'Innovations in Technology, Institutional and Extension Approaches towards Sustainable Agriculture and enhanced Food and Nutrition Security in Africa'

INNOVAFRICA

Food security through smallholder adaptability

TANZANIA

Country Report

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Edited by Mehreteab Tesfai

April 2018

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

List of Acronyms

AGRA	Alliance
ANSAF	Agriculture Non State Actor Forums
ASDP	Agricultural Sector Development Programme
CBSD	Cassava brown streak virus diseases
CAADP	Comprehensive African Agriculture Development Programme
CIMMYT	The International Maize and Wheat Improvement Center
DANIDA	Denmark's development cooperation
EPINAV	Enhancing pro-Poor Innovation in Natural resources and Agricultural Value Chains
EASs	Extension And Advisory Services
FFS	Farmers Filed Schools
FIPS	Farm Input Promotions
IITA	International Institute of Tropical Agriculture
IIAs	Innovative Institutional Approaches
LITAs	Livestock Training Institutes
MATIs/	Ministry of Agriculture Technical Institutes
MAPs	Multi-actor Platforms
NIBIO	Norwegian Institute of Bioeconomy Research
NMBU	Norwegian University of Live Sciences
PPP	Private Public Partnerships
RECODA	Research, Community and Organizational Development Associate
SAIs	Sustainable Agriculture Intensification systems
SAGCOT	Agricultural Growth Corridor of Tanzania
SACCOS	Savings and Credit Cooperative Societies
SSA	Sub- Saharan Africa
SUA	Sokoine University of Agriculture
TAFSIP	Tanzania Agriculture and Food Security Investment Plan
TOSCI	Tanzania Official Seed Certification Institute
TAMISEMI	the Minister of State in the President's Office
TAGMARK	Tanzania Agricultural Market Development
WRS	Ward Research Station

Country context

Background

In Tanzania, agriculture is the major source of livelihood to large population (about 76.5percent) residing in the rural areas and major determinant of food security in the country. It is largely dominated by smallholder farmers who are the major producer of food crops (URT, 2014). However, the productivity and extent of agriculture intensification is low and its sustainability is threatened by decline in soil fertility, soil erosion, and reliance on expanding agricultural land in the face of climate change. Other unstainable practices include use of low yielding crop varieties, less adaptive varieties to changing local environment, continuous extensive farming with low input use, little and poorly planned crop diversification.

On the other hand, Tanzania is the second country in Africa (after Ethiopia) with the highest livestock population. However the livestock sector is still facing several limitations including poor quality and availability of forage. Improved pasture species with high nutritive values, highly digestible and drought resistance varieties can be used to complement the natural pastures. Improved varieties of forage will contribute to improved livestock production, which subsequently will lead to greater economic returns to farmers and improvement of nutrition status of smallholder consumers.

InnovAfrica project

InnovAfrica targets at improving FNS in Tanzania by integrating sustainable agriculture intensification systems (SAI), innovative institutional approaches (IIAs) with novel extension and advisory services (EASs), and by enhancing capacity building and knowledge sharing in smallholder farming through a strong EU-Africa Research and Innovation Partnership. The InnovAfrica project in Tanzania is aimed to address some of the above-mentioned limitations through enhanced dissemination of SAIs, EASs, and IIAs and strengthening linkages and synergies among different institutions and stakeholders for improving food and nutrition security. The project consists of six work packages and its implementation will be done in two project sites.

Project sites description

The two project sites in Tanzania are Rungwe District which is located in Southern Highlands and Lindi District in the coastal lowlands. The main activities that will be carried out in the project sites include:

Sustainable Agriculture Intensifications systems (SAIs)

The SAIs interventions are research on sorghum-legume and Brachiaria forage livestock system. In Rungwe, the project will introduce and test Brachiaria spp, with appropriate weeding management, sustainable water management and appropriate fertilizer application. While, in Lindi, the technology to be tested will be Sorghum + legume (the legume can be either pigeon pea, beans, peanuts, cowpea, or Bambara nuts), appropriate fertilizer application, soil and moisture conservation, including in situ rainwater harvesting.

Extension and Advisory Services (EASs)

InnovAfrica will establish one pilot Village Knowledge Centre (VKC) in one of the project site. VKC are ICT digital platform linking farmers through smart phones and social media as a conduit for faster and effective information and knowledge to rural communities. Through VKC, it is expected to bridge the knowledge, gender, and digital divides and empower the rural community by fostering inclusive development and participatory communication.

Innovative Institutional Approaches (IIAs)

The IIAs intervention in Tanzania is to establish one Multi Actor Platform (MAP) and integrated seed delivery system (ISDS). MAP members consisting of Ministry of Agriculture, RECODA, ANSAF as well as researchers, agro-dealers, farmer's organization as well as representatives of TOSCI and the Seed Unit in the Ministry of Agriculture was established and the Terms of Reference was agreed upon. The MAP will provide institutional supports to the project and enhance sustainable dissemination of innovationswithin in and beyond the project study sites. The work on ISDS will be carried out in Lindi where the focus of the project activities is on sorghum-based farming system.

Lessons Learned

- The common problems in the two study sites are declining soil fertility, low input use and limited extension services.
- Farmers use improved forage including multi-purpose trees and hydroponic technologies at Kibaha site.

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1 Introduction

Tanzania agriculture is dominated by small scale farming systems, which is the major producer of food crops and employs about 76.5 percent of the Tanzania population (URT, 2014). However, the agricultural productivity and extent of intensification is low in small-scale farming. The current productivity of major staples in Tanzania such as sorghum/millet is 1.2 t/ha (URT, 2016), which is below Africa average yield. However, considering the rate of increase in population (~2.5percent), the current productivity increase (<2.5 percent) is not sufficient to meet the growing demand for food. The 7-year average of total cereal production is 5.79 million tons (~0.83 tons/ year), while the average total cereal import is 0.79 million tons/year (ADBFS, 2011). The cereal import is thus necessary because the production is insufficient to meet the cereal needs of the population to ensure food security. About 13.7 million people are undernourished in Tanzania (ADFS, 2011), which accounts for 27 percent of total population. Despite presence of agricultural policies and strategies to increase adoption of technology such as Kilimo Kwanza, SAGCOT, AGRA, CAADAP initiative and support, the adoption and productivity is still low.

