Stakeholder Knowledge and Scientific review on

Sustainable Agriculture Intensification, Extension and Advisory Services and Institutional Approaches in Africa

(Deliverable 1.1)

European Commission | Horizon 2020 European Union funding for Research & Innovation

This project has received funding from the European's Union H2020 research and innovation programme under Grant Agreement No. 727201

DOCUMENT SUMMARY		
Project Information		
Project Title:	Innovations in Technology, Institutional and Extension Approaches towards Sustainable Agriculture and enhanced Food and Nutrition Security in Africa	
Project Acronym:	InnovAfrica	
Call Identifier:	H2020-SFS-2016-2	
Grant agreement no.:	727201	
Project duration	Starting date 01.06.2017	End date: 31.05.2021
Web--Site address:	www.innovafrica.eu	
Project coordinator:	Norwegian Institute of Bioeconomy Research	
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Report Information		
Deliverable name:	Report on Stakeholder Knowledge and Scientific review	
Editor (s):	Mehreteab Tesfai and Donald Njarui	
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Deliverable Number:	D1.1	
Work Package:	WP1	
WP Leader:	Kenya Agricultural & Livestock Research Organization	
Task Number:	1.1	
Task Leader:	Kenya Agricultural & Livestock Research Organization	
Dissemination Level:	Public	
Deliverable Nature:	Report	
Delivery Date	31.07.2018	

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List of Acronyms

CA	Conservation Agriculture
CAADP	Comprehensive Africa Agriculture Development Program
CDI	Centre for Development Innovation
CKWs	Community Knowledge Workers
COMESA	Common Market for Eastern & Southern Africa
CSA	Climate Smart Agriculture
DESA	Dietary Energy Supply Adequacy
EAC	East African Community
EASs	Extension And Advisory Services
ECOWAS	Economic Community of West African States
EFI	Eco-functional intensification
EGS	Early generation seed
EI	Ecological intensification
ESS	Ecosystem Services
FAO	Food and Agriculture Organization
FFS	Fasrmer Field Schools
FNS	Food and nutrition security
GDP	Gross domestic product
GR	Green Revolution
ICT	Information and communication technology
IIAs	Innovative Institutional Approaches
IOC	Indian Ocean Commission
IPM	Integrated Pest Management
IPRs	Intellectuals property rights
ISSD	Integrated seed systems development
IWRM	Integrated Water Resource Managment
MAPs	Multi-actor Platforms
NEPAD	New partnerships for Africa development
NGOs	Non Governmental Organzations
PPB	Participatory Plant Breeding
QDS	Quality Declared Seeds
SA	South Asia
SADC	Southern African development community
SAIs	Sustainable Agriculture Intensification systems
SAP	Structural adjustment policies
SDGs	Sustainable Development Goals
SEI	Socioeconomic intensification
SI	Sustainable Intensification
SPCs	Seed Producers Cooperatives
SSA	Sub- Saharan Africa
SSMP	Sustainable Soil Management Programme
VAD	Vitamin A deficiency

PART- I : General Introduction

The first part of this report gives an overview of the state of agriculture and food and nutrition security (FNS) challenges for Africa in general and in particular for sub saharan Africa (SSA). Further, the report briefly assessed the general performance of the four dimensions of FNS in SSA. It also outlines the policy responses and programmes by the African governments towards achieving FNS. This was followed by describing the concept of various forms of sustainable intensification systems including the sustainable agriculture intensification systems (SAIs), agriculture extension and advisory services (EASs) and innovative institutional approaches (IIAs). In general, Part I of this report reviews the various agriculture technologies, extension and institutions approaches implemented and promoted in the past and present in Africa and other relevant regions of the world. A detailed descriptions is provided in the second part of this report by six case study countries of the InnovAfrica project.

1 The State of Agriculture & Food Security in Africa

Mehreteab Tesfai

1.1 The State of Agriculture

Today, Africa accounts for 1.25 billion people which is approximately 16.4 percent of the total world population. In particular, the population of Sub-Saharan Africa (SSA) is estimated to reach 1.2 billion by 2030 and it is projected to quadruple to roughly 4 billion by the end of this century (AGRA, 2016). To feed these burgeoning population, balancing the food supply with the food demand (Table 1) while preserving the natural resource base and enhancing social and economic welfare is a challenging task (Toenniessen *et al.*, 2008). Agriculture in Africa has a great potential to provide adequate food supply while at the same time enhancing ecosystem services (FAO, 2017). About 60 percent of the rural population in SSA depend predominantly on agriculture for their livelihoods (AGRA, 2013; Toenniessen *et al.*, 2008). The agriculture sector accounts on average for 25 percent (ranging from 3 percent in Botswana to 50 percent in central Africa) of the gross domestic product (AGRA, 2016) and it provides on average more than 10 percent of the export revenues (Sasson, 2012). In addition, agriculture contributes to the development of national economy and social development through job creation and a source of raw materials for many other sectors. SSA's agriculture grew more than 1 percent in the mid-1980s than during the period between independence (in 1960s) and the launching of structural adjustment programmes in the 90s (Graaff et al., 2011). The contribution of agriculture to food and nutrition security (FNS) has been meagre and progress made so far is slow despite the immense natural resources and productive assets available in the continent.

Table 1.1 Overview of demand & supply-related FNS challenges in SSA

Demand Challenges	Supply Challenges
• SSA has a population of around 950 million, with an average annual growth rate of 2.5 percent (UN, 2010) • The population in SSA will almost double by 2050, to close to two billion people (UN, 2010) • About 50 percent of the population will live in cities by 2030 (Null, 2011) • Over 200 million people of the African population are now classed as hungry (FAO, 2012) • Despite declines up to 2007, hunger levels have been rising 2 percent per year since then (FAO, 2012) • About 40 percent of children under the age of five in SSA are stunted due to malnutrition (ChildInfo, 2013) • Incomes are rising with GDP per capita in SSA expected to reach $5,600 by 2060, and diets already beginning to change (Roxburgh, et al. 2011) • Between now and 2100 three out of every four people added to the planet will live in SSA (Null, 2011)	• SSA farmers lose eight million tons of soil nutrients each year, estimated to be worth $4 billion (Toenniessen *et al.*, 2008) • Nearly 3.3 percent of agricultural GDP in SSA is lost annually because of soil and nutrient loss (FAO, 2015a) • On present trends, African food production systems will only be able to meet 13 percent of the continent's food needs by 2050 (Global Harvest Initiative, 2010) • Cereal yields have increased by over 200 percent in Asia and Latin America but only by 90 percent in Africa between 1961 and 2011 (FAO, 2010) • In SSA, on average only 4 percent of cultivated land is irrigated (AGRA, 2016) • Between 1991 and 2009 per capita arable land fell by about 76 m^2 per year (IFPRI, 2012) • In SSA only about seven million ha of new land have been brought into cultivation between 2005 and 2010 (Farm foundation, 2011) • With no adaptation to climate change, total agricultural production will reduce by 1.5 percent in 2050 (Calzadilla *et al.*, 2009)

One of the underlying causes for meagre contribution to FNS and slow agriculture development in SSA is the low productivity of smallholder agriculture which in itself is affected by a range of factors including unsustainable land management practices, lack of access to affordable yield-enhancing inputs (especially quality seeds of improved varieties and fertilizer packets), post-harvest losses and food waste. In addition, factors such as weak support services in research, extension and finance, market imperfections combined with inappropriate policies, inefficient value chains, climate change and increasing climate variability (e.g. droughts and floods) exacerbates the problem of food shortage in SSA. As a result, malnutrition is rampant among children under 5 years of age and extreme poverty is persistent and pervasive in SSA (Table 1.1).

1.2 The State of Food Security

Despite some progress made since the last two decades, food insecurity remains one of the major challenges for SSA. In general, the prevalence of severe food insecurity in SSA is 26 percent of the total population but across sub regions, it is highest in central Africa (31 percent) followed by eastern Africa (28 percent), western Africa (23 percent) and southern Africa (20 percent) (FAO, 2016). The situations in SSA as a whole can be briefly assessed taking into account the general performance of four dimensions of food security and nutrition namely food availability, access to food, food utilization, and food stability.

i) Food availability: Defined as the ability to have sufficient quantities of food on a consistent basis which is fundamental to the achievement of food security and improve nutrition (FAO, 2017). The average Dietary Energy Supply Adequacy (DESA) is one of the key indicators used to determine whether or not undernourishment in a country is primarily due to insufficient food supply. For SSA as a whole, the index of DESA was 111 over the period of 2014-2016, meaning that sufficient availability of food was provided that effectively covered energy consumption needs (FAO, 2017). But, this does not mean that many of the population had access to the food supply simply because they cannot afford and/or not access.

ii) Food accessibility: The capacity to have sufficient resources – physical and economic-to obtain appropriate foods for a nutritious diet. Gross domestic product (GDP) per capita provides an indication of the likelihood of economic access to food markets and a good road network is essential for physical access to food markets by households. The average GDP per capita in SSA as a whole was US$ 3400 in 2014 which is three times lower than Asia and Latin America. It was even less than US$1000 International Purchasing Equivalents in several countries of SSA which could limit food accessibility (FAO, 2017).

iii) Food utilization: Proper food utilization implies that food is handled, prepared, stored and eaten in a healthy environment. It is assessed by the percentage of the population that has access to essential services such as improved water sources, sanitation facilities and electricity. Africa in general, particularly SSA still suffers from improper food utilizations that has resulted to a multiple burden of malnutrition namely under-nutrition, overweight/obesity, and micronutrient deficiency, despite some progress made over the last two decades (FAO, 2017; FAO, 2015b).

Progress in reductions of the proportions of undernourishment has been more impressive all over the world including for SSA (FAO, 2016). However, the prevalence of undernourishment

(in the number of people and percentage) was the highest in SSA over the last two decades and is projected to continue by 2030 (Figure 1.1). For example, the total number of undernourished people continues to increase in SSA with an estimated 217.8 million in 2014-2016 compared to 175.7 million in 1990-1992 (data not shown). This means that the target of ending hunger, achieving food security and improved nutrition by 2030 (Sustainable Development Goal, SDG) 2), would not be met (not even by 2050) under the *business-as-usual scenario*. So, what kind of production system should we apply in order to achieve SDGs 1, 2 and other relevant SDGs set by UN 2030 agenda? What should be avoided is a *one size fits all approach or one-size-fits-all solution* since SSA has a large agro-ecological diversity and farming systems (AGRA, 2016).

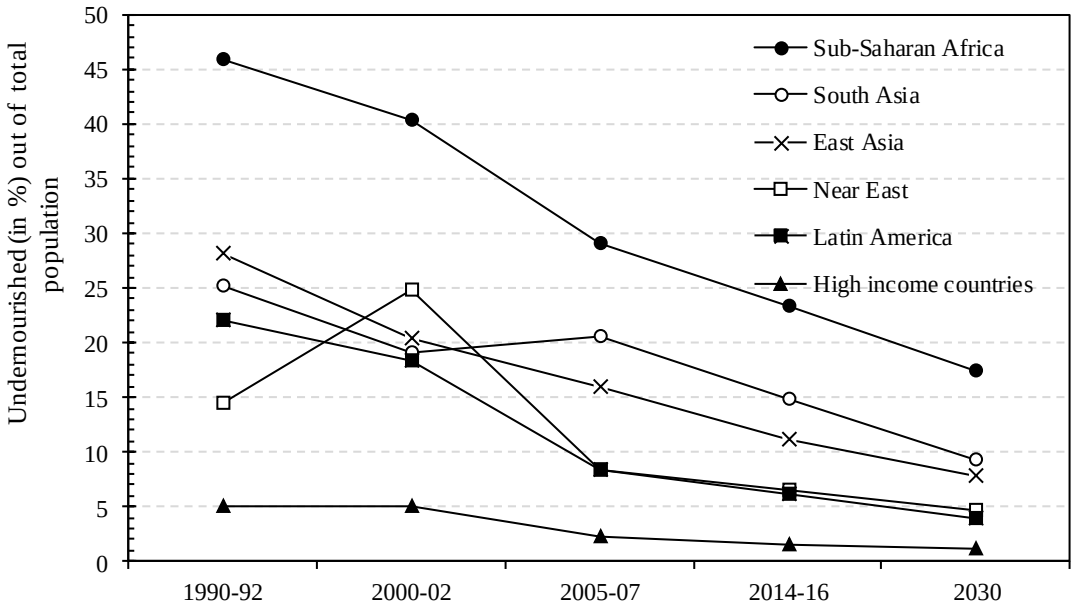

Figure 1.1 Reductions in the proportion of undernourished (percent) out of the total population during 1990-2016 and projections for 2030 in a business-as-usual scenario. Source: FAO Global Perspectives Studies, based on FAO, IFAD; and WFP (2015)

iv) Food stability: Food stability is a state when the household is not at risk of losing access to food at all times as a consequence of sudden shocks like economic or climatic crises (AGRA, 2016). A number of indicators are used to measure exposure to shock and vulnerability including cereal import dependency ratio and percentage of arable land equipped for irrigation development for instance in the case of Ethiopia (Tesfai *et al.*, 2015). In general, over the last two decades, food insecurity was the highest in SSA compared to Asia and Latin America. However, it is projected that food security situation in SSA is projected to improve considerably in the next decade (but more slowly than in other regions) taking into account the various policies and programmes initiated by African governments (Birgit and Karen, 2017).

1.3 Support to Agriculture development and Food Security

African governments have developed a range of policy responses and programmes towards the achievement of regional, sub-regional and country levels food and nutrition security. Some of these policies and programmes objectives and targets are briefly described below.

i) The AU Agendas 2063 for long term development: The agenda sets development vision over the next 50 years towards a prosperous Africa based on inclusive growth and sustainable development, among other things. For instance, under Malabo Declaration on "*Accelerated Agricultural Growth and Transformation for shared Prosperity and Improved Livelihoods*", African Heads of State and Government pledged to end hunger by the year 2025 through doubling current agricultural productivity levels, reducing postharvest losses and waste by half the current level and also allocating 10 percent of the total budget to agriculture (FAO, 2017; DeGhetto *et al.*, 2016).

ii) African Regional Nutrition Strategy: This is a continental roadmap that enhances and promotes nutrition for 2016-2025 through setting clear targets that include the attainment of 40 percent reduction in stunting, 50 percent reduction of anaemia, 5 percent reduction in wasting among children under 5 years of age by the year 2025 (FAO, 2017).

iii) The 'Feed Africa' strategy of the African Development Bank: This strategy enhances a competitive and inclusive agribusiness sector that creates wealth, improves lives and protects the environment in the next decade, i.e. 2016-2026 (FAO, 2017; ADBG, 2016).

iv) Tripartite Free Trade area Agreement: This agreement was signed by COMESA, EAC, and SADC to benefit from liberalized intraregional trade and to boost the flow of goods and services among member states (FAO, 2017; Siziba, 2016).

v) Policies on agricultural investment plans in middle Africa: The policies aim at enhancing agricultural productivity in key value chains (VCs); better natural resource management; promotion of a favourable policy framework; and enhancing the overall food balance and nutritional status (FAO, 2017).

vi) Policies for FNS in southern Africa: The objectives are to promote sustainable agricultural growth and socioeconomic development; and ameliorate private and public sector investment in the agricultural VCs (FAO, 2017).

vii) The SADC industrialization strategy and roadmap (2015-2063): The strategy is to transform SADC region by way of industrialization, modernization, upgrading and closer regional integration. But, the strategic thrust must shift from reliance on resources and low cost labour to increased investment and enhanced productivity of both labour and capital (FAO, 2017).

viii) The Regional FNS programme of the Indian Ocean Commission (IOC): The objectives of the programme are to promote agricultural products of common interest in the region and improve the production of basic food stuffs through increase productivity, output, competitiveness and trade between the islands, as well as to improve FNS and resilience in the Indian Ocean States (FAO, 2017).

ix) Economic Community of West African States (ECOWAS) regional policies and programmes: The goal is to stimulate increased investment and sustainable inclusive agricultural growth and guaranteeing food security and food sovereignty by 2025. As such, it focuses on three sectoral priorities: i) regional integration of production and trade in livestock and livestock products; ii)

adoption of sustainable intensification pathways adapted to the diversity of ecosystems; and iii) promotion of value chains (FAO, 2017).

x) The Zero Hunger Initiative for West Africa: The aim of the initiative is to increase the promotion of the right to food into concrete actions on the ground through concerted and coordinated investment, promoting nutrition-sensitive and climate smart agriculture (CSA), gender-responsive interventions as well as social protection strategies and programmes (FAO, 2017).

xi) East African Community (EAC) vision 2050: The goal is to improve the various agricultural practices including mechanization, irrigation, improved seeds and use of fertilizers thereby ensure increased productivity for FNS as well as economic prosperity of the population (FAO, 2017; EAC, 2015).

1.4 Options to agriculture development and food security

The agricultural productivity in Asia and Latin America on average has tripled between 1960 and 2015, owing in part to increased agricultural productivity by Green Revolution (GR) technologies that were implemented in late 1960s and 1970s (FAO, 2010). However, this was achieved at a heavy cost to the natural environment and ecosystem services (FAO, 2016). The transfer of the GR of Asia and Latin America to Africa had limited success, due to various reasons but mainly poor governance and inappropriate structural adjustment policies (SAP) that were implemented in 1980s and 1990s. The SAP made public administrations and their services inefficient and often corrupted (Dawson *et al.*, 2016; Sasson, 2012; Heidhues and Obare, 2011). In addition, climate vagaries, soil-related constraints, political instability and civil unrest have also contributed to the failure of GR in Africa (FAO, 2017).

Since then, several researchers, policy makers and development agencies have proposed a new GR to Africa. In relation to this, what are the lessons to learn from previous GR? Do we need a GR that is based on the principles and practices of sustainable intensification of agriculture or other intensification approach? These and other related issues are addressed in the next chapter. Moreover the chapter provides a discourse on the various intensification approaches that have been implemented and promoted in Africa and other relevant regions of the world.

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2 Sustainable Agriculture Intensification Systems

Mehreteab Tesfai

2.1 Introduction

One of the greatest challenges facing humanity today is food and nutrition insecurity. About 63 percent of the current world population (i.e. ~7.5 billion) is food insecure, of which 11 percent is hungry, 27 percent is deficient in micronutrients and 25 percent is suffering with obesity and overweight (IPES-Food, 2016). The most food insecure regions of the world are the people living in Sub Saharan Africa (SSA) and South Asia (SA) and the most food insecure people are the smallholder farmers. The main drivers impacting food and nutrition security (FNS) in Africa are population growth, inappropriate policies and socioeconomic forces that include poverty, inequality, inadequate use of agricultural inputs and weak agricultural extension services as well as adverse environmental factors such as climate change, extreme weather events, and land degradation (EU, 2016; NEPAD/CAADP, 2003). At the policy level, the Comprehensive Africa Agriculture Development Program (CAADP) agenda of the African Union aims at ensuring food security and economic growth through agricultural intensification, and places emphasis on protection of the natural capital through the judicious application of sustainable land and water management practices underpinned by enabling environment (Bwalya *et al.*, 2009).

2.2 What is Sustainable Intensification?

To meet the increasing demand for food, leading scientists have called for "sustainable intensification (IAASTD, 2009). Sustainable intensification (SI) has been given various definitions by many authors in scientific and development literatures (The Montpellier Panel, 2013; Pretty *et al.*, 2011; Godfray *et al.*, 2010; Royal Society, 2009). A common definition of sustainable intensification is *producing more outputs with more efficient use of all inputs – through various intensification process on durable basis while reducing environmental damage and building resilience, natural capital and the flow of environmental services* (Figure 2.1).

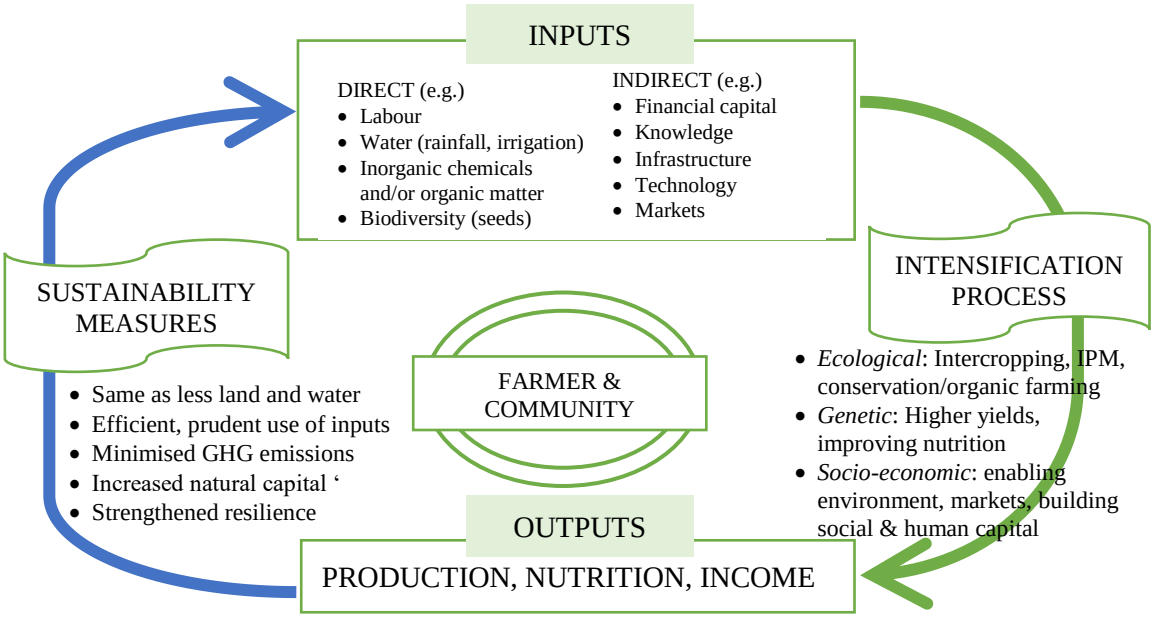

Figure 2.1 Theoretical model of Sustainable Intensification (After Montpellier panel report, 2013).

Box 2.1: *Components of Sustainable Intensification*

i) Increased production, income, nutrition or other returns:
- On the same amount of, or less, land and water
- With efficient and prudent use of inputs- there are no blueprints of which inputs to use
- Productive use of knowledge and capacity to adapt, innovate and scale up

ii) Minimizing greenhouse gas emissions:
- While increasing natural capital and the flow of environmental services
- Reduce impact on forests including through alternative energy sources

iii) Strengthening resilience and reducing environmental impact:
- Through innovative technologies and processes
- Minimizing the use of technologies or inputs that have adverse impacts on people and the environment

Source: Adapted from Pretty et al. (2011)

Box 2.1 shows the components of SI. This brings to the forefront of the debate on how to combine these components into a framework that can deliver SI and resilient and sustainable agricultural solutions to the food security challenges in SSA. Given the multiplicity of challenges in SSA (Table 1.1), SI should lead to an agricultural production system that is more socially acceptable, economically feasible and environmentally friendly. We should recognize that production alone will not solve current and future food needs of SSA. We have to examine the entire food system that includes how food is grown, stored, processed and consumed. Although SI is a promising pathway to food and nutrition security, it is not a silver bullet to resolving food challenges (mentioned in Table 1) in SSA. To be successful, it should go beyond top-down technologies for production and embrace systemic approaches including indigenous knowledge, practices and solutions (AGRA, 2016).

2.3 The need for sustainable agriculture intensification systems (SAIs)

Can SAI solve the challenge of FNS without repeating the environmental damage of the mid-20th century by the Green Revolution (GR) in Asia and Latin America? Prior to answering this question, the lessons to learn from past GR is that the unintended negative consequences, were often not because of the technology *per se* but rather, because of the policies that were used to promote rapid intensification of agricultural systems and increase food supplies without considering sustainability of the environment and ecosystem services (ESS). In other words, sustainability measures were not taken into account when implementing the intensification process (Figure 1). Yes, we assume SAI can contribute to solve the demand and supply-related FNS challenges facing Africa in general and the SSA region in particular.

Sustainable intensification techniques such as precision farming that is better-suited to the needs of small-scale farmers does not need to be technology intensive. It could include a move towards more need-based input application. These could be highly relevant for smallholders who are constrained with credit and inputs. Any savings on input use could be useful to smallholder economy as well as environment. Promoted by Pretty in the 1990s (Pretty, 1997), SAI has received increasing attention recently, particularly in the arena of international agricultural development. The Food and Agriculture Organization (FAO, 2012), the CGIAR (Beddington *et al.*, 2012), other organizations and Rockström *et al.* (2016) have promoted SAIs as a necessary approach to achieve FNS in 21st century.

A paradigm shift to SAIs with innovative technologies suitable to smallholders are needed to achieve the multidimensions of FNS that addresses malnutrition, environmental and socioeconomic aspects of FNS. Recent publications highlight SAI as a means to meet the rising global food demand, *yet the technologies under SAI, and the organizing principles for the approach need to be specified* (Godfray *et al.,* 2010). It should be recognized, however, that SAI is a new, evolving concept and its meaning and objectives are subject to debate and contest (Rockström *et al.,* 2016) as there are other intensification approaches synonymous to SAI concepts and principles.

2.4 Intensification approaches related to SAIs

The following intensification approaches related to SAI principles, have a common goal, i.e. to achieve FNS and sustainable agriculture but differ in their methodology.

i) Ecological intensification (EI): Ecological intensification is defined as 'increasing food production while reducing the use of external inputs and minimizing negative effects on the environment by capitalising on ecological processes and ESS approach' (Tittonell, 2014; Bommarco *et al.,* 2013; Cassman, 1999). Ecological intensification focusing on agriculture are termed as agro-ecological intensification. Practices or technologies that support ecological intensification are good agronomic practices such as intercropping (including mixed cropping, rotations, agroforestry, silvo-pasture, and green manuring), integrated pest management (the push-pull system for pest control), conservation agriculture, organic agriculture and water harvesting technologies.

ii) Organic Agriculture (OA): Organic agriculture is defined as 'A production system that sustains the health of soils, ecosystems and people'. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects (Halberg, 2009). It is a specific type of food production approach determined by process rather than by product, that emphasizes the sustainability of the local agro-environment while reduction in the use of synthetic inputs. Practices or technologies that can be grouped under organic agriculture include use of various forms of organic fertilizers including vermi-compost, biogas slurry, green manure and other bio-fertilizers. The application of OA in the dry tropics are limited due to shortage of organic residues and its competing use for feed, fertilization, fuel and/or building materials (Tesfai *et al.,* 2016).

iii) Eco-functional intensification (EFI): A term promoted by the organic movement, its goal is a more efficient use of natural resources and processes, improve nutrient recycling, use of innovative agro-ecological methods to enhance the diversity and health of soils, crops and livestock (Garnett *et al.,* 2012; Niggli *et al.,* 2008). Most of the practices or technologies applied in OA are also relevant to eco-functional approaches since it is based on agro-ecological principles. Little documentation exists with regard to upscaling the approach and whether it could be a solution to meet the growing food demands (Halberg *et al.,* 2015).

iv) Climate Smart Agriculture (CSA): Climate smart agriculture is defined as 'an approach that sustainably increases productivity, resilience (adaptation), reduces/removes greenhouse gases (mitigation), and enhances achievement of national food security and development goals' (Lipper *et al.,* 2014; FAO, 2010). Practices or technologies that are climate smart agriculture

include conservation agriculture, system of rice intensification, precision farming, among others. However, the effectiveness of these practices in meeting the objectives of CSA are context-specific. Moreover, there are critics that say, CSA has failed to encompass some important issues related to ESS (for e.g. the cultural services) and their interaction with agriculture (Neufeldt *et al.*, 2013)

Table 2.1: Examples of agricultural technologies implemented and/or promoted in SSA and other relevant region of the world

Technologies/approaches	Exemplary regions/countries	References (examples)
i) Conservation agriculture	Southern Africa (Zambia, Zimbabwe)	Thierfelder *et al.* (2012); Thierfelder *et al.* (2013)
ii) Intercropping/crop rotations		
• Maize-legumes systems	Southern Africa (Zimbabwe)	Thierfelder *et al.* (2015)
• Millets/sorghum-legumes systems	Southern Africa (Malawi)	Bezner Kerr *et al.* (2012)
iii) Integrated pest management		
• Push-pull system	East Africa (Kenya)	Hassanali *et al.* (2008)
iv) Soil & water conservation		
• Zai pit system	The Sahel (Burkina Faso, Niger)	Fatondji *et al.* (2011)
• Contour stone bunds	East Africa (Ethiopia, Eritrea)	Zougmore *et al.* (2014)
• Irrigation & water harvesting	North Africa (Tunisia, Sudan)	Biazin *et al.* (2012)
v) Organic fertiliser applications		
• Green manure	West Africa	Giller *et al.* (2009)
• Azolla	India	Lakshmanan *et al.* (2015)
• Bio-fertilizers	India	Lakshmanan *et al.* (2015)
+ Biochar	Latin America	Cayuela *et al.* (2014)
vi) Precision farming techniques		
+ Need based fertilizer application	India	Lakshmanan *et al.* (2015)
+ Microdosing	Niger, Mali, Burkina Faso	The Montpellier Panel (2013)
vii) The Green revolution	Asia and Latin America	AGRA (2016)
+ Use of high yielding varieties		
viii) Agroforestry	Humid/subhumid SSA	Liniger *et al.* (2011)
ix) Livestock feeding systems		
+ Bracharia forage grass	Kenya, Rwanda	Ghimire (2015)
x) System of rice intensification	Madagascar, Tanzania, India	Geethalakshmi *et al.* (2016)

v) Genetic Intensification (GI): Genetic intensification is defined as 'the process of concentrations of beneficial genes in varieties and breeds to improve food security, increasing yields as well as the nutritive qualities of crop varieties and livestock breeds' (The Montpellier Panel, 2013). Practices or technologies that represent genetic intensification include plant and livestock breeding such as convention breeding, human selection, biotechnology (cell and tissue culture, and marker assisted selection) and genetic engineering (genetic modification or recombinant DNA). The challenge to adopt these practices depends on how to ensure the new seeds and animals are both accessible and affordable, subject to biosafety regulations while supported by appropriate extension and advisory services.

vi) Socioeconomic intensification (SEI): Socioeconomic intensification is defined as 'the process of developing innovative and sustainable institutions on the farm, in the community and across regions and nations as a whole' (The Montpellier Panel, 2013). Strategies that support socioeconomic intensification include creating enabling environment to support technology uptake on sustainable basis. Some examples are creation of efficient input and output markets, building social and human capital and creating sustainable livelihoods. Securing land use rights, increasing investments in agricultural research and extension, and access to education and health care, are some of the challenges to implement the SEI in Africa.

All countries in SSA practise one or another form of the agricultural technologies listed (in Table 2.1) but what differs is the extent, and the forms of the technology practiced in these countries. Adoption and upscaling of the technologies and approaches by farmers will only happen and persist, if appropriate enabling environment is in place. One of these enabling environments are agriculture extension and advisory services and innovative institutional approaches, which are the subject of the next two chapters.

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3 Agricultural Extension and Advisory Services

Paul Guthiga, Sita Ghimire, and Mehreteab Tesfai

3.1 Definitions and Concepts

Agricultural extension and advisory services (EASs) is the application of scientific research, knowledge, and technologies towards improving agricultural practices through farmer education (Mayaka, 2013). EASs can also be defined as the different systems and activities that provide the knowledge, information and services needed and demanded by farmers and other actors in agrifood systems to assist them in developing their own technical, organisational, and management skills and practices (Birner *et al.*, 2009). There has been historical evolution in the agricultural extension approaches in Africa since the 1960s.

In the 1970s, extension focused mainly on farmer education, training and transferring technologies to increase production and improve yields (Davis and Heemskerk, 2012). There was little involvement of farmers in problem identification and technology generation. During the 1980s, extension incorporated farmer visits with farmer centred concept. In the 1990s, extension evolved to stress farm level linkages between researchers and farmers with more of participatory research methods and multiple partners (Gustafson, 1991). In the present time, pluralistic extension systems are evolving and extension is viewed as an innovation system that focuses on facilitating interaction, learning and linkages with farmers, farmer-based organizations, government agencies, private sector, non-governmental organizations (NGOs) and research institutes (Davis and Heemskerk, 2012).

3.1.1 Pluralistic Extension System

The pluralistic extension system is characterized by the coexistence of multiple public, private, and mixed extension systems and approaches; multiple providers and types of services; diverse funding streams; and multiple sources of information—all of which benefit from some sort of coordination and regulation that facilitates interaction and learning (Word Bank, 2012). It takes into account inherent diversity of farmers and farming systems and the need to address challenges in rural development with different services and approaches.

