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Improving Agricultural Support Services for Smallholder Farmers' Adaptation to Climate Variability in Rungwe District in Tanzania

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Abstract
Agriculture is the main source of livelihood in Tanzania. Agricultural development in Tanzania, however, has been constrained by climatic factors including climate variability and non-climatic challenges such as poverty, small size of land holdings, limited access to non-farm activities, poor access to and low use of improved seeds and fertilizers, limited access to financing for uptake of technology, global agricultural policies and diseases such as HIV/AIDS. In the era of climate change and variability, sustained and improved productivity occurs when smallholder farmers adapt to climate variability. Agricultural support services are important in bringing about resilience to the effects of climate variability. In this paper, strategies to improve the effectiveness of the whole service sector in the provision of agricultural support services are analysed basing on information derived from household socio-economic data, focus group discussions and key informants. It demonstrates that non-governmental organizations and private sectors are currently significant service providers in the provision of agricultural support services. The findings indicate that agricultural support services provided by the private sector though costly are by far more reliable compared to public sector. It is recommended that the government offers an enabling environment for the private sector in terms of assured economic stability, political stability and efficient markets so as to enhance the private sector towards provision of agricultural support services.

***Keywords**: adaptation, agricultural support services, climate variability, smallholder farmers*

Introduction

Climate variability is expected to disproportionately impact on many of the world's poorest populations who have the least economic, institutional, scientific, and technical capacity to cope and adapt (World Bank, 2012). Agriculture is one of the most vulnerable sectors to the risks and impacts of climate variability especially in sub Saharan Africa since the sector is inherently sensitive to climatic conditions (Yanda and Mubaya, 2011; Ahmed et al, 2011). The impact of climate variability on different crops has already been recorded in many African countries (Porter et al., 2014). Aggarwal (2009), Shiferawa et al (2014), Hassan and Othman (2019), Misana and Tilumanywa (2019) and Müller (2013) have also indicated that agricultural production is being adversely affected by climate variability in Africa.

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In Tanzania, agriculture accounts for 27.6% of GDP, 85% of exports, and engages about 80% of the workforce (URT, 2013a). The country has a relatively rich base of land whereby 44 million hectares or 46% of its land are suitable for agricultural production (URT, 2013a). However, only 10.8 million hectares, which is 24 % of the land is cultivated, mostly by smallholders who are constrained by a number of challenges (URT, 2013a). Smallholders in the country are facing climatic and non-climatic challenges such as poverty, small size of land holdings, limited access to non-farm activities, poor access to and low use of improved seeds and fertilizers, limited access to financing for uptake of technology, global agricultural policies and diseases including HIV/AIDS (Jayne et al., 2010; Salami et al., 2010; Yanda and Mubaya, 2011). Climate trend in Tanzania shows that the average annual temperature has increased by 1.0ºC since 1960 and is projected to increase by 1.0ºC to 2.7ºC by the 2060s (URT, 2015). Such an increase may result in the decrease of the potential productivity of agriculture especially in semiarid regions whose characteristics are naturally hot. The increase in temperature is also problematic as most of agricultural activities are dependent on rainfall instead of irrigation.

URT (2015) further indicates that in the last 40 years Tanzania has experienced severe and recurring droughts with devastating effects not only on agriculture, but also on water and energy sectors. Currently more than 70% of all natural disasters in Tanzania are climate change related and are linked to recurrent droughts and floods (URT, 2015). Kangalawe (2012) and Yanda and Mubaya (2011) indicate that smallholder farmers in Tanzania are among the most vulnerable to even small variability in the climate, with major impacts on livelihoods and food security. The impact that climate variability and climate change have on the agricultural sector in Tanzania, cannot be overemphasized. According to World Bank (2013), weather-related risks cost the agricultural sector in Tanzania at least $200 million per year. This calls for elaborate adaption responses for ensuring resilience of the sector and the economy as whole.

Adaptation to climatic variability is not new as it has been happening throughout history alongside adaptation to other drivers of environmental change. Smallholder crop farmers in Tanzania and elsewhere in Africa have been adapting to these climatic and non-climatic challenges in different ways (Herrero et al., 2014; Wood et al., 2014; Mapfumo et al., 2013). Agricultural support services are seen as essential not only for enhancing smallholders' productivity (Sokoni, 2014) but also their capacity to adapt to climate variability. Salami et al. (2010) and Kangalawe (2015) insisted that in order to adapt to climate variability smallholder farmers require efficient resource management systems and agricultural support services. Agricultural support services are those activities that support agricultural production such as training, research, extension, plant protection, irrigation, farm power, credit provision, storage, transport, input delivery, processing and animal health services (URT, 2013a). In this paper, the focus is on smallholder crop farmers' access to agricultural support services such as agricultural marketing,

transport, storage, packaging, extension, credit, research, and input supply (fertilizers, seeds and pesticides).

In Tanzania, after independence, especially from 1966 to mid-1980s, the government was the sole provider of goods and services to farmers and played a key role in production, processing and marketing of agricultural inputs and produce. The country's Structural Adjustment Programmes of the 1980's however, made the government not to continue to be the sole provider of agricultural support services (Crawford et al., 2006). The withdrawal of the government from providing these support services especially agricultural subsidies opened a greater participation of the private sector and NGOs in the provision of agricultural services (Sokoni, 2008).

The engagement of private sectors and other institutions aimed at enhancing productivity, competitiveness and profitability of the agricultural sector so as to contribute to sustainable livelihoods of the majority of Tanzanians. Nevertheless, it is uncertain that the private sector and NGOs have been able to fill the gap left by public sector in provision of agricultural support services. Agricultural support services are important in bringing about resilience to the effect of climate variability (FAO, 2013; Mustapha et al., 2012). Conversely, very often agricultural support services provided to smallholder crop farmers are not adaptive enough to offset negative impacts and to take advantage of positive ones. Generally, inadequate agricultural support services are a serious hindrance to agricultural development in Sub-Saharan Africa, including Tanzania. Therefore, an understanding of how agricultural support services are functioning in the context of climate variability and how smallholder farmers are adapting to climate variability in the study area is crucial.

This paper is based on a research that was conducted between May and September 2017, to explore the delivery of agricultural support services and how they could be improved to assist smallholder farmers' adaption to climate variability. Specifically, the current systems of provision of agricultural support services by the private and public sectors, smallholder crop farmers' needs for agricultural support services in context of climate variability in the study area and challenges faced by smallholder crop farmers in accessing agricultural support services are examined.

