yields unless adaptation measures are taken. Climate change, in addition, may reduce the land suitable for agriculture, potentially driving the clearing of native forests and pasturelands for crop cultivation, with a consequent significant increase in greenhouse gas emissions. The effects of climate change on African agriculture thus are severe and one of the most significant emerging challenges to household livelihoods.

In this context, this study has set out to analyze the barriers and opportunities for promoting "climate-smart" agricultural development in Sub-Saharan Africa. The term refers to agriculture that (i) increases productivity and income, (ii) adapts and builds resilience to climate change and variability, and (iii) reduces greenhouse gas emissions where possible (FAO 2010; see also Section 2). The research has consisted of a comparative assessment of relevant policies and practices in 15 countries across Eastern and Southern Africa: Botswana, Democratic Republic of Congo, Kenya, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, South Africa, Swaziland, Uganda, Tanzania, Zambia, and Zimbabwe. It has included literature reviews, document analysis and key-informant interviews with local researchers, government officials, agroindustry sectors, farmers and other civil society organizations in each of those countries. National-level reports were, in some cases, also screened and reviewed through *in loco* Validation Workshops with multiple stakeholders. Based on the comparative assessment of those national scoping studies, this synthesis report now presents a regional picture of the challenges and opportunities for climate-smart agriculture (CSA) promotion in Eastern and Southern Africa. It draws a number of observations as well as recommendations for policy-making and for targeted North-South and South-South cooperation.

This report is structured as follows. Section 2 elaborates on the CSA concept and its importance in the context of Sub-Saharan Africa. Section 3 summarizes the key findings and main observations from each of the 15 case-study countries. It identifies key farming practices that may be scaled-up, the policy and governance situation of CSA, challenges, shortcomings and opportunities in each of those countries. Section 4 then extracts key lessons from CSA promotion in this region of the world, points some ways forward, and draws recommendations to address each of the challenges identified.

2. Climate-smart agriculture in an African context

Among the various impacts of climate change on human activities and ecosystems, those on agriculture are some of the most worrisome. For one, climate change is affecting the rainfall patterns on which much of agriculture depends. Often, rainfall declines to levels that cannot carry a crop to full maturity (rain failure); in addition, rainy seasons are being altered, and downpours and flooding have become more common in many regions, leading to loss of soil cover, inundation of low-lying areas, destruction of crops, and population displacement. Besides impacts on rainfall patterns, climate change also shifts temperatures, frequency and predictability of other weather events (e.g. cyclones), and the spread of vector-borne diseases such as malaria (especially in hitherto malaria-free highland areas), amongst others. As such, it is imperative that efforts to address agriculture's, food security and rural development needs take climate change into consideration.

The vulnerability of African countries to climate change is generally compounded by strong dependence on rain-fed agriculture and natural resources, high levels of poverty, low levels of human capital, low levels of preparedness to climate change effects, and poor infrastructure in rural areas. Sub-Saharan African agriculture is 96% rain-fed (World Bank 2008). Its yields could fall by as much as 50% by 2050; in addition, temperatures in Sub-Saharan Africa are already close to or beyond thresholds at which further warming reduces yields (Cline 2008). As such, Stern (2007) estimates that global climate change will lead to reductions in per capita consumption of 4-5% for Africa, greater than in other regions of the world.

Yet, studies show that agriculture remains one of the most effective pathways out of poverty. Gross domestic product (GDP) growth that originates in agriculture is approximately four times more effective in reducing poverty than GDP growth that originates in other sectors (World Bank 2008). The risk which climate change poses to the sector, therefore, has significant implications for the poverty-reducing capacity of growth and development, as it can severely limit the options available to countries as well as create or further exacerbate continuing poverty and inequality. Tackling climate change and making agriculture more adaptive and climate-smart is, therefore, fundamental to further growth, to the extent to which rural and poor rural people are included and benefit, and to the sector's capacity to contribute to sustained progress on human development.

However, resources for adaptation in Africa are scarce, and climate change may actually aggravate current deficiencies. For one, climate change further reduces the natural resource base, such as land suitable for agriculture. This can lead to increases in clearing of native forest and pasture lands for crop cultivation, with a consequent significant increase in greenhouse gas emissions. Other key challenges include poor soil fertility, reduced soil organic matter, and increased occurrence of acidified soils, due in part to limited fallow periods and to poor cultivation and water management practices. The limitations of Africa's agriculture are further exacerbated by limited functioning of markets and prohibitive trade policies, constraining access to inputs (IFAD 2011). As a result, the average yields of grain crops in sub-Saharan Africa have stayed below 1 tonne per hectare since the 1960s, compared with average cereal yields of 2.5 t/ha in South Asia and 4.5 t/ha in East Asia (Gilbert 2012). Smallholder farmers, with limited capacity to invest or manage risk due to poorly functioning credit and insurance markets, are constrained in their ability to increase yields and incomes, and thus are particularly vulnerable to impacts of climate change and current climate variability. Women farmers may suffer the most, as they are estimated to receive less than 5% of extension, and less than 1% of all available agricultural credit

(IFAD 2007). Women also play a key but undervalued and unpaid role in maintaining agro-biodiversity, which may be diminished as a consequence.

Despite these facts and realities, disconnects still occur within policy and investment in ensuring that resource gaps are narrowed and the risks more broadly shared within the sector. For instance, a review of National Adaptation Programmes of Action (NAPAs) has shown that while all African NAPAs mentioned and gave priority to poverty, the treatment of gender inequalities as a key factor in adaptation capacity was treated less consistently and often less prioritized (Perch 2011). Furthermore, it has long been recognized that the intersections between agriculture, health and nutrition are fundamental, yet these remain out of the mainstream of discussion about ways to re-energize the sector, and they remain peripheral in some ways to the discussion on climate change and agriculture, where most of the focus tends to be on the economic rather than *socio*-economic relevance of the sector.

Arguably these issues also amount to problems of governance. Governance has been recognized as the most pressing sustainable development issue of the 21st century. A 2012 consultation by the United Nations Environment Programme (UNEP) with world experts has identified today's most urgent need as "Aligning Governance to the Challenges of Global Sustainability" (UNEP 2012). Clearly, the African context is among those where such a need is most pressing. As Smith and Vivekananda (2009: 9) suggest, dealing with the complexities of climate change and development requires "social adaptation to social consequences", including action on policies and governance.

In this context, CSA becomes vital. It is an approach that can help reduce the negative impacts of climate change on food supplies, livelihoods and economies, and increase the adaptive capacity of farming communities to long-term climatic trends as well as to increasing variability in weather patterns (FAO 2010). But climate-smart agriculture is not a single specific agricultural technology or practice that can be universally applied; it is a combination of policy, technology and finance that involves the direct incorporation of climate change adaptation and mitigation into agricultural development planning and implementation (FAO 2010). As such, the next section explores what challenges and opportunities Eastern and Southern African countries have faced in its promotion.

3. CSA experiences, challenges and opportunities across Eastern and Southern Africa

3.1. Introduction

There is a wide variety of agricultural practices with climate-smart potential across Eastern and Southern Africa. This section maps out a number of them, identified in individual countries. It briefly describes the agriculture and the climate change vulnerability context of each of the 15 case study countries, some of the CSA practices identified, and the potentials they offer. In addition, the section identifies key aspects in the countries' policy and governance context, challenges to greater effectiveness, and issues of gender and broader social equity.