In pluralistic extension system, the role of private sector in delivering extension services has been realized more efficient than the public-sector agencies. This increases the likelihood of long-term and sustainable services. Such transfer of responsibility for funding and/or delivery of services to private organizations has been already taking places in many countries of the world. For example, the UK has fully privatized the public extension service while Germany, Nicaragua, Estonia, and others subsidize private extension services (Alex et al., 2004). The private sector or other service providers, however, are not all equally capable of undertaking all functions related to extension. Therefore, to ensure sustainability of pluralistic extension systems, building capacity of service providers and users is essential. Establishment of small but highly qualified and efficient support units by linking to universities and research institutions and provision for an Extension Learning Center, are profoundly beneficial.

The public sector may involves contract with other institution such as public-sector agencies, nongovernmental organizations, universities, extension consulting firms, or rural producer organizations to deliver extension services (Alex *et al.*, 2004). The services to be contracted are identified in consultation with users. In this system, the public funding agency draws up terms of reference and details of services to be provided, and offer contract on a competitive basis. Contracts may be administered by national governments (e.g. Mozambique), the national government in collaboration with lower level government (e.g. Venezuela), or by governments with an NGO who signs contracts with private companies (e.g. Honduras) or contracting of public extension agents (often subject matter specialists), by NGOs/private sector and farmer organizations (e.g. Uganda and Pakistan). The national government in collaboration with local government, or with an NGO signs contracts with private companies to deliver the extension services (Alex *et al.*, 2004).

3.2 Typologies of EASs

Extension approaches falls into three broad categories and are briefly discussed below:-

3.2.1 Public top-down (diffusion or government-driven)

This is a linear method of extension with a passive role for the farmers. The approach is based on trickle-down theory in which a few farmers receive information and are expected to pass it to other farmers through farmer to farmer dissemination and demonstration methods. The extension system is supply driven and is mainly provided and financed by government and/or donors. The extension approach is planned on the basis of national objectives not based on farmers' needs, problems, and capacities.

3.2.2 Participatory bottom-up (demand-driven)

It involves farmers throughout the research process i.e. from planning, implementation to problem identification/solving and evaluation of project results. The farm household is the central focus of participatory bottom up extension system. The extension system focus on farmer based needs analysis. The approach depends on the resources that are available to farmers and considers the problems and constraints from the farmers' perspective. Some of the participatory bottom-up techniques includes farmer field schools, participatory research and group learning processes, among others.

3.2.3 Private extension services

Services are provided by private extension agents and financed by either individual farmers, farmer groups, cooperatives, NGOs, etc. It may include cooperatives and farmer groups that provide extension services to farmers. Others are agricultural input companies (or agro dealers) who provide agro-chemicals, seeds, and veterinary services mainly at a fee and information and communication technology based EASs like the village knowledge centres that will be established in Kenya and Tanzania by InnovAfrica project.

3.3 Descriptions of EASs

Innovative forms of extension and advisory services are essential for the advancement of productivity and profitability of agriculture and livelihood of the farming community. However, unsustainable and inefficient extension and advisory approaches affect the ability to improve

the rural livelihood. In this section, we highlighted selected cases of successful and sustainable EASs approaches in Africa and other parts of the world.

i) Information and communication technology (ICT)-based EASs

ICT-based agricultural services have been adopted and used by public–private sector in different countries to successfully reach millions of smallholder farmers in different parts of the Africa. This approach is particularly driven by wide and deep penetration of the mobile telephony. One example is in Uganda where the Grameen Foundation has 800 Community Knowledge Workers (CKWs) who use mobile phones to provide farmers with information on agricultural topics, including market prices. The CKWs also document traditional farmer practices and share these through "technologies and practices for agricultural producers", an online platform that facilitates access to information (http://teca.fao.org/). Table 3.1 presents some of the strengths, weaknesses, opportunities, and threats (SWOT) of ICT-based EASs.

Table 3.1: SWOT analysis of information and communication technology -based EASs

Strengths + Better access to services + Cost effective: timely, anytime anywhere + Supplement the role of extensionists + Better research-extension-client system linkages	*Weaknesses* – Success depends on human commitment – Needs ICT skills and competency – Lack of personal touch
Opportunities + The future of agriculture is digitalization of ICTs + Multiple players in EASs provision using ICTs + Penetration of high-end mobile phones + Reducing cost of ICT infrastructure & services	*Threats* – Lack of institutional policy – Long term sustainability – Language barriers – Low literacy of rural farmers

ii) Farmer Field Shools

Farmer field schools (FFS) are "schools without walls" where groups of farmers meet regularly with facilitators. FFS was initially developed by FAO in Indonesia to respond to regular outbreaks of the Brown Plant Hopper (*Nilaparvata lugens*) despite frequent insecticides uses. This approach primarily uses non-formal education methods to teach farm leaders in each community how to reduce pesticide use, which in turn helps increase farm income. This approach is used by governments, NGOs and international agencies to promote integrated pest management (IPM). FFS integrates concepts and methods from agro-ecology, experimental education and community development, as a group-based learning process. FFS utilises the understanding of farmers about the ecological processes that affect crop and animal production, through field observations, simple experimentation and group analysis. The knowledge gain from this exercise enables participants to make their own locally-specific decisions about crop management practices.

The success of FFS are evident in Africa through sustainable agricultural intensification programmes, such as the Integrated Pest Management (IPM) programme. Van den Berg (2004), showed that due to the FFS trainings, farmers had substantially and consistently reduced their pesticide usage as well as convincingly increased their yields. The FFS stimulated continued learning and strengthened the social and political skills of farmers (Duveskog, 2013). In many SSA countries, FFS is serving as platform for capacity building, and introduction and

dissemination of new agricultural technologies. FFS approach increased agricultural production and farm income up to 80–100 percent in Kenya and Tanzania, (Nkonya *et al.*, 2010).

Some of the strengths, weaknesses, opportunities, and threats of FFS are shown in Table 3.2.

Table 3.2 SWOT analysis of Farmer Field Schools

Strengths + Applicable to wider area in different contexts + Reduce dependence on formal extension system	*Weaknesses* – Labour-intensive with relatively high programme and travel costs – Limited outreach, i.e. only a small number of interested farmers
Opportunities + Learning by doing + Farmers' fields are the learning ground	*Threats* – High uncertainty of long term sustainability – Scaling up technologies remains problematic

iii) Farmer participatory extension

This approach incorporates full involvement of farmers in the processes of learning about their needs, opportunities, and in designing solutions (Singh and Sekhar, 2015). Farmers participate in planning and execution of the various extension-related activities. One of the successful cases is the rice production transformation in the Philippines driven by national investment in irrigation systems and later on spearheaded by partnerships between farmers and the government institutions. The government of Philippines launched a farmer-run irrigation associations that managed the operation and maintenance of irrigation systems. The approach reduced operation and maintenance costs because farmers partially or fully managed the irrigation systems. The approach resulted in improved rice production, uptake of new technology and more sustainable irrigation schemes (Singh and Sekhar, 2015). Table 3.3 presents some of the strengths, weaknesses, opportunities, and threats of farmer participatory extension services.

Table 3.3: SWOT analysis of farmer participatory extension

Strengths + Farmers "learn by doing" + Farmers are actively involved in the research process	*Weaknesses* – Lack of information on how to effectively link farmer-led research into EASs
Opportunities + High involvment of farmers + Low cost	*Threats* – Sustainability of the appoarch

iv) Commodity-based advisory services

Commodity-based Advisory services is operated by a private-sector firm or government agencies. It gives attention to a single crop or to only one aspect of farming. The approach addresses all farm activities including extension, research, input supply, marketing and prices to increase production in the selected crop. Many countries have commodity based advisory services for major export crops such as tobacco, coffee, cocoa, sugar cane, oil palm, bananas, oranges, and cotton. For example, the Gujarat Co-operative Milk Marketing Federation in India, invest heavily in helping the farmers to increase their productivity by providing breeding services, veterinary care, extension advice and inputs often at low cost (Swanson and Rajalahti, 2010). The participating farmers contribute to the cost of commodity based advisory system therefore,

it is successful with enterprises that has cash generating opportunity e.g. major export crops and dairy production. It also requires participation and contribution of large numbers of farmers. Some of the strengths, weaknesses, opportunities, and threats of commodity-based advisory services are outlined in Table 3.4.

Table 3.4: SWOT analysis of Commodity-based advisory services

Strengths + Complement public run agricultural extension + Low level of education required	*Weaknesses* – Initial high cost might prohibit smallholders – Overreliance on donor funding for continuity
Opportunities + Serve smallholder farmers in rural areas + Suited for ICT-supported delivery systems	*Threats* – Sustainability of the appoarch

v) Farmer-to-Farmer extension

Farmer-to-farmer extension approach centers on mobilizing the communities to take on EASs responsibilities themselves so that they do not have to rely on public extensions systems. One successful farmer-to-farmer extension approach is the Sustainable Soil Management Programme (SSMP) that HELVETAS Swiss Inter-cooperation has implemented in Nepal since 1999, with financial assistance from the Swiss Agency for Development and Cooperation (SDC) (Wellard *et al.*, 2013). For more than 15 years, the Sustainable Soil Management Project trained several thousand farmers in 20 of the 39 mid-hills districts of Nepal. In its last phase, SSMP was active in 378 villages in seven districts, supporting 45,000 farmers (of which 61 percent were women) and trained over 2,000 experienced leader farmers. Based on estimates by local experts, around 40-50 percent of farmers have maintained SSM technologies after the programme's withdrawal. Farmer-to-farmer committees still function in many villages in the phased-out districts. Some of the strengths, weaknesses, opportunities, and threats of farmer-to-farmer extension services are presented in Table 3.5.

Table 3.5: SWOT analysis of farmer-to-farmer extension

Strengths + Low-cost + Improve feedback from farmers to extension staff	*Weaknesses* – Farmer trainers need coaching & technical backstopping – Conflict b/n farmer trainers and extension staff may occur
Opportunities + Used in combinations with other extension approaches (e.g FFS, T&V)	*Threats* • Issues of the sustainability of the approach • Communication is one way

3.4 Summary

The various agricultural extension and advisory services implemented and promoted in Africa have been facing several limitation that affect their effective access and sustainable use (Table 3.6).

Table 3.6: Common limitations of EASs in Africa

Limitations	References
+ Unsupportive national/regional level policies. Policies that affect the provision of agricultural EASs are mostly written in the larger context of policies for the agricultural sector.	Nahdy and Olupot (2013)
+ Inappropriate institutional arrangements to support extension e.g. extension materials, transport and communication, etc.	Chris et al (2015)
+ Lack of trust in government extension workers and programmes.	Braun and Duveskog (2008)
+ Inappropriate delivery approaches. Most extension workers are not responsive to the immediate needs of the farmers.	Chris et al (2015)
+ Weak/poor linkages and interaction between extension, research centres, national agricultural ministries and universities	Belay (2015)
+ Lack of commitment and political support. Most national government fail to allocate funds to run extension system.	Chris et al (2015)
+ Gender bias. Men have more contact with extension officers more than women.	Van de Pol (2003)
+ Low extension to farmer ratio (see Table 3.7)	Suarez *et al.* (2008)
+ Major extension focus is given on production side of agricultural food value chain	This Study

Table 3.7: Number of extension workers to farmer's ratio in some countries of Africa & other regions

Country	Total no. of extension workers*	Extension worker to Farmer/Household ratio	References
Ethiopia	45812	1:476	Abate (2015)
Kenya	5470	1:1000	Abate (2015)
Malawi	2175	1:1603	Abate (2015)
Tanzania	10891	1:469 to 1:2307	Elifadhili (2013)
Rwanda	1244	1:2550	MoA (2009)
South Africa	2210	1:487	Akpalu (2013)
Vietnam	34747	1:280	GFRGAS (2012)

* Number of reported extension workers by country between 2009 and 2012 (public) Source: Davis (2014)

Farmer population with demand for agricultural extension services has increased faster than the corresponding increase in the number of extension workers at field level. This leads to stretched capacity of extension officers thus unable to deliver effective extension services. Standard World bank ratio is 1 extension worker to 800 farmers. However, some developing countries have as high as 2500 farmers to one extension officer (Table 3.7).

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4 Innovative Institutional Approaches (IIAs): principles and applications

Ola Westebgen and Dismas Mwaseba

4.1 Introduction

The focus in this chapter is on the institutions involved in delivery and with regard to uptake of seed systems technological innovations. Institutions are broadly defined as "the rules of the game in a society" (North, 1990). It is a common phenomenon to distinguish between informal and formal institutions, with "conventions" belonging to the former category and "legally sanctioned rules" belonging to the latter (Vatn, 2015). Thus, institutions as a scholarly concept includes organizations and regulatory frameworks, but also encompass other social structures.

4.2 Integrated Seed Systems

Crop varieties that are well adapted and high yielding under the prevailing agroecological conditions, are one of the key input factors to achieve sustainable intensification. The institutions involved in the development and dissemination of crop varieties are commonly referred to as seed systems and it is common to distinguish between formal and informal seed systems (DeVries and Toenniessen, 2002; McGuire and Sperling, 2016). Formal seed systems is the chain of public and private sector activities and organizations producing and releasing certified seeds of officially registered varieties (Sperling *et al.*, 2008; Louwaars and de Boef, 2012). While, informal seed systems include saving from own harvest, farmer-to-farmer seed exchange, and purchase from local markets (Almekinders *et al.*, 1994) (Figure 4.1). An Integrated Seed System approach to strengthen farmers' access to preferred seeds entails a pluralistic approach to identification of intervention options.

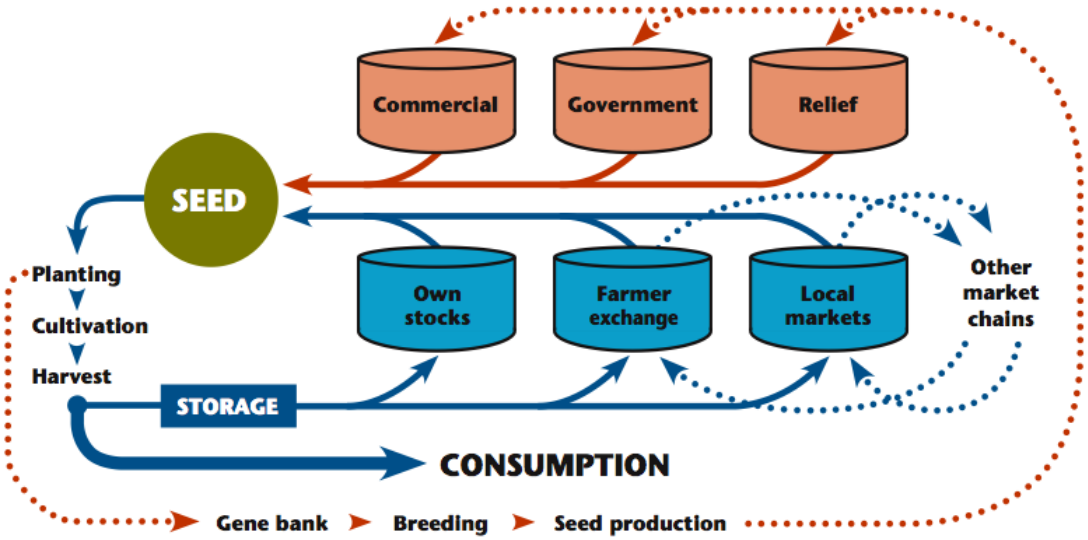

Figure 4.1: A heuristic Seed System model. The blue circuit illustrates the informal elements and the orange circuit indicate the formal elements of a seed system for a crop with multiple potential sources. Source: adopted from Sperling *et al.* (2008)

The green revolution approach to seed system development focuses on substituting informal seed systems with formal systems operating in a linear fashion, i.e. Research→Extension→Farmer (Louwaars *et al.,* 2013). After more than 40 years of policy formulation and project interventions following this reasoning, the World Bank's Agriculture for Development Report stated that more than 80 percent of the seed planted by African farmers still originates from informal seed systems (WB, 2007). And recent quantitative evidence from six developing countries and from 40 crops found that more than 90 percent of seed source came from informal systems (McGuire and Sperling, 2016). The persistent dominance of informal seed systems have led many scholars and practitioners to question the suitability of the linear green revolution approach to seed system development and to propose alternative seed system pathways under the concept of *Integrated Seed System* development (ISSD). The ISSD will be upscaled in Ethiopia, Tanzania and Malawi by the InnovAfrica project.

4.2.1 From theory to practice

The term *integrated seed systems* has been used by different scholars and practitioners conceptualizing ways to harness the best of both informal and formal seed systems in efforts to strengthen farmers access to good seeds (Louwaars and de Boef, 2012, McGuire and Sperling, 2013, Walsh *et al.*, 2013, Coomes *et al.*, 2015). The integrated seed system literature has several strands spanning from descriptive and analytical work focusing on how the seed systems farmers actually operates (Bellon and Brush, 1994; Almekinders *et al.*, 1994; Abay *et al.*, 2011) to a development oriented literature focusing on proposing concrete legal provisions (Louwaars and de Boef, 2012; Louwaars *et al.*, 2013) as well as organizational mechanisms for seed distribution (McGuire and Sperling, 2013; McGuire and Sperling, 2016).

One of the earliest realizations of the need for making development practices and policies more coherent with farmers' seed system practices was formulated by researchers and practitioners working with seed relief in emergency aid (Sperling *et al.,* 2008). In recent years, there is growing awareness among key actors and agencies such as the FAO of the need to shift emphasis from standard, repeat emergency seed distributions, toward interventions tailored to strengthen seed security and the resilience of seed systems in affected regions also in the longer-term (FAO, 2016a; FAO; 2016b; SeedSystem, 2016b). Tools for evaluating needs prior to interventions, notably the "Seed System Security Assessment", have been developed (FAO, 2016c; Sperling, 2008) and put to use (SeedSystem, 2016a; McGuire and Sperling, 2016). The integrated seed system perspective is implicit in training and capacity building for improving efficacy of seed related relief efforts (FAO, 2010) and in advocacy and communication material focusing on the importance of local markets as an intervention area for development actors involved with seed supply[1]. The original focus on seed relief has since expanded into a long-term seed system development focus based on the same integrative principles (Sperling and McGuire, 2012; Sperling, *et al.,* 2013).

Probably the most comprehensive operationalization of the Integrated Seed System concept is currently represented by the Integrated Seed Sector Development in Africa (ISSD) initiative led by the Centre for Development Innovation (CDI) at Wageningen UR and the Royal Tropical Institute (KIT) in the Netherlands. The ISSD has now been on the ground with projects in

[1] https://www.youtube.com/watch?v=HI7lfKY6v8Y

various African countries for some years. In Ethiopia and Uganda the ISSD approach is implemented in national comprehensive agriculture sector programmes. The operationalization is most advanced in Ethiopia where the ISSD has been instrumental in the formulation of the national Seed System Development Strategy (2013-2017) involving a number of national partners comprising universities, regional seed enterprises, and the Ethiopian Seed Growers and Processors Association[2]. Recently a national programme was established in Myanmar[3]. In addition, a number of scoping studies identifying potential interventions have been conducted under the ISSD initiative in Burundi, Mozambique, Ghana, Tanzania and in the two Indian states Uttar Pradesh and Odisha. Furthermore, the ISSD initiative has also been instrumental in securing policy support for integrated seed system approaches under the African Union's CAADP Commission as evident from two in two communiqués from the commission[4]. From its scholarly foundations (Louwaars and de Boef, 2012; Louwaars *et al.,* 2013) the ISSD approach has expanded its focus and is currently based on a set of eight guiding principles (Box 4.1).

Box 4.1: Eight guiding principles for operationalization of the ISSD approach
- Foster pluralism and build programs on diversity of seed systems
- Work according to the structure of the seed value chain
- Promote entrepreneurship and market orientation
- Recognize the relevance of informal seed systems
- Facilitate interactions between informal and formal seed systems
- Recognize complementary roles of the public and private sector
- Support enabling and evolving policies for a dynamic sector
- Promote evidence based seed sector innovation

Source: http://www.issdseed.org/topic/issd-guiding-principles

Some of the strengths, weaknesses, opportunities and threats of the integrated seed systems development approach are listed in Table 4.1. Like all development approaches, the integrated seed system approach is subject to change as the concept is translated into practice and policy in local and national contexts. Integrated development approaches has long been around in other aspects of agronomy for development such as Integrated Pest Management (IPM) and integrated water resource management (IWRM). Research on the operationalization of these concepts show that, there is great variation in how the different elements are operationalized (Mehta *et al.,* 2014).

[2] http://www.issdethiopia.org/
[3] http://www.issdseed.org/issd-myanmar
[4] http://www.issdseed.org/resource/african-union-commission-second-communiqupercentC3percentA9-integrated-seed-sector-development

Table 4.1: SWOT analysis of integrated seed systems development approach

Strengths + Seed production is economically attractive for farmers	*Weaknesses* – Government control institutions lack capacity and resources – Local seed marketing is still difficult due to moderate or slowly growing and fluctuating demand
Opportunities + High interest internationally in building more sustainable, equitable, and resilient seed systems + Harmonization of seed laws could facilitate regional cooperation if fully implemented	*Threats* – New seed legislation could limit legal spaces for informal seed transactions – Once the formal seed market is established, large commercial enterprises could compete with farmer organizations

Source: adapted from Christinck et al. (2014)

4.2.2 Options for intervention

The feasibility studies for ISSD undertaken by Wageningen researchers stresses the importance of variation in agricultural systems and the need to differentiate between development oriented and market oriented seed value chains (Louwaars and de Boef, 2012). They argue for a "pluralistic approach" based on the premise that seed sector development relies on interventions at policy and law level in tandem with interventions at the technological and institutional level by public-, private-, community-based and NGO-based actors the like. Interventions should also be pluralistic in the sense that different crops need different types of interventions.

i) Technical interventions

One technological level intervention often considered part of an integrated seed system approach is participatory plant breeding (PPB). PPB is an operationalization in plant breeding of the participation agenda of the "farmers first movement" (Chambers and Thrupp, 1994; Chambers and Ghildyal, 1985) that swept in the 1980s and 1990s and significantly changed the agricultural development agenda (Sumberg *et al.*, 2013; Sumberg and Thompson, 2012). The farmers' field schools approach also promoted in InnovAfrica project are commonly utilized to empower farmers in participatory research. Many PPB projects do not necessarily aim for official release of the varieties developed, but rather disseminate the varieties developed in informal seed systems and therefore have other needs for variety protection than conventional green revolution model breeding programs (Salazar *et al.*, 2007).

ii) Market interventions

Perhaps the most important intervention under the integrated seed system label is facilitation of the establishment of local seed businesses, variably referred to as community seed production and smallholder seed enterprises (Walsh *et al.*, 2013). The rationale for the need for such local scale community seed enterprises is the difficulty of making a business case for pure private sector investment outside of hybrid maize and vegetable seeds (Walsh *et al.*, 2013; David, 2004). Community seed production can be both commercial and non-commercial. Examples of non-commercial approach are "seed loan" schemes in which an institution gives to farmers seeds in loan with the expectation to be repaid with interest. Commercial channels are local informal markets and seed sale through small rural shops.

The literature on farmers' seed systems emphasize the importance of local informal markets and suggest more emphasis should be put on these markets for disseminating public varieties (Sperling *et al.,* 2013; McGuire and Sperling, 2016). Seed sale in local markets and by small scale vendors depends on appropriately sized seed packages. Making seeds available in smaller pack sizes is a simple and effective way to make quality seeds of various types accessible pursued by private companies as well as non-commercial initiatives (Sperling *et al.*, 2013). Foundation seeds for these market interventions are typically from public seed producers, but there are also examples of community seed enterprises that are linked with PPB programs such as the barley breeding program at Mekelle University in Ethiopia (Andersen and Winge, 2013).

Another market related integrated seed system approach is "crowdsourcing" of crop trait preferences and varieties[5]. The initiative Seeds4Needs led by Bioversity International has pioneered the use of "citizen science" to get farmers feedback on sets of varieties that includes both landraces and improved varieties (Beza *et al.*, 2017; Steinke and van Etten, 2017). The outcome of such efforts can both inform plant breeding programs (Mancini *et al.,* 2017) and contribute to improve marketing and access to information for integrated seed system projects (Sperling *et al.,* 2013).

iii) Policy interventions

The informal market interventions mentioned above are not always compatible with formal seed laws and regulations. Distribution of untested seeds of unreleased varieties are sometimes done when the need is obvious (e.g. in post-emergency contexts) even if such distribution is not strictly sanctioned by law (Thijssen *et al.,* 2008). Seed relief has often been the precursor to relaxation of the seed regulations and the International Treaty on Plant Genetic Resources for Food and agriculture (ITPGRFA) does indeed provide legal space for emergency distribution at the international level. Article 12.6 of the ITPGRFA says that "the Contracting Parties agree to provide facilitated access to appropriate plant genetic resources for food and agriculture in the Multilateral System for the purpose of contributing to the re-establishment of agricultural systems, in cooperation with disaster relief coordinators" (FAO, 2009). For long-term seed system development ad-hoc arrangements for relaxing variety release and seed testing has to be accommodated by national seed laws. The need to reform seed regulations to make them more compatible with farmers' practices in developing countries, has long been recognized by scholars and development practitioners (Tripp, 1997; Almekinders *et al.,* 1994). Researchers at Wageningen UR have brought this discussion up to a level where concrete legal provisions are suggested to reform both intellectual property rights (IPRs) regulations (De Jonge and Munyi, 2016) and seed sale regulations (commonly called seed laws) (Visser, 2016; De Jonge *et al.,* 2015; Herpers *et al.,* 2017).

One notable and well established integrated seed system approach to overcome the challenge of making sufficient quantities of certified seeds available to farmers is the Quality Declared Seed (QDS) system developed by FAO (FAO 1993). In this system, seed producers (often medium or large scale farmers) are responsible for meeting certain genetic and physical quality standards and the role of the national regulatory agency is to perform spot checks on a certain percentage of production farms. The seeds produced under this system are sold with a "quality declared seed" tag.

[5] Bioversity International https://www.bioversityinternational.org/innovations/seeds-for-needs/crowdsourcing/

4.3 Multi-Actor Platforms (MAPs

4.3.1 Background and Defintions

Generally, MAPs is defined as a process of interactive learning, empowerment and collaborative governance that enables stakeholders with interconnected problems and ambitions, but with often different interests, to be collectively innovative and resilient when faced with the emerging risks, crises and opportunities of a complex and changing environment (Woodhill and van Vugt, 2011). MAP represents cross sector collaboration and more widely used (Brouwer *et al.*, 2013). Also, generally, these MAPs are informed by the idea that "stakeholders depend on one another to achieve agricultural development outcomes, and hence need a space where they can co-learn, co-negotiate, and coordinate to overcome challenges and capture opportunities through a facilitated innovation process" (Schut *et al.*, 2017). As a result of increasing collaboration, exchange of knowledge and influence mediation among farmers, researchers and other stakeholders, MAPs supposedly enhance their 'capacity to innovate' and contribute to the 'scaling of innovations' (Schut *et al.*, 2017; Hermans *et al.*, 2017). Other scholars view these MAPs as the key means of gathering the experience of a broad group of people to discuss issues in a structured and transparent way so as to come to decisions about the best way for agricultural research for development (Macqueen *et al.*, 2014).

Multi-Actor Platforms (MAPs)[6] in agricultural research for development (AR4D) have recently been widely promoted especially in developing countries where experiences associated with the adoption of traditional AR4D model have been, to a large extent, disappointing. The main criticism of the model is that "the conventional emphasis on linear innovation processes—moving knowledge from scientists to extension agents to farmers—is an oversimplication of complex processes that are highlighted by non-linear learning processes, feedback loops, and other complex interactions that occur among far more heterogeneous actors" (Spielman *et al.*, 2010). Thus, the adoption of MAPs, which is based on the innovation systems[7] approach, is seen as marking the paradigm shift from the linear AR4D system. Moreover, justification for MAPs is based on, among others, the argument by AR4D actors that poor performance of the agricultural sector as a problem of the process rather than that of the availability of technologies (Adekunle and Fatunbi, 2012). Unlike the traditional AR4D model, the innovation systems approach emphasizes the collective nature of innovation and stresses that innovation is a co-evolutionary process, resulting from alignment of technical, social, institutional and organizational dimensions (Kilelu et al. 2013). In addition, it espouses systemic interaction among all stakeholders around specific commodities or production systems (Adekunle and Fatunbi, 2012).

The multi-actor approach aims to make innovation more demand-driven, and therefore should ensure genuine and sufficient involvement of various actors (end-users such as farmers/farmers' groups, foresters/foresters' groups, fishers/fisher's groups, advisors, businesses, etc.) all along

[6] According to literature other types of multi-stakeholder approaches include Innovation Platforms (see Schut et al., 2017) and Multi-Stakeholder Platforms (MAPs) (see Hermans et al., 2017); and Multi-stakeholder Partnerships (Bäckstrand, 2006).

[7] Innovation system is used to refer to dynamic network of agents interacting in a specific economic/industrial area under a particular institutional infrastructure and involved in the generation, diffusion and utilization of technology (Adekunle and Fatunbi, 2012)

the project: from the participation in the planning of work and experiments, to implementation, the dissemination of results and a possible demonstration phase. A multi-actor project proposal needs to demonstrate: i) how the project proposal's objectives and planning are targeting needs/problems and opportunities of end-users, and ii) how it complements existing research and best practices. A well-functioning platform is likely to have all or most of the following characteristics listed in Box 4.2.

Box 4.2: Characteristics of a well-functioning platform

i) Shared and defined 'problem situation' or opportunity
The stakeholders need to share a tangible concern or focus that brings them together. All groups will need to have some sense of why it is worthwhile for them to invest time and energy in the MAPs. However, although stakeholders need a common concern in order to start a MAP, the real nature and focus of their concerns and what the group sees as the real problems and opportunities, will only fully emerge during the process of developing the MAP.

ii) All the key stakeholders are engaged in the partnership
One of the key features of effective MAPs is that all those who have an influence on or are affected by the situation that sparked the process are involved from the start. Leaving out key groups or involving them too late can quickly undermine a MAP. But as the MAP evolves, the focus may change, meaning that new groups may need to be included and others may drop out. An effective MAP is gender aware, it ensures the voices of women and men, the young and the older are all being heard.

iii) Works across different sectors and scales
For most MAPs, the underlying causes of problems and the opportunities for solutions will be found across different disciplines; across the workings of business, government, and civil society; and across different scales from local to national, and even global.

iv) Follows an agreed but dynamic process and timeframe
Stakeholders need to have some understanding of the process that they are being invited to join and how long it is going to take, before they will commit themselves to take part. However, the process needs to be flexible and respond to changing needs. The process and timeframe will evolve over the course of the MAP, but at any one point in time, stakeholders need to have full information about the expected process.

v) Involves stakeholders in establishing their expectations for a good partnership
Partnerships need to develop clear rules about how people will work together – for example, in terms of communication, decision making, leadership, and responsibilities. Nevertheless, these rules will only work if they are developed and agreed on by those involved. Too often in partnerships, the expectations are not discussed and agreed, which can lead to unnecessary misunderstanding and conflict.

vi) Works with power differences and conflicts
Different stakeholder groups will come to a partnership with different levels of power related to their wealth, status, political connections, knowledge, and communication abilities. If those with great power dominate and those with less power feel excluded or overpowered, the partnership is unlikely to be constructive. Likewise, if conflicts are not recognised and are left 'under the table' to fester, they are likely to become a destructive influence on the partnership process.

vii) Fosters stakeholder learning

The human capacity for innovation and creativity comes from our ability to learn. To learn, we have to question and challenge our beliefs and assumptions and think of alternatives. Good MAPs provide a supportive environment with interactive learning processes where people can move beyond their own fixed ideas and positions to see things differently and from the perspective of others.

viii) Balances bottom-up and top-down approaches
In an ideal world, everybody would be involved in all decisions of all time. Nevertheless, this is simply not feasible, and societies have evolved different mechanisms for delegating decision-making. MAPs need to find a balance between working with structures and decisions that come from the top and supporting input from a wide diversity of stakeholders that comes from the bottom.

ix) Makes transformative and institutional change possible
Most of the issues and challenges we face in the world today are deep-seated. They lie in a mismatch between how the world is now and our past ideas, cultural attitudes, dominant technologies, decision-making mechanisms, and legal frameworks. 'Business as usual' will not help, and we need to focus on transformative change to remove underlying institutional blockages
Source: Brouwer et al. (2016)

4.3.2 Principles and Applications of MAPs

In this section, principles and applications of MAPs are explored drawing on field experiences as documented in the literature.