Conceptual Framework

Provision of agricultural support services is key not only to agricultural development but also to managing climate variability. For effective and efficient provision of the agricultural support services a combined effort of multiple stakeholders is unavoidable. The conceptual framework on Agricultural Innovation System (AIS) is adopted from Spielman and Birner (2008). The framework draws attention to a wide range of actors and organizations from public, private and civil society that are involved in bringing about agricultural

development, economic growth, and poverty reduction. The framework also emphasizes the role of the institutional and policy environment that affects performance and behaviour. The essential elements of an innovation system include a knowledge and education domain, a business and enterprise domain, and the bridging institutions— extension services, political channels, and stakeholder platforms that link the two domains. Throughout the system are farmers—both as consumers and producers of knowledge and information, as producers and consumers of agricultural goods and services, as bridging institutions between various components, and as value chain actors.

The interaction between and among the variables in the framework can make agriculture more dynamic, competitive and responsive to impacts of climate variability. In other words, applying this innovation system framework is particularly promising for agricultural development because it can help identify where the most binding constraints to agricultural innovation are located and how better to target interventions to remove such constraints. As noted earlier, climate variability combined with non-climatic factors remain as major challenges in agricultural development in Tanzania and Sub-Saharan Africa as a whole.

It is expected that with the integration of both the public and private sectors in providing agricultural support services as one of the key essentials, not only for enhancing smallholders' productivity but also their capacity to adapt to climate variability, will ensure opportunity to improve efficiency in production. Improved agricultural support services would help smallholder farmers improve their adaptive capacity and hence manage climate variability better in the future for sustainable production. Smit and Pilifosova (2003) noted that adaptive capacity is an inherent property of the system (human or natural) that defines its capability to deal with exposures individually or at community level. Adaptive capacity however, is affected by a number of factors, thus adequate support and engagement of different stakeholders at local and region levels is imperative.

Methodology

This research was conducted in Rungwe District (Figure 2) in Mbeya Region. The district is generally mountainous, with altitude ranging from 772 metres to 2,981 metres above sea level (URT, 2011). The simultaneous consideration of thermal, moisture, soil and topography characteristics permit the definition of broad agro-ecological zones which are useful in assessing not only the potential for crop cultivation but also the climate variability and adaptation strategies employed. Although the spatial variations in rainfall and temperature are not pronounced, they do make the district very suitable for producing a variety of crops and they are an important determinant of the type of agriculture that is undertaken within a particular zone in the district. The agro-ecological zones are the highland, middle land and lowland. Based on these agro-ecological zones, the agricultural support service needs and the magnitude of the impact of climate variability are also expected to vary between zones within the district.

Figure 2 also shows the study villages in Rungwe district. In this study, two villages from each zone were selected making a total of six villages namely; Ndaga and Goye (in the highland zone), Syukula and Kyimo (in the middle land zone), Ilimaand Katundulu (in the lowland zone). The reason behind selecting two villages in each zone was to determine the level of variability within a larger population.

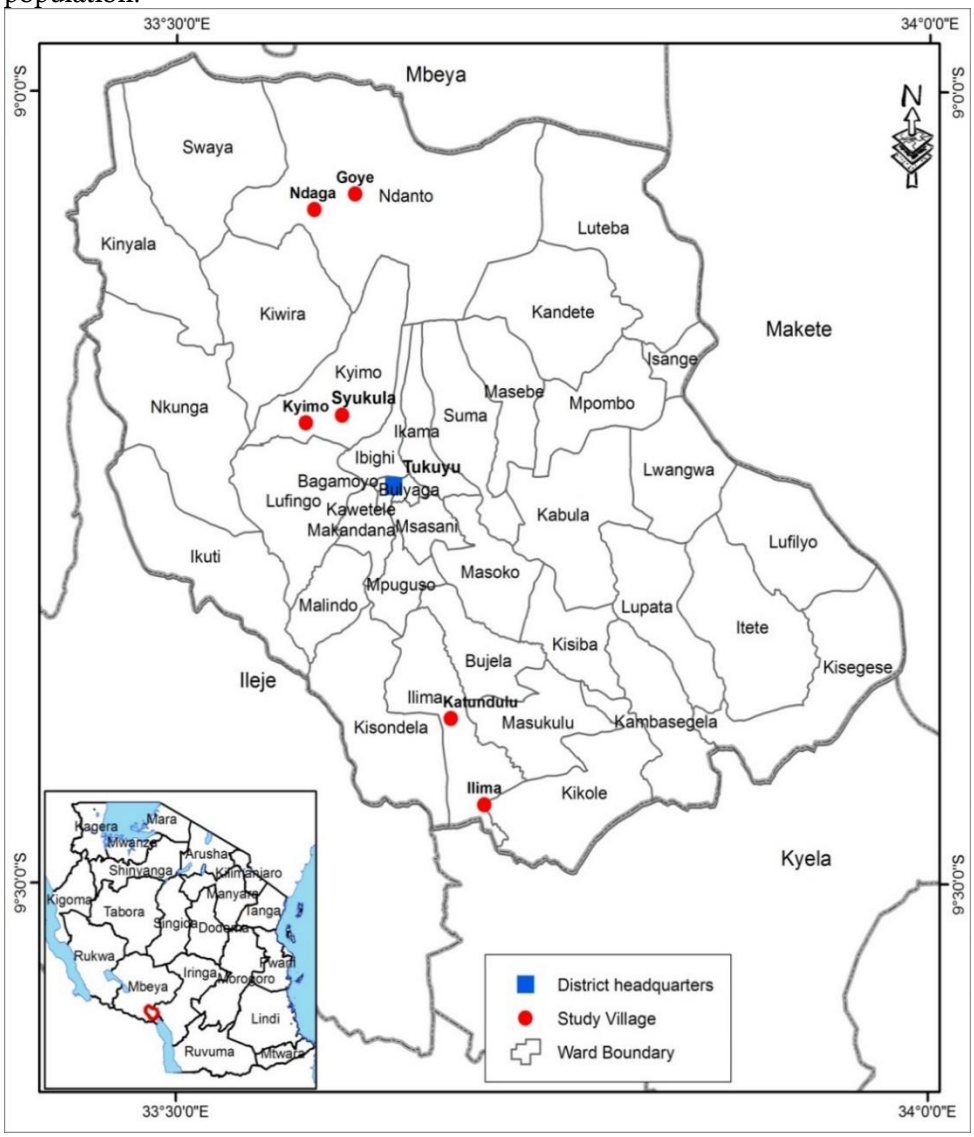

Figure 2: Location of the study villages in Rungwe District
Source: Geography Cartographic Unit (2017) where?