3.2. Botswana

Nearly three-quarters of Botswana's estimated 2 million people live in rural areas and subsist on agriculture, tourism and other non-farm activities (Batisani 2012). Still, the contribution of agriculture to GDP came down from 40% in the 1960s (at the time of independence) to 2.9% in 2012. There has been low arable development, and domestic food consumption has to be met largely by cereal imports. During drought periods, those imports can reach as much as 90%. Therefore, food remains a substantial component of Botswana's import bill – paid largely by mineral (74%) and beef exports (7%).

The country thus faces a situation of food insecurity and of vulnerability to international food-market volatility (IMF 2013). This situation became clear in the early 1990s and, more recently, after the 2008/2009 economic crisis, when diamond prices plummeted due to global recession and simultaneously access to the European Union (EU) market was temporarily blocked due to foot-and-mouth disease restrictions (Batisani 2012). All these factors highlight the multifaceted nature of the country's food insecurity.

Botswana suffers from endemic droughts that are becoming more frequent and severe due to climate change. The impacts of these droughts are aggravated by widespread poverty and inequality. Its rural context is that of a "dual society", i.e. there is a large number of smallholder farmers using low technology and dependent on drought relief (together with a poor urban class that faces high unemployment rates), while water, land and cattle is amassed by an elite. This scenario, in turn, is safeguarded by an institutional structure of unequal distribution of incomes from natural resources and thus "growth without development" (Hillbom 2014).

CSA practices taking place in Botswana include, most notably, minimum tillage and the R&D of drought-tolerant high-yield crop varieties. The former is practiced particularly in the Pandamatenga dryland area, where a third of the farmers practice it. These are commercial farms of 500ha on average. Crop R&D, in turn, targets sorghum, millet, cowpeas, peanuts and maize. It focuses on drought tolerance, early maturity, pest (witchweed) resistance, and high yields.

CSA-related policies in Botswana include its National Master Plan for Arable Agriculture and Dairy Development (NAMPAADD), the Integrated Support Programme for Arable Agriculture Development (ISPAAD), and the Livestock Management and Infrastructure Development (LIMID) programme. The primary objective of the Master Plan is to develop agriculture's competitiveness and reduce the country's reliance on imports of agricultural products that can be viably produced locally. This aim is to be achieved through programmes that enable traditional/subsistence farmers to upgrade their operations to a commercial level, and at the same time assist commercial farmers to improve their level of management and technological application. The programme focuses on dairy, horticulture and rain-fed farming, and its aims include reduced vulnerability through increased productivity, and soil and water conservation. Besides such investments in management and capacity improvement, the policies have as an economic incentive VAT exemption for agricultural products and farming inputs. A Young Farmers Fund (YFF) was also launched, in 2006 to issue loans at lower interest rates and longer repayment periods to encourage youth participation in agriculture.

That said, some key obstacles remain. First, there are perverse incentives in place that hinder CSA promotion. For instance, ISPAAD pays P.500 (USD 55) per hectare for minimum tillage, but P800.00 (˜USD 88) for conventional tillage, even if minimum tillage has the potential to increase yield through soil moisture conservation and at the same time increasing soil carbon. Thus a minor alteration to the programme that equates minimum tillage payment with that of conventional tillage and augmented with demonstration sites in farmers' fields could be an option for early action on climate smart agriculture in the country.

Second, agricultural policies in Botswana have faced little uptake, and usually practices have been discontinued after subsidies have been removed. For instance, the Arable Lands Development Programme (ALDEP, 1981 to 2008) and the Accelerated Rain-fed Arable Programme (ARAP, 1985/86 to 1995/96) had almost similar objectives to ISPAAD and NAMPAADD, but there were no residual benefits from these programmes on which the current ones could build on. Farmers promptly reverted to traditional practices. Therefore, there seems to be a clear need for greater participation of farmers in CSA governance in order to ensure that policies generate uptake and produce durable effects.

3.3. Democratic Republic of the Congo

The landscape of the Democratic Republic of the Congo (DRC) is covered by equatorial rainforests in its northern and central regions, while open forest (*miombo*) and savannah cover the south. Roughly, about 70% of the population depends on agriculture for survival, even if only about 7% of the country's area is used for agriculture and livestock farming (Nsombo et al. 2012).

Congolese farmers have already noticed alteration in rain patterns, and droughts and floods are amongst the major impacts of climate change in the region. According to a survey by the Ministry of Environment, 93% of farmers find that the rainy season starts late but ends too soon (Ministère de l'Environnement 2006). Dry spells during the rainy season have also been common, as has inundation over DRC's river valleys and alluvial plains (e.g. in Katanga region). These areas are very important to agriculture due to the high fertility of their soils; therefore, such inundations have had a major negative impact on agriculture. Conventional management techniques of these moist areas, such as drainage schemes, have failed to match up to the magnitude of the problem, to the detriment of food and income security.

The most implemented CSA practice in DRC is the production and dissemination of drought-tolerant seed varieties, mainly of maize, rice, cowpea, groundnut and beans. The country has significant freshwater reserves, but irrigation is not sufficiently developed to deal with drought. Therefore, these seeds become a major adaptation strategy to secure better yields and support household food security in face of climate change. The work has been carried out by DRC's PANA-ASA project, which has operated since 2010 in four of the country's provinces: Eastern Kasai, Bandundu, Lower Congo, and Katanga. It promotes agricultural R&D around drought tolerance, provides personnel training, extension services, and drought-tolerant seeds to smallholders. But, aside from its limited reach, a difficulty has

been the excessively academic nature of that training, which hinders communication with local trainers and farmers.

Another intervention – more successful in terms of communication – has been agro-meteorological monitoring. With the support of the rural radio "Ditunga", agro-meteorological reports have been collected and transmitted to farmers across Eastern Kasai province. A similar initiative is taking place in Katanga, with the community radio "RCK". Transmissions include weather reports and also information on agroecology, seed production, water management, adaptation to climate change, and early warning. Still, technological and financial constraints remain present.

Finally, there are small-scale agroforestry initiatives, such as near the city of Lubumbashi, aiming at regenerating *miombo* forests integrated together with agriculture. However, as in other cases, these actions remain marginal. They show some ways forward, but lack of financial means or greater public policy support hinder the scaling up of such initiatives. The national budgeting process lacks transparency or substantive stakeholder participation, and public budgets remain insufficiently supportive of CSA.

3.4. Kenya

Kenya's rural landscape contains a mixture of large-scale farming, pastoralism, and small-scale farming. All have increasingly suffered the impacts of climate change, notably droughts. Large-scale farming usually has access to irrigation, for crops such as rice, coffee, floriculture, pineapples and horticulture crops. Small-scale mixed farming, in contrast, is more dependent on rainfall and, therefore, more vulnerable to climate change. This is important to Kenya because this sector accounts for 75% of its total agricultural output and 70% of the marketed agricultural produce, in addition to employing most of its rural population. Similarly, pastoralism (consisting of cattle, goats, sheep and camels) takes place primarily in the arid zones and has suffered increasing water shortage and livestock mortality.