Increasing crop productivity is required in Tanzania through sustainable agriculture intensification. Agricultural production is largely determined by water availability and soil quality, extent of input use, improved agricultural technology at farm level, lack of enabling policies and extension services (Funk and Brown, 2009). The average fertilizer use among Tanzania farmers is 14 kg N/ha (ADFS, 2011).Decline in soil fertility, soil erosion, and reliance on expanding agricultural land to increase production threaten sustainability of agriculture, especially in the face of climate change (Amuri, 2015). Other unsustainable practices include use of low yielding crop varieties, less adaptive varieties to changing local environment, continuous extensive farming with low input use, little and poorly planned crop diversification, low productivity and less resilience to climate change.

Regarding livestock, Tanzania is the second country in Africa with largest livestock population (comprising 25 million cattle, 16.7 million goats and 8 million sheep) which are potential source for human nutrition and household income (URT, 2015). However, the main limitations for livestock productivity are poor quality and availability of forage. Availability and quality of forage declines tremendously during the dry season because native pastures are characterized by rapid maturing grasses and thus lignified quickly (Mwilawa *et al.*, 2008). Improved pasture species with high nutritive values, highly digestible and drought resistance varieties can be used to complement the natural pastures, which are becoming scarce. Improved varieties of forage will contribute to improved livestock production, which subsequently will lead to greater economic returns to farmers and improvement of nutrition status of smallholder consumers.

However, there have been limited efforts in Tanzania for increasing the quantity and quality of forage through establishment of improved pastures due to lack of pasture seed delivery systems (Mtengeti *et al.*, 2008). Lwoga and Urio (1985) reported that there is no pasture-seeds production programme in Tanzania and consequently the county relies on imported seeds. Similarly, Kavana et al. (2017) claimed that, poor pasture production in Tanzania has been due to lack of high quality pasture-seeds which resulted to poor livestock productivity because most pastoralists are largely depending on poor communal rangelands.

Different available varieties of Brachiaria (*Brachiariabrizantha CV. Piata, Brachiariabrizantha CV. Xarases and Brachiariadocumbens CV Balisisk*) are used in tropical and sub-tropical regions. These are improved pastures for livestock production because of their high productive performance and best adapting capacity to climate change (Table 1). Although, different varieties of Brachiaria have been tested and seemed to perform well in other countries such as Kenya and Brazil (Kaleme *et al.*, 2001), little research has been done in Tanzania.

Table 1: Some facts about the Brachiaria forage species

Facts about Brachiaria	Source
• Brachiaria species are C4 grasses, which give very high forage production potential and very fast growth	de Melo *et al.*(2010)
• Several species of Brachiaria are apomictic and reproduce asexually through seeds	Kaleme et al. 2001)
• Different varieties of Brachiaria (e.g. B. documbens and B. brizantha) enhance soil fertility through increased organic carbon content in the soils	Lal Kimble (1997)
• Some Bracharia grasses have been reported to suppress soil nitrification by releasing biological nitrification inhibitors (BNI), which subsequently contributes to reduced N_2O emissions	Moreta *et al.* (2014)

Drawing on the above, there is a need for innovative delivery of sustainable intensification technologies to increase productivity per unit area and to attain the required FNS. Although agricultural research institutes and universities have conducted a number of participatory researches, the uptake of technologies has been slow (EPINAV, 2017). Thus, there is a need for innovative dissemination of the technologies that brings multi-sector stakeholder involvement.

Tanzania is one of the six case countries where the InnovAfrica project is implemented. This project brings in proven technologies and best practices coupled with innovative dissemination strategies. The main objective of InnovAfrica is to improve FNS i) by integrating sustainable agriculture intensification systems, innovative institutional approaches with novel extension and advisory services, and ii) by enhancing capacity building and knowledge sharing in smallholder farming in Sub-Saharan Africa (SSA) through a strong EU-Africa Research and Innovation Partnership.

InnovAfrica project main activities include:

- Interdisciplinary review and mapping of sustainable agriculture intensifications (SAIs), Innovative Institutional Approaches (IIAs), and Extension and Advisory Services (EASs);
- Setting up of innovative Multi-Actor Platforms,
- Farmer-led on-farm experimentation of innovative SAI, IIAs, &EASs,
- Agricultural food value chains (VCs),
- Novel institutional and policy frameworks; and
- Exploiting and disseminating project results through selected EASs.

Sokoine University of Agriculture (SUA) is the main implementing agent of InnovAfrica in Tanzania with support from other stakeholders/actors that constitute the MAP. Major project activities are as follows: research on sorghum-legume and Brachiaria forage livestock system under SAIs; multi-actor platforms and integrated seed delivery system under IIAs, and establishment of Village Knowledge Centre under EASs.

Active participation in project activities right from planning through implementation and evaluation inform implementation of the project. This will be mainly done through MAPs. Monitoring and evaluation of the project will be done against project objectives. In addition, its impact will be assessed based on productivity, food and nutrition security, as well as ecological aspects. On the other hand, to promote uptake of innovations and up-scaling of innovations various dissemination strategies involving farmers, extension staff and other stakeholders will be undertaken. This report gives a general overview on the implementation plan of the project in two project sites namely Rungwe and Lindi districts, Tanzania, after incorporating suggestions from the stakeholders during national inception workshop.

