Agricultural Policy Research in Africa

COMMERCIALISATION PATHWAYS AND CLIMATE CHANGE: THE CASE OF SMALLHOLDER FARMERS IN SEMI-ARID TANZANIA

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ACRONYMS

APRA	Agricultural Policy Research in Africa
CCI	Crop Commercialisation Index
DAICO	District Agriculture, Irrigation and Cooperative Officer
NGO	non-governmental organisation
PRA	Participatory Rural Appraisal
PVA	Participatory Vulnerability Analysis
SLF	Sustainable Livelihood Framework

EXECUTIVE SUMMARY

The semi-arid drylands of central Tanzania have been characterised by low and erratic rainfall coupled with high evapotranspiration. Up until now, farmers of these local dryland farming systems have been able to cope with these climate conditions. However, climate change has led to new weather patterns that overwhelm traditional dryland farming practices and re-shape farmers' commercialisation pathways. This paper explored the pathways in which smallholder farmers in Singida region in Tanzania engage with markets and commercialise in the face of climate change. The paper is based on the study that was carried out during 2020, covering three case study villages in Singida region of semi-arid central Tanzania. The paper also examined how farm-level decisions on commercial crops and the commercialisation pathways they are part of, affect current and future resilience to climate change. Climate resilient commercialisation of smallholder dryland agriculture remains the centrepiece of inclusive sustainable development.

This study was conducted using the qualitative Participatory Vulnerability Analysis (PVA) toolkit (Ulrichs et al., 2015). The qualitative tools used included village mapping, transect walks, climate trends and timelines, a seasonality calendar, individual life course histories, farm-sector structural changes and institutional mapping. These qualitative results were complemented by quantitative results from the APRA household survey that was conducted in the same region in 2018 (APRA, 2019). Farmer's commercialisation of the crop sub-sector was measured as the ratio of sales and the value of production of all crops. The analysis also generated an index measuring vulnerability of agricultural enterprises varying in the level of riskiness and returns across different sources of production risks – seasonal droughts, dry spells, floods, and pests and diseases.

The results of this study showed that dryland agrarian communities in Singida region face changing climate and weather patterns with mixed impacts on different crops and livestock species over time and space. A rise in extreme weather conditions, particularly seasonal droughts, prolonged dry spells, and floods, are increasingly overwhelming farmers' adaptive capacity. At the same time, changing weather patterns, such as increases in rainfall, have created new possibilities for growing high-value, water-demanding crops such as paddy and horticulture. In addition, the results showed that Commercialisation opportunities may not benefit everyone equally, however. In some cases, they may expedite existing resource-access disparity into income inequality. For example, the rising demand for land suited to growing onions was associated with higher rents which are unaffordable for resource-poor farmers.

It also was observed that devastating surges in pests and diseases, that seemed to be linked with climatic and environmental changes, are the most stringent biological stressors affecting production and commercialisation potential.

In relation to farmers' choices of agricultural enterprises, resilience, food security and income-generating potential of respective enterprises were important factors. As the majority of farmers depend on food purchases to smoothen consumption, particularly during bad years, families deprived of livestock assets and those less engaged in producing commercial crops were increasingly vulnerable to food insecurity.

In addition, while COVID-19 did not have serious health impacts in rural areas, some farmers were either unable to sell products, or had to sell at throwaway prices. This was particularly the case for commodities like sesame and cattle, associated with global exports and distant urban markets, respectively.

In Tanzania, rural microfinance services for smallholder farmers including credit and insurance were found to be underdeveloped – hence limiting the capacity of farmers to both finance and risk-proof their farm investments. In relation to social groups particularly vulnerable to climate change, such as women and youth, the ability to commercialise was closely related to the equitable access, ownership and control over productive resources.

A final finding was that from a political economy perspective, a historically perceived "marginality" of semi-arid drylands has left such areas disproportionately deprived of public investments in appropriate productive and market infrastructure such as community water reservoirs, dryland irrigation facilities, better rural roads and market centers.

Based on these major findings, the study recommends the following action pathways to support inclusive and profitable agricultural commercialisation while building adaptive capacities and resilience of vulnerable dryland farming communities:

1. Promote delivery of a broader range of dryland crop varieties adapted to shifting weather patterns, including changes in seasons.

2. Advance climate and weather science and information systems to inform local farming decisions.

3. Improve rural micro-finance services, including tailored credit and insurance products, for smallholder farmers to support and risk-proof farm investments.

4. Strengthen dryland-focused research and development, extension services and crop protection to upgrade productivity and build resilience in dryland agriculture against climatic and non-climatic shocks such as pandemics.