Response measures have focused mostly on the development of new, drought-tolerant crop varieties and on new technologies for increasing productivity in the face of deteriorating growing conditions. These programmes have cushioned the affected populations against the impact of declining rainfall trends or the increasing frequency of flash floods. They include, for instance, the National Accelerated Agricultural Input Access Programme (NAAIAP) that provides hybrid seeds and fertilizers to farmers, a Fisheries Project that provides fingerlings and fish feed, among others. In tandem, there have been programmes focused specifically on promoting climate change adaptation through crop diversification, adoption of drought-tolerant varieties, uptake of high-value crops, minimum tillage, water harvesting, and various resource conservation practices.

A major gap, however, is poor coordination across programmes, among actors, and the lack of a comprehensive, overall strategy. This situation is partly the result of government restructuration after the 2010 Constitution. It transferred implementation functions to counties while retaining policy-making with the ministries. A very weak linkage exists between the county staff and the ministry headquarters

staff, and information does not flow from one level to the other in either direction. There is no systematized information on the number of projects formulated and the level of funding undertaken, actual expenditures, nature of projects, the extent to which these projects are informed by scientific findings, implementation area, etc. Multiple stakeholders participate in the Kenya Climate Change Working Group, which involves government agencies, donor parties, and civil society organizations. However, the participation of smallholder farmers and other local actors remains limited.

Lack of "two-way" communication with smallholders, in suitable language, and top-down policy-making remain key barriers to CSA promotion. Projects impose practices that are not necessarily socially acceptable, while ignoring farmers' local knowledge and preferences. For example, pastoralists where encouraged to reduce herd sizes in order to reduce vulnerability to climate change – but without getting any replacement for the loss of income and security. Likewise, the promotion of crop agriculture among pastoralists has hardly worked. Pastoralists have also suffered the most from land tenure insecurity, due to the emphasis of individual ownership, to the detriment of their traditional communal institutions. Furthermore, high-cost CSA technologies that require purchasing inputs remain inaccessible to the majority of small-scale farmers.

Lastly, gender issues also pose barriers to the majority of smallholders in CSA uptake. Constraints on women include: little control over farm decision-making bodies, insecurity of land tenure and of access to resources, low levels of literacy, limited resources to purchase inputs, and social restrictions on meeting with extension agents and accessing other sources of information. Women traders and other businesswomen, in turn, face difficulties obtaining permits, financing and services (Barrett et al. 2009).

3.5. Lesotho

Lesotho is a small mountainous country completely surrounded by the Republic of South Africa. Its altitude ranges from 1,388 m above sea level on its southwestern border to 3,482m in its eastern mountains. In total, mountains take up 60% of the country's surface and only 11% is suitable for cultivation, under a temperate continental climate. More than 77% of the population live in rural areas and depend on agriculture and livestock farming. Population pressure has resulted in increased landlessness, currently estimated at about 60%. Most farms are smaller than 1ha in size. Maize is by far the most popular crop, accounting for some 60% of the cropped area, followed by sorghum (10-20%), wheat (10%), and beans (6%).

The contribution of agriculture to the GDP, however, stands at less than 10%. This perennially forces Lesotho to appeal for assistance from the international community, thus illustrating the vulnerability of the country's agricultural sector. Crop failures are common and exacerbated by climatic hazards such as hail and early frosts. Drought chronically affects the country. Pastures are limited by intensive cultivation and relatively dense human settlement. The restricted grazing areas within the lowland zone are heavily used and significantly degraded.

CSA experiences in Lesotho have included primarily conservation agriculture and other agroecological practices. Conservation agriculture has been practiced in Lesotho since the 1970s. The system is commonly called *likoti*, a Sesotho name for "basin agriculture". It includes pit digging and direct

planting, along with some inorganic or organic fertilizer. Crop residues are retained and staple crops are rotated and/or intercropped. In the following season, seeds are planted again in the same pits. The *likoti* system has shown promise as a means of increasing yields and conserving soil and water resources (Silici 2011).

Another traditional CSA technology is Lesotho's *machobane* farming system, a form of cultivation that utilizes crop rotation, relay cropping, and intercropping practices with the application of manure and plant ash (see Mekbib et al. 2011). The system provides resources to poor farmers with a sustainable system that do not require expensive inputs, is easy to implement, and supplies them with food all year around. Its fundamentals are: the use of organic fertilizers (e.g. manure, ashes and other organic waste) to build and maintain soil fertility; perennial vegetation cover; natural pest control; relay harvesting (i.e. planting the same crop at different times, to harvest it at different times, allowing for almost year-round harvest); utilizing various crops adapted to different weather conditions (e.g. carrots, winter wheat, peas); and keeping at least one animal in the household, for manure and food (milk, eggs and meat). The rationale behind it includes farmer self-reliance based on intensive labor, appreciation of their own resources available, and collective practical learning.

Other than that, Lesotho's Agricultural Research Department has been active developing drought-tolerant crops and cultivars, but their adoption by farmers remains a formidable problem (Machepha 2010). The stakeholders consulted said more should be done to promote two-way communication between government and the grassroots farmers about climate smart agriculture. Many participants felt that climate change adaptation should be informed by successful ground-level experiences in vulnerability reduction, hence the need to involve farmers on the ground in formulating climate change policy.

Besides lack of smallholder participation, policies in Lesotho have suffered from little cross-sectoral coordination and limited means of implementation (e.g. finance, extension services). Environmental and agricultural policies exist, but without incentives to CSA.

Finally, one of the main barriers to CSA implementation – and rural development more broadly – in Lesotho's institutional framework is its gender imbalance. Section 18 (4c) of the Constitution of Lesotho explicitly discriminates against women in terms of access and use of land (See Government of Lesotho 2000; African Development Bank 2005). Makoa (1997) and the Lesotho report to the African Union Solemn Declaration on Gender Equality in Africa (Government of Lesotho 2006) note that some aspects of Basotho culture incorporated into customary law place women under the perpetual custody and protection of men (e.g. customary law proscribes women from inheriting land). The *Land Act of 2010* provides for equal title to land for both men and women; yet, according to the Deeds *Registry Act* of 1968, no land can be registered in the name of a married woman in community of property; moreover, the constitution grants customary law precedence over other law. In rural areas, cultural attitudes dictate that a man heads a family and that he has control over family property. As a consequence, women are severely hampered in their access to land and associated livestock and implements, even from inheritance.

3.6. Madagascar

Madagascar is an island country rich in natural resources, but which suffers from a lack of sustainable financing mechanisms and poor governance (World Bank 2013). About 72% of the Malagasy population depends on agriculture. In 2010, the National Periodic Household Survey found that more than three-quarters (77%) of households fell below the national poverty line, and an estimated 92% of the country's population currently lives on less than USD 2/day (World Bank 2013). There is a high level of vulnerability to climate change, notably to alteration in rain patterns and extreme weather events.

The two major CSA experiences in Madagascar are: (a) Conservation agriculture and (b) System of Rice Intensification (SRI), among others. Conservation agriculture practices have focused on maintaining soil coverage and performing crop rotations and other associations to improve fertility (National Resource Team of Madagascar 2013). That has improved soil physical properties, its mineral and biological balance, reduced weed infestation, and improved resilience to weather events. SRI, in turn, consists of a number of agronomic techniques to create optimal soil, water and nutrient conditions in order to accelerate rice seedling growth. This approach reduces water consumption, the number of seeds needed, dependence on external inputs (e.g. improved seeds or artificial fertilizers) and thus increases rice yields without significantly increasing the costs of cultivation. SRI results in twice the outputs (4t/ha) of conventional cultivation (2t/ha) (GSRI 2013).