Principles of MAPs
MAPs involve partnerships and can be effective only when certain basic principles are adhered to. Principles presented below are drawn based on PROLINNOVA's experiences (see for example, Waters-Bayer *et al.*, 2014; Critchley *et al.*, 2007):

i) Partnership as part of the agenda: a goal in itself
One basic principle is that partnership itself should form part of the overall agenda amongst partners. It needs to be understood from the beginning that the relationship itself needs building and culturing, and this must be a conscious effort. Therefore, a prerequisite for this to occur is an understanding from the beginning that functional partnership itself is a goal.

ii) Shared ownership
A second guiding principle is that partnership implies shared ownership of the agenda and programme of activities, and an overall sense of joint responsibility for outcomes of endeavours. This distinguishes partnerships from other forms of collaboration, where overall ownership and responsibility stays with the main organisation while others contribute their part as per agreement – for example, under a sub-contract. Sharing of ownership and responsibility by definition implies a relative reduction in the central role of the coordinating organisation, and it is the reluctance of many organizations to make the step that forms a major bottleneck in many non-functioning partnerships.

iii) A culture of equality
Shared ownership and responsibility in turn imply equality. It is important – but challenging in practice – to establish a culture of equality amongst actors in a partnership. This is especially

so when there was previously an unwritten hierarchy, which placed – say – government agencies above NGOs, and all other agencies above farmers' organisations.

iv) Matching individual interests with the common agenda
Partnerships need to be able to link the common agenda to important institutional and personal interests of the partners. Addressing partners' own institutional interests allows them to create time, and even to provide their own resources for activities of the partnership. The link to personal interests creates commitment with the people involved and allows them to find space in their already-full diaries.

v) Openness and transparency
Partnership cannot work unless there is openness and transparency in decision making. This implies that, at the very beginning and to the greatest extent possible, partners need to make their interests and expectations clear. They must articulate what is at stake for them: what they stand to gain and what they could lose through the partnership. The resources that can be made available from internal and external sources should be openly discussed. This allows the partnership to move together from a common position of understanding and respect for each other's positions.

"Open nucleus": The platform needs to be prepared to change its partnership composition if and when necessary: that is what we mean by the principle of being an "open nucleus" arrangement. The partnership starts with a smaller group of (often) the most committed partners and then allows others to join at a later stage: begin small, establish the relevance of the partnership through evidence and gradually grow by accommodating others.

vi) Breaking down barriers of competition and territoriality
Partnership can only work when competition between agencies with conflicting interests is turned into agencies working together towAR4Ds a mutual goal. Thus, unless there is a change in mindset (a prerequisite) between agencies that were previously competing, then partnership is impossible, and becomes illusion. Underlying this principle is the very real concern that farmers are confused by various development organizations offering different rewAR4Ds and conflicting advice. A simple, consolidated stand achieved through partnership can help to end these mixed messages and the energy wasted on one-upmanship amongst agencies.

Applications of MAPs
Drawing on experiences from various programmes that have adopted a similar approach such as PROLINNOVA (for details see Critchley *et al.*, 2007) there are ways that can be adopted to make MAPs work effective. And these are outlined as follows:

i) Capacity building and learning by doing
Stakeholders need to understand what the potential benefits are and what is expected of them when a new of way of working is proposed. Capacity can be built in two ways. The first is through training workshops and written information. The other route to better understanding of how partnerships can be built and improved is through "learning by experience".

ii) Start with looking into what is already there

Commitment of partners is also likely to be greater if the new initiative builds on relevant existing initiatives and networks, and gives serious attention to these while acknowledging them as a valid starting point.

iii) Choosing partners
There is need to avoid inviting only very like-minded individuals and organisations to avoid conflicts but for purpose of achieving consensus quickly. However, this may result in excluding stakeholders whose contribution could be critical. Strategic choices have to be made in which the existing culture of collaboration between civil society and government institutions, as well as own facilitation capacity of the coordinating organisation are critical factors.

iv) Role definition: specialist input, backstopping and facilitation
Clarity is needed about roles and responsibilities of each MAPs members. Overlapping roles can be a source of inefficiency, confusion and even conflict. In many cases, there is a need for formalisation of roles agreed between organisations involved in the partnership through, for example, signing of memorandums of understanding (MoUs).

v) Governance
Closely related to the above is the issue of partnership governance. Questions to be addressed include: What is the structure and process for decision-making within the partnership? Who decides on what? A partnership implies that some of the power and control from the initiating organisation (which often holds the budget) is transferred to the other partners. This is essentially what the governance set-up should cater for.

vi) Commitment grows from successful first actions
Partnerships need to be built on a shared will to succeed – by pooling together resources and enthusiasm. When a partnership has been built, one of the best ways of strengthening bonds between partners is by facing a shared problem together – and allowing commitment to be demonstrated and reinforced through success. Another facet to commitment is not just at the human level, but a demonstration that materials and other resources can also be shared.

vii) Ensuring effective communication
Good and effective communication is the central strategy to achieve openness and transparency. A regular flow of information either through meetings, phone calls or written materials is also critical for implementation and coordination of activities.

viii) Joint planning, implementation, monitoring and evaluation
Achieving joint implementation, joint planning and joint Monitoring &Evaluation are essential characteristic of true partnership. To achieve this, good facilitation is required, which is the responsibility of the main facilitating agency, or the organisation to which this is delegated. Without it, the spirit of partnership will fade.

4.4 Summary

In the case of ISSD, it is important to recognize that there are considerable ideological differences between actors involved and that several aspects of seed system development is contested. One example here is the role of the public and the private sector in seed system

development and the related debates about IPRs and seed laws. There are no "apolitical" development interventions and the fact that Integrated Seed Systems approaches seems to "have something for all" does not guarantee that all interests will be equally well served when projects are implemented.

It is a significant challenge to create effective and sustainable platforms for AR4D projects as reported by several authors (Faysse, 2006; Critchley *et al.*, 2007; Reid *et al.*, 2014). However, the use of multi-actor approaches for AR4D offers lessons learning opportunities for the implementation of MAPs. For instance, the MAPs established by InnovAfrica project, are expected to make a significant contributions to achieve the project objectives.

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5 Other innovative SAIs, EASs, IIAs implemented and promoted in the past and present

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This chapter takes in to account selected innovative SAIs, EASs and IIAs that are not covered under the InnovAfrica project but have high potential to increase agricultural production.

5.1 Sustainable Agricultural Intensification

There are several technologies available and/or adopted across the globe for sustainable intensification of crop and livestock production systems. Examples include no-till, integrated soil fertility management, precision agriculture, organic agriculture, water harvesting, drip irrigation, mulching, crop rotation, cover crops, heat and drought tolerant crop varieties, disease resistant crop varieties and animal breeds, vaccines and crop protection technologies. The main SAI technologies that are not currently implemented in InnovAfrica project but have high potential in agricultural transformation in Sub-Saharan Africa are elaborated below.

5.1.1 Conservation Agriculture

High demand for food and competition for land and water resources by non-agriculture sectors, exerts pressures on the remaining arable land, water and other natural resources in Sub Saharan Africa (SSA). Here, the role of conservation agriculture comes in. Conservation Agriculture (CA) is a system of agronomic practices that include three main underlying principles: i) minimum or no mechanical soil disturbance throughout the entire crop rotation, permanent organic soil cover, diversified crop rotations in case of annual crops or plant associations in case of perennial crops (Palm *et al.,* 2014). CA aims to conserve, improve and make more efficient use of natural resources through integrated management of available soil, water and biological resources combined with external inputs. CA can be applied in all agro-ecological systems irrespective of the farm sizes. It would be one of the most preferred technologies in the areas that experiences acute labour shortages. The benefits of CA have been well documented for developing countries including those from Africa with an average increase in crop yield of 79 percent (Pretty *et al.,* 2006). Besides yield benefit CA improves soil structure, sequesteres more carbon, and increases water use efficiency.

Figure 5.1 Maize and bean crops grown under zero tillage at Embu County, Kenya (Photo by BecA-ILRI Hub).

However, even with several reported success stories of CA, Giller *et al.,* (2009) stated that the empirical evidence of the beneficial effects of CA is not clear and consistent. Negative effects of CA do exist, especially in the short term: increased weed competition and residue-borne diseases (Giller *et al.,* 2009). Other limitations of CA include competing multiple use of crop residues for mulching, livestock feed and building materials; shortage of organic residues; lack of capital to apply herbicides; increases labour demand for weeding and residue-borne diseases; increases herbicide use; soil compaction from wet soils, waterlogging; soil acidity; and aluminium toxicity. In dry parts of SSA, the adaptation of CA (for e.g. zero tillage) has been limited due to long lasting dry season resulting in little opportunity for cover crops to survive and crust prone soils to adapt (Rockström, 2009). Mulching is also difficult to achieve in savannah agroecosystems due to free grazing conditions (Rockström 2009). To achieve full benefits of CA in SSA, more emphasis on water conservation may be needed (Rockström, 2009).

5.1.2 StrigAway Imazapyr Resistant (IR) maize

Striga is a parasitic weed that causes yield losses in range of 20-100 percent and affect livelihoods of about 300 million people in SSA (DFID, 2010). In SSA, about 2.4 million hectares of maize cropland is infested with Striga resulting in yield loss of 1.6 million tons per year, valued at US$383 million (Woomer et al., 2008). Over the past five decades research on striga control has focused on agronomic practices, crop rotation, intercropping, organic matter usage, improved fallows and push-pull system, host plant resistance and the application of herbicide. StrigAway Imazapyr Resistant (IR) maize technology comprises of herbicide-resistant maize seed and systemic imazapyr herbicide. This technology increases yields in between 38-82 percent higher than traditional maize varieties, and other benefits includes reduced herbicide toxicity in maize, reduced farm labour and striga management (DFID, 2010). The technology has been implemented in East Africa including Kenya and Tanzania.

Figure 5.2 A field trial contrasting Striga infested maize (left side) alongside StrigAway Imazapyr Resistant, IR maize (right side) (Photo by AATF)

5.1.3 Orange-fleshed Sweet Potato

Vitamin A deficiency (VAD) is a public health problem in more than half of all countries, especially in Africa and South-East Asia, hitting hardest young children and pregnant women in low-income countries (WHO, 2017). Orange-fleshed Sweet Potato (OFSP) varieties are high in Vitamin A and are being applied in many African countries to alleviate VAD. For example, more than 60 per cent of farmers in Uganda and Mozambique have adopted vitamin OFSP varieties, and intake of OFSP among children and women has increased by two-thirds or more in both countries (EIARD, 2013). The International Potato Center (CIP) has been implementing the Sweet potato Action for Security and Health in Africa (SASHA) initiative to improve the food security and livelihoods of 10 million households in SSA. The program develops the essential capacities, products, and methods to reposition sweet potato in food economies of SSA countries.

5.1.4 Water Efficient Maize for Africa

Drought is a common challenge for agricultural development causing frequent crop failures in SSA and other regions of the world. Maize, the widely grown staple food crop in Africa is severely affected by drought causing crop failure, hunger, and poverty. Water Efficient Maize for Africa (WEMA), a public-private partnership has developed several drought-tolerant and insect-protected maize varieties for smallholder farmers in SSA through African seed companies. WEMA has developed more than 80 drought-tolerant (climate-smart) maize varieties adapted to the prevailing weather conditions and diseases of different regions. In 2016, the WE2109 variety was launched in Tanzania, and WE3127 and WE3128 hybrids were released in South Africa. Under moderate drought, WEMA's drought-tolerant maize can increase yields by 20 to 35 percent compared to varieties developed at the beginning of the program in 2008 (Situma, 2017).

5.2 Extension and Advisory Services

An ideal EASs provider should meet immediate need of the farmers as they change their production and livelihood systems and some of the roles are mentioned in Box 5.1

Box 5.1: The main roles and responsibilities of EASs providers

- Advise farmers on problems or opportunities in agricultural production, marketing, conservation, and family livelihood
- Facilitate development of local skills and organizations and links with other programs and institutions
- Transfer new technologies to farmers and rural people
- Address public interest issues in rural areas such as resource conservation, nutrition and family education, and youth development
- Serve as bridge between researchers and farming communities in transferring innovations (researcher to farmer) and
- Provide feedback on technology (farmer to researcher)

Source: USAID (2013)

Ineffective EASs and lack of coordination between EASs and research institutions are often seen as bottleneck in technology transfer and a cause for low adoption of agricultural technologies in many developing countries. Some of the EASs not covered in InnovAfrica project are briefly described below.

5.2.1 Training and Visit Extension

The Training and Visit (T&V) extension approach was promoted by World Bank from mid-1970s to mid-1990s in about 70 countries from Asia and SSA. The approach aimed at building a professional extension agents through trainings and in turn made regular visits to farmers' fields to disseminate research results. The extension agents assisted farmers to increase production and incomes for e.g. by accelerating the dissemination of green revolution technologies, and to provide appropriate support for agricultural development (Venkatesan, 1997). This approach had high impact in irrigated areas but had minimal impact in the rain-fed areas due to lack of relevant technologies (Swanson and Rajalahti, 2010). The T&V extension was not sustained beyond the life of T&V extension projects due to the high cost associated with staff salary and benefits.

5.2.2 Innovative, Market-driven Extension Approaches

The transformation of agriculture from subsistence to commercial scale is imperative to improve food and nutritional security and the livelihood of rural households. The commercialization of agriculture is equally important to generate income that works as driver of attracting more youth and women in agriculture sector. The innovative, market-driven extension analyses market needs and promotes the production of agricultural products with assured market and high return. This approach is very timely in view of the increased population growth, affluence and changes in food habits that has created markets for high value agricultural products such as e.g., fruits, vegetables, fish, and other animal source foods. It is important for every farming household to identify suitable enterprises based on available resources and access to different market for their products. Working with a team of the people having common interest in post-harvest handling and marketing of these products to urban markets and beyond are necessary. There is also a need to for strengthen capacity of government extension agents for e.g. on farm management, marketing high-value crops and products, micro-finance, and

agribusiness management. This enables farmer group and extension agents to work together to identify niche market for a given high value product and to diversify their products (Singh and Swanson, 2006).

5.3 Innovative Institutional Approach

5.3.1 Agricultural Cooperatives

Cooperative is an autonomous association of persons united voluntarily to meet their common economic, social, and cultural needs and aspirations through a jointly-owned and democratically-controlled enterprise (ICA, 2005). Cooperative enhances economic opportunities and empowers people to improve their quality of life. Some of the benefits of agricultural cooperative includes strengthen bargaining power, maintain access to competitive markets, capitalize on new market opportunities, obtain needed products and services on a competitive basis, improve income opportunities, reduce costs; and manage risk (NCFC, 2005). Agricultural cooperatives can be broadly classified into three categories: i) marketing cooperatives, ii) farm supply cooperatives and iii) service cooperatives (Cropp and Ingalsbe, 1989). Agricultural cooperatives are quite common in Africa but they often fail because of problems in management accountable to the members that leads to inappropriate political activities or financial irregularities in management (Akwabi-Ameyaw, 1997).

5.3.2 Agro-dealers

The scarcity and high costs of basic farm supplies are among the major factors responsible for low adoption of improved technology and low agricultural productivity in SSA. In Africa, various non-governmental organizations including Alliance for a Green Revolution in Africa (AGRA) and CARE International have been involved in establishing rural agro-dealers in several countries. These agro-dealers run small business and carter services to poor farmers in remote areas. Besides selling affordable farm supplies in the quantities needed by small-scale farmers, the agro-dealers also educate farmers on safe handling and efficient use of farm inputs. These agro-dealers also receive periodic training to advance their knowledge on existing and new input and their application (AGRA, 2009). A regular backstopping of agro-dealers is necessary to access credit and update on technical matters which is currently achieved through donors funding. Provision of such support from the government is necessary for continuous engagement of agro-dealer beyond donors funding for sustainable and timely supply of agricultural inputs at affordable rates.

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PART II: Case Country Review

Part II of this report reviews the state of agriculture, FNS and the various agriculture technologies in SAIs, approaches in EASs and IIAs implemented and promoted in six case study countries of InnovAfrica Project. These countries are Ethiopia, Kenya, Malawi, Tanzania, Rwanda and South-Africa. One or two cases of success stories as well as failure stories in either of these applied approaches and technologies are discussed. Lessons to learn from the past experiences with respect to SAIs, EASs and/or IIAs are drawn and possible measures to improve the SAIs, EASs and IIAs are suggested.

6 ETHIOPIA: *Sustainable Agriculture Intensification, Extension and Advisory Services and Institutional Approaches*

Nigussie Dachassa, Mengistu Ketema, Kibebew Kibret, Bosena Tegegne, Tesfaye Lemma and Feyisa Hundessa

6.1 State of Agriculture

Agriculture is the basis of Ethiopia's economy accounting for about 50 percent of the country's gross domestic product (GDP), 85 percent of exports, and over 80 percent of total employment in the labor force (Deloitte, 2016). The largest share of export value comes from cash crops such as coffee and sesame (USAID, 2015; FAO and IFC, 2015). Agricultural production in Ethiopia is practiced mostly in the highlands and mid-lands (IFPRI and EDIR, 2011). Five major cereals namely teff (*Eragrostis tef*), wheat (*Triticum aestivum* and *Triticum durum*), maize (*Zea mays*), sorghum (*Sorghum bicolor*), and barley (*Hordeum vulgare*) are major staples and play dominant roles in cropping systems depending on elevation, rainfall, and market access in the high- and midlands of Ethiopia (USAID, 2015). Major root and tuber crops produced in the country include potato (*Solanum tuberosum*), enset (*Ensete ventricosum*) and sweet potato (*Ipomea batatas*).

Ethiopia has two dominant agricultural systems, i.e. mixed agriculture practiced in the highlands and midlands, where crops and livestock production is integrated, and pastoralist agriculture in the lowlands. On average, crop production makes up 60 percent of the sector's outputs whereas livestock production accounts for 27 percent. Agriculture is dominated by smallholder farmers and it is predominantly rain-fed, using traditional technologies with low inputs and low outputs subsistence production system, accounting for 95 percent of the total area under agriculture. Smallholder agriculture contributes a share of more than 90 percent of the total agricultural output (FAO, 2014; Birhanu *et al*., 2016). The landholding is very fragmented and the average size is about 0.95 ha per household (USAID, 2015). Of the total number of farming households in the country about 25 percent are women-headed households (FAO, 2014).

Livestock notably cattle, sheep and goats are raised and contribute about 47 percent of the agricultural GDP and 85 percent of farm cash income (IFPRI, 2013; FAO and IFC, 2015). In the highlands, cattle are also kept as a source of draft power and moved out of the agricultural areas to grazing elsewhere during cropping seasons. In lowland areas, cattle are kept as a financial reserve and are sold smallholders living in the highlands or live animal for export. A small volume is sold directly to domestic abattoirs (USAID, 2015).

The potential irrigable land is estimated to be about four million hectares and roughly about 10 to 12 percent of the total irrigable land is under production using traditional and modern irrigation schemes. Therefore, contribution of irrigation to the national economy is quite limited compared to its potential (MANRMD, 2011).

6.2 Food Security Status

Ethiopia's population is estimated at about 104,957,438 (UN, 2017). Given that the country is mainly dependent on agriculture for the livelihoods, this huge population places a heavy stress on limited natural resources and per capita food production. Per capita cereal consumption in Ethiopia is low (150 kilograms per person per year). Although absolute crops and livestock yields have been increasing steadily at the expense of bringing more cultivable land (extensification), the amount of farmland per person has been dwindling at a rate that is twice as much as the increment in the yields. This resulted in little improvements in per capita food production because agricultural productivity per unti area (intensification) is decreasing due to host of factors. These factors include population pressure, drought, limited land and lack of oxen for ploughing, outbreaks of plant and animal diseases, soil erosion and nutrient depletion, frost attack, shortage of cash income, poor farming technologies, weak extension service, high labor wastage, poor social and infrastructural facilities and pre and post-harvest crop losses (Birara *et al.*, 2015). If these trends persist, per capita cereal production could decline by 28 percent by 2025 (USAID, 2012). This level of food production could leave more millions of Ethiopians exposed to hunger and undernourishment (Gashaw *et al.*, 2017). About 10 percent of Ethiopia's population is chronically food-insecure and this figure rises to 15 percent during years of drought.

6.3 Sustainable Agricultural Intensifications systems (SAIs)

There is no universally accepted definition for agricultural intensification. Cochrane (2014), for instance, defined agricultural intensification, in a very general way, as actions that make agricultural systems more productive through the use of various practices that include, but not limited to, improved seed varieties and resource management, irrigation, farming practices, diversification etc. Dixon *et al*. (2001), on the other hand, described agricultural intensification as an increase in the productivity of existing land and water resources in the production of food and cash crops, livestock, forestry, and aquaculture with increased and more efficient use of external inputs.

A growing population and limited natural resource base means that, if current and future food and fiber needs are to be met, natural resources will have to be used in a more sustainable way. Promoting sustainable agriculture requires that farm management techniques foster synergies, conserve nutrients, increase economic stability, and promote equitable outcomes for male and female small-scale farmers. Several researches have been conducted in the area of agricultural intensification over the past decades. Some of the SAIs practices implemented and promoted are summarized as below.

6.3.1 Crop rotation

Crop rotation is the system of varying successive crops in a definite order on the same ground over time (diversification in time), especially to avoid depleting the soil and to control weeds, diseases, and pests thereby maximize yield (Tolera *et al.*, 2009). Many research findings conducted in different parts of Ethiopia have confirmed the effectiveness of this practice in restoring soil fertility and improving yield of the subsequent crop (e.g. Getachew and Chemeda, 2016). The findings of research conducted in Bako demonstrated that maize following Niger

seed produced mean grain yield advantage of 971 and 1527 kg ha^{-1} compared to haricot bean and tef (Tolera *et al*., 2009).

The crops involved in the rotation vary across regions. For instance, Asfaw *et al*. (1997) reported legume-cereal and oilseed- cereal sequence as the predominant cropping pattern practiced by smallholder farmers in western Ethiopia. Nugusse (1995) found that Haricot bean is the best precursor crop for maize at Awassa and Nazareth. However, Tadesse and Tolessa (1998) reported that Niger seed is the best precursor crop for maize with a yield advantage of 50 percent compared to sole cropping followed by haricot bean.

6.3.2 Intercropping

Intercropping is the practice of growing two or more crops at the same time during the same cropping season in the same piece of land (Geiler *et al*., 1991; Willey, 1979). The system has been shown not only to be more efficient than sole cropping (Remison, 1978; Willey, 1979) but also to improve the overall ecology (Adelana, 1984). Intercropping is an important practice for the development of sustainable food production systems, particularly in cropping system with limited external inputs (Getachew *et al*., 2006). This is due to some of the potential benefits of intercropping systems such as high productivity and profitability (Yildirim and Guvence, 2005), improvement of soil fertility through the addition of nitrogen by fixation and extraction from the component legume (Hauggaard *et al*., 2001), reducing damage caused by pests, diseases and weeds (Altieri and Libeman, 1986; Banik *et al*., 2006), improvement of forage quality (Getachew *et al*., 2006), and efficient use of environmental resources (Eskandari and Ghanbari, 2010).

Intercropping is among the most researched and adopted cropping systems in Ethiopia (Table 6.1). The results of intercropping have shown better use of growth resources in intercropping and higher combined yield than sole cropping. A study on intercropping by Workayehu (2014) found that basic intercropping reduced weeds by almost a third and that intercropping and weeding significantly increased plant height, yield, and monetary benefit.

Table 6.1: Intercroppping systems research carried out in the various parts of Ethiopia.

Intercroping systems	References
• Soybean with maize	Solomon (2014)
• Maize with lablab forage legume	Weldeyesus (2017)
• Lupine with wheat, barley and finger millet at different seeding rates	Yayeh (2014)
• Cassava with maize in southern Ethiopia	Fisseha and Tewodros (2014)
• Cassava with taro, *enset*, sweet potato, sorghum, and maize in south and southwestern parts of Ethiopia	Eyasu (1997) Mekonnen, and Badji (1997)
• Common bean double intercropping with maize	Tamado *et al*. (2007)
• Maize with faba bean and maize with haricot bean in eastern Ethiopia	Tilahun *et al*. (2012); Ashenafi (2016)

6.3.3 Soil and water conservation measures

The severe land degradation existing in most parts of Ethiopia has been among the most threatening challenges for the farmers and government. As a result, past and present governments have been making concerted efforts to reverse the situation through various environmental interventions. Soil and water conservation practices that showed the greatest potential for soil loss reduction include terracing, grassed waterways, and stabilization structure (Tesfahunegn *et al*., 2012). In addition, vegetation cover and exclusion practices have been found to be the most effective means to prevent runoff, enhance better utilization of available water resources, and prevent nutrient losses (Girmay *et al*., 2009). Ample evidence also exists on the impact/ contribution of area closures in land rehabilitation including vegetation restoration as well as nutrient restoration (e.g. Mekuria *et al*., 2011).

Various forms of efforts to control soil erosion through induced soil and water conservation (SWC) measures have been underway for nearly four decades (Kebede, 2014). In fact, the use of traditional stone bunds on agricultural lands has been a commonly used practice since many centuries in the Tigray highlands and North Shewa (Kebede, 2014). Other good examples of land management practices include the terraces of the Konso people, terraces and bunds in the Hararghe highlands, which are the UNESCO world heritage (Osman and Sauerborn, 2001), and the Drashe area to reduce soil degradation and increase soil and water conservation. Building soil bunds by farmers in Wondo Genet area for conserving water, especially for growing sugarcane was also reported by Kebede (2014). The SWC activities were implemented by mobilizing farmers through their peasant associations, mainly in food for work programs (Bewket, 2007) although the approach was criticized for its top-down approach.

Nowadays, the SWC approach has been shifted towards integrated and participatory watershed development approaches to improve rural livelihoods with sustainable natural resources management. The SWC campaign promotes the combined use of physical measures (such as level soil bunds, terraces, stone bunds, and level *fanya juu)* and biological measures like planting of millions of seedlings every year at the national level (Kebede, 2014).

6.3.4 Irrigation development and water harvesting

Irrigation development

Irrigation is conceived as one of the intensification strategies used by smallholder farmers (Cochrane, 2014). The Ethiopian government is pursuing plans and programs to ensure FNS, and overall economic growth by developing irrigation schemes that are small to large scales in an effort to substantially reduce poverty. Ethiopia could irrigate over 5 million hectare with existing water sources (Sileshi *et al*., 2010). However, at present only 4 to 5 percent of the cultivable land, is irrigated under the existing irrigation schemes. Seleshi *et al*. (2010). In areas where irrigation has been practiced in full or as supplementary, positive results have been recorded. Ayele *et al*. (2013) reported a 27 percent higher household income due to the use of irrigation in the Lake Tana basin. Yihun *et al*. (2013) also reported a three-fold yield increase of teff grown under irrigated fields compared to rain-fed teff cultivation. Despite the multi-faceted benefits expected from irrigation and concerted efforts from government and other stakeholders, improving agricultural water management has been hampered by inappropriate policy, institutions, technologies, capacity, infrastructure, and markets (Sileshi *et al*., 2010). To

make investments in irrigation effective, the traditional irrigation systems need to be supported by research, extension services, and local government policy (Gutu *et al*., 2014).

Water harvesting

One notable example of the traditional irirgation system is the spate irrigation. Spate irrigation is a type of water management system that wets land prior to planting of crops. This system has been practiced for millennia in arid climates of the world such as the Middles East, Northern Africa, Eastern Africa and South Asia (Peter, 1987). For example, the spate irrigation farmers in Eritrea and Ethiopia have developed agricultural land by diverting ephemeral rivers (springing from adjacent highland catchments) to the nearby lowlands by constructing diversion structures. The flood water that also consists of eroded nutrients and sediments are retained in a series of field bunds to grow crops using residual soil moisture.

Future climate change is expected to bring elevated risks in spate irrigation system. These risks and/or uncertainties include more rainfall variability and floods insecurity in the spate irrigation system. The fact that the spate irrigation system heavily depends on the availability of floods makes the system more vulnerable to climate change and variability. When a big flood enters the command area of the spate fields, it destroys flood channels and creates deep gullies, exacerbating land degradation. On the other hand, when there are more medium and small-sized floods, the diversion structures are capable of diverting and conveying the floods to the adjacent fields. As a result, the availability of water to the spate irrigated fields will increase and more moisture will be retained in the deep soil profile which leads to increase crop yield. Thus, not all climate changes are negative for spate irrigation system: it all depends on the flood characteristics, rainfall conditions in the catchments and also the resilience to those changes made by farmers (Tesfai, 2001).

Success stories of SAIs

There are a number of success stories from the use of different SAIs across different parts of the country. Notable examples include:

- The watershed-level soil and water conservation practices implemented following participatory and integrated approach. These SAIs resulted in significant reduction of soil erosion, rehabilitation of degraded vegetation cover, and better recharge of ground water resources in the downstream areas. This made the availability of irrigation water more sustainable.
- The soil and water conservation efforts in the Tigray region, those in Hararghe region which resulted in re-emergence of a vanished lake called Lake Chercher, the Konso, and many others are good examples of success stories related to adoption of land management practices as SAIs.
- The common use of small-scale irrigation using water from rainwater harvesting, spate irrigation, hand-dug well, river water diversion etc. In areas where the natural rainfall is not adequate (in terms of distribution and quantity), has registered remarkable increases in crop yield and income to smallholder farmers across different parts of the country.
- The use of improved varieties of different crops has also resulted in dramatic increases in crop yield in different parts of the country.

Failure stories of SAIs

i) The soil and water conservation program: In the past governments, most of the soil and water conservation initiatives planned and implemented across the country did not result in the intended outcomes. The main reason for these failures was the approach followed, which was top-down approach. Most of the interventions engaged the community through food for work programs, which increased dependency on these projects as main sources of livelihood. As a consequences, as soon as the project is over, the activities stop there.

ii) The rainwater harvesting campaign and irrigation schemes: The rainwater harvesting campaign practiced in the country about a decade ago was another good example of failure at catchment scale. That campaign did not produce the expected levels of achievement. However, it created awareness on rainwater harvesting across the country. In addition, there are too many small-scale failure stories in the adoption of the many SAI practices in the country. For instance, areas which were under irrigation have been abandoned due to salinity and sodicity build up and/or waterlogging.

Lessons Learned from SAIs

The most important lesson learnt from the past and present SAIs are as follows:

- The adoption and dissemination of SAIs should be participatory rather than a top-down approach.
- The role of social capital is important for the adoption of SAIs
- Combined use of SAIs deliver better results as compared to the use of a single SAI.
- Policy support is central for widespread adoption and implementation of a given technology (e.g., watershed management).
- Investment in infrastructures and other public goods is needed for sustainable intensification.
- Gender equity in technology adoption and outcomes is essential.
- Win-win outcomes are possible with adoption of SAI practices.
- Incorporating crop residues and nutrient havesting from runoff water (where relevant) to improve the SAIs.

6.4 Extension and Advisory Services (EASs)

The histriocal development of EASs in Ethiopia could be described as follows:

i) Agriculture extension approaches in 1950s- 60s: Ethiopia started agricultural extension services in the 1950s and early 1960s, when a model similar to the United States Land Grant approach was used, in which universities reached out to communities with research-based knowledge and through adult education. The Imperial Ethiopian College of Agriculture and Mechanical Arts (IECAMA) (now Haramaya University) started providing agricultural extension services in addition to research and teaching (Belay, 2015). In 1963, the Ministry of Agriculture was established, and the mandate of agricultural extension service provision was transferred to this institution under its extension department established at different levels. During this time, the country started implementing several national development plans.

ii) Agriculture extension approaches in 1970s- 80s: A Comprehensive Integrated Package Projects (CIPPs) were then initiated and implemented from 1967 to 1975 to develop peasant agriculture. Under CIPPs' umbrella, Chilalo Agricultural Development Unit (CADU) and

Wolayita Agricultural Development Units (WADU) were established. CADU was established in 1967. Its major objectives were to improve the living standard of the peasant population through increasing agricultural production and promoting rural infrastructure via a 'model farmer' approach. WADU was established in 1970 by avoiding the 'model farmer' approach and instead demonstrating technologies on peasants' farms that were relatively resource-poor (Abate, 2007).

A minimum package program (MPP) approach then followed these programs, to help to scale up the CIPPs. MPP I lasted from 1971 to 1974. The country then espoused the socialism system. During this time, the government implemented "quasi-participatory extension approaches". Following the land reform and cooperative movements from 1975 to 1980, the second phase MPP-II got delayed and re-started and implemented from 1980-1985 after efforts were done to adapt it with the military government's socio-economic and political system. In the mid-1980s, various new programs were implemented, such as the National Program for Food Self Sufficiency (1986–1989), the Modified Training and Visit (T&V) Approach, and the Peasant Agriculture Development Projects (1986–1995) (Abate, 2007). Research Extension Liaison Committees (RELCs) were formed in 1986 both at the national and zonal levels. The establishment of the national RELCs was believed to provide a suitable forum for consultation among different stakeholders.

iii) Agriculture extension approaches in 1990s- early 2000s: In 1993, the Sasakawa Global (SG-2000) promoted the use of productivity-enhancing technologies and access to inputs and credit, coupled with training using 0.25 to 0.5 hectare demonstration plots that were closely supervised by research and extension. SG-2000's goal was to increase food production and stimulate links between research and extension (Belay, 2015). SG-2000's strategy was later taken up by the Ministry of Agriculture as part of smallholder intensification extension strategy, known as the Participatory Demonstration and Extension Training System (PADETS) in 1994/95, which combined elements of the previous T&V system with the SG-2000 fertilizer and seed credit package. This approach used large demonstration plots called Extension Management Training Plot (EMTP), usually a quarter to half a hectare in size. PADETS is a package approach where the important package of recommendations was used, including improved crop varieties, improved seedbed preparation, optimum seeding rate, methods of fertilizer application, fertilizer rate, and use of pesticides. PADETS also gave equal emphasis to human resource development (organization, mobilization, and empowerment) along with its efforts to promote appropriate technologies to the users.