2 Description of Project Sites

2.1 Rungwe District

Two study sites in Rungwe districts (Figure 1) have been selected, namely Southern Highlands and the Coastal lowland belt. The Southern Highlands zone comprises a number of regions including Mbeya, Iringa, Njombe, Rukwa Ruvuma, Katavi, and Songwe. It is ecologically very diverse. The landscape varies from flat plains, e.g. in Usangu to undulating plateaus in high altitude areas, e.g. Ukinga and Umalila Mountains. Climatically, the zone is also highly diverse because of the diversity in landscapes. Temperatures vary from warm tropical in areas lower than 700 m above sea level to cool temperate in areas higher than 2000 m above sea level. Rainfall ranges from 700 to 2600 mm and come as bimodal rain between November and June (Lazaro, 2003). Various farming systems exist including coffee-banana in Mbeya especially Rungwe and Mbozi districts while sorghum/millet/legume based farming system, dominate much of the area and will form the focus of this study.

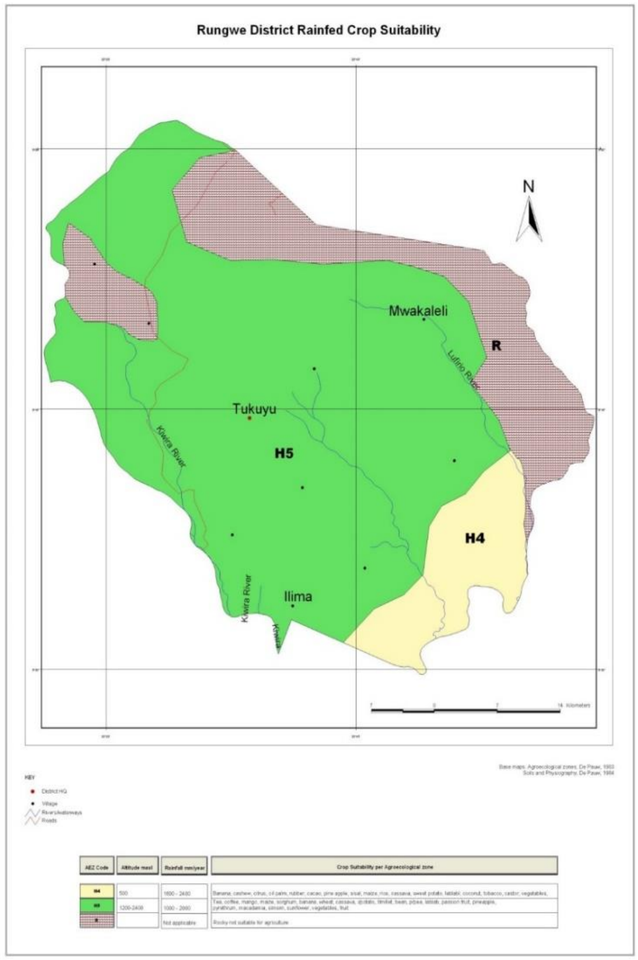
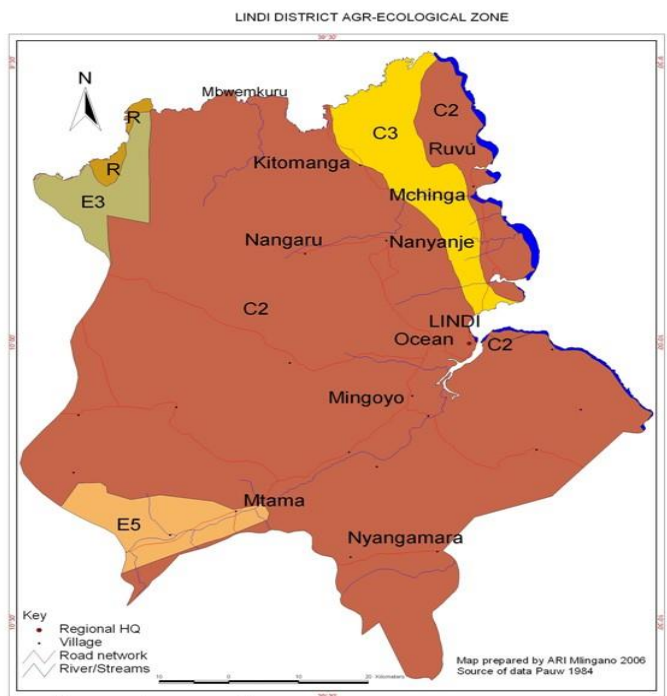


Figure 1: Rungwe district and agro-ecological zones

In Rungwe District, the arable land including pasture covers 1668.2 km^2, forest covers 44.5 km^2, mountainous and residential cover 498.3 km^2 (Rungwe Profile, 2010). Rungwe District in Mbeya Region in Southern Highlands was been selected for the project because of its rich experience in dairy cattle keeping. The District is mainly mountainous and receives relatively more rainfall than most parts of the country. It is densely populated and has two ecological zones (H4 and H5). The main economic activities are crop production (tea, coffee) and livestock keeping (particularly cattle). The main livestock keeping system is zero grazing. However, sustainable dairy production in the district is negatively affected by inadequate forage. The InnovAfrica project will introduce and test a climate smart grass –called Bracharia spp. Besides this, a Village Knowledge Centre will be established to spearhead extension services. Implementation of project activities will be done through MAPs.

2.2 Lindi District

Generally, the coastal lowlands belt runs parallel to the Indian Ocean and represents a range of agro-ecological environment. It covers Tanga in the North to Mtwara further in the South. Other regions in this area are Coast, Dar es Salaam, Lindi and part of Morogoro region. Also, included are the twin islands of Unguja and Pemba in Zanzibar. Much of these areas lie at an altitude of <300 m above sea level. The coastal lowlands are largely characterized by infertile sand soil. However, there are some areas of fertile clay in raised areas and river flood plains (Mdoe *et al.,* 2013). The farming systems include rice/-cassava and coconut/-cassava/-clove -based farming systems (dominant in Zanzibar); cassava/sorghum; cashew/cassava/coconut that cover much of the area.