5. Counteract the historical marginalisation of the semi-arid drylands by expediting public investments in productive and market infrastructure to unlock commercialisation potential and build resilience in the dryland farm-sector.

1 INTRODUCTION

Smallholder agriculture is the engine of economic growth and inclusive development in Africa. Commercialisation of smallholder agriculture is central to the development and modernisation of African agriculture. Agricultural commercialisation entails both market orientation and market participation – the former underscores production decisions in response to market signal and the latter involves simply offering produce for sale and use of purchased inputs (Kirsten et al., 2013; Boka, 2017). Other authors have expounded agricultural commercialisation to envisage increased productivity per unit of land and labour to produce greater surpluses for the market, hence contributing to higher incomes and standard of living (Jayne et al., 2011; Kirsten et al., 2013; Wineman et al., 2020). In this paper, agricultural commercialisation is expressed as the ratio of crop sales and value of production that farmers realise through market participation and in some cases by responding to market signals.

Semi-arid drylands have high natural climate variability and constitute over half of Tanzania's landmass (Hatibu et al., 1999; Yanda et al., 2015). While floods and droughts are naturally occurring hazards in Tanzanian drylands (CIMA and UNISDR, 2018), changes in their magnitude and frequency associated with climate change will pose a major bottleneck to profitable agricultural commercialisation.

Smallholder commercialisation decisions are made in the face of uninsured risk and productive resource constraints. Climate is a major source of production risk shaping farmers' production decision space and in turn, commercialisation pathways. In this paper, a commercialisation pathway is defined as a farmer's decision-making process and the outcomes of engaging with markets in pursuit of livelihoods given agro-climatic, sociocultural and political economy conditions. Underdeveloped risk management options, such as crop insurance, are among the drivers of farm-level vulnerability and undermine investments in smallholder agriculture. In Tanzania, crop insurance is still in its infancy and piloting stage (URT, 2021), with limited prospects of scaling-up and uptake by smallholder farmers (Osumba et al., 2020).

African agriculture is predominantly rainfed, making it susceptible to the impacts of climate change and variability. In arid and semi-arid areas, climate change is leading to an increase in harsh weather conditions and extreme events (Mutabazi et al., 2015; Tumbo et al., 2020). Growing crops and rearing livestock in the drylands are juxtaposed in the fragile and precarious farming environment. In African drylands, particularly in sub-Saharan Africa, a majority of farming households are poor and food insecure. It is clear that fighting poverty in Africa is going to be more difficult with climate change (Soergel et al., 2021), as its impacts threaten to exacerbate negative impacts and undo progress made towards poverty reduction (Alemaw, 2020).

Climate change is an added disruptor to a constellation of shocks facing smallholder African agriculture and is already threatening livelihoods and food security in sub-Saharan Africa including Tanzania (Tumbo et al., 2012; FAO, 2014; Mutabazi, Amjath-Babu and Sieber, 2015; FAO, 2017; Nyamweza, 2019; Tumbo et al., 2020). Climate modelling under both high and low emission scenarios (RCP 8.5 and 4.5, respectively) project about a degree rise in temperature and high uncertainty in rainfall patterns. For many parts of tropical Africa including Tanzania, rainfall projections are uncertain (Deryng, 2015; Luhunga et al., 2018; Tumbo et al., 2020). Farmers in the semi-arid areas of Tanzania are observing a warmer and drier climate, seasonal shifts, less reliable and variable rainfall patterns, and more intense rainfall events (Matata, Bushesha, and Msinda, 2019; Silungwe et al., 2019; Borhara et al., 2020). Due to the uncertainty in projected rainfall, developing adaptation options tested against a range of future conditions and enhancing decision-making under uncertainty is particularly important (FCFA, 2017).

Over half of Tanzania is accounted for by semi-arid and sub-humid drylands that are experiencing low and erratic rainfall, high potential evapotranspiration, and extreme weather events (Hatibu et al., 2006; Yanda et al., 2015). Based on a business-as-usual scenario (RCP 8.5), Deryng (2015) projected an expansion of Tanzanian drylands by 2030 with up to 5 per cent of the current sub-humid savannah becoming semi-arid. Relative to high potential areas, semi-arid drylands lag behind in terms of public investments for rural development (Jobbins, Conway and Fankhauser, 2016; Matata, Bushesha, and Msinda 2019). In relative terms, semi-arid rural areas have been left with less effective social and economic services, market infrastructure, fragile food systems and greater levels of poverty (Hatibu et al., 2006; Mutabazi et al., 2015; IFAD, 2016). Apart from a dire need to strengthen dryland adaptation, African drylands are also key to mitigation. Africa contains an estimated 356Gt of the global carbon stock, 211Gt (59 per cent) of which are in the drylands (Bernoux and Chevallier, 2014).