Three major challenges remain for further uptake of such CSA practices in Madagascar. First, those techniques require material means and expertise that are not sufficiently available. For example, lack of material resources (e.g. weeders, fertilizers) and irrigation infrastructure often makes farmers opt for conventional cultivation instead of SRI. Moreover, the local price of rice is very low and, therefore, does not stimulate the required investment in intensive production. Similarly, in conservation agriculture much knowledge is needed (for instance on agronomy, waste management, etc.), and at the beginning of the project the ecological process is very low and the production can decrease – an initial period that poor farmers may find difficult to go through. Second, funding comes largely from abroad, tied to short-term projects, and initiatives are scattered. Usually there is no post-project monitoring, and farmers frequently discontinue the practice due to the lack of incomes. Third, there are public policies in support of CSA practices such as SRI and conservation agriculture, but mainly in the form of information sharing, farmer training, and extension services. The country lacks an overall, comprehensive strategy, a CSA investment framework, or regulatory and economic incentives. A *National Policy on Climate Change* exists, but it focuses more on disaster prevention and lacks policy instruments to effectively promote CSA.

3.7. Malawi

The agriculture sector is the backbone of Malawi's economy. Agriculture generates over a third of the country's gross domestic product (GDP) and 90% of its export revenues. While tobacco, sugar, coffee

and tea are Malawi's primary cash crops, maize is the primary staple crop for domestic consumption. More than 90% of the people, mainly comprising resource-poor rural communities, are predominantly engaged in subsistence rain-fed agriculture, and 60% of them are food insecure on a year-round-basis. More than 40 percent of the smallholder farms cultivate less than 0.5 hectares on average (WFP 2010). Increasing land pressure (due to population growth) has also meant that many smallholder farms are reducing or foregoing crop rotation. Continuous cultivation is the most predominant cropping system. It is characterized by low yields, with the majority of farmers growing (indigenous/traditional) varieties of maize and other crops without proper management practices or external inputs (which frequently are too expensive for smallholders to afford).

Periods of severe drought have combined with high population growth and rising inflation to increase Malawi's dependence on international aid. More than 90% of Malawians use fuel wood (firewood) for cooking (Government of Malawi 2011). The current annual rate of consumption is estimated to exceed the rate at which natural regeneration is able to replenish the stock. Forest clearing for agriculture, fuelwood and for tobacco curing is therefore a major problem and a leading cause of degradation and greenhouse gas emissions. The need for more land for cultivation, as cultivable land becomes scarce pushes farmers into marginal areas.

CSA techniques practiced in Malawi include: conservation agriculture, minimum tillage, and agroforestry. These techniques are regarded as more accessible practices than (expensive) external-input-intensive cultivation. Agroforestry as practiced in Malawi is termed 'fertilizer tree systems'. Selected tree and shrub species such as *Faidherbia albida*, *Sesbania sesban,* **Gliricidia sepium and Tephrosia vogelii** are planted either sequentially (during fallow) or simultaneously (intercropped) with an annual food crop. Doing so helps maintain soil cover, improves nutrient levels, increases soil organic matter (via the provision of mulch), improves water filtration, and provides a secondary source of food, fodder, fibre and fuel (Garrity et al. 2010). Leguminous agroforestry species such as *Sesbania sesban*, *Tephrosia vogelii* and *Cajanus cajan* (pigeon pea) are generally used due to their ability to fix atmospheric nitrogen in the soil in a form available to plants. In addition to offering potential food security benefits, agroforestry goes some way towards countering deforestation.

Quinion *et al. (*2010), after studies in the regions of Kasungu and Machinga, drew some conclusions regarding the benefits of agroforestry. Incomes were diversified due to opportunities to harvest wood for construction materials and firewood, in addition to improved yields. Intercropping of maize with legumes such as pigeon peas, cowpeas, beans, groundnuts and other crops such as pumpkins, cassava, and sweet potatoes has made farmers realise yields of up to 1215 kg maize and 545kg of soya/ha (Business Innovation Facility 2012). When intercropped with groundnuts, maize yields went up to 5330kg per ha. There are, however, constraints, as many farmers that use crop remnants for animal feed cannot afford to use them for soil cover, or they would threaten their food security (Arrington 2013). In addition, farmers need proper seedlings to engage in agroforestry, and seedlings for some fertilizer-tree species are not easily available to the farmers.

At the policy level, Malawi's *National Climate Change Policy*, *Agricultural and Food Security Policy*, and *Livestock Policy* all recognize environmental issues and the importance of sustainable agricultural

development. However, there is no guidance – let alone incentives – for practices suitable to the country's various agroecological regions. Financial resources are inadequate, and there is a lack of coordination across sectors (with clear definition of stakeholders' roles and responsibilities) or between the central government and local level institutions.

Malawian farmers, nevertheless, through farmer organizations such as the National Smallholder Farmers Association of Malawi (NASFAM), have shown interest in such CSA practices. Such interest has come mostly from women, as the focus crops (soybeans and groundnuts) cultivation require less physical strength and is frequently done by them. Yet, gender inequality has hindered the adoption of such practices. **Women's weak position in Malawian society** means that, generally, they have less access to income and credit and no voice in decision-making, making it difficult for them to find other sources of income or influence action on climate change in Malawi.

3.8. Mauritius

The Republic of Mauritius comprises the main island (Mauritius) and the Outer Islands of Rodrigues, Cargados Carajos Archipelago (St Brandon) and Agalega Islands. From a monocrop economy founded on sugarcane for sugar, Mauritius has today developed into a vibrant, middle-income country with a diversified economy based on tourism, manufacturing, offshore finance, services, and ICT. Sugarcane production is also being expanded to include power generation from sugarcane residue (bagasse), production of ethanol and special refined sugars.

Agriculture in Mauritius occupies about 40% of the land area, 90% being under sugarcane, and 10% under food crops, tea, tobacco, palm, fruit and flowers. About 70% of the sugarcane sector is under corporate management, while the remaining 30% is owned by some 22,000 small individual planters. The non-sugar agricultural sector is composed of about 6,000 small-scale planters, and 6,000 livestock keepers.

As a Small Island Developing State (SIDS), Mauritius is highly vulnerable to climate variability and climate change. A narrow resource and livelihood base, high dependence on external markets, increasing population, frequent extreme weather events, and the high risk of sea level rise, make Mauritius (as other SIDS) particularly exposed to the vagaries of a changing climate. Average rainfall has been decreasing about 100mm over the last 50 years in Mauritius. Rainfall pattern has also changed, with a delay in the onset of summer rains and a longer dry season (3-4 months, as opposed to 2 months some decades ago), and heavy rainfall has become more frequent, causing flash floods and high run-off to the detriment of aquifer recharge. With greater evaporation and lesser recharge of underground aquifers, utilizable water resources are expected to decrease by about 13% by 2050 (Republic of Mauritius 2010). Climate change is also expected to change sugarcane phenology, with higher vegetative growth to the detriment of sucrose accumulation, under conditions of increased mean temperatures and a narrowing of the day and night temperature amplitudes. The Agricultural Productions Systems Simulator Model (APSIM) predicts cane yield reductions of 34-48% and sugar yield reductions of 47-65% with a 10-20% decrease in rainfall and a 2^{o}C increase in temperature (SNC 2010).