Aez_code	Altitude (masl)	Rainfall(mm/year)	Physiography
C2	<500	800 - 1000	Nearly level to gently rolling plains and plateaux (0-10%) developed on quaterna
C3	<500	800 - 1000	Strongly dissected uplands to rolling to steep hills derived from Jurassic sands
C5	<200	1000 - 1200	Flat to gently undulating plains developed on old alluvial terraces not flooded
E3	200-750	800 - 1000	Flat to rolling plains low altit developed on intermediate metamorphic rocks
Ocean	Not applicable	Not applicable	Not applicable
R	Not applicable	Not applicable	Rocky terrain

Figure 2: Lindi district and agro-ecological zones

Lindi Region (Figure 2) is the second site where sorghum-based research will be done under the InnovAfrica project. Lindi region is densely populated with 13 people per square km. The area receives 800-1000 mm rainfall per year. The main economic activity is crop production involving cassava, sorghum, and cowpea. Although soil fertility is relatively low, farmers rarely use modern agricultural practices. Instead, shifting cultivation is common. Crop production is largely for subsistence farmers with little surplus. Therefore, Lindi was found to be the ideal site for this project. The technology to be tested is: Sorghum + legume (Pigeon pea, beans, peanuts, cowpea, Bambara nuts). Project activities will include institutional innovation on Integrated Seed Delivery Systems. Selection of project sites will be done after consultations with the District authorities and stakeholders.

After the presentation of work packages and project sites, participants were divided into two groups and were asked to discuss several aspects related to the project implementation. They were asked to discuss the criteria (Table 2) for selection of the study villages (Figure 3) and farmers and lead farmers as well as to give comments on the survey exercise and proposed SAIs, IIAs, and EASs. After the discussions, each group was asked to present their views.

Table 2: Criteria for selecting villages in the study sites

Lindi district	Rungwe district
• The village should have high production of sorghum and legumes records • The village should be among those which receive little rainfall • Accessibility must be easy • There should be availability of land for implementation of test technologies • Farmers in the village must be willing to participate in the project	• Population of cattle - villages with many dairy cattle should be selected. • Availability of land for pasture farms in the village • Readiness of dairy cattle keepers to use their land for demonstration (demonstration plot) • Accessibility • Willingness to participate in the project • Proximity to ward resource centre

Figure 3: Discussion on criteria for selecting villages and participants: Left: Lindi team; Right: Rungwe team (Photo by Kenneth Mapunda)

Visit to dairy cattle farmers

Participants visited four livestock keeping families at Kibaha (Figure 4). They also visited Kibaha Education centre. The main aim of the visit was to learn how livestock keepers (in the Coast region) carried out livestock farming. Participants were also interested to know how these farmers obtained fodder for their animals, challenges they faced and strategies they used in addressing them.

The farmers who were visited had between two to five cows. They used zero grazing system because all of them were located in areas where free grazing was not possible due to shortage of grazing land. The farmers had to get grass from distant places and transport it to their cowsheds. In order to reduce the problem, some of the farmers had planted some pasture around their homesteads. However, due to scarcity of farm land, the pasture was not sufficient to meet the demand for feeds. One of the farmers opted to use hydroponic technology in producing fodder for her cattle.

Figure 4: Ms. Rose Mohamed showing the grass in her pasture plot at Kibaha

It was also noted that some farmers had received cows on credit basis from Covenant Bank. However, the cows did not perform as expected probably due to poor genetic mutations. For example, in one family, one cow had not conceived at all. In the same family, one cow which had given birth did not produce the amount of milk that farmers were expecting despite the investment farmers had put in. The bank was informed about the problem and farmers were still waiting for the feedback. Generally, all farmers who had taken dairy cattle on credit were not happy with the performance of the cows.

Box 1: Kibaha Education Centre

Kibaha Education Centre is a multipurpose Educational Institution situated in Coast Region 40 kilometres west of Dares Salaam along Morogoro Road. The management officer briefed the participants that the Centre was established in 1963 with financial support from the Nordic countries - the then Tanganyika Government on one hand and the Government of the four Nordic Countries on the other i.e. Denmark, Finland, Norway and Sweden. The main objective was to fight against ignorance, diseases and poverty.

In the fight against ignorance, Kibaha Education Centre has been providing Pre- Primary, Primary and Secondary Education to Students to Tanzanian pupils/students. This has been possible through the available Education infrastructures, which include Tumbi Pre – School, Tumbi Primary School, Kibaha Secondary School, Kibaha Girls Secondary School and Tumbi Secondary School. Kibaha Public Library has enabled Students and the nearby communities to enrich their knowledge. In fighting against diseases the Centre has continued to provide health services to the Public through Tumbi Regional Designated Referral Hospital. Victims of road accidents have been receiving proper attention and lives of many patients have been saved due to the efforts done by health practitioners of this hospital.

In the fight against poverty, Kibaha Folk Development Centre has been providing long and short term vocational training courses. Youth and neighbouring communities have received entrepreneurial skills and outreach programmes which have enabled them to be self-reliant. This was the main area of interest for the participants. It was noted that the centre had good infrastructure that can be utilized to

provide training to livestock keepers around the area. The management officer expressed their readiness to collaborate with the project and be partners in activities that would be beneficial to both parties. At the end of the visit, one of the participants thanked the centre administration for sharing their experience with the team and participants travelled back to Dares Salaam.
Source: Field observation

3 Problem Analysis

The various aspects of InnovAfrica project context, i.e. its ecological, nutritional and socioeconomic dimensions should be well understood before a development operation is initiated**.** The common methods used to understand the context is conducting a problem tree. A problem tree requires the selection of core problem (the stem) defining its causes (the roots) and consequences or effects (the branches). Hence, the core problems, their causes and effects facing smallholder farmers in Rungwe and Lindi districts are presented in Tables 3 and 4, respectively.