According to the 2012 census, Rungwe district had a total population of 339,157 people with an average household size of 4.1 - slightly below the regional household average size of is 4.3 (URT, 2013b). The overall population density is 153 people per square kilometre. Rungwe district was selected for this study because it is one of the districts which have not only an outstanding contribution in terms of agricultural production in Mbeya region but also is impacted by climate variability and other stress factors (Kangalawe, 2012). The total sample size within the selected villages was 362 smallholder crop farming households (Table 1). As indicated in Table 1 the number and percentage of sampled households depended much on the total number of households in each village. Generally, out of 362 respondents, 183 were males and 179 were females. More than three quarters aged between 30 and 59 and a few were below 30 and above 60 years.

Table 1: Sample size within the selected villages in Rungwe district

Zone	Ward	Village	Number of Households	Sample Households	% of Total
Highland	Ndanto	Ndaga	836	80	9.5
		Goye	347	33	9.5
Midland	Kyimo	Kyimo	953	92	9.6
		Syukula	1056	102	9.6
Lowland	Ilima	Ilima	91	18	19.7
		Katundulu	387	37	9.5
Total 3,770				**362**	**9.6**

Data collection involved both qualitative and quantitative techniques namely, focus group discussions (FGDs), key informant (in-depth) interviews, structured interviews using questionnaires and review of relevant literature. Use of interviews and FGDs aimed at capturing broad based information related to smallholder crop farmer's agricultural decision making. In-depth interviews involved consultations with key government officials including District agricultural officers, agricultural extension officers, village and ward executive officers, agro-dealers and representatives of smallholder crop farmers' associations. In total 27 key informants who were purposively selected were interviewed. As for structured interviews, a questionnaire was administered to a total of 362 randomly selected smallholder crop farming households.

Six focus group discussions were held involving smallholder crop farmers, one in each village. Each group had 5-10 participants both men and women. Apart from FGDs conducted at the village level, two more FGDs were conducted, one with agricultural extension officers at Kyimo ward and the other with researchers at

Uyole Agricultural Research Institute (ARI-Uyole). Collection of secondary data involved reviewing literature on agricultural support services, climate variability and adaptation strategies including published and unpublished materials.

Content analysis was used to analyse qualitative information from focus group discussions and key informants' interviews. Data from the questionnaires was computer processed using the IBM Statistical Product and Service Solutions (SPSS) version 20 programme and analysed to produce descriptive statistics such as frequencies, means, and percentages.

Types of agricultural support services provided

The analysis of data from different sources has shown that smallholder crop farmers receive a wide variety of agricultural support services (ASS) from both the public and private sectors. Table 2 and Table 3, indicate the types of agricultural support services as were reported by smallholder crop farmers at household level. From the two tables it is learnt that some ASSs are more prominent than others for both the service providers. Specifically, the public sector seems to be dominant in the provision of fertilizers as it ranked higher in percentage (90.8%) ahead of the private sector, though for a difference of 2.2% only. Comparatively, the private sector is significantly leading in five agricultural support services (seeds, pesticides, markets, transport and storage).

Table 2: Types of agricultural support services from public sector by zones

Zone	Support services by public sector										Total
	Fertilizers	Seeds	Pesticides	Marketing	Transport	Storage	Packaging	Extension	Credit	Research	
Upper	15	14	13	6	4	1	1	4	2	1	19
	23.1%	21.5%	20.0%	9.2%	6.2%	1.5%	1.5%	6.2%	3.1%	1.5%	29.2%
Middle	31	20	0	1	0	0	0	1	0	0	33
	47.7%	30.8%	0.0%	1.5%	0.0%	0.0%	0.0%	1.5%	0.0%	0.0%	50.8%
Lower	13	12	0	0	0	0	0	0	0	0	13
	20.0%	18.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	20.0%
Total	59	46	13	7	4	1	1	5	2	1	65
	90.8%	70.8%	20.0%	10.8%	6.2%	1.5%	1.5%	7.7%	3.1%	1.5%	100.0%

Note: Percentages and totals are based on respondents who reported to receive a particular support service.

It should be noted also that some respondents said no or did not respond in all choices of some questions that is why the total is less than 362

Table 3: Types of agricultural support services from private sector by zones

Zone	Support services by private sector										Total
	Fertilizers	Seeds	Pesticides	Marketing	Transport	Storage	Packaging	Extension	Credit	Research	
Upper	107	104	100	65	18	0	1	0	1	0	108
	32.9%	32.0%	30.8%	20.0%	5.5%	0.0%	0.3%	0.0%	0.3%	0.0%	33.2%
Middle	143	148	86	107	51	3	1	6	1	1	168
	44.0%	45.5%	26.5%	32.9%	15.7%	0.9%	0.3%	1.8%	0.3%	0.3%	51.7%
Lower	38	34	20	25	10	3	1	2	0	0	49
	11.7%	10.5%	6.2%	7.7%	3.1%	0.9%	0.3%	0.6%	0.0%	0.0%	15.1%
Total	288	286	206	197	79	6	3	8	2	1	325

	88.6%	88.0%	63.4%	60.6%	24.3%	1.8%	0.9%	2.5%	0.6%	0.3%	100.0%

Note: Percentages and totals are based on respondents who reported to receive a particular support service.

It should be noted also that some respondents said no or did not respond in all choices of some questions that is why the total is less than 362.

In general terms, the private sector seems to provide varied agricultural support services to the majority of the smallholder crop farmers in the study area as compared to the public sector. The public sector is also better at provision of extension, credit and research services though at the minimal level. This is not surprising because institutions such as Uyole and TACRI are governmental institutions dealing with agronomic research for different crops while extension officers are also government employees.

Agricultural inputs (fertilizers, seeds and pesticides)

Agricultural inputs (fertilizers, seeds and pesticides) support services featured strongly compared to other support services for both the public and private providers particularly in the middle and highland zones (Table 2 & 3). It should be noted that, the middle land zone on one hand is a dominant zone for maize production, one of the crops that is subsidized by the government for both fertilizers and seeds. The highland zone on the other hand is a zone of Irish potatoes, one of the crops which are not subsidized in terms of fertilizers and seeds. Because of the intensification of Irish potato cultivation, there is a high uptake of fertilizers, seeds and pesticides in the highland zone. Currently, apart from individual initiatives some farmers are served by Kilimo Trust, an organization that operates in East African countries that established its office in Tanzania in 2014 and its operation in Rungwe district started in 2017. The organization provides extension services, farmer on-field trainings, improved seeds, pesticides and fertilizers to Irish potato growers individually or in groups.