The negative impacts of climate change, in conjunction with other causative factors, on agricultural productivity and profitability may lead to abandonment of cultivable areas, with further negative consequences such as soil erosion, soil fertility loss, land degradation, increased siltation of freshwater bodies and the lagoon in slope areas, etc. Some of the positive effects include an extension of the cropping zone for certain crop and fruit species due to the rise in temperature (e.g. litchis and mangoes can now be produced at higher altitudes than was previously possible), and production of off-season crops due to seasonal variations with consequent changes in crop phenology and productivity (e.g. litchis, mangoes, pineapples). This creates the possibility of higher prices in local and export markets, and therefore higher farm incomes.

CSA experiences in Mauritius have included a set of agroecological practices such as intercropping of food crops and ornamentals (e.g. onions with runner beans, coriander and marigold), mulching (with sugarcane or maize stalks, to improve soil moisture and prevent erosion), crop rotation, rainwater harvesting, and biological pest control. However, uptake has been limited because such practices tend to be labour-intensive, and labour is expensive in Mauritius.

The Republic of Mauritius has been proactive in tackling climate change issues. There is no specific and separate CSA policy as such, but many of the existing and proposed agricultural policies, plans and activities include elements of CSA. For instance, the *Mauritius Île Durable* policy promotes water-saving technologies such as drip irrigation, provision of free composters to farmers and households, support to farming and other associations to move from conventional farming to agroecological farming, promotion of low energy technology (solar dryers and evaporative cooling) for agro-processing, etc. Similarly, a *Food Security Fund* set up in 2008 (about MUR 1 billion, or USD 33 million) supports crop, livestock and fisheries sectors to, *inter alia,* develop coping strategies to increase climate resilience, through projects such as introduction of new crop varieties and setting up of climate-related crop insurance schemes.

Still, there is insufficient intersectoral coordination or mainstreaming of climate change into the policy instruments of other sectors that can impact on agricultural production, e.g. land allocation and land management, water management, biodiversity protection and conservation. Research on the technical issues of climate change and agriculture remains limited, too, and there is therefore insufficient local, scientifically generated data and knowledge on CSA. As a consequence, extension services are not sufficiently equipped to disseminate research findings to farmers to support their adaptation strategies. Finally, uptake of research by end-users is limited because the benefits of new technologies or approaches are not always validated for the local context, nor sufficiently demonstrated to farmers, and there are no policy incentives for the adoption of CSA practices. Unlike in other African countries, gender disparity is not significant or perceived as a hindrance to CSA in Mauritius. Yet, general risk-aversion and resistance to change among farming communities create important social hurdles to CSA promotion.

3.9. Mozambique

Mozambique covers a wide variety of agro-climatic regions in the southeast of Africa and is highly vulnerable to the impacts of climate change, due to factors such as widespread poverty, inequitable land distribution, and large dependence on rain-fed agriculture. Historical data shows that Mozambique is already undergoing climate change, particularly recurrent droughts (in the provinces of Maputo, Gaza and Inhambane) and floods (in the provinces of Gaza, Sofala, Zambézia, Nampula and Cabo Delgado).

Agriculture still falls short of adopting climate-smart practices, and agricultural policies and environmental policies are not yet harmonized or synchronized. The country has a National Adaptation Program of Action for Climate Change, a Livestock Policy and others. However, climate issues have negligible presence in those other sectoral policies, and in the national budget there is a very little climate change financing effort.

3.10. Namibia

Namibia is one of the driest countries on Earth. Much of its soils have been dry for millions of years, and low fertility constrains crop farming much as lack of rainfall. Agriculture represents only 5.1% of its GDP, yet it provides livelihoods to 70% of the population. This is particularly livestock farming, as some perennial grass species grow even in the semi-arid areas. Usually, livestock graze on common-access pastures and woodlands, from which people harvest firewood and natural plant products, too. Farming units are centered on a single household, with women doing most of the crop cultivation work (largely cereals for subsistence). Such communal farmers grow three main cereals: pearl millet (*mahangu*), sorghum and maize, and they rear cattle for draught power, meat, milk, and for financial and social security. Land distribution, however, is highly skewed, as some private commercial farms take much of the land.

Namibia has suffered greatly from pasturelands degradation over the previous decades, and that has been aggravated by increased droughts and water stress due to climate change. The main issue has been bush encroachment on rangelands, which increased from 4.56 million hectares in 1957 to 26 million hectares by 2002 (de Klerk 2004). As a result, meat production and exports have been hampered. Currently, severe droughts are also common, as is flooding in the northern communal areas, such as on the Zambezi river floodplains.

CSA practices have focused on promoting irrigation (to reduce dependence on limited and erratic rainfall) and drought-tolerant crops, such as pearl millet (*mahangu*) and sorghum. Both crops are being bred to improve production under Namibia's agroclimatic conditions.

These activities have largely been driven by government policy: *Vision 2030* and the Fourth National Development Program (NDP4), which aim to gradually diversify crop production and adapt farming to climate change. These policies have promoted such agricultural R&D and the improvement of farming practices through the public extension services.

Barriers, however, remain. Farmers and cooperatives usually are unable to take credit from financial institutions because they do not have a proper business account with financial track record to establish

viability and ability to repay loans. **Land tenure**, too, presents challenges especially for communal areas, because communal farmers cannot offer their untitled land as collateral for loans. In the end, CSA practices remain inaccessible to most farmers, due to the material constraints of governmental support and to the costs of transitioning from conventional practices.

Finally, women, despite their crucial role in smallholder farming in Namibia, face even greater challenges. They do not own property, are the least educated, and are excluded from decision-making processes and resource management and allocation. As a consequence, they benefit the least from the proceeds. Policy measures and interventions, in turn, have not specifically addressed this imbalance.

3.11. South Africa

South Africa has a dual agricultural economy, with both well-developed commercial farming and more subsistence-based production in rural areas. About 13.7% of its land is potentially arable and 68.6% is grazing land (Mukheibir and Sparks 2006). Most (14.2 million hectares) of the arable portion is devoted to commercial agriculture, while 2.5 million hectares is used for subsistence/small-scale farming by the majority of the rural population. The main crop is maize, followed by wheat, sugarcane and sunflower.

A large portion of the country is semi-arid and particularly vulnerable to the impacts of climate change on rainfall. CSA practices have included field rainwater harvesting techniques, conservation agriculture techniques (e.g. minimum tillage, crop rotation, intercropping), and the development of drought-tolerant crop varieties (e.g. maize hybrids and open-pollinated varieties). Meanwhile, the livestock sector has experiences with manipulation of feeding practices (e.g. dietary content) and animal breeding to reduce methane emissions from cattle (Campbell *et al*. 2011). In tandem, there is utilization of manure for biogas production in order to generate energy instead of greenhouse gas emissions from waste (Koneswaran and Nierenberg 2008).