The major problems of the farming systems in the selected sites varied but have some commonalities. In Rungwe, high population density and humid climate with high rainfall and mountainous landscape makes farming to small plot size, and somehow intensive. While in Lindi, the relatively low rainfall and its sparsely distributed population make farming more extensive with small extent of shifting cultivation (Ball and Gregory, 2007). However, in both sites, the common problems are declining soil fertility, low input use (fertilizer and improved varieties) and limited extension services. The main problems faced by smallholders in Rungwe and Lindi districts are presented in Tables 3.

Table 3: Problems facing smallholders in Rungwe and Lindi districts and their priority ranking

Problems at Rungwe District	Rank	Problems at Lindi Distrcit	Rank
• Soil fertility depletion	3	• Soil fertility depletion	3
• High population pressure	1	• Youth disengagement in agriculture	**7**
• Periodic droughts & excessive rainfall (Shift of season – start and finishing of rain seasons Erratic rainfall)	**5**	• Periodic droughts & excessive rainfall (Shift of season – start and finishing of rain seasons Erratic rainfall)	**1**
• Low access to quality seeds of improved and/or farmer preferred varieties	9	• Nutrition insecurity	**4**
• No site- & crop-specific fertilizer applications	6	• Low access to quality seeds of improved and/or farmer preferred varieties	**5**
• Inadequate capacity in extension systems	**8**	• Weak linkages among VC actors	**2**
• Weak linkages among VC actors	**4**	• No site- & crop-specific fertilizer applications	**6**
• Youth disengagement in agriculture	**7**	• Inadequate capacity in extension systems	**8**
• Nutrition insecurity	**10**	• Low population pressure	**9**
• Feed shortage	**2**		

4 Promising SAIs, IIAs and EASs in the project sites

4.1 Sustainable Agriculture Intensifications (SAIs)

The two project study sites (i.e. Rungwe and Lindi), with contrasting agro ecological conditions, the technologies prioritized are also different. In Rungwe, the InnovAfrica project will introduce and test a climate smart grass called - Brachiaria spp, with appropriate weeding management, sustainable water management and appropriate fertilizer application. While in Lindi, the technology to be tested will be Sorghum + legume (Pigeon pea, beans, peanuts, cowpea, Bambara nuts), appropriate fertilizer application from available resources, soil and moisture conservation, including *insitu* rainwater harvesting.

Table 4: Proposed SAIs for Lindi and Rungwe District

Proposed SAIs at Lindi	Proposed SAIs at Rungwe
i) Sorghum ↔ cow peas; *ii) Sorghum ↔ pigeon peas; or* *iii) Sorghum ↔ peanuts* • Use high quality seeds • Modern technologies for water conservation (e.g. rain water harvest, mulching/use of cover crops) • Use of alternative pest management system (Integrated pest management) • Soil conservation and fertilization • Use of existing village regulations in ensuring the project activities are accomplished.	• Highly sustained production Brachiaria spp taking into account climate change: • Sustainable water management • Weeding management • Fertilizer application • Timely harvesting and forage conservation practices • Integrated farming systems involving crop rotation

Based on the problem analysis of the two sites, and priorities put forward by stakeholders, SAIs to be implemented in each district is presented in Table 4.

Criteria for selection of farmers for farmer-led field experiments

- Farmers who produce the intended crops
- Farmers shall be literate
- Farmers use recommended modern farming practices
- Willingness to embrace new technologies
- Resident farmers in the project village
- Farmer using recommended modern farming practices
- farmers ability to disseminate knowledge
- Independent farmer, i.e. non alignment to any existing institution)

Seeds of improved sorghum variety will be provided by CIMMYT. Local sorghum variety will also be used as a control. Sorghum and legume cultivars/varieties that will be used in the experiment will be selected from among the locally available improved and local varieties. The experiment will be conducted in such a way that uniformity in trial designs, data collection and arrangements, monitoring and documenting innovations by farmers across the implementers of the work package (WP3.1) is maintained. Thus, CIMMYT protocols for executing the field experimentation will be employed and adjusted to the study sites. In the course of the project, attempts will be made to keep track of local innovations and innovators as per guideline.

Brachiaria experiment: The productive potential of three varieties of Brachiaria, i.e. *Brachiariabrizantha CV. Piata, Brachiariabrizantha CV. Xarases and Brachiariadocumbens CV Balisisk*) will be tested against the best local pasture species (control). The best local pasture species refers to the key native grasses most abundant in local areas, with high yielding potential and most preferred by livestock. The field experimental design will follow the Randomized Complete Block Design (RCBD), where three varieties of Brachiaria will be tested in four replications (Figure 5).

	Treatment 1 ↓	Treatment 2 ↓	Treatment 3 ↓	Treatment 4 ↓
Replication 1 →	Brachiaria 1	Brachiaria 2	Brachiaria 3	Best Local
Replication 2 →	Brachiaria 2	Brachiaria 3	Best Local	Brachiaria 1
Replication 3 →	Brachiaria 3	Best Local	Brachiaria 1	Brachiaria 2
Replication 4 →	Best Local	Brachiaria 1	Brachiaria 2	Brachiaria 3

Figure 5: Field experiment layout for Brachiaria grass trial. Note that Bracharia 1 is *Brachiariadocumbens CV Balisisk*, Brachiaria 2: *Brachiariabrizantha CV. Xarases*, Brachiaria 3: *Brachiariabrizantha CV. Piata*, and Best Local will be identified in the field.