The higher consumption of inputs in the highland and middle land zones was associated with the commercialization of the potatoes, changes in potato varieties and intensive cultivation of potatoes on one hand and the loss of soil fertility and climate variability on the other hand. During FGDs in the two zones, the discussants indicated that their land was no longer productive without the use of fertilizers. This assertion is true with regard to the geology and soils of the area. FAO (2015) reveals that, much of the soils in this area have a low pH; as a result, these acidic soils show reduced uptake of chemical fertilizers. Bakari (2015) also noted that, change in Irish potato varieties, intensive use of fertilizers and change in farming practices in some parts of Rungwe district have led to land degradation. This suggests that chemical fertilizers alone will not address the problem. Therefore, integrated soil fertility management is needed.

Smallholder crop farmers further indicated that, due to climate variability there has been a lot of fungal diseases, root disesease and crop pests which has led to the use of more fertilizers and pesticides. This observation was supported by the District agricultural officer who mentioned some prevalent crop diseases including *Bud diseases, Fusarium wilt, Banana weave/nematode, Blossom end rot, Maize streak, Pod rot, mirids, Root rot, coffee leaf rust and coffee berry* diseases (DALDO's office, 2017). Accordingly, a new crop pest *TutaAbsoluta* (commonly known as *'kanitangaze'*which is a devastating pest for tomato, has developed over the last two years. In such a situation for farmers to earn decent produce, intensive use of fertilizers is imperative. A similar case of intensive use of fertilizers is reported by Ponte and Brockington (2020) in the Uluguru mountains where they observed that root diseases are affecting cabbage cultivation, and fertilizer needs to be applied to any crop (even maize) to obtain decent yields. This indicates that reliance on use of fertilizers has increased in different parts of the country and to most crops.

Credit support services

Effective management of the prevalent and new emerging crop diseases and pests require a great deal of capital of which most of the smallholder farmers do not afford in the absence of affordable credit services. The financial credit service is almost not accessible by the majority of the smallholder crop farmers as it is indicated by less than five percent of the respondents. Only 3.7% of the respondents indicated to have accessed credit services (Table 2 & 3) from both the public and the private sectors. Some of the surveyed villages have a ward bank or a Savings and Community Credit Organization (SACCOS) which offers financial credit.

Marketing and transport support services

The marketing and transportation services featured well particularly with the private sector (Table 3). Farmers indicated that, the markets for their produce are available both at local and international levels. At the local level, they have weekly markets in different locations in the district while some are selling their agricultural products either in other regions within the country or outside the country mainly in Zambia and Malawi. Household data indicates that, 74.9% of the respondents sell their produce within the village markets, 4.7% in district markets, 1.9% in regional markets and only 0.3% sold their products outside the region.

Key informant interviews and group discussants informed that, most of the products are sold immediately after harvest, and dominant selling style is '*on farm selling'* where the buyers/business men and women come directly to a farm and negotiate for best the prices. This practice is mostly dominant in the selling of Irish potatoes, bananas and maize both in the highland and middle land zones. Farmers, however, are not satisfied with the unfavorable market chain that is dominated by middle men (commonly known as *dalali*). This strategy might seem

advantageous in terms of saving time, transport costs and market charges but it denies the smallholder farmers control over their activities in the value chain. A few smallholder farmers (9.4% of all respondents) have joined common interest groups (i.e. cooperative societies or farm organizations) that are helping them in stabilizing prices and save them from middlemen who very often take advantages of a bumper harvest and disorganization of the farmers to exploit them.

Most of the farmers' organizations are in the middle land and lowland zones particularly for tea, coffee and banana crops. The first farmers' organization is the Umoja waWakulimawaMatundanaMbogambogawa Wilaya yaRungwe(UWAMARU) (in English, Rungwe District Vegetable and Fruit Growers Organization). This organization started in 2015 with its main focus being on promoting production and marketing of avocado as a cash crop. Later in 2016, they incorporated vegetable growers. During the survey the organisation had 315 registered members in the district and more members were invited to join. The organization has been able to secure a stable market for their products. Currently, they are selling avocados to South Africa and Kenya. The UWAMARU also facilitates access to fertilizers and improved avocado seedlings by members of the organization. Once each year, UWAMARU organizes farmers' visits to other areas where avocados and vegetables are grown especially in Njombe Region with the aim of exchanging knowledge, information and experiences. The challenges the organization is facing include inadequacy of extension officer services, inadequate supply of fertilizers and absence of credit facilities.

The second farmers' organisation is Rungwe Livestock Union (RLU), which was established in December 2016. The aim of this union is to have a collective market for bananas and animal products. During the interviews the organization reported to have 106 registered members. Like in the former organization the main challenge for this organization is lack of credit services. The third organization is Rungwe Organic Tea Cooperative (ROTCo) which started in 2016 as well. Currently, the organization has about 1,000 members. The aim of the organization is to encourage the growing of organic tea and to have a common stand on the price of the product. Like other farmers' organisations, they were found to be constrained by inadequate capital for accessing the required agricultural support services including fertilizers, markets and extension services.

The third farmers' organization is Rungwe Smallholder Tea Growers Association (RSTGA) established in 1998. This organization has about 15,000 registered smallholder tea growers who are spread in 118 villages of the district. The organization aims at increasing green leaf production and boosting farmers' income. In doing so the organization provides access to agricultural inputs including personal protective equipment, fertilizers and plucking shears on credit bases. RSTGA also provides market to its members. It owns 30% shares in Wakulima Tea Company (WATCO) tea processing plant where farmers sell their

produce. Also, farmers have access to agricultural extension services from the Tea Research Institute of Tanzania (TRIT) which works in the 118 villages.

The RSTGA owns a SACCOS established in 2008, which allows members to access credit facilities at reasonable conditions. All other farmers growing different crops apart from tea and business men were allowed to join the SACCOS. For the smallholder farmers the highest credit amount they can be given is 3,000,000 million TZS that would be returned in 9 months at the interest of 15% while for the businessmen the highest amount they can take is 20 million TZS. The amount and the interest rates are decided upon by the Tea Board.