South Africa has a wide range of CSA-related policies, such as the *National Climate Change Response Policy*, which describes climate response strategies for different sectors (including agriculture); rural development programmes that include, *inter alia*, redressing historical injustices and securing land to black populations; and an upcoming national strategy on agroecology. A Climate Change Sector Plan for Agriculture, Forestry and Fisheries (CCSP) was gazetted as Notice 7 of 2013, and it is the precursor of an anticipated policy on CSA. Several decision support and information tools aimed at increasing local communities' resilience to climate change impacts are also in place, the prominent one being a South African Risk and Vulnerability Atlas, which is available online.

However, implementation faces difficulties and some goals have not been achieved. For instance, the country is not on track in terms of achieving its stated goal of transferring 30% of all agricultural land to black African farmers over a 15-year period, and very few women have benefitted from it so far (Madzwamuse 2010). Land tenure is particularly problematic; access to land remains insufficient, and many who do access it have only temporary user rights. They thus are not sufficiently motivated to invest in CSA practices or any form of land improvements (Mnkeni et al. 2010).

Another issue is poor policy coherence. First, there are few incentives in place for farmers to actually adopt the practices being promoted. Second, a number of South Africa's agricultural policies conflict with each other. For example, the promotion of agroecological practices conflicts with government

efforts to promote conventional agriculture based on external inputs, machinery for soil tillage, etc. Besides creating objective conflicts, this lack of coordination also creates confusion among farmers and investors.

Some civil society organizations in South Africa warn that CSA has been framed too broadly. As such, it risks being "hijacked" by big players that could use it opportunistically to obtain government support and economic opportunities while bypassing key issues such as gender inequality or the highly skewed land ownership in the country.

3.12. Swaziland

The Kingdom of Swaziland is a land-locked country in the southeastern part of Africa, between South Africa and Mozambique. Agriculture in Swaziland is dualistically divided into commercial estates on Title Deed Land (TDL) and subsistence farms on Swazi Nation Land (SNL). The commercial sector, which occupies about 40% of the cultivated land, produces mostly export crops such as irrigated sugarcane, citrus and pineapples. Commercial estates are characterized by high levels of mechanization and irrigation infrastructure. The commercial estates generate about 81% of the national agricultural commodity value, with agriculture contributing to 8.1% of Swaziland's GDP in 2012 (Central Bank of Swaziland 2013). Crop production in SNL, on the other hand is labour intensive, rain-fed and thus more vulnerable to climate variability and climate change (Penin and Hlophe 2013). It is in such communal lands that 75% of the country's population lives, strongly dependent on subsistence agriculture and local natural resources for their livelihood (Central Bank of Swaziland 2013).

Climate change impacts are already being witnessed in Swaziland in the form erratic rainfall, droughts, and changing temperatures. These changes have direct impacts on availability of water and agriculture production. As such, some CSA practices and technologies being adopted and implemented in Swaziland include the following: conservation agriculture to maintain and improve soil fertility, agroforestry with fruit trees, and selection of drought-tolerant crop varieties (e.g. maize).

The challenges to implementing CSA in Swaziland include: lack of comprehensive climate change policy and legislation, lack of legislation to implement key food security related policies, lack of local infrastructure to support the manufacture and repairs of climate-smart equipment, inadequate capacity within the Ministry of Agriculture, a land tenure system that does not provide security over investment, traditions and culture that leave women in disadvantage, and poverty. All conservation agriculture equipment is currently imported, and expertise for repair is not locally available. Most farmers are unable to face the high upfront costs, not only of machinery but also of hybrid seeds. In turn, there are no policy incentives or market premiums for CSA production. Meanwhile, Swaziland's agricultural extension services suffer from increasing shortage of personnel and obsolete infrastructure (e.g. the number of agriculture extension officers decreased from 300 in 2003 to less than 100 at present). In Swaziland the budget allocated to agriculture has not yet reached the 10% mark: in the 2010/2011 financial year agriculture was allocated 6% of the national budget, below the 9% allocated in 2009/2010, but above the 3.5% allocated for the 2014/2015 financial year (Shongwe 2010; Nkambule 2014).

The other challenges stem from traditional institutions. Under the traditional land tenure system (SNL), the king owns all the land. Through local chiefs, plots are allocated to household heads for housing and

farming. However, users do not formally own the land and cannot use it as collateral for obtaining loans to develop their faming activities. As such, the farmer also lacks security that would encourage investing in CSA. Moreover, this system discriminates against women. Despite their constitutional rights, in practice traditional rules still have precedence. As a result, women still fail to obtain land from local chiefs – even when they are the household head (in such cases, the land may go to a male son or another relative).

3.13. Tanzania

Tanzania is located on the eastern coast of Africa, south of the equator. Its eastern side is a coastline of about 800 km long marking the western side of the Indian Ocean. Tanzania has about 88.6 million hectares of land suitable for agricultural production, including 60 million hectares of rangelands suitable for livestock grazing (United Republic of Tanzania 2007). However, part of this land is only marginally suitable for agricultural production and livestock grazing because of factors such as drought proneness and tsetse infestation. Currently, only 23% of the arable land is under cultivation, and 97% of that is rain-fed. As for the rangelands, only 50% is used for livestock grazing (United Republic of Tanzania 2001).

Like many other developing countries, Tanzania's agriculture is more vulnerable to climate change adverse impacts due to its dependency on rainfall. The adverse impacts of climate change already being experienced in Tanzania include reduced crop yields due to drought and floods, reduced water availability, and increased occurrence of crop and livestock pests and diseases.

CSA practices in Tanzania include: traditional rainwater harvesting, community-based irrigation schemes, rice cultivation intensification, mixed farming systems, agroforestry, and utilization of drought-tolerant crop varieties and livestock breeds. A main example of a traditional rainwater harvesting technique in Tanzania are the *majaluba* fields, which consist of making canals in the soil and relying on gravity to irrigate crops (e.g. maize, rice) with rainwater. A successful example is the *Mwega Irrigation Scheme* in Kilosa Morogoro, which counts on a community management system based on water use groups. It is operated and maintained by a water-use fee collected from members and provision of labour through communitarian work (Rwehumbiza et al. 2007). At Mwega a wide range of crops (e.g. maize, rice, and vegetables such as onions and sweet pepper) are produced, thus capturing a broader market.

Other CSA practices include terrace cultivation (e.g. *ngoro*, or *matengo* pits) that uses organic material to reduce erosion and improve soil fertility (Rwehumbiza and Mahoo 2002); a mixed farming system of coffee, banana, and intensive animal keeping system in Kilimanjaro, Kagera and Mbeya regions, where manure from the livestock is used as organic fertilizers and the animals consume crop residues (banana peels, pseudo-stem and leaves); and multi-story agroforestry systems using crops such as beans, cassava, yams, vegetables, leguminous and fruit trees (e.g. mango, avocado, citrus). In some cases, biogas is also produced from cow dung for local energy provision, reducing fuelwood harvesting and deforestation.

The utilization of drought-tolerant breeds and varieties in Tanzania has relied now only on breeding R&D, but also on the selection of more resistant foreign or indigenous types (e.g. of maize, cassava,

sorghum, millets, sweet potatoes, as well as more resistant livestock breeds such as *mpwapwa*). For instance, new bananas cultivars (e.g. *Malindi*, *Mtwike*, *Fia*) have been introduced in Kagera region and have performed better than the traditional *matoke* cultivar under the changing climatic conditions. Still, other indigenous crops such as yams and cocoyam remain un-promoted despite their inherent potential to perform well under the changing climate that is irregular and unreliable. Meanwhile, Tanzanian pastoralists have been shifting from cattle to goat and sheep farming, as these animals need less water, can consume rougher fodder, and thus are more resistant to droughts.