The criteria for identification will include among others, i) the best growth performance, ii) high yielding variety, iii) relatively abundance and iv) highly preferred by livestock. The size of each sub-plot will be 20 m^2 (4 x 5 m) and the distance between sub-plot will be 1m apart. All treatments will receive similar agronomic practices such as land preparation, sowing, fertilization, weeding management and control of pest and diseases.

Data collection: Some of the main data to be collected in the field and methods of measurements are shown in Table 5.

Table 5: Data collection methods

Data/parameter	Methods
Growth performance of each variety	Growing period from sowing to harvesting
Seed viability	Comparing germination rate of tested varieties
Growth characteristics	• Linear measurements of tillers, leaves and stems • Leaf Area Index
Number of individual plants	Counting randomly in 0.5 m x 0.5 m
Number of tillers	Counting randomly in 0.5 m x 0.5 m
Yield (above ground biomass)	Dry matter determination of collected sample in the laboratory
Daily temperature and rainfall	Records from weather station
Incidences of pest and diseases	Field observation

4.2 **Innovative Institutional Approaches (IIAs)**

Innovative institutional approaches will used in the course of implementation of project activities. These are the multi-actor platforms (MAPs) and integrated seed delivery system.

Multi-actor platforms (MAPs): A national MAP for the project was established during the launching meeting held in Dar es Salaam. Members of the MAP include Ministry of Agriculture, RECODA, ANSAF as well as researchers, agro-dealers, farmers as well as representatives of TOSCI and the Seed Unit in the Ministry of Agriculture. Also, during the meeting, it was also agreed that local MAPs be established at District level in order to provide a forum to discuss and chart the way regarding agricultural development in their respective areas. Experiences gained through local MAPs will be widely shared during forums of national-level MAPs. As clearly outlined in the project document, MAPs would play a key role in facilitating functional linkages between smallholders, civil society, agri-business sectors, government agencies, non-governmental organizations, scientific community and help in disseminating, and scale up promising results within in and beyond the study sites.

Integrated seed delivery system (ISDS): In Tanzania InnovAfrica provides an opportunity to work on problems associated with seed delivery system in the country especially as regards smallholder farmers' access to quality and affordable seeds that would contribute to improved crop productivity by smallholder farmers by building on earlier work including

- DANIDA funded quality seed programme under the Ministry of Agriculture, Food Security and Cooperatives
- Availability and accessibility of improved seeds of staple food crops by smallholders farmers in Tanzania on Enhancing pro-Poor Innovation in Natural resources and Agricultural Value Chains (EPINAV)
- New Cassava varieties and Clean seed to Combat CBSD and CMD project (5CP) funded by the Bill & Melinda Gates Foundation and led by the International Institute of Tropical Agriculture (IITA). CMDis a prevalent cassava disease.

The work on integrated seed delivery will be carried out in Lindi where the focus of the project activities is on sorghum-based farming system.

4.2 Extension and Advisory Services (EASs)

The importance of agricultural extension in agricultural and rural development is widely acknowledged, especially in a country like Tanzania where agriculture provides the major source of livelihood to the majority of the population in the country. In this regard, the National Agriculture Policy (URT, 2013) stated that, "extension services are crucial in supporting poverty reduction in rural areas and market competitiveness for commercial agriculture in the domestic and global markets. It enables producers to realize increased production and productivity through accessibility to information for marketing and other support services essential for agricultural development". Besides, other initiatives such as Kilimo Kwanza and phase two of the Agricultural Sector Development Programme (ASDP II) acknowledge the importance of agricultural extension services in the transformation of the Tanzanian agricultural sector.

Provision of extension services in Tanzania has largely been the responsibility of the Government. However, since the mid-1980s the public sector has been withdrawing from direct production and provision of goods and services as well as reliance on centralized control and state ownership of the major means of production (Rutatora and Mattee, 2001). As a result, there has been an increase private sector and NGO participation in the production, processing and marketing of agricultural inputs and produce. Thus

The major extension providers in Tanzania are

- Ministry of Agriculture and Cooperatives;
- TAMISEMI
- Outreach activities undertaken by training institutions such SUA and MATIs/LITAs,
- Non-governmental organizations,
- Donor-supported projects,
- Private agribusiness,
- Community-based organizations (CBOs,) e.g. farmer's groups, associations, cooperatives, societies and networks

A major concern widely shared in Tanzania is the performance of extension services, which have been found wanting. A sample of studies conducted a couple of years back generally point to poor performance of the agricultural extension services in the country (Daniel, 2013; Philip, 2014). Others point to general disappointment regarding the delivery of extension services (Mwamakimbula 2014; Wambura *et al.*, 2016). There is thus need for improving extension services in order to serve the needs of Tanzanian. As such, establishment of a Village Knowledge Centre in Rungwe offers an opportunity pilot test the use of this approach based on the of the smart phones phones/e-learning App will be used to communicate with farmers.

5 Agricultural Value Chains and Actors

5.1 Legumes value chains

Smallholder farmers in almost all regions in Tanzania grow legumes while bean is the most important legume grown in the country. Other important legumes include cowpea, pigeon pea, bambaranuts, chickpea and groundnuts. Although legumes are not listed among priority crops in equal levels with crops such as sorghum/millet and rice, their contribution to smallholders as food and with respect to nutrition security, source of income, and soil fertility improvement are comparable to none. In 2008, Tanzania produced 899,000 Mt of legumes. Most of this was sold within the country and only a small amount was exported.

But despite being one of the largest producers in the region, Tanzania's legume farmers have one of the lowest yields in the world (0.5 t/ha). Getting legumes from a smallholder farmer to consumer's plate is a very complicated and inefficient process. In most cases there are too many people involved including multiple traders and brokers. Processing is also inefficient or none existing, as in many cases hand or low quality machines that lead to postharvest losses are used. All this means that legumes in Tanzania can be expensive compared to other crops. However, in a few cases some more efficient and competitive supply chains can be found.