Despite such credit services that are provided, the SACCOS also faces shortage of financial and human. Due to financial difficulties the SACCOS has also to borrow money from other financial institutions. The key informants at the SACCOS informed that the concern regarding the inadequacy of financial capital has increased due to climate variability as improved seeds take shorter time to mature and hence farmers need credit to purchase the required inputs in order to increase production.

RSTGA also has a collectively owned tea project, community radio (Chai FM), input fund facility, trust certification premiums, community tourism programmes (Rungwe Tea and Tours Company) and a number of community capacity building projects such as building health facilities, water tanks and school classrooms in the district. With regard to community radio, tea growers receive extension services information broadcasted directly through their own radio. Smallholder tea farmers under RSTG seemed to be comfortable with the agricultural support services provided by their organization and the information which assists them to cope with the climate variability in the area. Notwithstanding the fact that this private organization has success stories in providing agricultural support servicesand weather-related information to smallholder tea farmers, still the production is below the potential production capacity. For example, an official of theRSTGA narrated the following:

> "Our farmers however, still produce 50% of their production capacity. Farmers' production below their potential capacity is not only for tea but also for other crops in the district as well. Low productivity is mostly due to cost of agricultural inputs especially fertilizers which are rising at an alarming rate, inadequate extension services, inadequate transport facilities and the use of old-fashioned plucking shears which demand farmers to incur more cost of labour. We are yet to have more investment or interventions to help the effort of the farmers. Our district is a potential breadbasket if production costs are lower unlike now where the farmers are overweighed. I would appeal the government to help organisations such as this that is working with the farmers by reducing the prices of fertilizers and improving infrastructure" (RSTGA official, September 2017).

The fourth noted farmers' organization is RUCU (Rungwe Cooperative Union), which is a public entity and a dominant buyer of coffee in the district. Before economic liberalization of early 1990s and the current stiff competition in the free market economy, coffee producers sold their produce entirely through RUCU. The union also provided fertilizers and pesticides to coffee farmers. After the economic liberalization and especially between 2004 to 2015, RUCU's capacity to compete with private companies declined and most coffee producers sold their produce to private companies (Table 4) especially during the 2015/2016 and 2016/2017. As

Table 4: Trends in coffee marketing for 2015/16, 2016/17, 2017/18 and 2018/19 agricultural seasons

S/N	Name of the buyer	Tonnes bought in 2015/16	Tonnes bought in 2016/17	Tonnes bought in 2017/18	Tonnes bought in 2018/19
1	Tembo Coffee Company	43,862	245,085	257,160	-
2	TutafikaIkuti AMCOS	10,200	-		25,710.50
3	Mwaja Enterprise	13,000	35,500	27,000	-
4	Simike AMCOS	7,892	8,800	11,300	9,591.60
5	Nkunga AMCOS	8,566	12,200	25,000	28,227.00
6	Ukukwe AMCOS	7,450	5,050	7,671	8,624.00
7	Ukombozi AMCOS	7,636	11,240		19,676.20
8	Lima kwanza limited	19,048	23,400	20,700	-
9	RUCU	25,799	-		132,843.50
10	The Greenhouse Investment Company	8,000	42,000	-	-
11	Lufingo AMCOS	20,00	18,800	24,500	15,015.20
12	Ikuti AMCOS	18,000	6,470	9,000	40,361.80
13	Mpuguso AMCOS	8,000	14,509	29,500	
14	LugombeKibwe popular growers	2,022	3,000		
15	Meteorite Coffee Co.	21,350	77,200	3,000	
16	Coffee management service company	37,279	80,737	82,965	
17	Unyiha Associates	24,500	-		
18	Rumbiaa AMCOS	9,000	12,000	12,000	42,456.50
19	Makandana AMCOS		8,400	8,000	
20	Kyobo AMCOS		3,800	14,000	62,539.80
21	OLAM			39,150	
22	Kalonge Farm Ltd			45,000	
23	GDM Co. Ltd			3,000	
24	Malindo AMCOS			2,500	
25	Bujela AMCOS			12,500	38,094.90
26	Iponjola AMCOS			9,900	15,325.40
27	Kisondela AMCOS			13,000	53,645.10

28	Ruso AMCOS				6,637.20
29	Mpumisa AMCOS				75,818.50
30	Lupepo AMCOS				26,355.10
31	Isempu AMCOS				20,211.00
32	Ibungila AMCOS				11,073.00
33	Ndembela AMCOS				15,462.70
34	Nguiluka AMCOS				16,752.90
	Total	**291,604**	**608,191**	**656, 146**	**664,422.30**

Source: DALDO (2017; 2019)

indicated in Table 4, during these two agricultural years, RUCU was able to buy only 25,799 tonnes in 2015/2016 and none in 2016/2017 agricultural year while one of the private companies' (Tembo Coffee Company) bought about 43,862 tonnes in 2015/2016 and 245,085 in 2016/2017. Coffee production in the district has been declining due to unfavourable market prices provided by private companies. Also, some of the farmers uprooted their coffee trees and switched to either maize or Irish potatoes, which are lucrative cash crops (DALDO's Office, 2017). The production of coffee at district level, for example, fell to 191.3 tons in 2009/10 and 176.8 in 2013/14. In 2016/2017, however, the production rose to 608.2 tons. The increase was due to two factors; first, improved market prices that ranged from 3,500 - 4,300 TZS per kilogram for private companies and 4,600-6,000 TZS per kilogram for farmers' organisations (AMCOS). Although the price seems to be higher in AMCOS compared to private companies, majority of the farmers sold their coffee to private companies as the payments are done immediately after the selling. The other reason for the increased production was as a result of the Tanzania Coffee Research Institute (TACRI)'s effort to provide coffee varieties that are resistant to diseases such as coffee berry disease and coffee leaf rust.

The coffee market chain has however changed. As indicated in Table 4, by 2016/2107 only 11 AMCOS existed and did not buy much coffee as compared to private companies. In the 2017/2018 and 2018/2019 seasons, about 11 more AMCOS have been formed and bought more coffee compared to private companies. The change in the coffee marketing system has been attributed by the current change in the fifth government that insists on the use of AMCOS for selling all cash crops as a way of improving farmers' profit. Since 2018, the government has prohibited private companies to directly buy coffee from the farmers, but either through the AMCOS or coffee auction markets that are conducted at zonal levels. The shift of marketing coffee from private companies to AMCOS has also been possible due to the fact that through the AMCOS farmers are provided with agricultural inputs on credit.