Tanzania has policies that implicitly recognize the importance of CSA, such as its Tanzania Development Vision 2025, the National Climate Change Strategy, and its National Adaptation Plan of Action. Support comes in the form of subsidies to farm inputs, agricultural R&D and extension services. However, the effectiveness implementation remains limited. There is no robust framework to coordinate interdependent activities from different ministries and sectors in relation to CSA. Moreover, implementation faces limited funding, poor law enforcement, and a proliferation of fake or substandard agricultural inputs that have undermined the effectiveness of government subsidies. Finally, despite having their land rights enshrined in law, customary small landholders in practice get frequently trampled by large-scale land investments and fall victims of violent land conflicts.

3.14. Uganda

Agriculture is the most important sector of Uganda's economy. It employs about 65.6% of the population aged 10 years and older. In 2010/11, the sector accounted for 22.5 percent of total GDP. Agricultural exports accounted for 46 percent of total exports in 2010 (MAAIF 2011). The sector is also the basis for much of the industrial activity in the country since most industries are agro-based. Even though its share in total GDP has been declining, agriculture remains important because it provides the basis for growth in other sectors such as manufacturing and services. It is also the sector that provides equal opportunities for employment for both men and women in Uganda.

CSA experiences in Uganda involve primarily conservation agriculture techniques, such as minimum tillage, permanent soil cover, crop rotation, and agroforestry (e.g. alley cropping using *Calliandra* or *Sesbania* tree species with maize or finger millet). However, uptake is low. There has been increasing pressure from careless farming practices (e.g. cultivation on river banks and steep hill slopes) that have caused environmental degradation. Farmers frequently lack awareness of the full implications, and extension services remain limited. Moreover, such services have usually been characterized by top-down transfer of knowledge, without sufficient understanding of local problems, and heavy dependence on "demonstration plots" managed by outsiders. A successful experience in addressing those problems is the Transboundary Agroecosystem Management Program (TAMP), a FAO-funded project in the Kagera river basin, which has adopted a Farmer Field School (FFS) approach. It is based on first-hand, experiential education on agroecology principles and based on farmers' interests, needs, and concerns.

The country has overarching policies with links to CSA, such as Uganda's *National Climate Change Policy*, *National Agriculture Policy*, and the *National Land Use Policy*. However, conservation regulations lack adequate enforcement, there are no economic incentives to CSA practices, and the funding and training for agricultural R&D and extension services remain limited. Most initiatives are handled by NGOs or the

private sector. There are experiences with drought-tolerant maize varieties and cassava value-chain development, but both need further support. Overall, policy-making has lacked the necessary involvement of multiple stakeholders to understand better the realities on the ground; currently, stakeholder involvement tends to be limited to the implementation phase, in a top-down fashion.

3.15. Zambia

Zambia is a landlocked Southern African country with over 20% of its GDP coming from agriculture. It has maize as its staple crop, but Zambia also produces sorghum, millet, paddy rice, wheat, cassava, groundnut, sunflower, and soybeans at important scales. Yet, most Zambian farmers are limited to subsistence agriculture. They are the ones most vulnerable to a changing climate, which in Zambia takes the form of droughts and erratic rain patterns. It is predicted that maize yields – the staple responsible for half the caloric intake of Zambians (Dorosh et al. 2009) – may decrease as much a 30% (and wheat 15%) in the absence of effective climate change adaptation measures (Lobell et al. 2008).

Initial CSA experiences in Zambia have included the promotion of conservation agriculture and agroforestry. Conservation agriculture (CA), in particular, has received government extension support and accompanying subsidized inputs that have swayed many farmers into it. Nevertheless, it is important to observe whether no-till agriculture does not pose an undue burden on women, who are traditionally in charge of weeding in Zambia's rural areas (Kaczan et al. 2013). Innovations in the technological components of CA such as ox and tractor drawn implements and the use of herbicides (whose environmental impact is still to be determined through ongoing research on soil health) may reduce that impact.

One key determinant to the adoption of CSA practices in Zambia is the affordability of forefront investments. Such investments are needed, for one, because of the gestation period required for some of those practices to start yielding the expected benefits over several seasons (especially for the agroforestry technology components of CSA).

Relevant policies include a *Disaster Management Act*, a *National Climate Change Policy*, and a *National Climate Change Response Strategy*. Climate change issues have also successfully become a concern for policies in other sectors, such as agriculture. However, there is still a need for greater coordination to avoid duplication and build effective synergies. In addition, there is a need for greater stakeholder involvement in policy-making. At present, such involvement essentially occurs at the time of implementation, hindering any sense of "ownership" or representation in the policy and thus posing barriers to CSA uptake.

3.16. Zimbabwe

Zimbabwe is a country of largely sub-tropical climate (due to its altitude) in Southern Africa. As in other cases across Sub-Saharan Africa, agriculture plays a major role in the national economy and the maintenance of millions of livelihoods. It is estimated that agriculture contributes about 14% of Zimbabwe's GDP, 40% of its foreign currency earnings, 35% of all formal employment and 36% of industrial raw materials (Muir-Leresche 2006). The main crops are maize (the country's staple crop) and cash crops such as tobacco, coffee, tea, sugarcane, cotton and groundnuts. The country also has a small

commercial beef and dairy industry, though smallholder farmers rear mostly goats and particularly sheep. Smallholders make up more than 7 million of the country's population of 12 million. They are the ones most affected by erratic rainfall, droughts, low soil fertility and weak governance.

Government, international research organizations and universities, and NGOs are implementing many CSA initiatives. These initiatives have included R&D and dissemination of drought-tolerant crop varieties and livestock breeds, diversification of crop production (away from crop types and varieties that are susceptible to moisture stress), animal production diversification through the promotion of small livestock and breeds that are drought tolerant, promotion of climate change adaptation-related agronomic practices such as conservation agriculture, and promotion of climate change mitigation agricultural production such as organic farming. These activities are spread across nearly the entire country, involving thousands of vulnerable households. However, such initiatives remain largely isolated and lack a comprehensive, coordinated strategy.

Despite some awareness, climate change issues in Zimbabwe have not yet been mainstreamed into land-use planning and agriculture. There are useful policy initiatives, such as the Climate Change Response Strategy formulated by the Ministry of Environment, Water and Climate, which recognizes agriculture as a key sector. However, the ministry responsible for agriculture has not yet had the drive to mainstream CSA in its policies. As a result, incentives are not streamlined with climate concerns. Similarly, environmental policy-making has counted on substantive stakeholder consultation and involvement, unlike agricultural policy.

4. Conclusions and Recommendations

Climate-smart agriculture (CSA) is a pressing need across the world, notably in Africa. The livelihoods, food security and economic development of millions of rural households depend on the ability to overcome poverty while adapting to climate change. In addition, particularly in more developed regions, farming can and should be made climate-friendlier, as part of a broader effort towards sustainable agriculture. This includes adopting techniques and strategies that minimize the emission of greenhouse gases while providing for food security and other socio-economic needs.