Smallholder legume farmers that rely on seasonal rains usually are not very profitable (<27percent) and many lose money on their harvest. When growing legume producer's main costs are labor (either his/her own or hired) while use inputs including fertilizer is rare. The other people involved in the supply chain including traders and retailers who make profits of between 9 and 25percent. However, these problems notwithstanding, there is a growing demand among up market consumers in Dar es Salaam and other cities. Neighbouring countries also demand legume imports, as do institutional buyers (army barracks, hospitals, schools etc.) in Tanzania. Therefore, three supply chains can be identified for upgrading into value Chains i) integrated small-scale farmers, ii) whole sellers and iii) regional traders.

Apart from very low yields and high losses, the legume supply chains in Tanzania have some other weaknesses including:

- Very few farmers use improved varieties of legume seed because multiplication is insufficient and there are few ways to distribute them;
- Suppliers of inputs, such as pesticides, are too few particularly in remote areas;
- Government extension workers are too few and sometimes lack the required skills;
- Quality is low because different grades of rice are mixed together;
- Storage facilities are insufficient and many farmers store in their homes, which can further reduce quality, and;
- Transport is very expensive.

5.2 Sorghum value chains

Sorghum is grown across most semi-arid Tanzania and it is the fourth most important food crop. The most recent estimates by the Ministry of Agriculture, Food Security and Cooperatives suggest that 780 Mt of sorghum is grown in Tanzania. Most of this is grown by smallholder farmers on a total of 1.9 million ha of land divided into individual farms that are only 0.67 ha on average. However, production hardly meets demand.

More than 95percent of the sorghum harvested in Tanzania is consumed on the farm. Since many sorghum and pearl millet producers experience periodic food deficits, most grain trade is between neighbouring households. Small quantities of grain move from the few farmers able to produce a surplus to the many experiencing production deficits. Larger regional grain deficits are resolved through imports of sorghum/millet and rice. There is relatively little long-distance trade in sorghum and pearl millet. It is hard to accurately estimate the quantities of sorghum and pearl millet entering the national market. The Marketing Development Bureau of the Ministry of Agriculture and Cooperatives maintains partial records of grain flows into the major urban wholesale markets.

Like other cereals getting sorghum from the farmer to the consumer is a long and complicated process. Traders and brokers handle sorghum at village, district and national markets, which increases prices. They are able to make a lot of money because the prices change seasonally and from place to place. In addition, high post-harvest loses and low yields increase prices. However, some new ways of doing business are slowly emerging that use WRS and different types of farmer organizations. The challenge is to make farmers think more like businesspersons. Smallholder sorghum farmers often lose money on their crop (>70percent) because of low yields.

It is possible to increase the current yield from 0.7 Mt/ha to 2.5 Mt/ha by using good agricultural practices and this would make sorghum farming profitable (>63percent).

The main costs that farmer incur are his/her own labour, transport and inputs. In addition to farmers, traders make a profit of 24percent and processors a profit of 42percent. Apart from multiple traders and low yields, there are a number of other weaknesses facing the sorghum VC sector:

- Many farmers still cannot access inputs although efforts have been made to improve this;
- Input suppliers and farmers do not have access to financial services;
- There are few farmer organizations and most sell at the farm gate;
- The market is unpredictable due to export bans and the release of food aid;
- There are not enough storage facilities;
- Quality is low because of contamination and poor quality processing machines.

Four supply chains have been identified for upgrading into value chains:

- A chain that targets low-income urban consumers;
- One that works with institutional food security buyers like WFP and NFRA;
- An export chain to countries in the east African community, and;
- A less significant chain targeting urban up market consumers.

There is also potential to link the sorghum chains to businesses in the beer industry and animal feed industry. The first chain mainly needs greater farmer organization through marketing groups and WRS business models. This should reduce the number of traders and shorten the chain to the chosen miller in urban centres such as Dar es Salaam.

In order to further develop sorghum & legume VCs in Tanzania, it is recommended to focus on the following priority areas:

- Facilitate development of the upgrading of sorghum/millet and rice value chains as highlighted in the respective value chain analysis reports,
- Support expansion of the agro-input subsidy programme with TAGMARK and agro-dealers
- Promotion of WRS through training to farmers and SACCOS, construction / renovation of warehouses and support to management of SACCOS and WRS.
- Facilitate capacity development of farmers through training and extension services with FIPS-Africa and local partners (Farmer field schools, FFS, demonstration plots, linkage to companies, etc.)

6 Agriculture policies

Since independence Tanzania has implemented various policies having a bearing on the economy in general agricultural development in the country in particular. During the early part of its independence the country had embarked on promoting the market economy it had inherited from colonial times. However, this policy was abandoned in the second phase (1967-1983) following the launching of African socialism or *Ujamaa* based on the Arusha Declaration. The launching of this policy involved, among others, nationalization of several major private companies. However, some years later, the government liberalised trade under the second structural adjustment programme from 1986 to 1989. It should be noted that the groundwork for market reforms were laid out after implementation of the Economic Recovery devised with the help of the IMF respectively in 1986 and 1998.

Concerning agricultural policies, various policies and initiatives have been formulated including the Agricultural Sector Development Strategy (ASDS), which was adopted in 2005 and implemented through the Agricultural Sector Development Programme (ASDP). In addition, in 2011 the Tanzania Agriculture and Food Security Investment Plan (TAFSIP) was launched in the context of the African Union's Comprehensive African Agriculture Development Programme (CAADP). Other initiatives taken by the government relate to investment in the economy as a whole. However, regarding agricultural investment, the most notable programme is the Agriculture First "Kilimo Kwanza" policy. It was launched in 2009 and had as its main objective the fostering of a "green revolution" and transforming agriculture into a modern sector. Another major initiative to enhance investment in agriculture is the Southern Agricultural Growth Corridor of Tanzania (SAGCOT). This is an international PPP aiming to catalyse large volumes of private investment to increase productivity and develop commercial agriculture in the southern corridor (see Nijbroek and Andelman, 2016).