In 1996, it was decided to expand the agricultural extension demonstration programs by including other packages such as livestock, high value crops, and post-harvest activities. In the second half of 1990s, Farmer Training Centers (FTCs) were established in each *kebele*. The FTCs were designed as local-level focal points for farmers to receive information, training, demonstrations, and advice, and included both classroom and demonstration fields. Each FTC was staffed by three DAs, in the areas of crops, livestock, and natural resources.

In the late 1990s, the issue of research-extension linkage re-emerged following the development of a strategy by the Federal Government in 1999, which was meant to strengthen the existing loose linkages between research and extension. Consequently, a new form of institutional set up called Research-Extension Advisory Council (REAC) was established at the federal,

regional, and zonal levels. However, all the REACs were not institutionally anchored into the system, creating absence of conducive ground for sufficient interaction among farmers, development agents, and researchers.

In view of this, another multi-stakeholder platform called Agriculture and Rural Development Partners Linkage Advisory Council (ARDPLAC) was established in 2008. Following the renaming of the Ministry of Agriculture and Rural Development into the Ministry of Agriculture, the name ARDPLAC was also changed into Agriculture Development Partners Linkage Advisory Council (ADPLAC), which was also organized at national, regional, zonal, and woreda levels (MoANR, 2015). However, this structure has not yet been properly implemented, as actors are not meeting regularly, mainly because of lack of budget to finance meetings and other activities.

iv) Current agriculture extension approaches: The country has recently devised a new Agricultural Extension Strategy in 2017 consisting of nine pillars.

Box 6.1: The nine pillars of current EASs in Ethiopia
- Strengthening FTCs through active participation of community and capacity building;
- Enhancing agricultural knowledge and information systems;
- Enhancing client-oriented and multi-actor's advisory extension services;
- Facilitating market linkages and enhancing VC development;
- Mainstreaming gender, youth, and nutrition;
- Enhancing environmental management and sustainability;
- Enhancing institutional arrangements, coordination and linkages among key agricultural development partners;
- Developing and utilizing human resources for effective extension service delivery; and
- Establishing strong and dynamic result-based monitoring, evaluation, and learning for continuous improvement of extension service delivery.

Source: Agricultural Extension Strategy (2017)

Even though the provision of agricultural advisory services was traditionally a public sector activity, new actors have entered the scene to provide and finance advisory services, including non-governmental organizations, farmer organizations, academic/research institutions, private providers, commercial companies, and community-based organizations (Belay, 2015). In 2015, a new strategy was developed in an attempt to reinvigorate and revitalize ADPLAC and to strengthen linkages among agricultural stakeholders and facilitate the ground for strengthening agricultural advisory services in Ethiopia (Birhanu *et al*., 2016).

Success Stories of EASs

Two cases of success stories in EASs are described as examples in Boxes 6.2 and 6.3.

Box 6.2: A story on Interactive Voice Response and 8028 hotline

The implementation of the different extension approaches described above contributed to improved dissemination of new knowledge, skills, and technologies which enhanced agricultural production and productivity of smallholder farmers in the country. It should be noted that the extension approaches were changed from time to time to adapt to new demands for knowledge and technologies

as well as social, economic, political, and environmental dynamics. However, the success of any new approach depended on capitalizing on the achievement of the previous approach. The extension systems implemented created smallholder farmers communities that demand more knowledge, technologies, and skills thereby providing the impetus to provide more creative and effective extension services on the part of policy makers and government. Thus, the level of awareness for change in the livelihoods of smallholder farmers has been increasing in the perspective of technology generators and disseminators as well as stakeholders involved in providing required extension services.

Millions of smallholder farmers have evidently benefited from the series of extension services provided over the years in terms of enhancing productivity, income, and status of livelihood. The benefits achieved by farmers are exemplified by achievements recorded by the Agricultural Transformation Agency (ATA) of the country. The Ethiopian ATA in collaboration with MoA created an Interactive *Voice Response (IVR) and 8028 hotline service* to make extension information readily available to the smallholder farmers at any time (ATA, 2014). The hotline that began its services in 2014 in the four major regions (in their respective regional languages) was found to be very successful where the hotline received 1.5 million phone calls from 300,000 registered callers within a few months, providing them with information on high value crops and agricultural activities.
Source: ATA (2014)

Box 6.3: A story where a private processer provided extension service to the community
Involvement of the private sector in providing extension services to the producers is not common in Ethiopia. The full-fledged extension services are provided by the public sector. There have been a few extension services provided to link producers to processing firms. The National Strategy for Ethiopia's Agricultural Extension System has indicated that the role played by the *Dashen Malt Factory located in Gondar town* has become exemplary in terms of providing extension services by working with the public extension staff to promote malt barely production in barley production potential areas (ATA, 2014). In this regard, the factory has been providing trainings and information to farmers and extension workers on quality standards and requirements of the factory. It has also been assisting farmers to access improved quality seed and to facilitate collective marketing by creating linkages with farmers' cooperatives and unions.

A similar effort has also been made by *Heiniken brewery in tandem with Asella Malt Factory* by supporting malt barley producers in the area and purchasing the product from farmers at the end (Salamta, 2017). This implies that actors involved in agro-processing industries could enhance agricultural production and productivity by providing extension services, creating product markets, and strengthening linkages among actors.
Source: Salamta (2017)

Box 6.4: Lesson learned and measures to improve EASs
Lessons learned include:

- It has become evident that delivery of agricultural EAS should be supported by information and communication technologies (ICTs), which catalyze effective implementation of the systems.
- Promoting gender-sensitive agricultural EAS systems through farmer group approaches has been found to consolidate the effectiveness of technology dissemination.
- Pursuing the approach of voluntary involvement of farmers through persuasion rather than coercion is the appropriate way for effective implementation of EASs.
- Building human resource capacity by focusing on modern and participatory extension and advisory services is vital.
- EASs in Ethiopia have not focused upon livestock and respective veterinary services; (Atsbeha, 2013). Most of the extension approaches were biased against the livestock sub-sector and sustainable use of natural resources by putting more emphasis on the crop sub-sector.
- Irrigation extension is almost non-existent while more focus is given on rain fed agricultural production system.

- Extension agents are overloaded with non-professional activities.

Measures to improve EASs

- It is necessary to have integrated extension system where all sub-sectors are interlinked and synergize each other for enhanced positive outcomes.
- It is necessary to take away other burdens from the extension agent and make them focus on their professional activities in order to support the farmers.

6.5 Innovative institutional approaches (IIAs)

Innovation is a process of successful use of knowledge, originated from different sources and acquired by different mechanisms, for problem solving to achieve positive development outcomes. Institutions are norms, rules and organizations that structure interaction and serve as mechanisms for mitigating collective-action problems among multiple actors. Hence, *innovative institutional approaches refer to both structures and processes (institutional arrangements)* that fosters interaction and enable innovations by reducing transaction costs of exchange, knowledge or otherwise, and by facilitating coordination. The two main innovative institutional approaches currently being used in Ethiopian agriculture are: i) multi-actor/multi-level platform and ii) integrated seed sector development.

6.5.1 Multi-actor Platform (MAP)

Innovation is increasingly becoming important for SAI in the context of increasing resource scarcity, market competition, and climate change in SSA. Impact-oriented innovation requires appropriate and innovative institutional arrangements to facilitate linkage, interaction and learning in a multi-stakeholder's context. Innovative institutional approaches facilitate coordination of inputs (knowledge, resources, and social and political capital) and expectations of various actors that enable innovations. One of critical problems in Ethiopian agricultural innovation systems, has been, a weak link (Yenesew *et al*., 2016), and sometimes missing link between knowledge domain (e.g. research/extension) and demand domain (farmers/enterprises).

Box 6.5: ADPLAC main features

ADPLAC is a multi-level and multi-stakeholder platform established, through a participatory process, as a mechanism to strengthen linkages and interactions among actors in Ethiopian agricultural innovation systems. This innovative institutional approach recognizes all relevant actors, enterprises demand, intermediary and support domains, and sets out rules of engagement. ADPLAC has formal Organizational Structure and Operational Guidelines at Federal, Regional, Zonal and Woreda Levels (MoA, 2011).

The Federal Ministry of Agriculture and Natural Resources has developed strategic plan (2016-2020) to effectively operationalize ADPLAC and enhance its contribution towards realization of the country's five-year (2016-2020) plan for agricultural development, which is called Growth and Transformation Plan II (GTP II). The strategic plan for operationalizing ADPLAC provides vision, mission, goals, objectives, intended outcomes, and guiding principles, along with budget and framework for monitoring, learning, and evaluation. Pluralism, public-sector leadership, utilization of improved management information systems, empowering the demand domain, mainstreaming gender and youth, and integration of climate change and environment are among the guiding principles indicated in the document.

Source: Belay et al (2012)

Ad-hoc type efforts to facilitate linkages between components of agricultural knowledge system (research, education, and farmers) by agricultural ministry and National Agricultural Research Systems (NARS), through institutional arrangements like Research Extension Linkages Committee (RELC), dates back to the mid 1980s. Nonetheless, it was as recently as 2008 that Agricultural Development Partners' Linkages Advisory Council (ADPLAC) has been institutionalized with the financial support obtained from the World Bank through the Rural Capacity Building Project. ADPLAC is now embedded in the Federal Ministry and Regional Bureaus of Agriculture and Natural Resources (MoANR, 2015) as a functional mechanism for facilitating linkages and partnerships.

Table 6.2: ADPLAC strategic roles and its contributions to innovations systems.

Key roles	Agricultural innovation systems	Enabling innovations
• Creating efficient, effective, and synergistic linkages and partnerships among actors engaged in agricultural EASs. • Establishing ADPLAC at zonal & woreda levels • Establishing and strengthening sub-platforms which will facilitate exchange of information, knowledge, and experiences among actors. • Building capacity of regional, zonal, and woreda level ADPLACs. • Documenting best practices & facilitating experience sharing.	• Creation of institutional linkages and synergies; • Prioritization of existing critical challenges and their respective required interventions; • Alignment of different actors and research and development endeavors; and • Creation of opportunity for participatory monitoring, learning, and evaluation.	• Innovation in common beans value chain and onion seed multiplication in East Shoa Zone, Oromia Region. • Institutional innovation (arrangements) facilitated malt barley farmers' linkages with malt barley factory in Arsi Zone, Oromia Region. • Institutional innovation (arrangements) that improved access and use of improved agricultural technologies in Gurage Zone, Southern Nations', Nationalities' and Peoples' Region (SNNPR).

Source: Belay *et al.* (2012)

Birhanu *et al*. (2016) found out that ADPLAC served as an entry point for establishing a country forum for Agricultural EASs and contributed to the strengthening of agricultural advisory services by facilitating regular meetings of relevant actors/institutions throughout the country.

Moreover, International Livestock Research Institute (ILRI) and the other Consultative Group on International Agricultural Research (CGIAR) centers have been experimenting with similar innovative institutional approaches. At ILRI, for example, multi-stakeholder platform was employed to strengthen the selection and use of fodder options in Ethiopia. The project-driven multi-stakeholder platform enabled participatory selection of technologies that addressed priority problems and demonstrated tangible economic benefits. This, in turn, helped to win the trust of farmers and draw attention of a wider stakeholder. Among the lessons learnt are: i) the importance of focusing on less risky innovations that result in economic gains in the initial stage of engagement; and ii) linking innovation activities with value chain issues. In addition, public sector leadership/ownership is important for sustainability since organizations with long term

commitment and decision making power are well positioned to facilitate and sustain innovation processes.

Birhanu *et al*. (2016) documented status and performance of agricultural innovation platforms in Ethiopia. The authors identified a total of 61 platforms working on natural resource management, crops, and livestock. These platforms facilitated linkages of research and extension with farmers and enterprises and enabled introduction of technologies and scaling up of integrated crop-livestock-tree system for better production and value chains. Some innovation platforms contributed to emergence of private input supply (e.g. Innovation Platform for Technology Adoption) and institutional changes (e.g. Ethiopian Apiculture Platform).

6.5.2 Integrated Seed Systems Development

Seed is a critical input for improving agricultural production and productivity that can be a pathway out of food and nutrition insecurity and poverty in Ethiopia and elsewhere in Africa. Among the key challenges to increase agricultural productivity and product, quality improvement in Ethiopia has been limited access of smallholder farmers to quality seeds. Hybrid maize, for example, is in short supply; and open/self- pollinated crops, which are used as staples and important for household food security, have failed to attract commercial interests. This is critical as the use of appropriate and quality seed alone can boost production by at least 30 percent.

Relentless efforts are being exerted by the Ethiopian Government and its development partners to ensure the availability of demanded type of quality seeds at affordable prices to the majority of smallholder farmers. Such efforts are consistent with the continental objectives and aspirations as clearly indicated in the Comprehensive Africa Agricultural Development Program (CAADP) of New Partnership for Africa Development (NEPAD). Increasing access of smallholder farmers to quality planting material is a focus of Pillar 4 (under NEPAD program) aiming at improving agricultural research systems to disseminate appropriate technologies).

Ethiopian seed system can be categorized into the formal/commercial sector and the traditional or informal sector. The latter remains important in meeting diverse needs for seeds and accounts for a lion's share of the existing seed systems. Informal sources (own stock, local market and exchange) accounted for over 75 percent of the seed farmers sown in the 2016 cropping year (USAID, 2016). However, policies and regulations are often focused on the development of the formal seed sector in a linear fashion.

ISSD Program is operational in different regions of Ethiopia including the Amhara, Oromia, SNNPR, and Tigray regions. ISSD Ethiopia, which was initiated in August 2009 and currently in its third phase, is aimed at strengthening the development of a vibrant, commercial, and pluralistic seed sector development by focusing on seed policy, capacity strengthening, enterprise development, and facilitation of multi-stakeholder interaction for partnership and innovation. The ISSD program is coordinated by the Center for Development Innovation (CDI) at Wageningen UR and being implemented by a consortium of four Ethiopian universities namely Bahir Dar, Haramaya, Hawassa, and Mekele and Oromia Seed Enterprise (OSE) in partnership with farmers' cooperatives, regional bureaus of agriculture and natural resources,

public seed enterprises, research, and non-governmental organizations (https://www.wur.nl/en/show/Integrated-seed-sector-development-in-Ethiopia.htm).

The program uses regional multi-stakeholder platforms and private-public partnerships to address policy and institutional issues hampering development of the seed sector. The partner universities play special roles as independent and trusted source of evidence base for system interventions and in facilitating multi-stakeholder learning for innovation. The platform brings isolated actors together (farmers, entrepreneurs, policymakers, academics, practitioners, and research centers) and enables them to work on practical challenges, capture and share lessons, and enhance collective capacities.

The guiding principles for multi-stakeholder partnership are:

- Knowing critical issues leading to institutional and systemic impact.
- Objectively weighting the value of partnership in satisfying the main motive against alternative and risks before engagement.
- Existence of complementary competencies and resources to meet the parameter of strategic goals.
- Linking partnership with the core business of the partnering organizations.
- Prior consensus in the form of written document (MoU) detailing shared vision, objectives of respective partner, and division of roles and responsibilities.

Stimulating local seed businesses is another innovative aspect of the ISSD approaches. The unique nature of local seed business is that it is a system that exists within the interface between informal and formal seed systems, operating in both. Local seed businesses play an increasingly important role in introducing new and improved crop varieties in informal networks of farmers through their participation in demonstration and popularization activities of the national agricultural research systems. On the other hand, Seed Producer Cooperatives (SPCs) are also fully engaged in formal seed production as contract out growers to public enterprises. The concept acknowledges the importance of local community-based seed production for improving farmers' access to quality seed of locally adapted and preferred varieties. Local seed businesses target the segment of the seed market that is neither attractive for private companies nor fiscally sustainable for purely public programs. The concept strongly promotes entrepreneurship that has the potential to improve the demand-orientation, professionalization and efficiency of seed value chains by having profit as an incentive. Further, participation of farmers in activities of experience and knowledge-sharing can lead to the design and implementation of appropriate solutions to many bottlenecks that exist in the seed value chain.

Success of ISSD

Key areas of the project achievements in increasing production and availability of quality seed are mentioned in quantitatve terms (Table 6.4) below.

Table 6.3: Key areas of the ISSD project achievements in quantitative terms

• Increased training, coaching, supervision, investment support, experience sharing of 25 Seed Producers' Cooperatives (SPCs) and partner technical capacity for quality seed production, value addition and marketing of SPCs and stakeholders and partners. • About 14808.27 quintals (qt) (1 qt = 100 kg) of seeds of different varieties of nine crops (maize, potato, sorghum, tef, common bean, wheat, chickpea, groundnut, sesame) were produced by the SPCs in the region in 2017. • 57 new and improved varieties of four crops identified and promoted through CS and Participatory Variety Selection (PVS) trials with 1200 farmers, 50 percent are women, at six woredas (Doba, Chrio, Oda Bultum, Meta, Fedis and Kurfachale). • Three SPCs also granted donkey cart, seed threshing and seed claiming machinery by FARC, HU-research office and ISSD project. • Improved and farmers preferred crop varieties were promoted through various channels. More than 78 varieties of nine different crops were promoted in the region. The promotion activities have diversified the crop and variety portfolio in the field for improved food and nutrition security of both male and women. ▪ Audience of over 9850 farmers, extension workers, researchers, development partners in the SVC were reached to promote the value of quality seed.

Constraints of ISSD

The main constraints encountred by ISSD are as follows:

- Organizational, financial and marketing capacity of most SPCs are still weak. Linkage between seed producers especially SPCs with finance institutions, seed buyers and seed quality assurance are still a challenge. For instance, due to limited finance, SPCs failed to collect seed from their members, process, store and sell to potential customers at the right time, quality and quantity.
- Dependency syndrome of SPCs and poor in re-investment and sense of ownership. Some SPCs fail to perform the key tasks expected from them in performing seed businesses such as seed inspection by internal seed quality control committee, basic seed purchase on their own capital, etc.
- Problem of early generation seed (EGS) supply still not solved, even at regional and national level. Seed producers operating in Oromia East unit are the most affected in this regard to access basic seed.
- Weak collaboration between woreda Bureau of Agriculture and Natural Resources (BoANR) and cooperative agency in supporting SPCs for e.g. access to basic services (input, seed marketing, auditing).
- Recurrent drought resulted in failure of seed production at some SPCs and variety selection through crowdsourcing trials, and emergence of new diseases and pests (e.g. fall armyworm of maize, maize stalk borer, yellow rust, red spider mite of potato).
- Regional core groups are still inactive and fail to play key roles in enhancing seed value chain.

Lessons Learned and measures to improve IIAs

Tables 6.6 and 6.7 show the main lessons to learn from the IIAs and possible measures to improve the IIAs in this case the ISSD.

Table 6.4: Lessons Learned from IIAs

▪ Demand for new, improved and adapted varieties has been created due to PVS and crowdsourcing trials conducted at FTC and 1200 smallholder farmers' fields, of which 600 are managed by women. ▪ Women and men farmers have different preferences in crop and variety selection based on production practices, post-harvest management, food quality and market potential. Therefore, giving equal chance for both men and women farmers in any development intervention is very important to see the significant positive impact of the project. ▪ Farmers' choice in variety selection is interesting. Increased attention to gender helped to bring specific traits of crop varieties that end-users should pay attention such as color, aroma, taste and nutrition; process-and cook-ability; and kernel weight.	▪ We have discovered a rapid means to deploy a large number of new and improved varieties cost-effectively to farmers using the approach called *crowdsourcing*. ▪ Different seed promotion activities such as demonstrations, field days, seed fairs and multimedia coverage, have accelerated dissemination of farmers preferred varieties. ▪ SPCs are largely involved in seed production and marketing in the region, which are widely recognized by different stakeholders in the seed value chain. ▪ Close collaboration with woreda partners in implementation of CS and PVS trials are very promising due to signing of MoU with ISSD project and co-funding grant to implement the activities. ▪ Weak collaborations exist with woreda partners in implementing LSB development (no MoU signed and no finical support by the project in this regard).

Table 6.5 Major areas for improvement in IIAs

▪ Imporve organizational and financial capacity of SPCs through experience sharing, internal financial capacity by increasing share capital, by increasing members, by involving in off-season side business and by fund raising through different entertainments ▪ Improve dependency syndrome of some SPCs through replacing non-active committee members, experience sharing and increasing women farmers in leadership role, decision-making and benefit sharing. ▪ Mechanisms to improve or promote nutrition as a cross cutting issue besides promoting nutrition dense crop varieties by demonstrating different receipt development, food processing and preservation. ▪ The functioning of the regional seed core groups needs to be looked at strategically. Decision making in this collaborative arena is a practice that we want to maintain and increase in frequency. ▪ The link between regional seed core groups and the national seed advisory group, needs to be revamped in investment, infrastructure capacity of SPCs ▪ Mechanism to support regional seed core group to be more active and play a vital role in identifying key challenges in seed CVs, set a direction for implementation, monitor its implementation etc

In summary, there is need to strengthening public institutions (involved in EGS multiplication) through financial support, training, experience sharing and access to post-harvest seed processing technologies or means to functioning the existing seed processing plants.

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7 KENYA: Sustainable Agriculture Intensification, Extension and Advisory Services and Institutional Approaches

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7.1 State of Agriculture and Food security

Agriculture is the second largest contributor to gross domestic product (GDP) in Kenya after the service sector. The agriculture sector contributes 26 per cent of the gross domestic product (GDP) annually and a further 25 per cent indirectly through linkages with agro-based and associated industries. It accounts for 65 per cent of the country's export earnings, employs over 80 per cent of the total labour force and provides 75 per cent of industrial raw materials (GoK, 2012). The agriculture sector is dominated by production of cereals (maize, wheat, sorghum and rice), traditional food crops (sorghum, millet and cassava), export crops (tea, coffee and horticultural produce) and livestock (beef, dairy, pigs, small stock and poultry). Smallholder farms (≤ 2 ha) account for over 65 percent of the total agricultural output. The growth in the agricultural sector is closely linked to the overall economic growth in Kenya. It is estimated that a 1 per cent increase in the sector results in a corresponding 1.6 per cent increase in GDP (GoK, 2012). Despite, the importance of agricultural sector, productivity has generally remained low mainly due to weak infrastructure and institutions, fragmented markets, inadequate budgetary allocation to research and development and public extension. The recent phenomena of climate change has exacerbated the situation worst as a result of frequent cycles of drought and increased prevalence of pests and diseases.

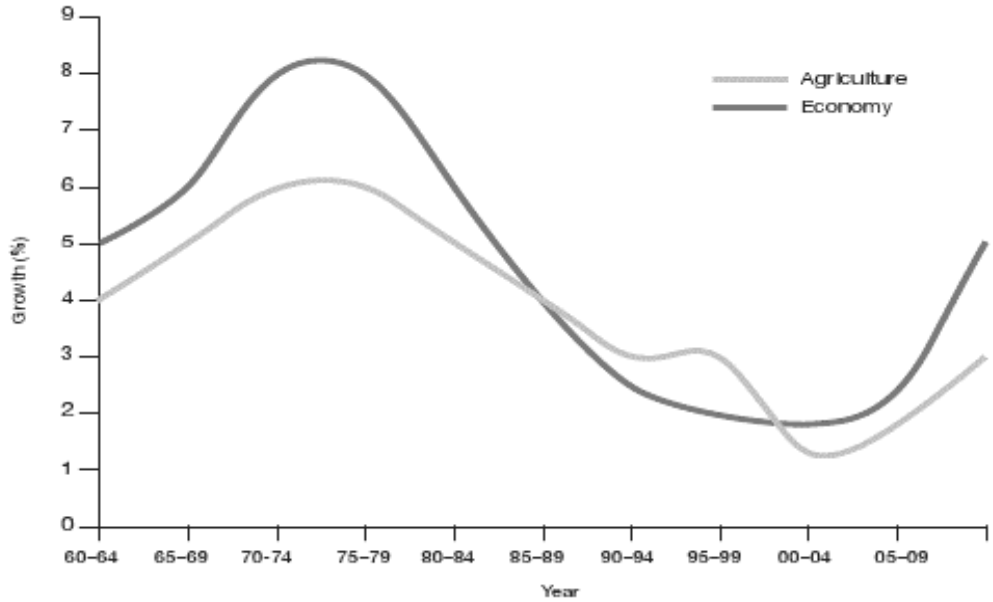

Figure 7.1: Trends in agricultural and economic growth during 1950 - 2008. Source: GoK (2010)

Kenya, for a long period has pursued the goal for improving agricultural productivity and has implemented several development strategies and programmes. *The Kenya's Poverty Reduction Strategy Paper (PRSP) of 2001*, *Economic Recovery Strategy (ERS) for* Wealth and Employment Creation, 2003-2007, *Strategy for Revitalizing Agriculture* (SRA) 2004-2014,

Agriculture Sector Development Strategy (ASDS), 2010-2020 and the *Kenya Vision* 2030 recognizes the significance of agriculture, with food security listed as one of key sub-sectors. The ERS focused on the revival of agricultural institutions and investment in agricultural research and extension services. The SRA set out to propel growth of agricultural sector to an average of 3.1 per cent and to reach 5 per cent by 2007 and reduce the number of people who were food insecure to below 10 per cent in 2015 (GOK, 2004). This was to be achieved through improved delivery of research, Extension and advisory services (EASs), access to quality inputs and financial services and markets. The mission of the ASDS is to create an innovative, commercially-oriented and modern agriculture to ensure a food-secure and prosperous nation. The Vision 2030, set out to achieve an average GDP growth rate of 10 percent per year up to the year 2030 by transforming key institutions and policies in agriculture (GOK, 2003).

Although Kenya has an enormous capacity to produce enough food to meet its food needs, the country is generally food insecure. The food insecurity is attributed to decline in agriculture productivity, climate change and inefficient food distribution systems. The economic review of agriculture 2007 indicated that 51 per cent of the Kenyan population lack access to adequate food and the country is becoming increasingly dependent on food imports. The inaccessibility to food is closely linked to poverty which stands at 46 per cent (KNBS, 2008). Self-sufficiency in maize was achieved in a few years during the 1970s when productions exceeded consumption (Kiome 2009). Per capita supply of the main staples has been declining since the early 1980s, and per capita supply of cereals (which provide most of the calories), declined from 140.9 kg/year between 1979 and 1981, to 115.7 kg/year in the 1992 to 1994 (Gitu, 2006). The average daily caloric intake availability is below the recommended level of 2100 Kcal (Kiome, 2009). About 30 per cent of the food consumed by rural households is purchased, while 70 per cent is derived from own production. On the other hand, 98 per cent of food consumed in urban areas is purchased while 2 per cent is own production (Kiome, 2009).

7.2 Sustainable Agricultural Intensification

Sustainable agriculture intensification systems (SAIs) can be defined as the process that uses environmental resources (water, solar radiation, nutrients) more intensively and efficiently to produce high output while reducing the negative environmental impacts and increasing contributions to natural capital and the flow of environmental services (Tittonell, 2014; Vanlauwe *et al.*, 2014). Future, increases in agricultural production and improvements in rural livelihoods will be derived from the innovations and intensification, rather than in the expansion of production area or exploitation of additional natural resources. There are several SAIs used by smallholder farmers in Kenya to improve productivity (Tables 7.1-7.4). The major SAIs for crop production are crop rotation and intercropping. Napier grass is the most widely used SAIs to provide feed for livestock (Box 7.2). Brachiaria grass (Box 7.1) has a tremendousl potential for livestock feed and as adaptation and mitigation measures to climate change in Kenya and other countries.

Table 7.1: Prevalent sustainable agricultural intensifications (related to cropping systems) implemented by smallholder farmers in Kenya

SAIs	Benefits	References
Crop rotation	• Biologically fixed nitrogen • Interruption of weed, disease and insect cycles	Thierfelder *et al.* (2015)
Intercropping	• Increase in yield per area of land, • Reduction in farm inputs, • Diversification of diet, • Increased labour utilization efficiency, and • Hedge against risk of crop failure	Bezner Kerr *et al.* (2012)
Cover Crops	• Improved soil fertility, • Enhancing biological control of pests, • Provide a regular supply of organic matter • Effective soil and water conserving measure	Mwangi et al. (2015)

Table 7.2: Prevalent sustainable agricultural intensifications (related to livestock systems) used by smallholder farmers in Kenya

SAIs	Benefits	References
Animal integration	• High biomass output and optimal recycling. • Enhanced nutrient recycling mechanisms	
Brachiaria grass	• Great ability to sequester and accumulate large amounts of organic C • Large shoots biomass • Adapted to low fertile soils	Ghimire (2015)
Napier grass	• Produce high dry matter • Establishment easily and require minimum management • Suitable for cut-and-carry for stall feeding	Mwendia *et al.* (2006)

Box 7.1: *Brachiaria* grass

Brachiaria grass is one of the most important tropical grasses distributed throughout the tropics especially in Africa. The genus Brachiaria consists of about 100 documented species of which seven perennial species of African origin have been used for pasture production in South America, Asia, South Pacific and Australia. It has high biomass production potential and produces nutritious herbage thus increase livestock productivity. Brachiaria is adapted to drought and low fertility soils, sequesters carbon through its large roots system, enhance nitrogen use efficiency and subsequently minimize eutrophication and greenhouse gas emissions. Brachiaria plays important roles in soil erosion control and ecological restoration. Brachiaria species have been important component of sown pastures in humid low lands and savannas of tropical America with current estimated acreage of 99 million hectare in Brazil alone.

Source: Njarui, et al. (2016)

Box 7.2: *Napier grass*

Napier grass (*Pennisetum purpureum*) is a tall bunch type perennial grass native to eastern and central Africa. It has a wide range of ecological adaptation, from seas level to an altitude of 2000 m. It is the most important fodder grown on smallholder farms for dairy production in Kenya. Over 80 per cent of farmers in the central highlands of Kenya depend on Napier grass as source of feeds It is a popular feed because of its ease of propagation and management. It grows vigorously and can reach maturity in 3 - 4 months after planting, has relatively good nutritive value and high yield (50-150 t/ha per year of fresh herbage). Furthermore it withstand repeated cutting of up to four to six cuts per year (Mwendia *et al.*, 2006). Napier grass is normally fed fresh in the intensive cut-and-carry stall feeding (zero grazing) system. The herbage is manually or mechanically chopped prior to feeding to reduce the selection of leaves and stems by the animals. However, it is commonly made into silage and used for dry season feeding. It is grown in pure stand and along terrace banks to control soil erosion but it can be cultivated in association with legumes such as Desmodium. The grass is also used in the integrated management of stem borers as trap crop in maize in the push-and-pull system. However, Napier grass requires high amount of fertilizer application and does not persist under direct grazing. Recently, the grass has become susceptible to smut and stunting diseases.

Source: Mwendia *et al.* (2006)

Table 7.3: Prevalent sustainable agricultural intensifications (related to mixed systems) used by smallholder farmers in Kenya

SAIs	Benefits	References
Push–pull IPM	• Fodder grasses (e.g. Napier grass and Molasses grass-*Melinus Minutifolia*) attract stem borers to lay eggs on the grass rather than maize, • Legumes such as Desmodium act as repellents, driving the stem borers away. • Desmodium also fixes up to 100 kg N ha and releases root allelo-chemicals that induce abortive germination of the parasitic weed, Striga. • Limit the use of synthetic and harmful pesticides where possible	Hassanali *et al.* (2008)
Agroforestry Systems	• Enhanced complementary relations between components increasing multiple use of the agro-ecosystem. • Maintain vegetative cover as an effective soil and water conserving measure • Effective fodder species include *Calliandra calothyrsus, Leucaena trichandra, Leucaena diversifolia, Chamaecytisus palmensis, Sesbania sesban, Morus alba* and *Gliricidia sepium.*	Liniger *et al.* (2011)

Table 7.4: Prevalent sustainable agricultural intensifications (-related to resource conservation systems) implemented by smallholder farmers in Kenya

SAIs	Benefits	References
Conservation Agriculture	• Greater stability in yields • Reduced demands for labour and much lower costs of farm power • Greater resilience to drought – through better water capture and soil moisture retention • Increased biodiversity both in the soil and the above-ground agricultural environment • Greater carbon sequestration and retention in soils; reduced emissions of greenhouse gases • Less soil compaction through reduced use of heavy farm machinery	Thierfelder *et al.* (2012; 2013
Fanya juu terraces	• Reduced soil erosion • Increase soil water retention	Zougmore *et al.* (2014)

7.3 Extension and Advisory Services (EASs)

In Kenya, the major providers of EASs are public sector including National and County governments, parastatals, research and training institutions), private and civil society such as NGOs, faith based organizations, cooperatives and community-based organizations. The main EASs implmented and promoted under Kenyan context are brieflty described in the following sectons.