Generally, although the private companies are still serving the farmers, over the recent years' farmers' cooperatives have been revived and empowered to provide agricultural support services to the farmers especially the marketing and input services. This is an indication that the private public partnership, if well

established and guided by policy frameworks, can work for the benefit of the farmers. This is what is insisted by the agricultural innovation framework which encourages the engagement of a wide range of actors and organizations from public, private and civil society that need to be involved in bringing about agricultural development, economic growth, and poverty reduction. The current policy environment in the coffee marketing has affected the performance and behaviour of the private sector who used to offer lower prices that discouraged farmers. The revival of farmers' cooperatives is in-line with the National Cooperative Development Policy (2002) which aims at providing implements, technologies and information to members of the union. If this is well implemented, farmers will have adequate knowledge and input supply to support them adapt to changing climate.

During interviews some key informants pointed out that most of the private sector organizations have the capacity (human resources, physical and financial) to render reliable services. For example, one key informant, when requested to comment on the status of provision of agricultural support services by the public and private sectors, narrated as follows:

> "Countrywide, the private sector has managed to reach out many farmers, the only problem is with unfaithful agro-dealers who sometimes sell fake agro-chemicals, the public sector (government) is better off in providing subsidized inputs although it comes a bit too late" (Source: Key informant, May 2017).

This assertion supports what is in Table 4 on the capacity the private sector in providing a wide range of agricultural support services to the farmers in the study area. This indicates that the private sector is taking an increasingly strong and proactive role in reaching out to the farmers in the villages. The private sector is and has been investing much towards helping smallholder farmers not only improve their productivity and market their produce but also be able to adapt to climate variability impacts. This is in line with the current National Agricultural Policy (2013) and the Public Private Partnership Policy (2009).

In order to tape the full potential of the private sector towards provision of agricultural support services and for the purpose of improving their services in the agricultural sector, the public-private partnership should be strengthened and the government should provide enabling environment as envisaged by the Public Private Partnership Policy (2009). The government should, for example, reduce the cost of doing business, further improve infrastructure such as roads, regulate markets so as not to marginalize consumers and review policies and strategies so as to provide subsidies for all crops. If implemented effectively they will ensure cost-efficiency not only to private sector but also to the farmers.

For a long time, in the fertilizer industry the country has been operating without a responsible authority to regulate the prices. The current establishment of the Fertilizer Regulatory Authority (TFRA), which was established in 2016 with the

aim of enforcing policies related to fertilizer manufacturing, importation and use of fertilizers, is commendable.

Extension support services

Another agricultural service that is provided to farmers in the study area is extension services. (Table 2 and 3). Inadequate extension services featured strong during focus group discussions and during key informant interviews. The majority of the farmers in FGDs lamented of not having extension services from extension officers especially over the last 10 years. Interviewed extension officers agreed to the inadequacy of their services to the farmers. They indicated that apart from being few they also face transport problems that make them unable to reach a wide area. They acknowledged the fact that they have not been able to reach many crop farmers in their villages. Specifically, one of the Ward extension officers narrated this:

> Currently the number of extension officers employed is promising but it is not tallying with the number of farmers to be served in the villages. Some villages have a big number of farmers. One extension officer in the village serves both crop cultivators and livestock keepers. Furthermore, there is poor working environment including inadequate means of transport to reach the farmers. In this ward none of the extension service officers has a motorcycle, we travel on foot. We also have limited financial support for carrying out demonstrations and field experiments on new technologies and innovations'' (Source: ward extension officer interview 2017)

The assertion is in line with the National Agricultural Policy (URT, 2013a) which aims at improving extension service provision although the intended results are yet to be satisfactory. The same assertion is similar to what Daniel (2013) revealed indicating that the implementation of Agricultural Policy of 2013 has resulted in an increase in the number of extension workers in different parts of the country but that there are still many challenges to address before the new policy could yield intended results. Some of the challenges documented by Daniel include low budget allocated for provision of extension services, late disbursement of funds irrespective of the growing season, poor working environment including unreliable means of transport to reach the farmers, limited financial support to carrying out demonstrations and field experiments on new technologies, sub-optimal housing and inadequate working facilities.

A study by Sokoni (2014) points out that due to inadequate extension services farmers training programmes through on-farm demonstrations are no longer practiced in the Rungwe district. Sokoni (2014) further argues that government resource allocation for agricultural services has not kept pace with farmers' extension needs and demand. The inadequacy of extension services compounded with limited financial services limit farmers' adaptive capacity to impacts of climate variability in the study area. According to Daniel (2013) inadequacy of extension services propagate farmers not only to lack appropriate technical knowledge, but also reduce their access to new technology and innovations on the

use of best agronomic practices such as fertilizer usage, timely planting, pests and disease control, timely weeding, and nutrient deficiency symptoms identification and correction.

It should be remembered that provision of extension services is a primary responsibility of the government (URT, 2013a). Since 2000 the government's emphasis has been on the need to deploy agricultural extension officers to work at village level with the target of employing about 15,000 extension officers by the end of 2015 (URT, 2009) and with the aim of having at least one extension service officer in each village. However, during the survey for this study in 2017 some of the surveyed villages had no extension officer (Table 5). This indicates that there is still inadequacy of extension service workers. From Table 5, it is only in the highland zone where the requirement in terms of number of extension officers per village is met, while in the middle land and lowland zones there is inadequacy of such civil servants.

Table 5: Number of extension officers in the surveyed wards

S/N	Ward	Zone	No. of villages	No of extension officers
1	Ndanto	Highland	4	4
2	Kyimo	Middleland	5	4
3	Ilima	Lowland	6	4

Discussants also informed that due to inadequacy of public trained extension service workers individual agro-dealers (private) do provide extension services to most of the farmers in their villages although their expertise is questionable. This kind of assertion has been documented by Sokoni (2014) who pointed out that in the absence of public extension services farmers rely on uptake of technology through private extension systems that are not always adequately trained and are not well linked to centres of scientific research, which means extension messages from private providers often lack scientific bases. Despite this challenge, Msuya et al (2017) show that private extension services form NGOs and CBOs as well as from private agribusiness companies are perceived to be more effective than those form the public sector. In the same way, Rutatora and Mattee (2001) indicate that the private extension services tend to intensify activities and resources to the extent that shows visible and tangible results compared to the public sector.

Spielman and Birner (2008) in their agricultural innovation framework emphasise the role of knowledge and education, business and enterprise, and the bridging institutions especially extension services for making agriculture more dynamic, competitive and responsive to impacts of climate variability. On the one hand efficient use of agricultural inputs and availability of extension plays a great role in improving adaptation to climate variability and change (Below, 2012). On the other hand, agricultural support services including extension services are essential for enhancing farmers' productivity (Sokoni, 2014). This therefore indicates the need for extension services either from the public or private providers.