Moreover, with respect to the seed system, the institutional and political setting is one guided by various legislations including the following:

- The Seed Policy Guidelines 1994;
- The Seed Act of 2003 and
- The Seed Regulations of 2007.
- Protection of New Plant Varieties (Plant Breeders' Rights)
- Act of 2002(2012) and
- Plant Breeders' Rights Regulations (2008), and
- Agricultural Policy of 2013

7 Lessons Learned

The main lessons learnt from the field visits and discussions held with the famers are:

- Preparation of fodder
- Poor cooperation between farmers
- Poor cooperation between farmers and extension officer
- Poor record farm keeping
- Poor awareness on importance of record keeping in business
- Introduction of interventions/resources without consulting extension officers
- Forage conservation
- Husbandry management (indoor house-keeping)
- They use improved forage including Multi-purpose trees
- Farmers at Kibaha use hydroponic technologies
- KEC has not successfully improved production
- Cattle credited by Covenant Bank were not producing well due to poor genetic history
- The price of milk is high because of production is low
- Animal housing was high quality but the cattle were handle in poor quality

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Annex

Table 1: Problems, causes and effects facing smallholders in Rungwe District

Problems	***Causes***	***Effects***
• Soil fertility depletion	• Low fertilizer use and poor management of soil • Shifting cultivation • No use of improved fallow	• Low yield per unit area • Depletion of SOM and low in nutrients
• High population pressure	• Good climate for crop and livestock production	• Small and fragmented landholdings • Encroachment of agricultural activity to the steep slopes, • Forest/vegetation cover, are highly prone to degradation • Rapid depletion of soil fertility due low input use and poor soil management
• Periodic droughts & excessive rainfall • Shift of season – start and finishing of rain seasons Erratic rainfall	• Climate change	• Frequent moisture stress in season • Significant yield reduction due to moisture stress and low soil moisture retention • Risky rain-fed agriculture can led to total crop loss
• Low access to quality seeds of improved and/or farmer preferred varieties	• Lack of capital • Not involving farmers in the research process	• Most of the cultivars are low yielding and disease/pest susceptible
• No site- & crop-specific fertilizer applications	• No regular soil testing	• Tremendous yield reduction • Farmers are reluctant to take up fertilizer recommendations. using blanket fertilizer recommendations
• Inadequate capacity in extension systems	• Institutional and technical limitations of DAs • Insufficient of logistics and financial supports	• Limit access of farmers on new technologies • Low adoption of improved agricultural technologies
• Weak linkages among VC actors	• Poor infrastructural, information and market net-workings	• Limited access to the right inputs at the right time
• Youth disengage in agriculture	• Alternative livelihood options in urban areas • Low profitability of agriculture entrepreneur	• Urban migration of youth • Slow adoption of new technologies by elder farmers
• Nutrition insecurity	• Limited awareness on improved food eating habit and diet as well as nutritional value of foods	• Malnutrition in terms of undernutrition • High morbidity

Table 2: Problems, causes and effects facing smallholders in Lindi Distrcit

Problems	***Causes***	***Effects***
• Scarce availability of pasture and low productivity of pasture	• Use of low yield pasture grass varieties • Poor access to improved grass varieties • Extended dry spells due to climate change	• Low productivity of dairy milk and products • Outbreaks of armyworms and locusts
• Soil fertility depletion	• Continuous cultivation without properly nurturing the soil • Competing use of organic materials	• Majority of the soils are generally low in OM, total N and plant available P • Deficient in certain micronutrients Zn and Cu (Mhoro *et al.*, 2015)
• Low population pressure	• High rate of migration	• Encourage extensive farming and shifting cultivation • Encroachment of agricultural activity to the reserved forest • Forest/vegetation cover, are highly prone to degradation • Rapid depletion of soil fertility due to limited fallow • Increase demand of food and animal products
• Periodic droughts & excessive rainfall • Shift of season – start and finishing of rain seasons Erratic rainfall	• Climate change	• Temporal moisture stress • Significant yield reduction for humid crops • Risky rain-fed agriculture can led to total crop loss
• Feed shortage	• Land scarcity and long dry seasons • Crop residues are insufficient and are used for other competing ends	• Limited land for grazing • Animals can graze only in some pocket areas (valleys & steep slopes, woodlots) • Limited number of livestock per capita
• Low access to quality seeds of improved and/or farmer preferred varieties	• Lack of capital • Farmers not actively involved in the research process	• Most of the cultivars are low yielding and disease/pest susceptible
• No site- & crop-specific fertilizer applications	• No regular soil testing	• Tremendous yield reduction • Farmers are reluctant to take up fertilizer recommendations. using blanket fertilizer recommendations
• Inadequate capacity in extension systems	• Institutional and technical limitations of DAs • Insufficient of logistics and financial supports	• Limit access of farmers on new technologies • Low adoption of improved agricultural technologies
• Youth disengagement in	• Alternative livelihood	• Urban migration of youth and men

agriculture	options in urban areas • Limited opportunities for livelihood in Lindi	(Ball and Gregory, 2007) • Slow adoption of new technologies by elder farmers
• Nutrition insecurity	• Limited awareness on improved food eating habit and diet as well as nutritional value of foods	• Low quantity of nutritious food due to low productivity and limited integration of crops (cereal and legumes) and livestock
• Weak linkages among VC actors	• Poor infrastructural, information and market net-workings	• Limited access to the right inputs at the right time • Limited market of agricultural produce