7.3.1 Evolution of public-led EASs

Different agricultural extension approaches have been implemented since the colonial and post-independence eras (1960s) to disseminate information to farmers but with varying success rate. The early extension models followed a "cookbook" approach to new technology and were supply-driven (McMillan *et al.,* 2001). The approaches were top-down instructional, non-participatory; commodity based and assumed that farmers were largely ignorant and unable to integrate new practices into their farming systems. The approaches paid more attention to the flow of information from research centres to extension agents and to the farmers. Farmers' participation in the development of technology was limited. Trials and demonstrations were mostly set up on research stations (Davis and Place, 2003). The model failed to successfully transfer many technologies to farmers mainly due to farmers' constrains and needs were not considered during research the process.

i) The Farming Systems Research and Extension approach: It was implemented between 1965 and 1980 advocated demand-driven extension services that were bottom-up and participatory rather than to prescribe solutions (Collinson, 2000). It had a distinctive feature of a three-way linkage (or linear model) between farmers, researchers and extension. Farmers' inputs in technology development were considered. However the system was poorly structured and paid little attention to smallholders and women farmers.

ii) The Training and Visit (T&V): This agricultural extension approach was introduced in 1982 after being used successfully in Turkey and India. The T&V used contact farmers and was designed to achieve results rapidly with minimum cost. Extension workers provided technical

messages and relayed farmers' problems to the researchers. The system however failed due to its rigidity, top–down orientation, high operational costs and lack of recurrent funding (Birner *et al.,* 2009). The system was non-responsiveness to farmers' needs and did not factor in country-specific economic, social and institutional contexts (Anderson *et al.,* 2006). An analysis of the strengths and weaknesses of T&V in Kenya is provided in Table 7.5

Table 7.5: *An analysis of the strengths and weaknesses of T&V in Kenya.* Source: Gautam (2000)

Strengths	Weaknesses
+ Wide coverage + Coverage of all types of farmers + Strong staff training + Development of professionalism at the district level + Strong presence of frontline extension workers + Sustainable without outside funding	– Very broad objectives – Strong top-down –Target not specific – Weak farmer participation – Low staff motivation – Weak monitoring and evaluation – Supply-driven messages – Little flexibility/accountability

iii) Farmer Field Schools: Farmer Field Schools (FFS) approach was first introduced in Kenya in 1995 on a pilot basis and by the year 2003 over 900 FFSs had successfully been implemented (Davis and Place, 2003). The approach is integrated and organized in a way that participants are not the objects of training but are able to use their experience as the subject of training and participants share in the control of decision making (Davis and Place, 2003). Farmers develop skills that allow them to continually analyse their own situation and adapt to changing circumstances and therefore the method transforms farmers from recipients of information to generators of local data. The FFS approach is sustainable without outside funding.

iv) Demand-Driven Extension: The traditional government approach to extension in Kenya had been supply-driven, slow and expensive (SARDEP, 2002). After 1999, the National Agriculture and Livestock Extension Program (NALEP), was formulated by the (then) Ministry of Agriculture and Rural Development to support the implementation of the National Agriculture Extension Policy (GoK, 2001). The overall aim of NALEP was to promote demand-driven extension services through information dissemination and integration of multiple actors (NALEP, 2009). The approach was flexible and responsive to farmers' needs. However sustainability was a problem for small-scale farmers due to limited resources.

v) Farmer-to-Farmer Extension: The farmer-to-farmers (F2F) extension approach strengthens the linkages between extension providers and farmers. The F2F extension approach also improves information flow, awareness and enhances farmer participation. Providing backstopping, training and building capacity among farmers and farmer groups facilitates and enables the farmers to be an active part of development in their communities. This approach has been quite successful in accelerating technology transfer and adoption. Some of the limitations of this approach include; high expectations from lead farmers, difficulties in keeping lead farmers motivated for the role and limited budgets to support lead farmers.

vi) Focal area approach (FAA): In 2000, the government of Kenya formulated the National Agriculture and Livestock Extension Programme (NALEP), to improve service delivery to the agricultural sector. The activities were geared towards addressing the objectives of the strategy

for revitalizing agriculture (SRA) (GoK, 2004), and contributing to the realization of the economic recovery strategy (ERS) for employment and wealth creation and the millennium development goal on reducing by half the number of food-poor by 2015 (GoK, 2003). To promote these key principles, the programme developed a 'focal area approach' (FAA). The approach focused on taking local contexts into account, understanding the social setup, learning from local indigenous knowledge and using multiple social networks as entry points into farming communities. The approach has been applied by the agricultural extension service in Kenya to harness the comparative advantages of various players for the overall development of rural areas.

7.3.2 Private Agricultural Extension

Through the devolved system of the County governments, there are opportunities for promoting publicly-funded but privately delivered EAS systems. This has paved the way for possible outsourcing of EAS delivery to NGOs, farmer-based organizations (FBOs) and private firms by enhancing the effectiveness of agricultural extension activities through the creation of a competitive environment. The result of increased private sector participation is higher in those aspects of extension service that are profit-driven such as, input procurement and distribution, cash crop production particularly in the coffee, tea and flower industries, and in the veterinary and artificial insemination services (Muyanga and Jayne, 2008). For example, the agrochemical companies deliver extension advice through farm inputs merchants (stockists), demonstrations during farmer field days and in agricultural shows. In the dairy sub-sector, companies give advice to farmers on animal feeds, veterinary and artificial insemination services (Chapman and Tripp 2003; Muyanga and Jayne, 2008).

The main strength of private sector extension system is limted or non existence of bureaucracies and short channels of communication characteristic unlike the public extension systems. However, private EASs are often constrained by limited capacity and heavy dependence on external support, and the assistance provided by private companies is often targeted to relatively well-off farmers dealing with high-value agricultural commodities, disadvantaging rural poor farmers who cannot afford the services (Rivera and Alex 2004). As they endeavour to outdo their competitors, they spread themselves too thinly on the ground and cannot promote superior products from rival companies.

7.3.3 Dissemination methods

Extension service providers use different dissemination methods to transfer technologies to farmers. Some of the main dissemination methods: their constraints and possible measures for imporvements are presented in Table 7.6 and factors leading to successful dissemination in Kenya are summarized in Table 7.7.

Table 7.6: Constraints of selected dissemination methods used in Kenya and possible measures

Dissemination methods	Constraints*	Possible measures
Demonstrations/shows & exhibitions	• Limited number of technologies transferred	• Increase number of demonstrations with diversified technologies
Field days	• Low content of extension technologies disseminated, • Poor at imparting skills	• Follow interested farmers with more training

		• Supplement field day with printed materials
Individual farm visit or F2F	• Locks out participation of wider stakeholders • Few extension providers	• Train and build capacity of more farmers
Educational tours	• Few numbers reached/benefit, • Not cost-effective • Distract farmers from engaging in other activities	• Increase number tours made to benefit more people • Short tours to reduce cost • Make follow to find out whether have gained what they learned
Barazas	• Poor in content • Low number of target technologies & beneficiaries	• Improve planning • Conduct regular baraza for different beneficiaries
Seminars	• Limited participation	• Provide more funding for participation • Reduce time for seminars • Seminar venue should be not far from the participant location.
ICT/mass media, radio programs	• Low computer literacy • Higher skills acquisition • Poor ICT infrastructure	• Use local established infrastructure • Use alterative ICT mean e.g. phones
Common interest groups	• Management challenges • Reconciling of different views and interests	• Train on management • Regular planning meetings
Group visit	• Few numbers reached/benefited, • Not cost-effective	• Focus on short distance visits

Source: Kingiri and Nderitu (2014)

Table 7.7: Success factors of selected dissemination methods used in Kenya

Dissemination methods	**Success factors**
On farm trials	• Good in content, • Skills acquisition • Beneficiaries participation
Demonstrations/shows and exhibitions	• High in content, • Skills acquisition, • Attract large number of participants, • Good for targeted technologies adding value, • Practical and makes a certain agricultural practice easy to understand
Field days	• Reaching many farmers/stakeholders, • Cost-effective
Individual farm visit or farmer-to-farmer	• Preferred by majority of farmers, • Minimal cost, • Time efficient, • Farmers' demand driven, • Participation and skills acquisition high
Educational tours	• Promote interaction and opportunities to learn new skills

Barazas	• Ideal for quick transfer of sensitization emergency messages
Seminars	• Gives detailed content of technology or innovation, • High number of technologies transferred, • High participation of wider range of stakeholders
ICT/mass media, radio programs	• Good in content, • Number of technologies passed on and beneficiaries/stakeholders participation
Common interest groups	• Ability to mobilize different groups; • Effective sharing of resources, • High level of participation, • Sense of identity
Group visit	• Is demand driven, • Time and cost effective, • Ideas are shared in groups, and • Specific needs of each group addressed

Source: Kingiri and Nderitu (2014)

7.3.4 Information and communication technologies in agricultural extension

Increased use of information and communication technologies (ICTs) in extension offers opportunity to improve knowledge flows among knowledge producers, disseminators, and users. The ICT approach enhance the collection, processing and transmission of data, resulting in faster extension of quality information to more farmers in a bottom-up and interactive channel of communication that narrows the gender disparities in access to agricultural information (World Bank, 2011). The farmers become part of the information flow process rather than receipt of information. The customer base for mobile phone-enabled services is growing rapidly in Kenya with establishment of several hubs by different organisation to offers opportunities to improve delivery of agricultural information. The main limitations to adoption of ICTs in agriculture are low level of education, cultural barriers of rural communities, limited digital skills of farmers and poor connectivity.

7.4 Innovative Institutional Approaches

Many institutions of agricultural research and development have recently deviated from the traditional linear model and have embraced engagement of multiple value chain actors to promote innovations in the agricultural system in order to conduct research that is more relevant to farmers (World Bank, 2006). Institutional innovations is a new form of operating procedures and platforms which open up bottlenecks in systems and facilitate product value chain effectiveness in inputs acquisition, production, processing and marketing processes (Makini *et al.*, 2016) and information.

7.4.1 Multi-actor platforms

The Agricultural Innovation Systems advocates for users and suppliers of knowledge and other users to ensure innovation takes place within the value chains (VCs). Inherent in the VC approach is an acknowledgement that in addition to the target group, there are other stakeholders in the chain that are interrelated. For example, intervention aimed at reducing postharvest losses and improving the quality of products and market access in the VC can have a greater impact on poverty reduction, nutrition and health. This process takes place in multi-

actor innovation platforms, which are widely viewed as promising vehicles for increasing the impact of agricultural research and development (Tenywa *et al.*, 2011). The platforms are characterized by sharing of information, identification of challenges and opportunities and agreement on joint activities related to a shared interest (Victor *et al.*, 2013).

Table 7.8: Multi-actor platforms: thier roles and institutions engaged

Platform	Role	Institutions engaged
East Africa Dairy Development (EADD) program in Kenya	A platform for stimulating multi-stakeholder collaboration aimed at improving productivity and incomes of smallholder dairy producer households	• Heifer International, • International Livestock Research Institute (ILRI), • Techno serve (TNS), • African Breeders Services Total Cattle Management Limited (ABS-TCM), • World Agroforestry Centre (ICRAF).
Garissa Climate Change Working Group	Effective dissemination of the climate advisories	• Representatives of different government departments (planning, livestock, KMD, irrigation, gender, agriculture), • Three civil society representatives from the four Garissa County districts.
Gadam Sorghum Innovation Platform	Utilize the opportunity availed by the sorghum demand from the East African Breweries	• KALRO, Ministry of Agriculture Livestock and Fisheries, • Smart Logistics, • Banks (Equity Bank, KCB, Cooperative Bank), • East African Breweries and East African Malting
Embargo innovation platform	Improve onion productivity and to enable them access both input and output markets.	• Farm Concern International, County Government, • Ministry of Agriculture, Livestock and Fisheries, • Syngenta, Osho, Amiran, • Orbit chemicals, Murphy, • Safari seed, • Monsanto, Amiran, Royal seed, • Taifa SACCO

Further, they engage VC actors at multiple scales from field to catchments and evolve them into larger networks for learning and mindset change (Tucker *et al.*, 2013). Each actor makes a contribution and also get benefits in a win-win situation (Cullen *et al.*, 2014; Makini *et al.*, 2013). A description of a few selected agricultural multi-actor innovations platforms in Kenya is given in the Table 7.8.

7.4.2 Seed delivery systems in Kenya

Good quality seed is among the most important factor that influence agricultural productivity. Government policies can influence smallholder agricultural food production by strengthening production and delivery seed systems (Vernooy, 2017; Mahop, 2015). A number of exogenous factors led to the shaping of the seed sector policies in Kenya from the 1970s to the 1990s. The

food shortages experienced in the late 1970s and early 1980s led to the adoption of the Sessional Paper No. 4 of 1981 on National Food Policy. The sessional paper emphasized on breeding programmes for improved crop varieties (Munyi and de Jonge, 2015, Ayieko, and Tschirley, 2006). In Sessional Paper No. 1 of 1986 on Economic Management for Renewed Growth, maize, beans, wheat and sorghum were identified as key crops for improving seed availability. The National Seed Policy of 2010 outlined interventions that aimed at addressing constraints in the seed sectors for agricultural productivity (Munyi and de Jonge, 2015).

Two seeds systems exist in Kenya, the formal and informal seed systems. The formal seed systems are state and commercial institutions engaged in seed research, development and distribution. These systems are responsible for producing and diffusing good quality crop seed varieties. However, high prices discourage resource-constrained farmers from using these seeds. Informal seed systems, in contrast, play important roles during times of volatile weather, or drought (Sperling *et al.*, 2010; Croft *et al.*, 2016). The informal seed systems includes, farmers own seeds, grain purchased from the local markets and neighbours and aid from NGOs (Munyi and de Jonge, 2015; Jones *et al.*, 2001). The informal seed systems suffer from a lack of quality control mechanisms and cannot guarantee minimum quality standards (Gibson, 2013).

The bulk of the seeding material for vegetatively propagated crops such as sweet potato, cassava and bananas (80-96 percent) and grain legumes (75-90 percent) is from farm-saved sources. (Ayieko and Tschirley, 2006). Seed aid programmes are critical in the semi-arid areas where drought is common (Munyi and de Jonge, 2015). However, there are seed regulation laws that govern production and distribution of seeds and are administered by state agency, Kenya Plant Health Inspectorate Services (KEPHIS).

7.5 Lessons Learned from past and present SAIs, EASs and IIAs

- Agricultural EAS help farmers to access information on technologies, markets, inputs, and finance, and upgrade their farming and managerial skills.
- Farmer Field Schools provides opportunities for farmer-to-farmer extension and can reduce farmers' dependence on formal extension systems.
- Farmer-to-farmer extension places farmers at the centre of knowledge generation and dissemination processes and their abilities to spread innovation, due to their comprehensive local knowledge and location, make them potentially better able to communicate with fellow farmers, and at lower cost.
- The informal and participatory nature of FFS programmes with built-in group dynamics and team building exercises makes it a good entry point for discussion on broader livelihood issues. The FFS might not be efficient if used only for increasing yields through "message delivery" or for demonstrating a technology.
- Despite the increasing number of actors offering diversified options for EAS delivery systems, substantial challenges remain in terms of harnessing the full potential of pluralistic agricultural extension systems
- The Training and Visit system was able to increase agricultural productivity without significantly raising costs. However, it did not allow the intensification and diversification of farming systems.

- The extension system needs to switch from merely "delivering messages," to engaging farmers in the learning process. This shift in focus toward a more balanced teaching-learning extension paradigm not only helps farmers learn but also helps the extension staff learn from farmers, especially innovative farmers.

Most of EASs in Kenya have common elements of "farmer first," facilitation, partnerships, and sustainability with increasing emphasis on farmers themselves and community-based extension and advocate for more demand-driven EAS delivery systems (Swanson and Rajalahti, 2010).

7.6 Measures to improve SAIs, EASs and IIAs

7.6.1 Sustainable Agriculture Intensifications

- Developing technological options that are relatively low-risk, but that do provide short-term returns on investment.
- Develop strong farmer-extension-research linkages;
- Besides improving productivity while conserving/restoring the natural resource base, SAIs should also aim at increasing resilience to climate shocks and change
- Undertake deliberate programs to expose farmers to technologies and information;
- Wider involvement of stakeholders and address gender equity;
- Documentation of successful technologies and approaches that have significantly contributed to food security;
- Develop modalities for up-scaling successful innovations

7.6.2 Extension and Adivisory Services

- More demand-driven delivery approaches tailored to the farmers' specific needs and demands should be advocated.
- An integrated approach of different extension and advisory methods that complement each other should be applied in diverse socio-cultural and economic situations in order to achieve the desired goals.
- Selecting the methods that fit the social setting and context is critical and the packaging of extension messages should be sensitive to community practices and beliefs for ease of adoption and uptake.
- Extension services need to be efficiently targeted to focus on the areas and groups where the marginal impact is likely to be greatest by utilizing more flexible systems that can identify the gaps and allocate scarce resources more rationally with appropriate flows of timely and reliable information.
- The services should increasingly be oriented to women's needs because women play a pivotal role in agriculture where they provide most of the labour and make key farm
- Strategies that exploit low-cost communication methods such as radio, demonstrations, printed media, and partnerships with the private sector and civil society would be more effective.
- Provision of an enabling environment for private sector participation in extension

7.6.3 Innovative Institutional Approaches

- Investment in agricultural research and extension systems that facilitate local innovation while enhancing spill-over of targeted technologies, complemented by investments in infrastructure, markets, and other enabling conditions
- Improvement of access to agro-inputs, profitable output markets for fresh and transformed products, access to cash and credit, minimal rural infrastructure, and proper access to agricultural knowledge and information.
- Investments into policy and other institutional issues that can enable adoption and reduce smallholder risk. Enabling government investments and policy frameworks is crucial for SAIs, including facilitating private sector engagement and smart subsidy programs.
- Promoting and strengthening farmers' organizations to increase economies of scale for procuring inputs, reducing produce collection costs, minimizing transaction costs of dealing with other value chain actors, better handling/storage, and enhancing value-added through processing. The organizations can also be extremely effective in representing farmers' interests and improving their bargaining power with private companies.

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8 MALAWI: Sustainable Agriculture Intensification, Extension and Advisory Services and Institutional Approaches

Mufunanji Magalasi, Victoria Ndolo and Mangani Katundu

8.1 State of Agriculture and Food security

8.1.1 State of Agriculture

Agriculture is critical to the Malawian population, not only as a main source of income and food, but also as a key driver of the econonony. Agriculture accounts for 35-40 percent of the gross domestic product (GDP), contribute 90 percent of the foreign exchange earnings and provides about 85 percent of the population in terms of employment (USAID, 2013). Malawi's land area covers 118484 km^2 (FAOSTAT, 2013), of which 59.1 percent is suitable for agriculture. Land ownership in Malawi varies widely, favouring those with large plantations who occupy best agricultural land while most Malawians possess either too small, marginal plots which may or may not be very viable for farming (Sahley, 2005). According to the Intergrated Household Survey (GOM & IHS, 2011) findings, male headed households have larger cultivated land (4 acres ~ 1.6 ha) compared to female headed households (2 acres ~ 0.8 ha). The new National Agriculture Policy states that

> *'...Of the total land cultivated, over 90 percent is under rain-fed agriculture, even though there are 407862 hectares of land in Malawi that could potentially be irrigated. Over the years, some investments have been made to promote irrigation farming in high-value crops, like sugarcane and rice, especially among small and medium scale farmers. Despite the potential for expanding irrigation, the country had brought 104,000 hectares under irrigation only by 201*4 (GOM National Agriculture Policy, 2016).

The main farming system is subsistence-based, rain-fed. Most farmers practice maize monocropping system while a few apply intercropping with legumes. Maize is the staple food crop. Other crops grown are sorghum, millet, pulses/legumes, root crops (cassava and potatoes i.e sweet and irish) and fruits- The major cash crops include tobbaco, groundnuts, rice, cotton and maize. Although annual maize production is lower (2,948,504 MT) compared to cassava (3,608,017 MT), maize provides 38,4 percent of calorie share from food crops (FAO, 2009; NSO, 2012).

Additionally, it has been observed that production and productivity of crops have generally been below the country's potential. The National Agriculture policy states that:

> *… maize yields were less than 1.3 metric tonnes per hectare before 2005/06 and increased to just above 2.0 tonnes per ha with the introduction of the Farm Input Subsidy Programme (FISP) in the 2005/06 production season. This made Malawi relatively food secure and self-sufficient. However, the current yields are still far below maize yield potentials of between five and ten tonnes per ha, implying a yield gap of three to eight tonnes per ha.*

International donors do provide policy and budgetary support through the Agricultural Sector-Wide Programme (ASWAP). ASWAP is a consortium consisting of international donors and other key stakeholders including non-governmental organisations. A brief description on the historical development of cereals and legumes cropping in Malawi are presented in Boxes 1 and 2.

Box 8.1: *Between 200 AD and 19th Century*
The cereals and legume cropping in Malawi is believed to have occurred around 200 AD and continued until the 19th century during the ancient kingdoms of south eastern and southern Africa. A mixture of agricultural communities from the Katanga Kingdom (around the Congo region), and the southern kingdoms of the Nkhamanga and later the Chewa, and Ngoni raiders from the South African Mfecane are recorded to live in the rift valley areas now known as Lake Malawi and Shire river valleys, joining the Zambezi river valley to the Indian ocean (McCracken, 2012). The main focus was to domesticate the bush, alongside taming animals, which destroyed the crops. In the range of mountains spreading from Kaphirintiwa (in central Malawi) to Nsanje (in the southern tip of the country) shrines are found in which people turned for advice to deal with blight, pests and drought (McCracken, 2012). At the time, the main skill for the farmer was to seek advice to control the environment and produce a few specialised crops. Successful cultivators in the lower shire valley were admired for their ability to choose 'the right plots for particular crops., Oral testimony as cited by McCracken (2012) is that:

> *Mphumbu will not produce good crop of bullrush millet. A light sandy soil is the best type for groundnuts. Ndrongo (a black soil) is ideal for cotton. Nsangalubwe (while not suited for most crops), is very favourable for maere (finger millet) of these nsenjere and nsonthe shows a suitable soil for maize*

Source: McCracken (2012)

From this review, it is clear that legume-cereal cropping practices in Malawi has a long history, including the experiential knowledge to choose suitable soils for the appropriate crops. Sorghum and millets have been cited as staple food crops for the people living from south through the centre to the north of Malawi. These crops are drought resistant and are adaptable to grow in semi-arid lands. On the other hand, maize which was introduced in the 19th Century is high yielding but vulnerable to drought (McCracken, 2012). Other notable crops that have done well in semi-arid lands over the centuries include beans. Growing cereals with legumes provide basic nutritious food containing sugars and protein.

Box 8.2: *Between second half of the 19th Century till Today*
By the second half of the 19th Century, Mangánja farmers in the Shire Highlands were growing sorghum, beans, millet, pumpkins and various kinds of Elueusine [finger millet]. They were also growing maize, the most important of the so called American crops: high yielding but vulnerable to drought, which had been introduced from the east coast, perhaps in the eighteenth century. On the *mphala* drylands of the lower shire, sorghum and finger millet remained staple crops, often intercropped with pumpkins, groundnuts, cucumbers and peas'

'Further north, millet and easily harvested cassava were convenient crops for peoples harassed by Ngoni raiders (Tumbuka, Tonga). Maize and finger millet were the main crops grown by Ngoni and Tumbuka cultivators on the Mzimba and South Rukuru plains. Further south, amongst the Chewa, sorghum and millet was introduced in the 1880s as a staple crop'
Source: McCracken (2012)

8.1.2 State of Food security

Food security exists when all people at all times have physical and economical access to sufficient, safe, nutritional food to meet their dietary needs and preferences for a productive and health life (FAO, 1996). In Malawi, food security is mostly equated to availability and access to maize. In the past decade, there has been a decrease in the national food production, speciafically cereals with an average of 3.6 million tonnes reported in the 2012 cereal harvest, the lowest in the past 3 years. Food security situation worsened with recurrency of droughts and

floods in 2014, 2015 and 2016 growing seasons. However, cereal production in 2017, specifically maize, increased to 3.5 million tons, which was above average, representing a 46 percent increase when compared to drought-affected year 2016 output (FAO, 2017). This increase was attributed to the good weather conditions and availability of inputs.

According to the Malawi Vulnerability Assessement Committee's evaluation report (MVACs), about 835,000 people (4.4 percent of the total population) will be food insecure in 2017/18 (FAO, 2017). This is a significant decrease compared to 6.7 million people who needed food assistance in 2016/17 and 1.9 million people that were estimated to be food insecure in 2013 (MVAC report). Nonetheless, it is important to note that, food insecurity among the population is exacerbeted by high poverty levels. For instance, in 2011, it was reported that 50,7 percent of the Malawian population live below poverty line i.e <1 US$/day (NSO, 2016). These people have <0.4 ha of land where a large percentage of the land is planted with maize. The IHS (2011) reported that poorer households were more likely to be food energy deficient with low dietary diversity and poor food consumption. This is believed to be due to having small piece of land (<1 0.4 ha) to grow maize and other crops. However, there are others who argue that the main cause of low productivity is not due to small arable land but rather by not applying improved technologies combined with weak institutions and inadequate policies. Countries like China where farmers plot size varied between 0.25 and 0.50 ha, can feed their family and sell part of their produce in the market. This is because the productivity is relatively higher by applying improved farming technologies that are underpinned by strong institutions and policies in place. Lack of crop disversifiaction has also been highlighted as a factor contributiing to food insecurity in Malawi in addition to poor access to loans or credit.

The Malawi Dietery and Health Survey (MDHS) found that nearly 37 percent of the children (under the age of 5) are stunted. This shows a decrease from 47 percent (MDHS, 2010) which is an indication that Malawi has improved from the previous worse status for stunting by WHO (GOM, NSO & ICF Macro, 2011). Although number of children that are stunted has significantly decreased, wasting (3 percent) and underweight (12 percent) have not changed much over the past 5 years. In addition, micronutrient deficiency particularly vitamin A is still high among the school aged boys and girls. On the other hand, an increase in selenium (Se) and zinc (Zn) defiency was registered among all groups of the populations (Micronutrient survey, 2015/16).

To address the issues of food insecurity and poverty, the Government of Malawi (GoM) placed food insecurity and poverty amongst the priority areas in the Malawi Growth Strategies (MGDS I, 2006-2011 and MGDS II, 2012-2016). These strategies indicate that reduction of poverty can be achieved through sustainable economic growth and infrastructure developemnt by focussing on agricultural and food security. In addition, the GoM has developed the National Nutrition Policy and Strategic Plan, which coordinates food security programming at national and community levels. For example, it is planning to develop enabling agricultural policies, improve nutrition and invest in crops and dairy production through 'Feed the Future'program.

Against this background, this chapter aims at exploring the innovative sustainable agricultural intensification systems, institutional approaches and extension advisory services that have been implemented and promoted in Malawi and to showcase a few successful and failure stories and possible measures to improve them.

8.2 Sustainable Agricultural Innovations

In Malawi, there have been several endeavours in promoting sustainable agriculture for food security, nutrition and economic growth. For instance in the 1970s and 1980s, the Government introduced modern ways of farming, including conservation agriculture. Contour bunds farming in arable land and use of intensive use of fertiliser increased food production at smallholder farmer level. Later the Ministry of Agriculture undertook a campaign for production of compost manure, and its utilisation was called witchcraft of the garden (locally called *ufiti wa mmunda*). In this technology, mounds of compost manure seeming like grave mounds were applied right across the fields. However, the application of this technology was hampered due to several constraints among others, high labour intensity. Additionally, there was a move to modify ridge formation and plant spacing in the Sasakawa 2000 programme, which also includes the use of improved maize varieties. One of the advantages of Sasakawa 2000 programme is increased yield of maize per hectare. The challenge was mostly high labour intensity (especially in the 75 cm distance between ridges). This requires reworking the fields from the previously used ridge spacing of 90 cm between the ridges.

Figure 8.1: Millet-legume intercropping in Mzimba district, Ekwendeni site, Northern region of Malawi (photo by Mangani Katundu).

Millet-legume intercropping is one of the SAI techniques being experimented in Northern region of Malawi (Figure 8.1).

8.3 Innovatve Institutional Approaches

Jere (2009) provided a detailed assessment of the structures and processes encompassing key Government institutions and civil society organisations in the area of development, environment and natural resource management in a study called ‘Institutional Mapping for Malawi’. These institutions embrace international government agencies like the United Nations, government ministries, and civil society organisations, which not only provide policy support and coordination, but are also involved in implementing development plans for Malawi,

including agricultural production. Jere (2009) further identified the roles, mandates and policies of institutions along with their challenges and areas requiring support and action. The main question is how these institutions apply the different innovations for growth.

One of the IIAs in the InnovAfrica project is the MAPs that is established in Malawi. The MAPs members (n = 4) consist of both public and private institutions. They will be fully involved from inception to project evaluation including in facilating the dissemination of project results. Another IIAs is the integrated seed systems delivery that will be upscaled to more areas and people in the country.

8.4 Extension Advisory Services

The experiences of previous initiatives and projects executed by Malawi Farmer to Farmer Agroecology (MAFFA) and Soil Food and Healthy Communities (SFHC) project. Thus, the farmer to farmer approach will be central to the project activities. It is hoped that very food insecure people will be fully included as lead farmers, sharing innovations and information. The Government's approach to the lead farmer approach utilised the so-called 'productive farmer' to transfer information to other smallholder farmers, which excluded those seen as unproductive and food insecure. The creation of a village-based farmer to farmer information sharing system became a very successful model in the MAFFA-SFHC implementation.

The Government's approach ended in working with 'productive farmers'. The inclusion of those viewed as non-productive helped to widen participation in farming activities because it empowers even those that were left out as key agricultural information leaders in the society. This approach showed a 6 percent improvement in food security amongst the 6000 participating farmers over a period of 5 years (Nyantakyi-Frimpong H. *et al.,* 2016).

8.5 Success stories and Failures in SAIs/EASs/IIAs

8.5.1 Success cases

During the Kamuzu Banda era, the intensification of maize with legumes was noticeable. The lead farmer *(Mchikumbi number one)* approach was inherited from the colonial model of 'lead farmer' (Khaila *et al.,* 2015; Chowa *et al.,* 2013). Maize was intensified as national staple food crop along with fertilizer intensification and strengthening of the Agricultural Marketing Corporation (ADMARC), known as Farmers Marketing Board during the colonial times. The aim was to make Malawi food self-sufficient. Whether planted as sole or intercrops, the cereal legume production was highly intensified. Legume crops were exported to the European Community, alongside cash crops like tobacco and cotton (Silumbu, 1992). The intensification of maize pushed millet and sorghum to the periphery because national policies insisted on maize cultivation and expansion during the Banda era. However, the millet and sorghum crops did not completely disappear. Even today, millets and sorghum are cultivated on the contour ridges around plots, as sole crops or intercropped with pigeon peas and cow peas.

Malawi Farmer to Farmer Agroecology project: The other success story comes from the Malawi Farmer to Farmer Agroecology project, reported by the Special Rapporteur of the United Nations on Food Security and Nutrition. The project partners constituted researchers

from University of Malawi, Chancellor College, Soils Food and Healthy Communities of Ekwendeni Hospital, University of Western Ontario, University of Manitoba and University of Michigan. The project encouraged smallholder farmers to experiment intercropping of cereal crops (such as orange maize, millet and sorghum) with legumes (such as beans, soy bean, ground nuts, cow peas, and/or root crops namely cassava, and orange sweet potatoes).

Using a farmer to farmer extension approach, two representatives from 308 villages that constituted the 6600 farmers participated in sharing information, both indigenous and from Government extension officers, through demonstration plots, use of drama, recipe days, farmer exchanges and meetings that dealt with issues of food insecurity, nutrition and gender issues in farming households.

Intercropping of legumes and cereals was encouraged for soil health improvement through biomass incorporation, and nitrogen fixation. The incorporation of soy bean, beans and pigeon pea residue provided nutrients for crop production in areas which used burning of bush before cultivation. Additionally, the project encouraged the use of compost and organic manure, and organic pest control methods. The high yields of maize and legumes showed a 6 percent rise when compared to the monocropping (Nyantakyi-Frimpong et al., 2016). Identification of agro-ecological factors linked to crop performance is important because even within the same sites, some crops would not do well in certain soils. For example, within Lobi area, ground nuts do not do well in Thambolagwa village whose soils are mostly sandy.

8.5.2 Failure Stories

In Dedza, the MAFFA project attempted to bring production of pigeon pea in 2012. The objectives of intercropping cereals with pigeon pea were to improve soil fertility through crop residue incorporation and improve soil structure by opening of soil pores using the deep rooting systems of pigeon peas. Pigeon peas could be used as food as well as cash crop. Therefore, it was hoped that farmers would benefit from the intervention of pigeon pea. However, during the introduction of the pigeon pea in the area, farmers were already producing other legumes such as beans, soybean and cowpeas for food and sale.