Processing, packaging and research support services

The processing, packaging and research agricultural support services are rarely accessed by smallholder crop farmers in the surveyed community (Table 2 and 3). As a result, smallholder farmers in the study area have no storage, processing and packaging facilities especially for perishable products such as vegetables and fruits leading to considerable postharvest losses and inability to secure good market prices. During a speech in 2017 the Deputy Minister for Agriculture indicated that about 40% of fruits and vegetables grown in the country had been rotting away due to lack of agro-processing facilities and the same goes for cereals and legumes which also account for 40-60% of post-harvest losses (Philemon, 2017). Due to lack of storage and processing services farmers are hit not only by post-harvest losses but also most of the produce is sold in raw form without value addition. Adoption of good agricultural practices and technology combined with improved access to packaging, storage and marketing on one hand will improve incomes through better access to markets. On the other hand, due to climate variability there is need for supportive policies to foster value addition in the production processes.

Comparison of accessibility, reliability and affordability of agricultural support services between public and private service providers

Comparatively, the private sector was more positively ranked in all four components (Table 6) that were compared. Farmers indicated that although services by the private providers are costly, they are accessible and reliable compared to public providers.

Table 6: Accessibility, reliability and affordability of agricultural supportservicescontrasted in percentages

Variables contrasted	Public		Private	
	Yes	No	Yes	No
Accessibility	14.1	85.9	86.2	13.8
Reliability	3.9	96.1	82.6	17.4
Affordability	5.5	94.5	19.6	80.4
Level of satisfaction of the agricultural support servicesprovided	3.9	96.1	29.6	70.4

Accessibility

As already noted, the government is subsidizing fertilizers and seeds particularly for maize. These subsidized inputs, which are supplied by the government through the agricultural voucher system, are generally inadequate. The national Agriculture Input Voucher Scheme (NAVS) programme was launched in Tanzania in response to the high food and fertiliser prices prevailing in 2007-2008. The government therefore instructed that the best way to improve national food security in the face of high international food prices was to promote the use of

agricultural inputs to raise productivity (DANIDA, 2011). Despite the good will of the system, inadequacy of the subsides has been the major challenge.

Participants in FGDs indicated that the subsidized inputs are not adequate as they are available for only a few people in their villages and that the number of beneficiaries keep on dwindling year after year. The inadequacy of the subsidized government inputs was confirmed by household data, which showed that only 17.4% had received subsidized inputs over the last 5 years while the majority (82.6%) have never received subsidized inputs. The district agricultural officers, ward and village extension officers indicated that in 2014/15 agricultural year the vouchers received per village were 70; in 2015/16 they received 50 vouchers per village and in 2016/17 only 25 vouchers were received in most villages in the district.The number of vouchers may increase or decrease depending on government budget. The district would distribute the vouchers in each village depending on the number of vouchers received. Table 7 shows the number of vouchers received against the number of households.

Table 7: Number of households and vouchers received in each village in 2016/17 agricultural year

S/N	Village	Number of households	Number of vouchers received per village	% of beneficiaries
1	Ndaga	836	50	6
2	Goye	347	50	14
3	Kyimo	953	25	3
4	Syukula	1,056	25	2
5	Ilima	191	25	13
6	Katundulu	387	25	6
	Total	3,770	200	7.3

Source: DALDO's Office (2017).

As it is indicated in Table 7 the two villages, Ndaga and Goye in the highland zone got double vouchers compared to the other villages in the district. The reason is that the subsidized inputs are meant for maize production only, and these villages are among the large maize producers in the district. Although the government is subsidizing maize crops only, crops such as Irish potatoes, bananas, coffee and tea are intensively grown and commercialized in the highland and middle land zones (Tilumanywa, 2013; Bakari, 2015). Of recent, cocoa is also emerging as an important cash crop in the lower zone which is also not subsidized despite the fact that it is very important for rural economy diversification and livelihood. The focus on only one crop reduces the capacity of the smallholder farmers to diversify not only their income but also adapt to adverse impacts of climate variability. The inadequacy of the subsidized inputs is also related to poor distribution of the vouchers irrespective of the number of households in a village. Table 7 shows that the number of input vouchers is not consistent with the number of households in a particular village.

Affordability and fixed packages

Agricultural inputs obtained through private vendors are costly as indicated by 80.4% of the surveyed farmers, yet they may have no alternative apart from buying them. Moreover, smallholder crop farmers informed that although public inputs are subsidized yet they are costly in the same way as those from the private vendors. Discussants and district officials reported that in 2016/17 agricultural season, the beneficiaries were supposed to top-up an amount of 116,000 TZS for the complete package as compared to 201/2016 agricultural season where the top-up was 75,000 TZS. This amount for the smallholder farmers seemed unmanageable. Table 8 shows the prices for the different packages and the amount that farmers needed to pay.

Table 8: Variations in subsidized and private inputs prices

S/N	Type of inputs	Weight per voucher	Farmers contribution (TZS)	Private price (TZS)
1	Planting fertilizer	DAP 50 kg	43,000	68,000-70,000
2	Growing fertilizer	CAN 50 kg	31,000	48,00-50,000
		UREA 50 kg	31,000	55,000-60,000
3	Maize seeds	Maize 10 kg	42,000	Price varies depending on weights of the packages (which ranges from 2 kgs)
	Total		**116,000**	

Source: DALDO's Office (2017)

As it can be seen from Table 8 there is a difference of TZS. 25,000 - 27,000 for the fertilizer used at planting and TZS. 17,000 - 19,000 for the boosting fertilizers between the public and private fertilizer prices. For smallholder farmers this is huge amount of money especially for those with large farms and those who cultivate different crops. But since the fertilizer from the public sources is inadequate majority end up to the private vendors. The third challenge associated with agricultural support services provided by the public sector is that the packages of subsidized inputs for maize are pre-packaged in terms of amount per hectare. This means that a farmer having more than one hectare of the same crop will have to make different arrangements for securing the needed additional amounts of fertilizers and seeds. Myeya and Kisanga (2018) noted also that high price of agricultural inputs in Kongwa and Bahi districts is one of the major challenges encountered by smallholder farmers in adapting to climate variability.