This comparative assessment of CSA-related practices and policies in 15 countries of Eastern and Southern Africa gives not only a view of the state of the art, but it also indicates challenges and ways forward for countries wishing to promote CSA. It has revealed that the onset impacts of climate change – particularly droughts, floods, and other alterations in rain patterns, with mainly negative consequences on agriculture – are already being perceived both by formal experts and rural populations in those countries. Yet, the promotion and the uptake of CSA practices remain limited. All countries have examples of both traditional and research-based agricultural practices that can be deemed climate-smart, but they are not mainstreamed and still receive limited support. Such practices include both agroecological techniques (e.g. mulching, intercropping, agroforestry, mixed farming) and from

agricultural biotechnology R&D, such as high-yield and/or drought-tolerant crop varieties and livestock breeds.

The challenges to better CSA promotion in Eastern and Southern Africa include the following. Firstly, **(1) material capacity and human resources are limited**. There are not only (**1a**) financial constraints, but also (**1b**) technological ones. Technology is usually imported and patented, such as improved seeds or equipment for which repair – let alone manufacturing – expertise is not locally available. Even for some agroecological approaches, such as in the case of machinery designed for conservation agriculture and small-scale farming, technology is either unavailable or imported. This incurs high costs for farmers and countries that are already financially constrained, besides continuous external dependence. Finally, in many African countries there is a perceived (**1c**) lack of extension staff numbers and CSA training. In some cases, this is aggravated by little willingness to revise their practices and embrace CSA.

Secondly, although the impacts of climate change are generally recognized, there is **(2) poor policy coherence**. This means (**2a**) a lack of adequate economic or regulatory incentives to CSA even when climate change adaptation and agricultural development are enshrined in public policy and recognized as national or regional priorities. Such policies generally provide an umbrella and overall goals, but often without specific policy instruments to realize them. In addition, there is (**2b**) insufficient cross-sectoral coordination, and sometimes conflicts. For instance, normally different ministries or departments handle climate and agricultural policies, and they are usually *not* synergistic or streamlined. In many cases, there are (**2c**) perverse incentives that hinder the promotion of CSA practices (e.g. in Botswana there are larger subsidies to conventional tilling than to no-tillage agriculture).

Thirdly, there is **(3) insufficient participation from smallholders, particularly women, in governance**. The norm has been (**3a**) top-down policy-making and, most frequently, (**3b**) "one-way" extension services where smallholder farmers are told what to do but seldom heard, let alone taken on board in policy- and decision-making. As such, policies have frequently failed to meet the needs, views, preferences and interests of poorer farmers, leading to low social acceptability and uptake. (**3c**) Women, in particular, continue to be systematically disadvantaged even though they play vital roles in Africa's agriculture. Discriminatory patriarchal traditional institutions have persisted even in contexts where legislation enshrines gender balance, hindering or preventing women from, e.g., owning or inheriting land, taking credit, or participating in decision-making.

All these challenges pose important barriers to the advance of CSA in Eastern and Southern Africa, but they are not insurmountable. Overcoming those challenges requires concerted, focused action from public and private actors, both domestically and at the international level. Some recommendations include the following. Firstly, there needs to be **greater budgetary allocation and (public and private) investments in CSA**, measuring up to the magnitude of the challenge and to the importance of agricultural development in those regions. North-South and South-South cooperation, therefore, have key roles to play, boosting those investments. For one, this could take place as finance for Reducing Emissions from Deforestation and Forest Degradation (REDD+, under the UNFCCC), which requires addressing agriculture as a deforestation driver and making it more sustainable. However, such cooperation should take place with a view to promoting **further human and technological development in Sub-Saharan Africa – not external dependence**. That can be achieved through capacity enhancement

and technology transfer that go beyond the exportation of technological products (e.g. machinery, improved seeds), but which rather seek to promote endogenous African scientific and technological development that builds on the local CSA *know-how* available. In the longer run, it is vital that such investments also build **value-addition industries** to ensure the economic development of Africa on a climate-smart basis.

Secondly, governments should put in place policy frameworks that are conducive and effectively incentivize CSA. A first step is to **revise existing policies** (e.g. subsidies, tax breaks, credit) to **eliminate perverse incentives**, then to align them with CSA. In addition, there needs to be **coordination across different ministries** and among different sectoral policies to reduce conflicts and create synergies towards CSA. This can be facilitated by the creation of intersectoral committees, think-tanks or communities of practice with multiple stakeholders, and eventually joint policies.

Thirdly, CSA promotion strategies need to ensure **equitable participation in governance**, both for the sake of fairness and of effectiveness (through greater social acceptability and uptake. That requires the **meaningful inclusion of smallholder farmers and other weaker actors in agenda-setting**, policy and decision-making regarding climate change adaptation and agricultural development. An essential requirement to achieve this is the **creation and strengthening of smallholder farmer associations**. In the same vein, Eastern and Southern Africa needs "two-way" extension services to promote an exchange and the mutual strengthening of scientific *know-how* and the traditional agricultural knowledge available. Finally, cutting across all these measures is a revision of all gender-discriminating policies and institutions, particularly with respect to women's rights over land, over other means of production, and their participation in decision-making. When these barriers stem from traditional norms, a way forward may be to obtain the support of traditional authorities such as monarchs or tribal chiefs, who may join the cause and become powerful advocates. (These challenges and respective recommendations are summarized on Table 1).

Table 1 – Synthesis of challenges and recommendations for CSA promotion in Eastern and Southern Africa

Main challenges	Specific challenges	Recommendations
Limited Material Capacity and Human Resources	Financial constraints	Public and private investments through greater budgetary allocation and North-South and South-South cooperation on CSA; value-addition wherever possible, to improve economic development
	Technological constraints	Focus on endogenous human, scientific and technological development in Africa; transfer of technology know-how, not just products
	Limited human resources (e.g. extension staff)	Training of scientists, technicians, and extension staff on CSA, with adequate investments in material means and personnel
Poor Policy Coherence	Lack of adequate policy incentives	Create regulatory and economic incentives that give "teeth" to climate and agricultural policies to effectively promote CSA
	Insufficient cross-sectoral coordination	Promote synergies among different ministries, departments and stakeholders through the creation of think-tanks, intersectoral committees, and/or multistakeholder communities of practice
	Perverse incentives	Revise existing policies to eliminate perverse incentives that hinder CSA
Weak participation of smallholders (notably women)	Top-down policy-making	Create and strengthen smallholder farmer associations, and bring them on board in governance for CSA
	One-way extension services	Ensure two-way extension services to benefit both from scientific, research-based and traditional knowledge
	Gender imbalances	Revise existing policies and institutions that put women in disadvantage, notably in their rights over land and of access to decision-making

All in all, Eastern and Southern Africa hold great potential for CSA, but this potential needs to be further explored. The region has a large number of traditional agricultural practices as well as research-based programmes and techniques that have CSA qualities. However, barriers remain both in material terms and in the policy realm. CSA promotion thus requires concerted action from multiple actors, but perhaps most notably from governments themselves – and from non-state actors who can work as advocates of CSA. To the same extent that climate change poses an enormous challenge to African agriculture, it may bring about an opportunity to transform it – not simply to change its material basis, but to shift its policies, institutions, and development strategies in the direction of sustainability and of a food-secure future free from poverty.

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