Through the MAFFA project, about 3000 farmers received seed and intercropped pigeon peas with maize. The pigeon peas were exuberant and produced a lot of biomass thereby improved the soil fertility through the shed leaves. However, there was a problem of pest attack on flowers and pods which reduced the yields. Consequently, the farmers in Dedza did not benefit much from the pigeon peas. The yields were too low (≥ 90 percent of the farmers failed) to cover their seed cost. In addition, farmers' assumed that they were losing their income and deprived of food because the pigeon pea was overtaking the crop land that would otherwise have been occupied by beans and the like. Agro-ecological methods of controlling the pests proved to be ineffective. Eventually, pigeon pea was excluded and instead common beans and soya beans were promoted in the area.

8.5.3 Lessons Learned

The main lessons to learn from the past and present SAIs, EASs and IIAs that have been implemented and promoted in Malawi context are shown in Table 8.1

Table 8.1: Lessons to learn and evidences-based references under the Malawi context.

Lessons learned	References
• The practice of cereal and legume intercropping has existed over a long period of time and it is embedded in the indigenous knowledge systems.	McCracken (2012)
• Experimenting different cropping systems should give equal attention to indigenous farmers knowhow and practises and ensure its sustainability by building up the existing systems	Wise (2017)
• Agricultural extension and advisory services have shifted from expert-based-services to farmer to farmer services whose voice were not heard because of low social status	Magalasi *et al.* (2015)
• Projects which are inclusive of a variety of players have shown better results than those done by one exclusive group	UN Special Rapporteur on food security (2015)
• Less attention is given to food insecure smallholder farmers, their farm production and access to markets	Bezner Kerr *et al.* (2010)
• More focus is given to food production phase than trying to understand the agriculture food value chain pathways and its financial sustainability.	GOM & IHS (2011)

8.6 Recommendations to improve SAIs, EASs, and IIAs

- In addressing the failing economic situation in Malawi, the national economic growth needs to keep up with a 2,8-3,0 percent per year (Randall, 2013).
- The annual economic growth rate should match with the population growth rate of 3,1 percent in order to achieve poverty reduction and reach middle income status by 2020 (FAO, 2013). However, with a limited domestic market, it was not possible to sufficiently generate a high growth rate without external linkages.
- The country, therefore, needs to diversify productive-based economy in order to mitigate vulnerability taking into account the high susceptibility to natural shocks such as climate change and associated impacts (Randall, 2013).
- Government policy seems cognisant of the importance of SAIs by testing and upscaling improved seed varieties and new farming technologies. The new national seed policy (2016) emphasizes on the use of certified seeds. More specifically, the side-lines landrace seeds like the orange maize, the idea of bumper yields for food security and sale of surplus production is at the centre of the government policy (Wise, 2017).
- Agricultural extension and advisory services are turning away from top-down (during the 1980s) to farmer inclusive approaches where indigenous knowledge is acknowledged and integrated in the farming systems (Chowa et al., 2013).

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9 TANZANIA: Sustainable Agriculture Intensification, Extension and Advisory Services and Innovative Institutional Approaches

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9.1 The State of Agriculture & Food Security

Tanzania agriculture is dominated by small scale farming systems, which is the major producer of food crops and employs about 70 percent of the population. Despite the importance of agriculture in contributing to livelihood of majority of population and food security, the productivity and extent of intensification is low in small scale farming. The current productivity of major cereals maize and rice is 1.3 t/ha and 2.7 t/ha for 2016, respectively (Mtaki, 2017), which is a slight increase from the 2008/9 productivity of 1.0 t/ha for maize and 2.5 t/ha for rice. However, considering the rate of increase in population in the country, the level of production is not sufficient to meet the growing demand for food. According to Tanzania Development Plan and Vision 2025, the Agriculture sector must show increased growth from 4,4 to 6,0 percent in order Tanzania to attain a middle income status (URT-TIC, 2016).

Currently, there is a growing competition for land between settlement areas, range land, reserved and/or protected land with crop land due to increased population. For the past decades, the increased in food crop production was achieved by bringing more land into cultivation (Amuri, 2015; URT, 2009). Land conflict between livestock keepers and crop farmers, natural resources (wildlife and forestry) conservationist and livestock keepers are widely reported in many parts of Tanzania. These land pressures clearly show that, it is high time for agriculture in the country to go for sustainable intensification. This means that, the increase in production must come from the same piece of land through improved productivity.

Among the most critical issues affecting the agricultural sector in Tanzania is climate change and variability. A study projected that the average daily temperature will increase by 2 to 4 °C while rainfall will decrease by 20 to 50 percent in 2075 (Shemsanga *et al.,* 2010). These major changes in temperature and rainfall pattern will inevitably alter both crop production and availability and quality of livestock forage. Shemsanga *et al.* (2010) highlighted that, the impact of climate change in Tanzania is widespread and significantly affecting agricultural production through crop failures, livestock deaths and outbreak of diseases. Brown and Funk (2008) projected the direct impact of climate change on agricultural and food systems in the next few decades. Also, Steinfeld et al. (2006) also projected that, the impact of climate change on natural grassland will be greater than cropland (where growing condition can be easily manipulated) and thus could reduce forage yield as much as 16-25 percent by 2030.

In Tanzania and other developing countries with similar ecological conditions, mitigation (through intensification of crop-livestock production) is one of the key factors that will shape the future severity of climate change impacts on food security. Unfortunately in Tanzania, a few research focus on testing crop varieties and fodder species which are highly productive and more resilience to the effects of climate change and variability have been done so far. The climate change projection model in Tanzania indicates that, the cereal crop production particularly maize will keep on decreasing for the next 30 years (Arndt and Farmer, 2011).

Another possible set back on increased productivity per unit area is the need for more inputs including fertilizers, pesticides, irrigation water and may be labour. With increased use of agrochemicals there is possibility of causing environmental degradation due to either excessive leaching of nutrients resulting in water bodies' eutrophication, increase load of pesticide residue in soil and harvested food crop, especially if used excessively. Non application of fertilizers makes small scale farmers to rely on natural soil fertility without any mechanism to ensure nutrient cycling. As a result, after some years of cultivation in areas where there is no soil nutrient recycling, the soil fertility declines severely to the extent that the soil cannot support crop growth. As a consequence, farmers are forced to shift and open new land for cultivation. Another major physical degradation of arable land in Tanzania is soil erosion and soil compaction. The physical degradation occurs due to tillage practices and use of crop land for grazing. Thus, the SI needed should also include technologies that avoid excessive use of inputs, judicious use of fertilizers and other inputs, but also conserve soil.

According to Daniel et al. (2013), agriculture in Tanzania is not performing well because of the following socioeconomic factors

- Poor research-extension- farmers linkage;
- Lack of strong supervision and an insufficient number of extension workers (see Table 3.7);
- Low involvement of the private sector on delivery of extension services;
- Inadequate service delivery performance standards and regulations;
- Lack of conducive working environments;
- Unsatisfactory knowledge on the advancements of technologies; and
- Poor coordination of agricultural extension services

Food security and poverty alleviation has been an important topic in the debate of developing countries of which Tanzania is not an exception. Tanzania is one of developing countries considered to be more vulnerable to food insecurity mainly due to their reliance on rain-fed crops (Arndt *et al.*, 2012). There is high seasonal variation in availability of food, where the acute shortage of food is more pronounced during dry season in many parts of the country. Tanzania was ranked as one of the countries with food insecurity in the list as the 152th country out of 187 countries by UN Human Development Index and 54th out of 79 countries by the Global Hunger index in 2011 (Von Grebmer *et al.*, 2012). Many regions in the country including those in central and northwest regions experience uni-modal type of rainfall and very long dry season which affects agricultural productivity of both crops and livestock fodder. The access to food and food utilization is still a major challenge in the country. A comprehensive food security and vulnerability analysis in the country indicates that, poor food consumptions were most prevalence in Mtwara, Manyara, Singida, Dodoma, Lindi and Arusha (URT, 2010). Majority of food insecure households are either agro-pastoralists or pure pastoralists living in rural areas.

In the following sections, the focus is given on the major SAIs and EASs approaches implemented and promoted in Tanzania as well as success factors and constraints faced. This is followed by success and failure stories involving SAIs and implementation of farmer-to-farmer approach are presented. Finally, an outline of key lessons learnt and suggestions for improvement of EASs in Tanzania are given.

9.2 SAIs, EASs and IIAs implemented and promoted in the past and present

9.2.1 Sustainable Agriculture Intensifications (SAIs)

In many parts of Tanzania, some form of conservation farming techniques has been traditionally used. The traditional/indigenous conservation techniques include minimum tillage, fallowing of land and use of organic matter (Shetto and Owenya, 2007). Improved agricultural technologies such as tillage using hand hoe and tractors were disseminated through government extension services. Introduction of fertilizers in 1970s had focused on the N containing fertilizers for top dressing. Although these technologies increased yield, saved time and labour, problem of soil erosion and compaction occurred and low response to N fertilizers were observed after some time (Löfstrand, 2005).

From 1950s to 2000s: conservation agriculture (CA) technologies (Shetto and Lyimo, 2001) and rain-water harvesting (Hatibu *et al.*, 1999) were used to alleviate soil erosion and moisture stress. To reduce compaction, subsoiling is required but the availability of powerful tractor was a major problem to do subsoiling (Löfstrand, 2005). The efficiency of indigenous technologies (like fallowing) was abondoned due to limited land which is induced by population pressure.

From 1980s to 2000s: promotion of minimum tillage, zero tillage (direct seeding) or ripping as another CA technique was introduced (Shetto & Owenya, 2006; Löfstrand, 2005). The major challenge of these technologies were low availability of crop residues and high cost of herbicides relative to manual labour, and sprayers, which is essential for weed control under no or reduced tillage (Shetto and Owenya, 2006). Currently, the cost of herbicides is much cheaper than labour cost for weeding. Other SAIs promoted in Tanzania include the followings:

i) Agroforestry: Among the CA techniques promoted was agroforestry, which aimed at combatting deforestation (Löfstrand, 2005) caused by clearing natural forests to open new farms after fallowing or abandoning the existing farms due to decline in soil fertility. Agroforestry was widely promoted in Northern Tanzania, Southern highlands especially in Iringa and Njombe, and semi-arid areas of Central Tanzania in Dodoma and Singida areas. Trees like *Grevilli arobusta, Sesbania sesban, Faidherbia albida, Casuarina equisetifolia* and fruit trees were recommended to be planted along the farm borders.

ii) Soil cover: is another CA technique that was promoted, especially in semi-arid areas of Central and Northern Tanzania. Soil cover crops, crop residue mulch, intercropping were promoted to protect the soil against heat, excessive moisture loss, erosion, heavy rainfall impact and weeds (Löfstrand 2005; Tengo and Belfrage, 2004). Intercropping cereal and legume were promoted to take advantage of N fixing legumes to increase N in the soil. The common legumes recommended for intercropping includes pigeon pea, common beans and sun hemp around the maize field. Sun hemp was planted to reduce stalkborer attack on maize by *push and pull system*, where the insect attack sun hemp instead of maize (Löfstrand, 2005).

iii) Residue management: is another CA that can contribute to SAI. The technique involves retenting residues in the soil surface as mulch. In areas, where there are livestock keepers, the common practice has been to remove crop residue and feed to the livestock or if retained in the field, it will be used for grazing.

iv) Use of cover crops: Cover crops such as lablab *(Lablab purpureus),* cowpea *(Vigna unguiculata) and* velvet beans *(Mucuna pruriens),* others includes *Tephrosia candida, Crotalaria grahamiana, Macrotyloma axillare, Macroptillium atropurpureum and Desmodium intortum* were introduced (Baijukya *et al.,* 2006; Löfstrand, 2005). The cover crops are planted towards the end of the season, but when there is some moisture to allow them to germinate. After maize or sorghum harvest, the cover crops grow to cover the soil. This was a new technique (not indigenous) to many parts of Tanzania. The cover crops proved to be efficient in protecting the soil during dry season inaddition to providing organic matter and nitrogen to the soil (Baijukya *et al.,* 2006).

v) Climate smart agriculture: Recent SAI techniques have given more emphasis to adapt to climate change impacts. As climate change affects many factors (e.g. moisture stress, pest outbreak, loss of soil organic matter, and increase erosion by water or wind) there was a need to have a combination of CA that can simultaneously address the climate change impact. Thus, the concept of climate smart agriculture (CSA) was coined that include a combination of technologies that are logically applied to enhance agricultural productivity and/or reduce greenhouse gas emissions in the face of climate change (FAO, 2010; Branca *et al.,* 2011). These combination include choice of drought tolerant varieties, moisture conservation, appropriate use of fertilizers, erosion control, pest and diseases management, crop rotation/intercropping and no/ minimum tillage to increase C storage in the soil. Some relevant CSA practices have been tested in mountainous areas of Tanzania such as in the Uluguru Mountains.

vi) Organic farming: Organic farming promotes use of locally available organic resources for soil fertility management and pest management. The organic farming restricts use of any synthetic agricultural inputs such as fertilizers and pesticides. There are inconsistent findings on the productivity under organic farming with some studies reporting lower productivity, other no differences, while other showed higher productivity than the conventional farming (Ton, 2013).

9.2.2 Extension and Advisory Services (EASs)

EASs refers to the provision of farmers with knowledge, information, experiences and technologies needed to increase and sustain productivity and for improved wellbeing and livelihoods (URT, 2013). Different agricultural extension and advisory services (EASs) have been adopted/adapted, implemented and promoted in Tanzania (Wambura *et al.,* 2012;. 2015) in order to improve agricultural productivity.

Wambura *et al.* (2012) recommended the need of shifting EASs from top-down extension (public driven) to participatory bottom-up (demand driven) and private extension services. Nkonya (2009) supports this view by suggesting that there is no single type of EASs which fit for all situations. Thus, many systems models, approaches, and institutional models can be adopted in delivering agricultural extension services (Wambura *et al.,* 2015).

Nkonya (2009) identified different models of extension services; namely: *i) traditional supply-driven, demand-driven, ii) participatory & pluralistic extension services, iii) private extension services, and iv) NGOs and a combination of models* which can be adopted in any developing

country like Tanzania. According to Wambura *et al.* (2012), the choice of which EASs to promote and implement depends on the followings:

- The mission or philosophy of agricultural extension;
- Approaches/systems/models;
- Institutional arrangements for agricultural extension systems -organizational structure, management;
- The role of the target group;
- Delivery mechanisms;
- The financing of agricultural extension; and
- Linkages for technology development, dissemination and adoption.

In Tanzania, delivery and funding of EASs is organized under public-private partnership, with the public providing technical advice, knowledge, skills and information and the private sector providing inputs (embedded information). However, the service is dominated by the public in terms of financing and delivery (Sicilima and Rwenyagira, 2001; URT, 2013).

Since the 1990s, EASs has undergone reforms in planning and delivery approaches as well as institutional reforms (Mvena and Mattee, 1988; Sicilima and Rwenyagira, 2001) in the context of pluralization of extension provision (Rutatora and Mattee, 2001). Although, the National Agriculture Policy (URT, 2013) guiding provision of service calls for pluralism, demand driven and innovative approaches, planning and delivery of EASs largely rests on ICT and technology transfer model (Wambura *et al.*, 2015).

Like wise, the recent development of ICT has the potential to address some of the challenges facing EASs in Tanzania. The ICTs, which are being used by farmers and other actors of EASs include Internet, mobile phones, emails, community radio, TV, telecentre and computers (Mtega and Malekani, 2009; Lwoga, 2010). According to Parikh et al. (2007), these ICTs for EASs have not been fully utilized by farmers, especially in rural areas of developing countries. This low use of ICTs for EASs has been attributed to high cost of ICT services, low literacy level of rural farmers, low income of rural farmers, and inadequate number of ICT service providers in rural areas (Lwoga, 2010). Mobile phone and radio have higher penetration rate in comparison to other ICTs (Sanga et al., 2013). Table 9.1 shows over the years various EASs approaches have been implemented and promoted in Tanzania. However, in many cases, a combined approaches were used.

Table 9.1: Overview of main EASs approaches promoted and implemented in Tanzania.

Approach/model	Status	Reference
Government led- • Ministry-based Extension (decentralized) • Training & Visit	Implemented through public extension T&V no longer in use	Swanson & Rajalahti (2010); Davis (2008)
Participatory approaches • Farmer to farmer, • Farmer field schools • Trials and demonstrations	In use by private & public	Namwata (2004); MAC (2000); Mvena *et al.* (2013); Davis *et al.* (2010); Kaburire and Ruvuga (2006)

Farmer-Based Organizations • Farmer groups; • Community-based extension	Implemented by public and private	Rivera (2008); Mattee & Lassalle (1994)
Market oriented (Commodity- based) • Nucleus & out grower scheme approaches • Common interest groups	In use mostly by private companies dealing with cash crops like coffee, tobacco, sugar cane, tea	Kalamata (2006); Martin and Sharp (2016)
ICT-based • Media tools (Newspapers, Radio & TV programs) • Mobile phone (TigoKilimo) • Mobile phone (SMS) • Ward Agriculture Resource Center (WARC)	In use by both public and private providers	Mtega & Msungu (2013); Sanga *et al.* (2013); Sanga *et al.* (2014)

Use of ICT for EASs in Tanzania: ICT based systems for EASs are being implemented in Tanzania (Table 9.2). According to Sanga *et al.* (2013), the following are examples of ICT based EASs:

Table 9.2: Examples of ICT based EASs in Tanzania

ICT based systems for EASs	References
i) Mobile phones are being used by farmers to get price information of agricultural produce from different markets in local languages	
• The use of mobile phones to search market information via SMS	Magesa *et al.* (2014)
• Vodacom Klub, Z Kilimo and TigoKilimo are offering service on farming and market information using SMS	Stoll (2015)
• The use of SMS for market prices, weather and extension through eSoko platform	Magesa *et al.* (2014)
• The use of web based system to disseminate livestock marketing information through Livestock Information Network and Knowledge System (LINKS) International Journal of Information and Communication Technology Research	Mussa *et al.* (2016)
ii) Using Internet (emails & website); mobile phones (call & SMS) and community radio stations to exchange farming experiences	
• Dissemination and sharing of agricultural information (e.g. market prices) using the: (i) Family Alliance for Development and Cooperation (FADECO) and Kilosa Community Radio (ii) radio broadcasting and community tele-centres	Lwoga (2010)
• Sharing best agricultural practices through (i) the AFRRI in collaboration with 3 Radio stations: Sibuku, TBC, and Radio Maria. (ii) Farmer Voice Radio (FVR) project (iii) Use of SMS alerting to an upcoming programme. (iv) Use of calls and SMS during the questions and answers radio program	Sanga *et al.* (2013)
iii) Sharing modern agricultural methods through radio and audio visual programme, for e.g.	
• Ministry of Agriculture Food Security and Cooperatives offers - UkulimawaKisasa‖ through TBC and Radio Free Africa: - • Inuka for farmers & livestock keepers and • "Shamba Shape-Up (SSU)" shown in ITV Television station	Sanga *et al.* (2013)
iv) Sharing knowledge and access agricultural information through tele-centres, for e.g	

• Use of television in shop selling farm inputs and the use of price information board, training farmers and youth e.g. at Kilosa Rural Services and Electronic Communication (KIRSEC) • Use of SMS by farmers • Depositing and withdrawing money through mobile money (e.g. M-Pesa, TigoPesa, Z-pesa) • Use of Internet for selling and buying their products	Lwoga, (2010); Sanga *et al.* (2013); Kiptot *et al.* (2017)
v) Provision of meteorological information through the radio, TV stations, for e.g.	
• The FarmSMS launched by Sokoine University of Agriculture (SUA) • TMA for farmers in Same and Lushoto	Churi *et al.* (2013)
vi) Linking farmers, extension agents and researchers	
• *Using crowdsourcing platform* (i.e. mobile and web based farmers' advisory system, "UshauriKilimo")	Sanga *et al.* (2016)

9.2.3 Innovative Institutional Approaches (IIAs)

This section describes the current status of seed systems in Tanzania and explores opportunities for further development of integrated seed systems in the country.

Integrated Seed System development: current status

Several development oriented studies in Tanzanian seed sector have been carried out. Haug et al. (2016) studied the functioning of the formal seed system in Tanzania with the objective of identifying the bottlenecks for improving farmers' access to improved seeds (Haug et al., 2016). The Bill & Millinda Gates Foundation (BMGF) commissioned study Tanzania seed sector assessment (2014) had the explicit objective to identify options for interventions to develop an integrated seed sector in the country (ISSD, 2015). A study commissioned and published by the Tanzanian Organic Agriculture Movement (TOAM) entitled Farmer Managed Seed Systems in Tanzania (2015) focused, as the title suggests, on how farmers' seed systems can be enhanced. The latest study of this kind is the USAID and AGRA commissioned study. A Legal Guide to Strengthen Tanzania's Seed and Input Markets (2017) which focused on how the legal framework can become more conducive for commercial seed system development. While, the studies differ in outlook and conclusions, in general give a good overview on the state of Tanzanian seed systems.

In the following, we describe the existing formal technological and institutional elements of farmers' seed systems in Tanzania. The name and function of the Tanzanian institutions in the formal seed system are described in Table 9.3.

Table 9.3: Seed related organizations and their function in the seed system.

Organizations	Seed System Function
Seed Unit, Ministry of Agriculture, Food Security and Cooperatives	• Policy and law development and enforcement
National Seed Committee	• Advisory body to the MAFC • Responsible for release of new varieties and advising the Ministry on various matters related to seed industry
Tanzania Agricultural Research Organization	• Breeding new varieties via some participatory programs

International Agricultural Research Organizations (e.g. CIMMYT, ICRISAT, CIP)	• Supply breeding materials • Takes part in collaborative breeding with TARO, University and private actors • Training of scientists etc
National Plant Genetic Resource Centre	• Conservation of genetic resources • International collaboration • Participatory Varietal Selection
Sokoine University of Agriculture	• Basic and applied plant science, • Breeding • Socio-economic analyses, adoption studies
Tanzania Official Seed Certification Institute (TOSCI)	• Variety approval, registering (DUS and VCU tests) in national catalogue • Seed certification
Agricultural Seed Agency (ASA)	• Basic seed and certified seed production in the government seed farms and distribution
Private seed companies	• Seed production and sale
Tanzania Agricultural Seed Trading Association (TASTA)	• Organize the private seed companies
Non governemnetal organizations (NGOs)	• Seed distribution (post emergency and chronic stress situations) • Community seed banks? • Seed vouchers and fairs?
Agro-dealers	• Retail of certified seed produced by various seed companies
Individual farmers or farmer organizations	• Both on the end-user side of the seed chains but can also be involved in contract • Certified seed production, QDS production and informal seed production

The organizations involved in the development and dissemination of new seed varieties play the following roles as outlined in Box 9.1.

Box 9.1: The national plant genetic resource centre
Formal conservation of genetic resources is the responsibility of the National Plant Genetic Resource Centre (the gene bank) located in Arusha. The gene bank reports to the Ministry of Agriculture. In addition to seed conservation, the gene bank is involved with collecting genetic resources in the form of landraces, improved varieties and crop wild relatives. The gene bank also supply some of the genetic resources used in formal breeding programs. Such breeding programs are commonly led by the research stations of the TARO and the breeding material is often sourced from the international agricultural research centers of the CGIAR and some landraces are sourced from the gene bank or farmers.
Source: Ngwediagi et al (2009)

Certified seed is produced in isolated farms, as well as by small scale farmers located in various parts of the country under a Quality Declared Seed (QDS) scheme (Ngwediagi et al., 2009). Some of the seeds are distributed by private seed companies, while ASA also distributes and markets seed. Quality control and certification is the responsibility of the Tanzania Official Seed Certification Institute (TOSCI). According to the ISSD report, Tanzania has 65 registered and active seed companies, out of which 41 are members of the TASTA. There are about 1500

registered agro-dealers. In addition, several NGOs support farmers through training on seed production and marketing. This institutional set-up functions in the framework of the laws and regulations outlined in Table 9.4

Table 9.4: Seed related legislations in Tanzania, their function and related international frameworks.

Seed legislation	Seed system function	International framework
Protection of New Plant Varieties Act (2013)	Protect breeders rights (Farmers privilege)	UPOV 91
Seed Act (2003) Amendments (2014)	• Seed laws protect the farmer by establishing a legal obligation for the seller to guarantee the quality of seed by means of standardized inspection and testing procedures" (FAO, 2015) • Create a level playing field, because the laws set the rules of the market for different seed suppliers (Louwaars, 2005). Quoted from (ISSD, 2017)	• Seed law harmonization agreements for the Economic Community of West African States (ECOWAS) • South African Development Community (SADC) and • Common Market for Eastern & Southern Africa (COMESA) subregions.
Quality declared seed scheme	• Increase quantity of improved seed available • Local scope	n.a.
Farm input subsidy programs?	• Make improved seeds more accessible	n.a.
National Biotechnology Policy 2010	• Conservation, sustainable use and equitable benefit sharing • Farmers' rights	ITPGRFA

n.a. not available

While all of the formal institutions have played and continues to play an important role in farmers' seed systems in Tanzania. It is generally recognized that despite about 50 years of existence, the formal seed supply channels only deliver a small part of the seeds used by the country's smallholders. The second most certified crop is sorghum followed by sunflower and wheat, beans and paddy rice (Figure 9.1). The share of certified seed use is highest in larger commercial farms and a substantial share of the certified hybrid sorghum is under contracted farming for beer brewing.

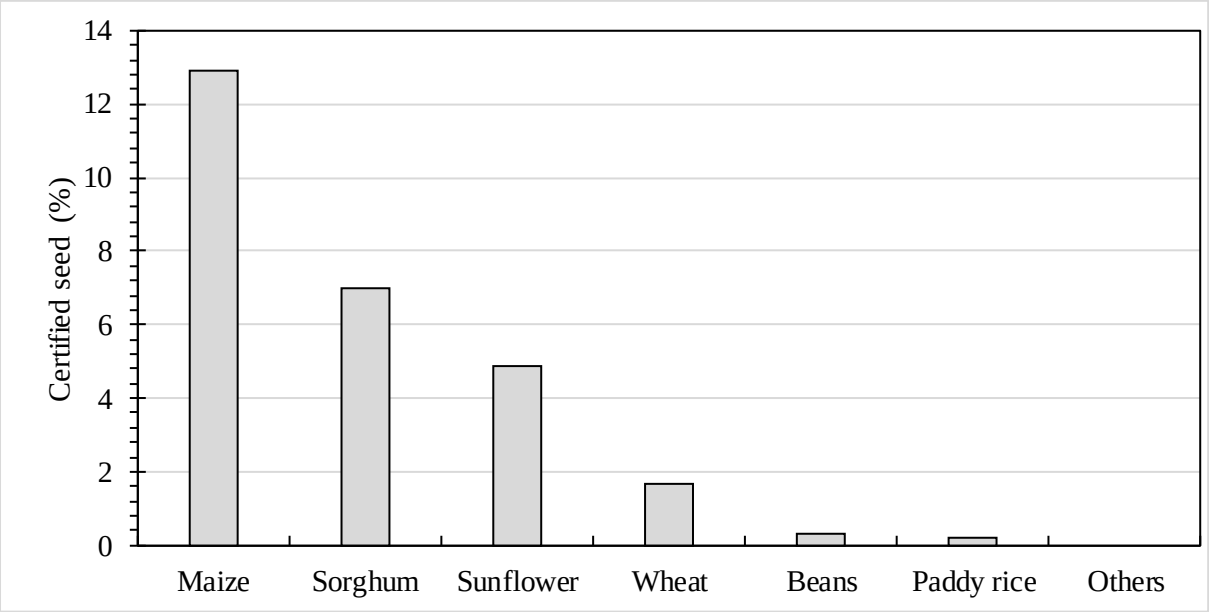

Figure 9.1: Share of certified seed in the various crops.
Source: ISSD (2017)

Furthermore, the report shows that in 2007/2008, 48 percent of the certified seed (mostly hybrid maize and sorghum seed) was imported and the rest was produced nationally. According to another source cited in ISSD, "in 2011/2012, more than 25 per cent of all required maize seed, half of all vegetable seed, and almost 80 per cent of all cash crop seed (cotton, tobacco etc.) originated from the formal seed system." Thus, informal channels continue to supply the bulk of seeds.

Box 9.2: Tanzanian regulatory framework in famerl led seed systems
The ISSD (2015) study of African Seed Laws identified some weaknesses and problems in the Tanzanian regulatory framework with regard to support to farmer-led seed systems. With reference to the 2003 Seed Act, ISSD Africa found the following about the freedom to exchange and sell seed within farmer-led seed systems: "Tanzania provides an exemption to the rule that all seed that is sold needs to be certified: "Nothing in this Act shall, be construed as preventing the sale of quality declared seeds as such to a neighbour farmer, whereby such seeds are grown by a smallholder farmer for use as seeds in his own farm". It says this in spite of Tanzania being one of eight African countries that has implemented the less stringent standards for certification known as "quality declared seed" (FAO, 2006)" But since only QDS or standard certified seeds can be sold, the ISSD study concluded that *"it appears that the sale of farm-saved seed is illegal." The study also finds the farmer representation in stakeholder and decision making forums too weak: "Tanzania includes farmers in the variety release committee, but not in the National Performance Trial Technical Committee; the documents reviewed for this study do not describe the members of Tanzania's certifying agency. When identifying which groups should be represented, the laws do not distinguish between large commercial farmers and smallholder farmers" (ISSD 2017).Further: "A National Seed Act is in place but there is yet to be a Seed Policy for the country. Currently, all aspects of the seed industry are covered under the agricultural policy."*
Source: ASARECA/KIT (2014).

Notwithstanding these concerns, the overall conclusion with regard to the space for Integrated Seed System Development in Tanzania is positive in the ISSD report: "In general, the seed law in Tanzania provides environments for achieving the aspiring goals of production and supply of quality seed. The legal instruments in place allow for the existence of a pluralistic formal (public and private sector) system and an intermediary system, which produces and distributes QDS. In this context, the existing frameworks show an intention to support a pluralistic seed sector development, which is one of the basic tenets of an ISSD approach. However, it is obvious that the informal seed system is not adequately taken care of by these policies. There is a need for a more inclusive policy process that is cognizant of the informal seed system and its contribution to the agricultural sector.The seed policy, which is to be developed in the context of TAFSIP and the National Agricultural Policy (2013), will guide seed sector development, and its development provides an opportunity for the current programme."

Current examples of approaches to strengthen seed security that can be categorised as ISSD in Tanzania includes: the initiative by the Ministry of Agriculture, Food Security and Cooperatives (MAFC) to request BMGF to support the efforts of the government to improve the seed sector. Several meetings have been held between the officials in the MAFC and BMGF. So for BMGF has agreed to support the following

- Research in developing new improved varieties (Breeding)
- Early generation seed production (Pre -basic and Basic seed)
- Support ASA for production of seeds of few crops (list not yet revealed), support TOSCI on capacity building and on reorganising its functions.

Community seed management: Examples are seed fairs, seed banks and vouchers, seed exchange programmes. The principle behind all these approaches is to harness the strengths of the traditional exchange and local market systems. According to the report, community based seed multiplication exists for sesame, groundnuts, sorghum, cowpeas, pigeon pea, maize, green gram, rice and cassava and involves an estimated 30,000 farmers (Ngwediagi *et al.*, 2009). There has been some pilot projects with release of varieties originating from farming communities (ISSD Tanzania).

For example, the consultants commissioned by BMGF have advised TOSCI to take the responsibility of issuing Phytosanitary certificates and seed /plant import permits which was the responsibility of the Plant Health Services Unit. Another initiative by the Ministry is the development of the Seed Industry Development Strategy for Tanzania, the draft document is already in place for further improvement. The strategy has covered several areas on seed issues including seed security.

Local seed business: This category includes initiatives led by farmers or their associations to produce and market seed as a business. Examples include farmers and associations are contracted by seed companies or agro-dealers to produce certified seed; QDS production by farmers and farmer associations; informal sector market-oriented seed production e.g. in cassava and sweet potato production supported by NGO's.