Affordability of agricultural support services was judged by farmers in terms of the packages and its components. In terms of packages, the subsidized support services comprise of 3 different fertilizers (DAP, CAN, UREA), which are both planting or boosting fertilizers (each 50 kg) and maize seeds (10 kg). All fortunate beneficiaries have to get the whole package of 1 bag of fertilizer used for planting,

1 fertilizer bag for boosting and 10 kg of maize seeds. There is no room for selecting a single entity under the package. While the package is so standardized and binding some farmers have very small land holdings of which they cannot buy a full 50kg bag of fertilizers. Therefore, most smallholder farmers resort to private agro-dealers who have smaller packages of fertilizers (e.g. 5 kgs and 25 kgs), which are affordable and convenient. Some smallholders even buy 1kg or 2kg of fertilizers, measurements that are available in private agro-dealers' outlets. Butsuch smaller re-packages are prone to compromise in the quality of inputs especially where there is inadequate guidance from qualified extension officers and/or a fertilizer regulatory body.

Reliability

Another problem associated with public services was related to reliability of inputs. Discussants and key informants indicated that the subsidized inputs are brought very late while the planting season is almost over in the study area. Unreliability of the inputs and particularly of the subsidized fertilizers has led to dissatisfaction with the public service as it was indicated by 96.1% of the respondents. One of the reasons for dissatisfaction was due to the government scheme for the provision of subsidized fertilizers and seeds through the agricultural vouchers system, which usually take too long to be delivered to the needy farmers. District agricultural officers and village extension service officers revealed, for example, that for the 2016/17 agricultural season the inputs were received in March 2017, while the planting season was in October 2016.

Challenges facing smallholders in accessing agricultural support services in the study area

Smallholder crop farmers from the study area indicated that availability of agricultural support servicesis critical not only for crop production but also for adaptation to climate variability. Despite the considerable enthusiasm about the availability and reliability of agricultural support servicesespecially from private agro-dealers, more than ninety percent of farmers revealed six challenges considered to constrain them from accessing the required agricultural support services in all the three zones. These challenges included low income to purchase agricultural inputs (87.6%), inadequate extension services 50.1%, poor roads (18.3%), unreliable markets (13.3%) and inadequate credit services (59.7%). These challenges are responsible for smallholder crop farmers producing below their potential capacity because their economies are weak while prices of agricultural inputs are rising and the market conditions are not favourable. Proportionally, farmers' low income and limited access to financial services by smallholders are among the largest barriers for needy farmers to get funds for preparing farms and agro-inputs.

During key informant interviews and focus group discussions it was revealed that each ward has a microfinance facility or a SACCOS in the study area. However, there are stiff conditions for the smallholder farmers to access financial credits.

Financial institutions are not always ready to provide such funds to the needy smallholder crop farmers. Among the reasons for the limited access to quality and appropriate financial services is lack of valuable bond and that agriculture is unpredictable hence smallholder farmers lack collaterals to access loans from financing institutions. Due to this most of the ward banks/SACCOS end up serving the businessmen at most rather than smallholder farmers. However, the current effort by the government to formalize land titles so that farmers can have collateral/bond is recommended.

Farmers were asked if they were aware of the farmers' bank, the Tanzania Agricultural Development Bank (TADB) that was launched in August 2015 and established as an apex national-level bank with the key role of being a catalyst for delivery of short, medium and long-term credit facilities for the development of agriculture in Tanzania. In the six surveyed villages all the participants in the FGDs claimed to have not been aware of this bank except for a few key informants who also complained that there is no adequate information about the bank in their locality. During focus group discussions in Goye and Ndaga villages, discussants informed that roads to and from the farms are too bad. Poor roads have increased transport costs. This has been due to the fact that large vehicles cannot reach the farms hence they have to use motorcycles from the farms to the main roads and then use vehicles from the main roads to the markets.

According to Philemon (2017), poor access to finance and inadequate infrastructure are seen as the largest barriers to doing business in Tanzania. Below (2012) indicates that investing in rural infrastructure could be one of the factors that would play a great role in improving adaptation to climate variability and change as improved infrastructure will reduce the cost for transporting not only produce but also inputs and the saved money can assist farmers to purchase inputs and improved seed that are resistant to crop pests and diseases.

Conclusion

Smallholder crop farmers in Rungwe district are serviced by both public and private sectors in terms of agricultural support services. The findings from this research indicated that the need for fertilizers and pesticides is high especially in the highland and middle land zones. Other equally demanded support services are marketing, credit and extension support services. The critical needs for these agricultural support services are a result of commercialization and intensive cultivation of crops such as Irish potatoes and bananas, change in crop varieties, increasing climate variability and soil characteristics. Comparatively agricultural support services provided by the private sector though costly are by far more reliable, indicating that if enabling environment for the private sector in terms of assured economic stability, political stability and efficient markets are provided, the role of the private sector towards provision of agricultural support services will be considerably enhanced.

The current system of agricultural support services provision in the district limits the potential ability of the farmers to adapt to the impacts of climate variability. This is because with commercialization of Irish potatoes and banana more extension service is required in the area. However, inadequate number of extension services hinders farmers to quickly use the required knowledge and technology at the production level. Again, due to lack of institutional human resource and financial capacity of the public sector, the private sector is taking advantage of lack of enforcement of the available policies especially with the fertilizer services. Furthermore, the current system of the public support services subsidizing only one crop limits farmers' capacity to diversify while diversification is one of the important strategy toward addressing climate variability impacts. Future resilience of smallholder farmers in the district will depend on the extent to which the different actors (public and private institutions) in the agricultural support services are linked, re-organized and re-think about their approaches in the context of the changing climate.

Farmers in Rungwe district are facing challenges in accessing agricultural support services due to inadequate financial credits, little incomes that do not suffice purchase of agricultural inputs, poor infrastructure, inadequate extension services, lack of unified marketing systems and high prices of agricultural inputs especially fertilizers. Furthermore, smallholder farmers are not organized into established farmer groups except for a few especially those growing tea and coffee and of recent avocado. Thus,there is a need to strengthen the capacity of the farmers by encouraging and supporting the development of farmers' organizations at village levels where all crop growers can be registered and at a later stage a national farmers' registry can be established.

Household financial capacity is a main challenge to accessing agricultural support services as well as adapting to climate variability. Farmers could be helped to acquire land titles, which can be used as bond to access financial services when need arises. Such services should also be supported by elaborate and innovative research for development by supporting research on how to improve farm productivity and profitability. Enhanced farm productivity should also consider focus on crop diversification as a way that smallholder farmers could use to adapt to climate variability impacts and ensure livelihood security.

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