Box 9.3: Quality declared seed scheme
The Quality declared seed (QDS) scheme is the most significant in Tanzania: QDS is produced by a registered trained small-scale farmer or a group of small-scale farmers producing seed for their own use or for sale to neighbouring farmers within the ward where the QDS is produced. Any farmer who wishes to become a QDS dealer must submit an application to the Tanzanian Official Seed Certification Institute (TOSCI). A minimum of 10 per cent of a district's registered QDS production is inspected by TOSCI. According to the Tanzania ISSD study: "TOSCI is currently delegating inspection tasks to the district agricultural offices, as the institution alone cannot fulfil the demand for inspection services." Seed sampling is done by an Authorized Seed Inspector, in accordance with QDS and International Seed Testing Association (ISTA) rules. Lots passing the quality test are registered as QDS and can be sold. A declaration is completed for each seed lot and the producer labels the QDS bags. The ISSD study found that a number of LSBs exists for various crops: several local seed multipliers produce maize, pearl millet, groundnuts, sorghum, sunflowers and sweet potatoes. Some of them were producing informally, others were producing QDS seed, and a few of them were even producing certified seed - all on an individual basis.
Source: Ngwediagi *et al.* (2009)

Integrated Seed System Development: options for development

The ISSD report identified five to seven priority crops in each zone: Bambara nuts, bananas, beans, cassava, chickpeas, cowpeas, groundnuts, pearl millet, pigeon peas, sorghum and sweet potatoes. The Stages and opportunities for intervention:

i) Conservation and access to genetic resources: Collaboration between gene bank and community seed management (e.g. Community Seed Banks, crowd sourcing) in making landraces available for participatory variety selection and use in breeding process

ii) Breeding: For most crops, except maize and sorghum hybrids there are limited business opportunities and there is a need for public programs and incentive structures to involve private actors in variety screening of the selected under-resourced crops. Production of early generation seeds. There is a potential for more effective sharing of tasks between ASA and private actors also at early generation seed production. The ISSD report suggest that this can be the situation for some grain crops such as maize, wheat and to a lesser extent rice.

iii) Seed multiplication: This is perhaps the stage with most options for interventions. The ISSD report lists the following:
- Support existing, emerging and new seed producers with seed extension so that they have access to the most appropriate technologies for their circumstances (including water harvesting and irrigation).
- Provide existing, emerging and new seed producers with seed business support, so that they can improve their response to market demand and their seed revenues
- Support TOSCI in the on-going development and decentralisation of seed crop inspection to district agricultural offices;
- Build on the current QDS system to ensure quality control of all crops for which seed is sold, and allow for marketing of the seed beyond ward boundaries;
- Develop QDS standards, protocols and quality control mechanisms for vegetatively propagated crops

iv) Marketing and distribution: This is another stage that receives much attention in the ISSD report. The opportunities for intervention identified are:

- Support local seed businesses in developing brands for their seed;
- Promote collaboration between local seed businesses and private seed enterprises, through contract farming and other means;
- Pilot marketing of QDS seed in open markets;
- Expand the area for distribution of QDS (from Ward to Division to District)
- Promote seed fairs during times of peak demand;
- Investigate and pilot opportunities for seed source traceability to fight counterfeit seed;
- Provide seed advisory services to ordinary farmers to create a larger market for quality seed and to promote locally produced quality seed.

v) Seed chain service providers: This intervention area cover several stages and is about how bottlenecks in the seed value chain can be overcome. The ISSD study identified the following opportunities for intervention:

- Extension-seed producer collaboration to demonstrate the benefits of the use of high quality seed;
- Technical and entrepreneurship training for emerging seed businesses;
- Develop suitable financial products with financial partners to allow seed multipliers to invest in seed farming, handling and storage equipment and infrastructure as well as in seasonal production costs;
- Develop quality control systems in seed marketing channels;
- Develop real-time electronic seed availability systems (see above under seed marketing and distribution).

vi) Institutional support: The ISSD report further emphasises the need for building a conducive institutional framework for ISSD at different levels. This institutional framework should include District Level Implementation Partnership, Zonal Implementation Teams, Zonal Taskforce, Zonal Platform, National Taskforce and National Seed (ISSD) Platform as well as a network of Supporting Organizations (ISSD, 2015).The ISSD report further identified existing seed sector projects in all the zones of proposed work and thereby also arrived at list of potential implementation partners. The ISSD report summarizes its opportunities analysis according to four key areas of intervention in the different zones (Table 9.5)

Table 9.5: Key areas of seed intervention in the differnet zones of Tanzania.

Seed system per zone	Community-based seed systems	Local seed businesses, QDS and relief seed systems	Seed value chain	Policy Issues
Northern Zone	Bananas, Sweet potatoes,	Common beans, Pigeon peas, Sorghum,	Variety demand (e.g. pigeon peas)	Quality control, disconnect between variety release and seed demand
Central Zone	Pearl millet, Sorghum, Cassava,	Sweet potatoes, Groundnuts,	Limited markets, Research challenge, Seed Service providers.	QDS development:
Western Zone	Cassava, Sorghum,	Common beans, Sweet potatoes, Groundnuts	Research challenge, No seed farms	Quality inspection to be improved,
Eastern Zone	Cassava,	Pigeon peas, Sweet potatoes, Cowpeas, Sorghum,	Demand for locally adapted varieties, Access to EGS	QDS development,
Lake Zone	Cassava, bananas, sorghum, Pearl millet	Chickpea, Common beans, Sweet potato,	No formal seed, Need for EGS,	QDS inspection, District bylaw enforcement
Southern Zone	Pigeon peas, cassava, sorghum	Sweet potatoes, Bambara nuts, Groundnuts,	New varieties, EGS,	QDS inspection, decentralization
Zanzibar	Cassava, Sweet potatoes, bananas,	Rice, Cowpeas,	Quality control in vegetatively propagated crops needed, EGS production	High public sector involvement, Seed policy needed,

Source: ISSD (2015)

9.3 Success story of SAIs and EASs

9.3.1 Success story of SAIs

The success stories of SAIs implemented in Tanzania could be summaried as follows:

- The case of soil water harvesting in Mwanga District, chololo pits in Dodoma, and CA with crop-livestock integration in Arusha.
- The use of cover crops in Manyara has been recorded successful in significant reduction of soil erosion.
- Soil and water conservation using terraces and grass strips is has also been successful in Lushoto, Usambara Mountains.
- Intercropping, crop rotation or cover crops with legume has performed very well in the past from 2010 to 2015, especially using lablab and pigeon pea due to availability of export market for these legumes, especially to India. However, currently, the export market for most legumes has declined.

9.3.2 Success story of EASs

A success story regarding EASs in Tanzania is based on the experience of Farmers' Groups Network of Tanzania or MVIWATA's in using farmer-to-farmer EASs approach. Since 1995, MVIWATA has promoted farmers' (both men and women) participation in networking and decision-making processes in the country.

Key features:

- Underscoring the importance of multifaceted nature of farmers' issues and the need for their empowerment through their direct involvement, while identifying priority problems and

testing out practical solutions identified by researchers and the farmer groups (Mattee & Lassalle, 1994).

- Diverse farmers groups worked closely with field officers to disseminate different agricultural innovations and practices.
- Groups act as the guarantor to gain access to credit facilities and markets for their produces. This has enabled adoption and use of technologies (Mattee & Lassalle, 1994).
- MVIWATA acts as a platform for actors to collaborate in developing and testing agricultural innovations.

The roles played by MVIWATA in agricultural innovation include

- Has enhanced farmers' voice in development and dissemination of technologies.
- Has promoted recognition of farmer institutions and knowledge in EASs planning and delivery at policy and practice levels.
- Has taken EASs focus beyond food security to livelihoods and well-being improvement
- Has promoted integrated rural development approach.
- Has enhanced communication and building social solidarity among the farmers and other stakeholders.
- Has reached a large number of farmers and helped improved increase in yield. By December 2015 100,000 (female and men) small-scale farmers were reached by MVIWATA.

It is reported that in Morogoro, through farmer-to-farmer approach to extension where 193 farmers trained other farmers as a result of which, rice and maize production changed significantly. Rice production rose from 3.9 tons to 9. 0tons per hectare while maize rose from 3.0 tons to 8.0 tons per hectare (MVIWATA, 2013).

9.4 Lessons Learned

- Both public and private institutions are central to ensuring equitable access to extension services with respect to the economic and sociocultural realities of the different rural communities.
- Despite reforms, financing and delivery of EASs are still heavily dependant on public sector.
- Public EASs are still strongly focused on production techniques and not on a value chain approach.
- Innovative EASs approaches do impacts farmers in terms of empowerment and enhanced livelihood.
- Many private extension providers are donor/project based and very selective in terms of commodities and services provided, thus sustainability is questionable.
- Many farmers are left out of reach by EASs due to inadequate resources, poor coordination and inadequate accountability and there are few frontline extension agents with limited in-service training opportunities. Thus, adoption rate of technologies among smallholder farmers is very low.
- An appropriate policy is a fundamental factor in EAS delivery systems and therefore absence of EAS policy in Tanzania seems to be a limiting factor.
- There is a poor linkage between extension, research and education (training).
- Promoting Public Private Partnership is important as it could play a critical role in service delivery in terms of financing, filling capacity gaps, value addition and marketing.

- Proposing establishment of Village Knowledge Centre (VKC) to link rural farmers with researchers and agriculture extension agents and other actors like policy makers, processors and traders.
- Demand-driven participatory and pluralistic extension services work better than traditional supply-driven EASs.
- Combining the private extension services with NGOs, has shown better performance and produce expected outcomes.
- Erosion control techniques especially in steep slopes or mountainous areas have not performed well in some areas due to being labour intensive.

9.5 Recommendations to improve EASs

- Reforms have to focus on strengthening demand for services and accountability through participatory approaches so as to make EASs flexible, user-driven and focused on local problems.
- Extension and research systems need to go beyond the superficial linkages and engage in strong collaborative partnerships at all levels by adopting an interactive learning approach as well as promoting integrated decision-making and innovation for sustainable agriculture by all actors including small-scale farmers. Thus, actively involving them in setting the research agenda, implementing trials and analyzing findings and results. One way is to establish Local Agriculture Research and Extension Committee (LAREC) at community level (ward and district).
- Research need to be more integrated into the agriculture sector transformation by moving away from Agricultural Research and Development to Agricultural Research for Development
- The agricultural education and training system should adapt and strive to meet the new dynamics of agricultural innovation and system perspectives.
- Include VKC enabled with e-Agric-Extension in the National ICT Policy
- Local Government authority be encouraged to adopt ICT for extension in VKC to reach many farmers using minimum efforts
- Improve farmers, extension agents and researchers interaction/linkage using ICT
- Capacity building to users of VKC in ICTs for extension
- Strengthening VKC using ICTs for extension in a gender sensitive way (i.e. social inclusion)

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10 RWANDA: Sustainable Agriculture Intensification, Extension and Advisory Services and Institutional Approaches

Mupenzi Mutimura, Jacqueline Tuyisenge, Leonidas Dusengemungu

10.1 State of Agriculture and Food Security

Agriculture plays an important role in Rwanda's economic development and poverty reduction strategies. Agriculture accounts for 33 percent of gross domestic product (GDP) and employes nearly 80 percent of the labour force. The agriculture sector is charactersied as subsistence farming relying on rainfall, with limited use of improved seeds, pesticides and fertilizers. A large part of the country's agricultrual land is severely degraded and the soils are acidic (REMA, 2015). In addition, drought and high incidence of pests and diseases are factors contributing to low production. The average land holding size for most of households is around 0.6 ha (NISR, 2015a; NISR, 2015b). Nearly 50 percent of the farm household in Rwanda experience food insecurity.

Land and soil degradation: is a major environmental problem in all types of land use systems in Rwanda. Looking at the land scape for agriculture practices in Rwanda, more than 70 percent of farming activities is carried out on slopes ranging from 5-55 percent gradient (MINAGRI, 2013). When combined with the high and often intense rainfall, this leads to high soil erosion by water (Karamage et al., 2016). Karamage et al., (2016) reported that about 56 percent of the national cultivable area is vulenrable to soil erosion. This equates to be 421 t/ha which is responsible for about 95 percent of the soil loss at national level. Twenty-six percent of the total croplands is located on a slope >30 percent which accounts for 60 percent of the total soil erosion in Rwanda.

Table 10.1: Soil nutrient losses total (tonnes per year) from farm land in Rwanda versus SSA average

Soil nutrients (total	Rwanda (t/yr)	SSA average (t/yr)
N	41210	
P	200	
K	3055	
OM	945,200	
Source	Mupenzi et al. 2012	

The main factors contributing to such high erosion rate in the country (Table are not necessarily the steep slopes of the terrain but inadequate integrated soil and water conservation measures coupled with the torrential rainfall and the highly weathered soils dominated by Nitosols.

The livestock sector: plays a crucial role in food security, nutrition, and poverty reduction in Rwanda. Cattle and milk have a high socio-cultural value in Rwanda, represent a significant source of protein in the typical Rwandan diet, and make up a growing share of total agricultural production. The dairy sub-sector offers a pathway out of poverty for large numbers of livestock-keeping households. The livestock sector contributes about 10 percent to agriculture GDP and 3 percent to national GDP. Current status of livestock is dominated by crossbreds and local cattle over improved dairy cow breeds.

The livestock productivity in Rwanda is, however, constrained by inadequate quantity and quality of forage production (Mutimura *et al.*, 2015). Inadequate management of forage options, diminishing grazing land and nutrient depletion are among the major factors affecting livestock production. Livestcok feeds and feeding have been the major challenges that hinder the livestock productivity in the country. The current efforts are directed to gradual increase of improved highly productive dairy cows and overall reduction of cattle population to reduce pressure on the existing land resources.

Recently, the Government has made tremendous efforts to comprehensively address the low agricultural productivity and food insecurity. The National Agriculture Policy was one of the efforts developed in 2004 (which was later updated in 2017), from which five-year strategic plans were in place to drive agriculture transformation. The core programmes for yield increase include:

- *Land use consolidation,*
- *Irrigation,*
- *Mechanisation,*
- *Erosion control through bench terraces,*
- *One cow per poor family,*
- *Fertilizer import and subsidies, and*
- *High yielding crop varieties.*

i) Land use consolidation and erosion control through bench terraces: Construction of bench terraces contributed in controlling erosion and creating productive lands, but the terraces are still under exploited due to a combination of social, financial, and institutional challenges that were not taken into consideration at the time of interventions.

ii) Irrigation: The irrigation system was an important pillar of the National Agriculture policy, it is still restricted to thin marshland covering only 7,5 percent of the potential area. The low coverage of irrigation development is associated with limited infrastructure and inadequate water use efficiency system.

iii) Mechanisation: Mechanisation is among the less developed programmes because of low expertise and promotion of machines, which are not adapted to local context of agricultural terrain and landscape.

iv) One cow per poor family: Thanks to the rapid economic transformation made by the Government where high-yielding dairy cattle has been offered (MINAGRI, 2009a). Accordingly, in 2006 the Government launched the *Girinka* or *"One cow per poor family"* Program, which distributed improved breeds to low-income households. To date, nearly 250,000 Rwandian households have received cows.

v) Fertilizer import/subsidies and h*igh yielding crop varieties:* the use of quality inputs (e.g. fertilizers, seeds) is still low, which translates into the current gaps in crop and livestock yields (Figure 10.1).

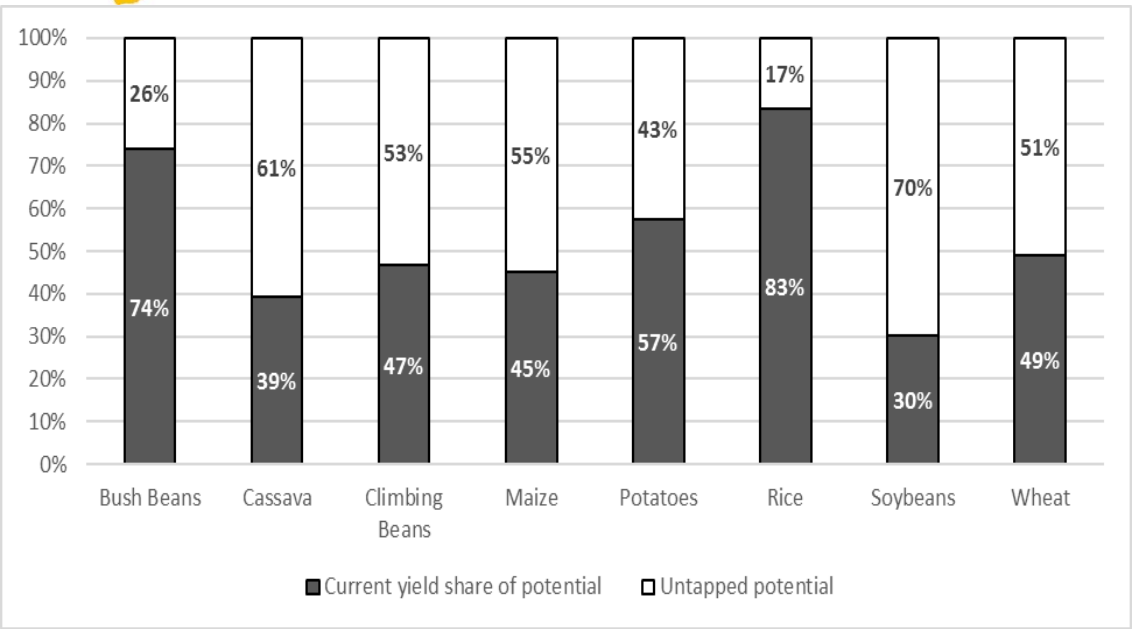

Figure 10.1: Actual food crop yields versus yield potential (adapted from MINAGRI, 2016)

Increasing agricultural yields is vital to support rural growth and achieve food and nutrition security. Despite the agricultural output growth in recent years, through crop intensification programme (CIP), the full potential to increase yields remains still untapped (Figure 10.1). For example, crop competitiveness assessment conducted in 2016, found that yields for several crops were less than half of their potential, taking the agro-climatic conditions into account (MINAGRI, 2016). This shows that cassava and soybean are currently produced at 39 percent and 30 percent, respectively indicating the possiblity of increasing yiled by more than double on the same cultivated acreage.

This chapter attempts to review the main sustainable agricultural intensification systems, extension and advisory services and innovative institutional approaches that are implemented and promoted in the past and present in Rwanda, draw lessons to learn, and suggest possible measures to improve the farming systems.

10.2 SAIs, EASs, IIAs implemented and promoted in the past and present

10.2.1 Sustainable agricultural intensification systems

Based on agro-ecologies, different sustainable agriculture intensifications have been implemented in Rwanda. Innovation technologies includes irrigation and mechanization, erosion control, improved crop varieties, improved forages and management practices for livestock farming including communal cowsheds. Current farming system are monocropping intercropping of maize-legumes, mixed livestock and agroforestry. Land consolidation and crop intensification are adopted.

Some of the sustainable agricultural intensification practices that have been applied in Rwanda as well as in the study areas include:

- Crop intensification programme;
- Livestock intensification programme;
- Use of chemical amendments (fertilizers and pesticides);
- Integrated soil fertility management;
- Land husbandry and irrigation and mechanisation;
- Crop-livestock integration;
- Agroforestry

The major crop grown in Rwanda are cassava, orange sweet potato, potatoes, maize, rice, wheat, beans (bio-fortified) and banana (RADA, 2006). Along with crop intensification, livestock intensification practcies are also common. The use of improved forages have increased livestock productivity. For instnace, cow fed with Brachiaria grass cultivar cv Piatá increased milk yield by 38 percent when compared cow fed with feed resources like Napier grass (Mutimura *et al.,* 2018). In addition, heifers fed on Brachiaria grass cv. Mulato II increased 35 percent of body weight gain more than Napier grass (Mutimura *et al.,* 2016). Also, the Reticulo-rumen retention time of cv. Piatá in dairy lactating cows was (63 hours) less than that of Napier grass (83 hours) which influenced higher dry mater intake in Piatá than in Napier grass. Thus, cows fed with cv. Piatá produced higher milk. Also, these improved forages play a great role in improving environmental health. Cows fed with Brachiaria grass cv. Mulato II produced less enteric methane (126 L/day) than the ones fed with Napier grass (146 L/day) of enteric methane production (Mutimura *et al.,* 2016).

10.2.2 Extension and advisory services

Since 2009, extension approaches in Rwanda are participatory where all stakeholders define their vision, analyse their constraints & needs, and plan together for implementations, monitoring and evaluation (MINAGRI, 2009b). The approaches are demand driven, market-oriented extension, process and result oriented extension. Currently, EASs in Rwanda are based on the following principles (MINAGRI, 2017)

i) Institutional capacity development: Institutional capacities are built in specific areas where specialized extension is in demand. “Research-into-use platforms” is established to improve dialogue and links between research and extension.

ii) Quality proximity extension services to farmers: Continuous support from public extension officer and other partners focus on building capacity of farmer promoters, farmer field schools facilitators and their cooperatives. A performance evaluation and incentive system is developed to improve the level and accountability of the advisory services delivered. Extension messages are matched to evolving realities and priorities, introducing issues such as nutrition, gender, and savings, use of weather and climate information, integrated pest managemetn and climate smart agriculture.

Options for extension delivery methods are becoming more pluralistic with the widespread use of mobile phones and information and communication technology. An extension communication system is built to allow direct feedback from extension workers to farmers. Consideration is given to vulnerable households for e.g. those recently graduated from social protection programmes or with no or limited literacy skills. Most of the implementation is done at the local government level and much emphasis is given on coordination between MINAGRI agencies (e.g. Rwanda Agriculture Board and National Agricultural Export Board) and local government /other stakeholders.

iii) Tailored and demand-driven services by private sector: Complementing the *Twigire Muhinzi* (Farmer' self-resilience) system, which targets all farmers including small subsistence farmers, specialized private sector extension and service delivery systems for high quality, consistent and market-oriented extension and advisory services to farmers is being promoted. At present, private sector extension is provided in some high-value commodities. Relationship and trust building between commodity specific value chain actors is crucial and is supported, specifically for high-end value chains.

10.2.3 Innovative institutional approaches

The MultiActor Platform (MAP) that is established in Rwanda are one of the IIAs in the InnovAfrica project. The MAP representatives are from public and private organizations. Representatives of MAP members have signed a Terms of Reference (ToR) and reached a memorandum of understanding with the Rwanda Agriculture Board (RAB). MAP recognizes the complementarities and potential synergy of different actors in agricultural development. The MAP members are expected to involve in planning, validation, progress monitoring and evaluation, designing scaling up strategies, providing inputs to innovative policy framework, and identifying key strategic value chain pathways. The involvement of MAPs in the project will guarantee the relevance of project interventions and create conditions for rapid uptake of technologies.

10.3 Success Stories of SAIs and/or EASs

Over the last 20 years the Government of Rwanda has developed a robust long and medium term policy and strategy framework to guide its interventions (NST1, 2017). In line with this framework, the core agricultural programmes implemented are soil erosion control (aggressive terracing program), land use consolidation, irrigation, mechanisation, importation and subsidies of fertilisers and high yielding crop varieties.

Table 10.2: Average yield (tons/ha) production before and after terracing

Crop	Before terracing	after terracing (4 years later)	Increased by
Maize	0.8	3.2	4 fold
Wheat	1.0	2.2	2 fold
Bush beans	0.3	1.9	6 fold
Climbing beans	0.4	3.0	7 fold
Soybeans	0.3	1.5	5 fold
Irish potatoes	1.2	24	20 fold

Source: NST1 (2017)

The implementation of these programmes led to a number of positive outcomes including implementing the soil erosion control programme, the radical terracing technologies in the steep lands which significantly increased productivity, reduced yield gaps and promoted exports, especially potatoes and beans in neighbouring countries. On-farm yields increased for almost all the crops (Table 10.2).

The conservation programmes also promoted increased on-farm tree planting through tree nurseries managed by individuals and farmer cooperatives in the rural areas. Agroforestry offered the greatest opportunity for landscape restoration (1.1 Million ha) in the country. Forest cover has been increased from 19 percent (in 2000) to nearly 30 percent (in 2017) through afforestation and agroforestry development. As a result of the conservation programme, contribution of agriculture to GDP raised to 33 percent (NISR, 2016); employment raised to 72 percent (IPAR, 2015); fertilizer application rate reached 29 kg/ha (REMA, 2015) and about 81 percent of the total degraded land was treated by soil erosion measures (SIA, 2011).

10.4 Failure Stories of EASs

Agriculture extension services called *Agasozi Ndatwa* (model village) was initiated by the Government of Rwanda in 2008 as stipulated in the National agricultural extension policy (MINAGRI, 2009b). The *Agasozi Ndatwa* literally meaning is 'the hill which is nice to see' or 'the hill that we show off with pride'. Farmers cultivating land in the *Agasozi Ndatwa* (model village) must grow the crops chosen by the government for the area. It was aimed at mobilizing community to jointly implement the development plans. Its objectives were i) to Jump-start self-betterment for a continuous process of improvement at each *Umudugudu*[8] in all matters related to land management; ii) to create a spill-over effect for self-betterment in other critical areas other than agriculture (including, health, education, organization of cooperatives, credit and savings, resettlement) etc.; and iii) to influence a positive mindset at the different levels towards values and/standards and discipline for high performance of farmers.

Though, the *Agasozi Ndatwa* was expected to be the basis for other agricultural activities, it was not successful and not scaled up at national level as it was hoped for in the strategy (MINAGRI, 2009b). The failure was mainly due to top down approach by the goverment ambitious program that was not based on the farming communities' needs and capacities (Ansoms and Cioffo, 2016).

10.5 Lessons Learned

Sustainable agricultural intensifications, extension and advisory services as well as innovative institutions have been priority of Rwandan government in order to increase food and nutrition security. Nevertheless, the following lessons were learnt from this review:

- *In cropping systems*, major focus is given to sensitize modern cropping system (e.g. crop intensification program- mostly in the consolidated land) while scientific evidence exists for higher production and lower impact of pests and disease outbreaks under multi-cropping systems;

[8] *Umudugudu* is the lowest local government administrative level.

- *Infrastructure challenges* that include insufficient number of feeder roads, inadequate rainwater collection facilities, lower than needed storage and drying facilities, limited facilities for cold storage at market outlets;
- *Limited access* to affordable farm technologies and inputs by smallholder farmers. Fertilisers and high yielding crop varieties could, if optimally used, boost the production on a sustainable productive environment such as well managed terraces and soil management, and irrigation schemes. The adoption of these practices has been confronted by frequent crop failure caused by erratic rainfall and crop diseases (such as army worms for maize), poor crop response to fertilizers without liming and manuring in acidic soils of Rwanda;
- *Inadquate postharvest handling* and low product quality coupled with undeveloped grading. Limited number of agro-processing businesses and narrow range of agro-processed products exist plus shortage of skills and training in processing, packaging, and marketing; and
- *Agricultural value chain in Rwanda* is currnetlty characterized by poorly organized post harvest aggregation and transport, inconsistent capacity for effective value addition, and insufficient utilization of inputs.

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11 SOUTH-AFRICA: Sustainable Agriculture Intensification, Extension and Advisory Services and Institutional Approaches

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11.1 State of Agriculture and Food security

11.1.1 State of Agriculture

Agriculture covers about 79 percent of total land area and consumes about 63 percent of the freshwater in South Africa (Blignaut et al., 2015). However, agriculture contributes a relatively small percentage (~0.4%) to the Gross Domestic Product (GDP), but still remain vital in providing employment and earning foreign exchange (Blignaut et al., 2015). South African agriculture can be divided into two agricultural economy i.e. well-developed commercial farming and smallholder farming (Mudhara, 2010). According to Aliber and Hart (2009), the commercial farming system produces about 95 percent of the total agricultural produces on 87 percent of the agricultural land which is dominated by white farmers. In contrast, the smallholder farming system is dominated by poor-resourced black farmers, who are mainly farming on the former homeland areas, which make about 13 percent of the total agricultural land (Aliber and Hart, 2009). The dualistic nature and division between the commercial farming and smallholder farming systems can be attributed to the past laws and injustices associated with apartheid in South Africa (Neves et al., 2013). Moreover, apartheid resulted in the inequalities in the population that left the majority of the black population sinking into continual poverty and food insecurity even after more than 20 years of democracy (Agholor and Obi, 2013). Thamaga-Chitja (2012) noted that the South African smallholder farming system is dominated by women, children and elderly people while men and youth emigrate from rural areas to seek better opportunities in urban areas. Therefore, the focus of the current review is on the smallholder farming system in South Africa.

South African smallholder farming system can be best described as the small farms that are labour-intensive, uses indigenous knowledge and often lack resources, lack institutional capacity and extension advisory support (Liebenberg, 2015) Moreover, the production in smallholder farms is often characterised by low yields, which are often significantly lower than the potential mainly due to limited water and nutrient availability in the soils, degraded soils, ineffective water and nutrient management practices (Walker and Schulze, 2006). Consequently, the majority of the smallholder farmers produce for subsistence under rainfed farming systems and a very small number of the smallholder farmers market their products (Aliber and Cousins, 2013; Pienaar and Traub, 2015). Goldblatt (2010) argues that only 12 percent of the South African land is suitable for the rainfed crop production. The rest 88 percent of the land is suitable for grazing. Consequently, livestock farming is the largest agricultural sector in the country in terms of contribution to GDP.

11.1.2 State of Food security

Despite efforts made in agricultural research, extension services and government institutions in the past, food and nutrient security for smallholder farmers in South Africa still needs to be improved. The National Planning Commission (NPC) reported that about 40 percent of the black South African population lives in rural areas, where poverty, landlessness and food insecurity are the major challenges that threaten their livelihood (NPC, 2012). Although South

Africa is food secure at national level, the majority of rural people live in poverty and are food insecure at the household level (De Cock *et al.*, 2013). Most of the unemployed rural communities are forced to supplement their social grants incomes by subsistence farming (Stats SA, 2012). The high rate of unemployment, poverty, malnutrition, illiteracy, lack of skills, growing economic inequalities and HIV/AIDS pandemic are widely recognised as major socio-economic challenges faced by the smallholder farmers in South Africa (Arko-Achemfuor, 2014; Cele, 2016).

The South Africa's National Development Plan (NDP) has identified smallholder agriculture as the vehicle through which poverty alleviation and rural development can be achieved (Zarenda, 2013). Nkwana (2015) reported on the three key guiding strategies that were approved by cabinet in 2013 (see Table 11.1).

Table 11.1: Three key guiding strategies to FNS

Strategies	Descriptions	References
Fetsa Tlala Production (FTP)	FTP signifies a multi-sectoral approach to food production as a pillar of food security in South Africa	DAFF (2014)
National Policy of Food and Nutrition (NPFS)	NPFS was introduced to address the challenges of the Integrated Food Security Strategy in coordinating and streamlining different sectors and programmes addressing food security	DAFF (2014)
Household Food and Nutrition Security Strategy (HFNS)	HFNS shows a multi-sectoral approach to food security through the inclusion of different sector departments involved in the four pillars of food security (i.e. availability, accessibility, utilization and stability of food)	DAFF (2015)

These government initiatives emphasize commitment to promote the eradication of hunger and the achievement of food security. Consequently, the increased budgetary allocation by the Department of Agriculture, Forestry and Fisheries (DAFF) and Department of Rural Development and Land Reform (DRDLR) clearly indicate the commitment of South African government to support programs that aim to improve food and nutrition security of the smallholder farmers (Aliber and Hall, 2012; DAFF, 2014).

The aim of this chapter is to describe and identify constraints and possibilities of the most innovative Sustainable Agriculture Intensification systems (SAIs), Extension and Advisory Services (EASs), and Innovative Institutional Approaches (IASs) promoted and implemented in South Africa by smallholders.

11.2 Sustainable Agriculture Intensification

The major constraints in rainfed agricultural productivity in South Africa are *i) water scarcity, ii) high rainfall variability, iii) soil degradation and iv) associated climate change* (Moeletsi and Walker, 2013; Calzadilla *et al.*, 2014). The high population growth, economic development, climate change and deteriorating water quality further exacerbate the water scarcity and competition for water amongst different users in South Africa (DWAF, 2013). Currently, the number of farms in South Africa has dramatically decreased (i.e. almost by two-thirds) when

compared to the early 1990s (Goldblatt, 2010). Despite the reduction in the area under crop production over the last 20 years, productivity remains relatively constant, indicating an increasing trend of intensified production (Goldblatt, 2010). Unsustainable use of soil and water resources has resulted in severe environmental impacts such as groundwater depletion, soil fertility degradation, soil erosion and leaching of nutrients into downstream (Goldblatt, 2010; Alexandratos and Bruinsma, 2012; Blignaut *et al.*, 2015). According to South African Yearbook (2008/9), more than 5 million hectares of cultivated land in South Africa is acidified, low in fertility and prone to erosion. Murungu *et al.* (2011) argues that the soil fertility degradation in South Africa is caused by the burning of crop residues under intensive tillage on monoculture farming system, which results in high rates of soil erosion.

According to Goldblatt (2010), the population of South Africa is expected to grow from 49 million (in 2009) to 82 million by the year 2035. To support this rapidly growing population, food production has to be increased using Sustainable Agriculture Intensification (SAI) approach (Goldblatt, 2010). Godfray *et al.* (2014) defined the SAI as producing more outputs through efficient use of all inputs on durable basis while reducing environmental damage and building resilience, natural capital and the flow of environmental services. Promoting SAI practices in smallholders will maximize the use of limited inputs to render higher outputs. Leaving crop residues in the fields and later incorporating into the soils, will improve soil fertility and reduce soil erosion (Murungu *et al.*, 2011). Under this context, different SAI systems such as conservation agriculture (CA) and soil-water management practices, have been widely promoted and implemented in South Africa.

11.2.1 Conservation Agriculture

According to Smith *et al.* (2016), conservation agriculture (CA) has three basic principles i.e. minimum soil disturbance by tillage, maximum soil cover, and crop rotations that work together to reduce nitrogen loss in the soil, to promote water and soil conservation and to improve agronomic use efficiency of fertilizer and manure. Furthermore, CA presents a real opportunity for smallholders to alleviate poverty by increasing crop yields and food diversity, reducing production costs while sustaining environment for both current and future generations (Smith *et al.*, 2016). Within this context, crop rotation, intercropping, use of crop cover, green and animal manure practices are the most common methods that have been promoted and used by smallholder farmers in South Africa (Cele, 2016).

11.2.2 Soil-water management practises & irrigation development

According to Goldblatt (2010), South African farmers will have to double their irrigation areas by 2050 in order to meet the growing food demands of the burgeoning population. However, South Africa has no surplus water for irrigation expansions (DWAF, 2013). As little can be done to increase the rainfall, the focus of South African research has been to improve the capture of rainfall, increase the availability of water in the soil and water-use efficiency (Annandale *et al.*, 2011). Within this context, soil-water management practises such as mulching, planting on contour and rain water harvesting have been promoted and implemented in smallholder farming systems (Denison and Wotshela, 2009; Everson *et al.*, 2011; McCosh *et al.*, 2017; Moswetsi *et al.*, 2017). Moreover, soil-water management practices control soil erosion in fields located on steep slopes and consequently it reduces leaching of nutrients to downstream (Everson *et al.*, 2011). McCosh *et al.* (2017) argues that the stored water during rainwater harvesting can be used to supplement irrigation during long dry spells and critical stages of crop growth. This

prevents crop failure caused by drought and maintains crop yields during below-normal rainfall seasons and may even increase crop yields in normal and above-normal rainfall seasons.

11.3 Extension and Advisory Services

Most of the information reached smallholder farmers through verbal and personal experience (Smith *et al.*, 2016). Consequently, smallholder farmers often communicate through informal associations and communities gatherings (Kruger and Gilles, 2014), but very rarely through formal organisations and department of agriculture extension advisory. Smallholder farmers received little attention and governmental support in relation to Extension and Advisory Services (EASs). The main functions of the EASs will be to provide the technical advice and guidance about specific technologies, provision of secondary data on soils, climate and market access (Akpalu, 2013). Furthermore, EASs should tap existing farmer's knowledge and strengthen their capacity to influence extension policies. Currently in South Africa, EASs are mainly provided by DAFF but it is supported by various state agencies that deliver services to provincial departments of agriculture and farmers (Table 11.2). The EASs is hindered by the lack of resources and infrastructure and it is highly skewed towards certain farmers over others (Hall and Aliber, 2010).

Table 11.2: The main EASs providers in South Africa and their respective major roles

Extension service providers	Roles
Agricultural Research Council	• Promotes research and innovation
National Agricultural Marketing Council	• Provides advisory services and statutory instruments in the marketing of agricultural products
Land Bank	• Provides wholesale and retail funds to farmers, historically disadvantaged people and rural entrepreneurs
Farmer organizations, Cooperatives,	• Provide EASs for smallholder farmers in South Africa
Non-Governmental Organizations (NGOs)	• Create sustainable livelihoods for farmers to alleviate poverty by improving their capacity
Agribusiness and seed companies	• Provide EASs and inputs such as seeds, fertilizers and pesticides for farmers in South Africa

Source: Provincial budgets and expenditure review (2010) and Hall and Aliber (2012).

Most of the participatory approaches have been implemented and promoted to smallholders through NGOs and researchers associated with Universities, Parastatal Agricultural Research Institutions and Corporate Social Investment bodies, commodity groups, agro-processors and private sector (Kruger and Gilles, 2014). For example, the promotions of the CA to smallholders have been executed through projects funded by Government and other implementing agents, such as Land Care and Grain SA (Smith *et al.*, 2016). The National Land Care Programme (NLP) is a bottom-up, community-based approach and funded by DAFF. NLP seems to be the most promising programme to promote CA in smallholder farmers. As part of the NLP, four-year demonstration and farmer-based trials were conducted at Bergville in KwaZulu-Natal (Kruger and Gilles, 2014). The project applied different Innovative Institutional Approaches (IASs) such as farmer to farmer learning and extension, multi stakeholder platform building processes and the participatory design approach.

11.4 Institutional Approaches in South Africa

Despite the numerous policy intervention and programmes since the birth of democracy in South Africa, the access of smallholder farmers to institutional support services such as credit; extension; inputs such as seeds and fertilizer; and agricultural markets is still limited (Aliber and Cousins, 2013). Different policies and programmes such as Comprehensive Agricultural Support Programme and Micro agricultural financial institutions of South Africa and Land Care has been introduced by the South African government to address farmers access to institutional support services. These services increase the access of the smallholder farmers into market opportunities, lower costs of business, and the overall competitiveness of the agricultural sector (DAFF, 2017).

The new Agricultural Policy Action Plan (APAP) 2014-2019 is the most promising integrated approach that aims to improve the access of the smallholder farmers to product value chains. Other innovative plan for the South African government include Agri-park, which is defined as a network innovation system of agro-production, processing, logistics, marketing, training and extension services, located in a District Municipality (DRDLR, 2015). Furthermore, Agri-park enables a market-driven combination and integration of various agricultural activities and rural transformation services. Therefore, the Agri-Park is farmer-controlled entities that serve as catalysts around which rural industrialisation can take place through comprehensive, centrally planned agricultural value chain with multiple upward linkages (DRDLR, 2015).

InnovAfrica project will establish one MAP in South Africa as one of the IIAs. The MAPs members (n =10) comprised of farmers organizations, public sectors and NGOs. The MAPs will be engaged at all the project stages to disseminate and maximize impacts of the project results.

11.5 Success stories of SAIs and/or EASs

There is a need for documented success stories in both the commercial and smallholder agriculture sectors. Farmers are often sceptical when it comes to adopting a new practice and only start practicing when they see an innovation is working from fellow farmers (De Wit *et al.*, 2015).

11.5.1 Rain water harvesting

The South African Water Research Commission (WRC) conducted a study to demonstrate rainwater harvesting and conservation methods such as mulching and minimum tillage at two sites namely Ntshiqo (in the Eastern Cape) and Muxhileni (in KwaZulu-Natal) (McCosh *et al.*, 2017). A participatory action research (PAR) was employed to participate all stakeholders including farmers throughout the research process. Farmers were involved in all stages of the project and were treated as experts. Farmers were engaged through workshops, focus group discussions and questionnaires interview to understand the specific challenges they are facing in increasing agricultural productivity. Farmers implemented the field demonstrations, managed and monitored the trials with close support from the research team. Furthermore, cross visits and farmer-to-farmer approaches were undertaken to assist farmers to gain a better understanding of the SAI system and to share lessons learnt.

The results from the study indicated that rainwater harvesting, and conservation methods is one of the SAI systems that can be adopted to improve agricultural productivity in low yielding rainfed areas while reducing negative environmental impacts. Furthermore, the involvement of all the stakeholder, especially farmers in all the stages of the project increased the adoption of the SAI system.

Figure 11.2: Rainwater harvesting improved gain yield and quality at Ntshiqo (McCosh *et al.*, 2017).

11.6 Failure stories of SAIs and/or EASs

11.6.1 Siyakhula Project

A project known as the Siyakhula (Massive Food Production Programme) was implemented from year 2003 to 2008 in the Eastern Cape Province to enhance food security by increasing maize production while ensuring environmental sustainability through the promotion of CA (Tregurtha, 2009). The project promoted economic empowerment in the agricultural sector by providing funding opportunities and grants. According to Tregurtha (2009), the programme was designed in such a way that farmers get their seed, fertilisers and pesticides for free in the first year the farmers, with the government providing finance through Uvimba Bank. In the second year the farmers were required to pay back 25 percent of the money provided in the previous season, such that by the fifth year they have to bear the full cost. The receipt of this payment would trigger the release of funds to purchase inputs for the new planting season. However, the low yields achieved in previous years resulted in a very small percentage of farmers that were able to pay the sum of the money which was a condition for continued participation in the programme.

Figure 11.3: Poor EASs resulted to low crop yields (Tregurtha, 2009).

Consequently, some farmers left the project due to the delays in their payments which resulted in the accumulation of their debts. According to Tregurtha (2009), the lack of knowledge, skills, conflict within groups and loss of interest by project partners, were some of the main reasons for the project's failure. Poor EASs approaches used to disseminate information about weather forecast and selecting suitable cultivars resulted in the low crop yields (Tregurtha, 2009) and about credit access, inputs and agricultural market also add to the project failure.

11.7 Lessons learned

From the study by Grain SA using the CA Farmer Innovation Programme (FIP) approach at Bergville, it was noted that the farmer-led experimentation is invaluable in the learning, adoption and adaptation process (Kruger and Gilles, 2014). Some of the main lessons to learn from the past and present SAIs, EASs and IIAs that have been implemented and promoted under South African context are presented in Table 11.3.

Table 11.3: Lessons to learn and evidences-based references under the South-African context.

Lessons to learn	References
• New ideas need to build on existing practices and priorities of the smallholder farmers.	McCosh *et al.* (2017).
• Environmental concerns need to be embedded into the project design as it is not usually the major focus by smallholders. • Farmers focus on obstacles and challenges (e.g. the risk of yield decline) at the early stages of transition and need more support during transition time	Cele (2016)
• Innovative SAI systems need to reduce labour costs to be affordable by smallholders. Moreover, access to inputs, materials and tools is a prerequisite for adoption of the innovative SAI systems • Peaks of participation and adoption of SAI systems are reached during project implementation but decline thereafter	Smith *et al.* (2016)

• Insufficient involvement of farmers in research and policy development limits the widespread adoption of SAI systems • SAI systems interventions have been rejected mainly due to lack of commitment, awareness, knowledge, skills and finances	Arslan *et al.* (2014)

A continuous interaction among farmer support groups and stakeholders becomes relevant and appropriate to maximize the outputs and outcomes of the SAI systems interventions. Moreover, the promotion of SAI systems interventions are mostly done through projects funded by various agencies. Therefore, there is a need to prepare an exit strategy in order to continue the project by the local stakeholders in a sustainable way.

11.8 Measures to improve SAIs, EASs and IIAs

To increase the adoption of SAI systems by smallholder farmers, the following measures are suggested:

- Demonstrate the economic and social benefits of adopting SAI systems at the local level,
- Smallholder farmers need to be directly involved in the development, validation and selection of the best SAI systems at local level.
- Integrate the indigenous knowledge and scientific management practices to enhance adoption of SAI systems by smallholder farmers because scientific practices are built up from what is already known by farmers.
- Up-to-date information (e.g. on soils, weather), inputs, capacity-building, policy support and linkages with markets and formal and informal extension networks is required to enhance the adoption of different SAI systems by smallholder farmers.
- The EASs should move from researcher-managed demonstrations to farmer-led trials for meaningful farmer involvement, learning, adoption and adaptation.
- Multi/inter-disciplinary approaches is required to increase adoption of SAI systems to increase yield, food security while sustaining the environment. South-African women are the main working force who are directly involved in the various farming practices. Therefore, set up processes, policies and programmes that is supportive and inclusive of women should be encouraged
- Integrated innovations initiatives are required to improve the livelihoods of smallholder farmers in South Africa, while reducing negative environment impacts, as climate change impacts advances.

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PART III: Implications and Synthesis

Part III of this report attempts to explain the implications of the review with regard to its contributions to the InnovAfrica project objectives, outputs, outcomes and/or impacts. Particularly, the information in the second part of this report is highly valuable to different workpackages of the project and to the study sites as well. This third part of the report also synthesizes the informations in each chapter and gives concluding remarks and recommendations.

12 Implications of the review report from InnovAfrica perspectives

Donald Njarui and Mehreteab Tesfai

12.1 Introduction

The goal of InnovAfrica project is to improve food and nutrition security (FNS) and this is in line with the Comprehensive Africa Agricultural Development program (CAADP) agenda of the Africa Union to ensure food security and economic growth through agricultural intensification and conservation of environment (Bwalya *et al*., 2009). There is a vast amount of literature available that covers various types of sustainable agriculture intensification systems (SAIs), extension and advisory services (EASs) and innovative institutional approaches (IIAs) implemented and promoted in the past and present in Africa and other relevant regions of the world. Despite the generation of new sustainable agricultural technologies from agricultural research in Africa and availability of advanced production technologies from the developed world, uptake of these superior technologies by farmers remains low due to a range of factors, among others, information is often scattered and/or inaccessible to users. Hence, it is necessary to systematically review, analyse, and describe the key concepts, approaches and methods of these innovations to address FNS challenges in Africa.

We have sought to assess the implications of how the findings from this review report will influence implementation of research activities by InnovAfrica project. The report has mapped, identified gaps and characterized the most innovative SAI systems, IIAs and EAS approaches, which are promoted and /or implemented in Africa and other relevant regions of the world, directly addressing the issue of agricultural productivity and FNS. The literature has shown a range of SAIs that are practiced across several farming systems in Africa and other region of the world. This chapter assesses the implications of the results of this review report by focusing on the objectives of WP1 of InnovAfrica project. That is *to map and identify constraints and possibilities of the most innovative sustainable farming systems, extension and institutional approaches promoted and implemented in Africa and other regions to address specific FNS challenges.*

12.2 Implications of the review

A rigorous literature review and analysis of stakeholder knowledge and information pertaining to SAIs, EASs and IIAs in Africa and other relevant regions of the world was carried out. As a result, this report has presented updated information on the concepts and applications of various forms of intensification systems in chapter 2, agricultural extension and advisory services in chapter 3 and institutional approaches notably the integrated seed systems and multi-actor platforms in chapter 4, and other innovations not addressed by InnovAfrica project in chapter 5. The research experiences on cropping systems and forage systems along with various EASs and IIAs implemented and promoted by each case study country, have been described from chapters 6 to 11. These knowledge and information will be uploaded in the project knowledge platform (Task 1.6) shared and exchange among the countries through various dissemination methods both in electronic and printing media. In effect, it will increase the knowledge and capacity of InnovAfrica partners and other stakeholders to test, adopt and/or up-scale the suitable SAIs, EASs and IIAs in the case countries.

12.2.1 Agriculture intensification systems (SAIs)

Chapter 2 of this report has presented 10 SAIs (as examples) that were successful and promoted for upscaling and adoption. A list of references are given for further reading to each types of SAIs. For example, the maize-legumes systems have been promoted in Africa e.g. Zimbabwe and other regions of the world and (Thierfeldet *et al*., 2015) and will be promoted by InnovAfrica in the neighbouring countries of Malawi and South Africa and tested in Ethiopia. The Brachiaria forages has been promoted successfully in Kenya and Rwanda (Ghmire *et al.,* 2015) and will be up-scaled in other parts of these countries and evaluated in Ethiopia, Malawi and Tanzania. The specific SAIs technologies suitable for maize-legume, millet/sorghum-legume intercropping systems are described in each case country chapters 6-11. The knowledge and experiences of the countries with regard to the specific farming system and the implications to the study sites are shown in Table 12.1 below.

Table 12.1: The review report serving as source of information to specific SAI technologies

SAIs technology	SAIs		Source of information
	Testing	Upscaling	
Maize Legume CS	Ethiopia		Weldeyesus (2017); Ashenafi (2016); Solomon (2014); Tilahun *et al.* (2012); Yayeh (2014); Tamado *et al.* (2007)
		Malawi	Nyantakyi-Frimpong et al., (2016); Thierfelder *et al.* (2015); McCracken (2012); Bezner Kerr *et al.* (2012)
		South-Africa	Thierfelder *et al.* (2015)
Millet/Sorghum-Legume CS		Malawi	Bezner Kerr *et al.* (2012)
	Tanzania		< ditto >
Brachiaria forage grass system	Ethiopia		Ghimire (2015)
	Kenya	Kenya	Njarui, et al. (2016); Ghimire (2015)
	Rwanda	Rwanda	Ghimire (2015)
	Tanzania		< ditto >

InnovAfrica will apply the knowledge gained from this review in developing strategies to implement the SAI using suitable IIAs and EAS that have been identified. However, adoption and upscaling of the technologies and approaches by farmers will only happen and persist, if supported with appropriate enabling environment. Two of these enabling environments are suitable agriculture extension and advisory services and innovative institutional approaches.

12.2.2 Extension and advisory approaches (EASs)

Chapter 3 of the report has classified the topology of EASs into three main categories i.e. *public top-down (diffusion or government-driven), participatory bottom-up (demand-driven) and private extension services.* The various types of EASs under each category have been characterised and their main strengths, weaknesses, opportunities and threats (SWOT) were analysed. Gaps and constraints of the EASs applied are also identified in the respective CC chapters 6-11 (Table 12.2). The information from the SWOT analysis of EASs could be a valuable input to the different work packages particulary to Task 1.4 in WP1.

Table 12.2: The review report serving as source of information to specific EASs

EASs	EASs		Source of information
	Upscaling	Testing	
Integrated farm plan		Ethiopia	Kessler et al (2016)
		Rwanda	< ditto >
		South Africa	< ditto >
Village Knowledge Centre		Kenya	www.climaadapt.org
		Tanzania	< ditto >
FPRTs + F2FE	Malawi		Bezner Kerr et al. (2012)

The review has provided a range of pluralistic EASs which focus on facilitating interaction, learning and linkages among farmers and other intermediaries. InnovAfrica will build on success of these EAS to disseminate SAI. InnovAfrica will use Village Knowledge Centres (VKC) which have been used successfully among rural communities in India. The review has also presented the case of farmers' participatory research teams (FPRTs) and farmer-to-farmers extension (F2Fe) approaches that have been found to be practical, effective in Malawi (Bezner, 2012). The integrated farm plan (PIP) also successfully implemented and adopted in Burundi (Kessler et al 2016) influence the mind-set of farmers from subsistence production to commercial thereby changing the social-economic impact of the farmer.

12.2.3 Innovative Institutional approaches (IIAs)

Chapter 4 of the report has provided a detailed description on IIAs concepts, definition and applications notably the integrated seed systems development (ISSD) and Multi-Actor platforms (MAPs). The Ethiopia and Tanzania experiences on implementation of the ISDS and the success and failure stories are articulated in chapters 6 and 9, respectively (Table 12.3). These approaches are promoted in InnovAfrica to empower farmers in participatory research. The integrated seed system has been used in dissemination of plant varieties (Sumberg *et al.*, 2013) and in establishment of community smallholder seed enterprises (Walsh *et al*., 2013). There are cases of successful community seed enterprises in Ethiopia (Andersen and Winge, 2013) and over 75% of the seeds own by farmers in 2016 originated from local markets and exchange among farmers (USAID, 2016). InnovAfrica will gain a lot of information from these successful classical examples to disseminate the technologies using integrated seeds delivery systems in Ethiopia, Malawi and Tanzania.

The review has also shown that MAPs have been widely promoted in many developing countries in adoption of agricultural technologies. MAPs enhance the innovative capacity and contribute to the scaling up (Schut *et al*., 2017; Tenywa *et al*., 2011), and this is an assurance for their suitability in InnovAfrica. In Kenya, there are several MAPs that are involved in promoting technology for specific agricultural commodity such as dairy and in dissemination of climate advisories.

Table 12.3: The review report serving as source of information to specific IIAs

IIAs	IIAs		Source of information
	Testing	Upscaling	
Integrated seed systems development		Ethiopia	Andersen & Winge (2013)
		Malawi	Wise (2017)
		Tanzania	ISSD (2015)
Multi-Actor Platforms	Ethiopia		www.climaadapt.org
	Kenya		< ditto >
	Malawi		< ditto >
	Rwanda		< ditto >
	Tanzania		< ditto >
	South-Africa		< ditto >

The review has outlined the characteristics of a well functional MAP and this provides the basis to assess the success of MAPs during the implementation of InnovAfrica activities. Additionally, the basic principles to adhere to and ways that can be adopted to make MAPs effective in their operations are enumerated. These guidelines and principles will be used during operation of the MAPs (WP2) and in dissemination and up-scaling of suitable innovations (WP6).

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13 Summary and Conclusions

Njarui Donald and Mehreteab Tesfai

13.1 Introduction

Food insecurity affects millions of people in Africa, particularly the smallholder farmers, women, children and the poor (Nagothu, 2015). The driving factors to food insecurity have been well documented and include climate change, unfavourable policies, weak institutional framework, poor infrastructure and market linkages and lack of adoption of improved technologies such as seeds and fertilizers (EU, 2016; NAPAD/CAADP, 2003). Other factors include dependence on rainfall for crop production, land degradation, unfavourable land tenure and ownership that does not encourage investment and high population growth. African governments have prioritized the issue of improving food and nutritional security (FNS) and have promoted implementation of sustainable agricultural intensification (SAI) through the use innovative institution approaches (IIAs) and extension advisory services (EASs) to increase agricultural productivity and improve FNS.

This review report is organized into three parts i.e. Parts I, II and III and 13 chapters containing several sections. Part I presents the general introduction and consists of Chapters 1 to 5. It presents an analysis of the status of agriculture and food security in Africa and application of SAIs, EASs and IIAs in Africa and other relevant regions of the world. The second part of the report consists of Chapters 6 to 11 that deal with six case study countries review on the above mentioned topics. And part III of the report covers Chapters 12 and 13 that briefly summarizes the information in this report and finally give some concluding remarks. In total, the number of publications reviewed in this report are about 141 in SAIs, 88 in EASs, 79 in IIAs related topics and 163 in cross cutting themes that inlcude climate change, gender and capacity building.

The first chapter of the report provides an in depth description of the current state of agriculture and food security in Africa and highlights the importance of agriculture in the economy and enhancing the ecosystem services. The authors pointed out that, over 60 percent of rural population in Sub-Saharan Africa (SSA) depend on agriculture and the sector contributes up to 50 percent of gross domestic product (GDP) and on average 10 percent of the export revenue. However, the state of FNS in SSA is low despite immerse natural resources and assets available in the continent. In all the regions, food insecurity is prevalent and is highest in central Africa (31 percent) and lowest in western Africa (23 percent). However, Africa government have developed several short, medium and long term policies and programmes aimed at enhancing sustainable agricultural growth, promote food security and socio-economic development.

In Chapter 2, a new and evolving concept and definitions of sustainable intensification in agricultural production was discussed. The SI is based on efficient use of input, innovativeness, resulting in increased productivity while conserving and protecting the environment. The authors acknowledged that to increase food production, application of SI alone will not solve the FNS challenge in SSA. There is a need to examine the entire food value chain and pay attention to local practices and solutions. They emphasized the need for innovative technologies among smallholders in order to achieve FNS, address malnutrition, environmental and social economic aspects. Finally the authors described a range of intensification approaches that are

related to SAIs whose goal is to achieve FNS. Some of these approaches include ecological intensification, organic agriculture, climate smart agriculture and genetic intensification.
Chapter 3 opened with a brief description on the evolution of EASs in Africa; from the 1970s to present. The early extension approaches did not involve farmers in problem identification and technology generation unlike present time where EASs have evolved to pluralistic systems that promote interaction among key stakeholders. The Chapter discussed the three broad categories of EASs that are used to provide knowledge, information and services to in order to improve agricultural productivity. These are public top-down, participatory bottom-up and private extension services. Additionally, the authors explored a few successful EASs approaches that have been applied in Africa and other part of the world identifying the strengths and weakness of these approaches.

Chapter 4 focused on application of IIAs in delivery of technological innovations, addressing mainly the ISSD and MAPs as a key important innovations in enhancing technology delivery. The authors revealed that more than 80 percent of the crop seeds planted by African farmers originate from the informal seed systems and recommended the need to strengthen the resilience of seed systems and harness both formal and informal seed systems in order improve access to good quality seeds. The informal seed system which involves community seed enterprises with small packages is the most effective ways of improving accessibility. The MAPs are defined as a process of interactive learning that enable stakeholders to be innovative to solve their own problem. Furthermore, the principles and guidelines for functioning successful MAPs is described to ensure genuine and sufficient participation of all actors involved in technology development, implementation and dissemination of results. Engagement of MAPs members in each case country will be from the start of the project in active forward looking and intensive way.

In Chapter 5, other SAIs, EASs and/or IIAs not covered in previous Chapters and not addressed by InnovAfrica project are discussed. These include conservation agriculture, strigAway Imazapyr resistance (IR) maize, orange fresh sweet potatoes and water efficient maize for Africa from SAIs perspectives. Implementing these SAIs innovations led to significant increase in crop production in addition to improving soil health and reducing farm labour. The key EASs discussed (in this chapter) include training and visit, commodity-based advisory systems, farmer field schools and innovative market drive extension approaches.

13.2 A brief summary of case countries review

The six case study countries of InnovAfrica project are Ethiopia, Kenya, Malawi, Rwanda, South Africa and Tanzania which cobnstitute a total population of 292 million (28 percent of SSA). Each chapter of the case countries (chapters 6 -11) begins with an analysis of the state of agriculture and food security and the factors that drive food and nutrition insecurity. In all the case countries, except South Africa, agriculture is recognized as the backbone of the economy. It accounts for 26 to 50 percent of gross domestic product (GDP); with highest contribution being in Ethiopia and lowest in Kenya. Agriculture is also the largest employer for more than 80 percent of the labour force. Smallholder farmers account about 70 percent of all farmers and up to 90 percent of the national food supply comes from them. Most of the crop production is pre-dominantly rain fed. In South Africa, the contribution of agriculture to GDP is relatively small. Crop-livestock and inter-cropping systems are commonly practised except in Malawi

where mono-cropping dominates the agricultural landscape. Although crop diversity exists, maize is the most widely grown crop except in Ethiopia (where it is teff). The major factors contributing to low production in these countries include climate change, low adoption of improved technologies, weak advisory services, soil and nutrient loss, unfavourable policies and weak institution framework.

Table 13.1: The interventions coverages of SAIs, EASs & IIAs in case countries of InnovAfrica project

Sustainable Agricultural Intensification	Ethiopia	Kenya	Malawi	Rwanda	S-Africa	Tanzania
Intercropping of legumes with cereals	●	●	●	•	•	●
Use of cover crops		●				●
Animal integration in farming systems	•	●		•		•
Brachiaria grass/ Napier grass	●	●	●	●		●
Push–pull integrated pest management		●				
Agroforestry systems	●	●		●		●
Conservation agriculture	•	●	•	•	●	•
Fanya-juu terraces	•	●		•		•
Contour bunds farming	●		●		●	
Soil cover/mulching	●	•	•	•	●	●
Climate smart agriculture	•	•	●	•	•	●
Organic farming/ compost manuring	•	•	●	•	•	●
Soil & water conservation	●	●	•	●	●	●
Integrated soil fertiltiy management	●			●		
Extension & Advisory Services						
Farming systems research & extension	●	●	•	•	•	•
Training and visit system	●	●	•	•	•	●
Farmer field schools/ Farmer training centers	●	●	•	●	•	●
Demand-driven extension/ Participatory extension	●	●	•	•	•	•
Farmer-to-farmer extension	•	●	●	•	•	●
Integrated farm plan (PIP)	●			●	●	
Private agricultural extension	•	●		●	•	•
ICT-based extension/village knowledge centre		●				●
Government led top-down extension	●	●	●	●	●	●
Innovative Institutional Approaches						
Multi-actor innovation platforms	●	●	●	●	●	●
Integrated seed systems	●		●			●

Note: Size of circles is proportionate to the intensity of interventions in each case country.

Due to low agricultural productivity, these countries are food insecure and depend on food aids or imports to meet their food demands. The majority of the rural people are food insecure at household level except South Africa which is food secure at national level. In Ethiopia, more than 10 percent of population are food insecure at any one time and this figure rises to over 15 percent during drought. The rural households particularly women and children are the most vulnerable. Interestingly, although Malawi remains one of the lowest income countries in Africa, it managed to reduce the population who are food insecure through agriculture inputs subsidy programme. About 4,4 percent of the population are classified as food insecure with nearly 37 percent of the children being malnourished.

In all the case countries, the SAIs, EASs and IIAs implemented and promoted (in the past and present) to increase agricultural productivity and improve FNS, were reviewed and described in each chapter. Innovations in agriculture technology, extension and institutional approaches implemented and promited in each case country are presented in Table 13.1 in which some are common across countries, while others are specific to certain faming system. Moreover one or two cases of success and failure stories were reported in each case country. The strength and limitations as well the lessons learned and measures to improve the application of these innovations were outlined in each case country. Several lessons to learn have been mentioned in the case country chapters but the main lessons learned are presented in Table 13.2.

Table 13.2: The main lessons to learn from each case country experiences.

ETHIOPIA	RWANDA
• Adoption and dissemination of technologies should be participatory rather than a top-down approach. • Combination of SAIs results better than use of a single SAI technology application. • Demonstrations, field days, seed fairs and multimedia coverage, have accelerated seed disseminations to farmers.	• Agricultural value chain actors have limited capacity for value addition. • Major focus is given to sensitize crop intensification program in the consolidated farm land. • Inadequate postharvest handling and low seed quality coupled with under developed seed systems are indispensable agricultural problems
KENYA	SOUTH AFRICA
• Agricultural production and improvement will be derived from innovations and intensifications. • EASs strengthen the capacity of farmers knowledge to improve productivity. • IIAs reduces barrier in systems and facilitate product value chain effectiveness	• New ideas need to be built on existing practices and priorities of smallholder farmers. • Environmental concerns need to be embedded during project design phase • Access to inputs, materials and tools is a prerequisite for adoption of innovative SAI systems
MALAWI	TANZANIA
• Cereals and legume intercropping is embedded in the indigenous knowledge systems. • Agricultural EASs have shifted from expert-based services to farmer to farmer extension. • Agricultural projects that are farmer inclusive have shown better results than others.	• Public EASs have more focus on the production side of agricultural food value chain. • Many private extension providers are donor/project based and very selective in terms of commodities and services provision. • Promoting public - private partnership could play a critical role in service delivery system

13.3 Conclusions and Recommendations

This report has attempted to describe and analyse the state of agriculture and food security in Africa in general and in the six case study countries of InnovAfrica project, in particular. Despite some progress made since the last two decades, food insecurity remains one of the major challenges for SSA. The report has also mapped and characterised a range of SAIs, IIAs, and EASs that have been promoted and implemented by the governments and private sectors in each case country in the past and present initiatives and other relevant regions of the world. There are similarities of these innovations across the case countries but some are specific to certain farming system. The farming systems and farmer typology differs among the six case countries. Although, there is evidence that adoption of these innovations led to increased productivity, none of them alone can be regarded as a silver bullet in resolving the food and nutrtion insecurity in SSA. A combined applications of the SAIs, EASs and IIAs will be more effective under the specific context of the case countries of InnovAfrica project.

Table 13.3: Measures to improve the SAIs, EASs and IIAs in the case countries of InnovAfrica project.

Measures to improve
i) Sustainable Agriculture Innovations systems
• Demonstrating the economic and social benefits of adopting SAI systems at the local level.
• Involving smallholder farmers in the development, validation and selection of the best SAI systems at local level.
• Integrating the indigenous knowledge and scientific practices to enhance adoption of SAI systems by smallholder farmers
• Developing technological options that are relatively low-risk and provide short-term returns on investment.
• Increasing resilience to climate shocks and change, besides improving FNS by SAIs,
• Documenting successful technologies and approaches that have significantly contributed to FNS;
• Developing modalities for up-scaling successful innovations
ii) Extension and Advisory Servcies
• Promoting more demand-driven delivery approaches tailored to men and women farmers' needs and capacities
• Using an integrated approach of different extension and advisory methods that is context specific
• Packaging extension messages should be sensitive to community practices and beliefs
• Using low-cost communication methods (such as radio, demonstrations, printed media) and partnerships with private sector and civil society
• Providing enabling environment for private sector participation in extension
• Networking formal and informal extensions to enhance adoption of different SAIs by smallholder farmers.
• Moving EASs from researcher-managed demonstrations to farmer-led trials for meaningful results.
iii) Innovative Institutional Approaches
• Increasing women farmers in leadership role, decision-making and benefit sharing to improve dependency syndrome of some seed producer cooperatives (SPCs)
• Increasing members of SPCs (involving in off-season side business and fund raising) to improve organizational and financial capacity
• Demonstrating different receipt development, food processing and preservation to improve nutrition
• Encouring policies and programmes that is supportive and inclusive of women act

There are some examples of success stories on SAIs, EASs and/or IIAs and also failure cases

too that have been mentioned in the case countries chapters. Nevertheless, there are key lessons to learn from application of these innovations (Table 13.2). Measures that can be undertaken to improve the effectiveness of SAIs, EASs and IIAs thereby increase productivity and improve livelihoods of smallholders in the case countries are listed in Table 13.3. Some of these measures will be captured by the InnovAfrica project during the process.

13.4 References

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