Despite agro-climatic challenges in the semi-arid farming system (Magero, 2019), the dryland farm-sector also offers eminent opportunities for profitable production and commercialisation. Dryland agriculture has sustained a range of high-value commercial crops (Hatibu et al., 2006), such as tobacco, cotton, cashew nuts, oil seeds, grain legumes and horticulture. Parts of the semi-arid regions of central Tanzania are expected to be increasingly wetter with climate change (Deryng, 2015; Tumbo et al., 2020). Taken together, there are opportunities for enhanced productivity in drylands through newly adapted crops and appropriate management of agricultural water.

Generally, traditional strategies and practices to cope with climate variability in the dryland farming system are increasingly overawed by climate change which manifests as a growing incidence of weather extremes, and there are as yet a lack of strategies to help farmers respond better. For example, the climate-smart agricultural technologies and practices advocated in the Tanzanian Agriculture Climate Resilience Plan (ACRP) for 2014-2019 (URT, 2014) were not scaled-up due to budgetary constraints. Furthermore, market-based risk management options such as crop insurance products are still in their infancy and have yet to show evidence of their potential for scalable uptake in Africa (Njue, Kirimi, and Methenge, 2018; Bulte et al., 2020). However, there are prospects for weather-index based crop insurance, particularly in the semi-arid central Tanzania, where weather-related risk accounts for over half of the yield loss of cereals such as maize (Gornott et al., 2018).

Agricultural commercialisation is critical for the transformation of African agriculture needed for propelling inclusive growth and rural poverty reduction (Bouis and Haddad, 1990; Kirsten et al., 2013; Glover and Jones, 2019). In Tanzania, commercialisation of dryland agriculture has the potential to utilise vast arable land and supports the livelihoods of vulnerable populations.

Climate change and commercialisation are interrelated in different ways. On the one hand, climatic shocks and stressors may affect the supply of produce farmers offer for sale, and hence lead to loss of income (Orr et al., 2021). On the other hand, successful commercialisation may also foster resilience to climate change (Kuhl, 2018; Papaioannou and de Haas, 2017; Biagini and Miller, 2013) by safeguarding value chains from contraction and failure (Chambwera and Macgregor, 2009; Conway, Nicholls, and Brown, 2019). Dryland farmers choose among crops while considering, among other factors, how the chosen crop or animal species would fare under risks and uncertainties associated with climatic and environmental changes. Effective adaptation to climate change risks requires a proper choice of crop varieties and animal breeds (Westengen et al., 2019; Singh, 2018). Smallholder farmers' choices of agri-enterprises to commercialise in under risk and uncertainty are multi-dimensional and complex (Backus, Eidman, and Dijkhuizen, 1997). Farmers' enterprise choice decisions involve experiential judgement in the risk-return space in the context of local conditions such as resource endowments, seasonality, technology and market opportunities.

This paper was motivated by the lack of studies investigating the commercialisation of African agriculture in the face of climate change. Focusing on Tanzania, the study was guided by the following set of questions:

- How do farm-level decisions on commercial crops, and the commercialisation pathways they are part of, affect current and future resilience to climate change?
- What is the role and importance of climate change among the local and external factors driving farm level decisions?
- What are the key uncertainties facing farmers, and how do climate shocks and stressors figure among them?
- What are the farm-level strategies for tackling climate-related uncertainties?
- What are the barriers and opportunities for changing crops in response to changing climate signals? Are there particular lock-ins that would make changes difficult?

The research questions were addressed mainly through a qualitative study that was complemented by a 2018 APRA quantitative survey focusing on the commercialisation of sunflowers in Singida region (APRA, 2019; Isinika and Jeckoniah, 2021). The qualitative study was adapted from the methods articulated in the Participatory Vulnerability Analysis toolkit developed by Ulrichs et al. (2015).

The remainder of this paper is structured as follows: Section 2 presents a conceptual framework of the study, while Section 3 addresses the approach and methodology. The analytical results and discussion are presented in Section 4 and address broader aspects of livelihoods, commercialisation and climate change in Singida region. The specific topics addressed in Section 4 include: 1) agricultural commercialisation at the district level; 2) local livelihoods, climate change and commercialisation; 3) farm-sector vulnerability and structural changes; 4) the crop marketing system and commercialisation pathways; and 5) institutional roles and political economy. Finally, Section 5 presents conclusions and implications for policy.

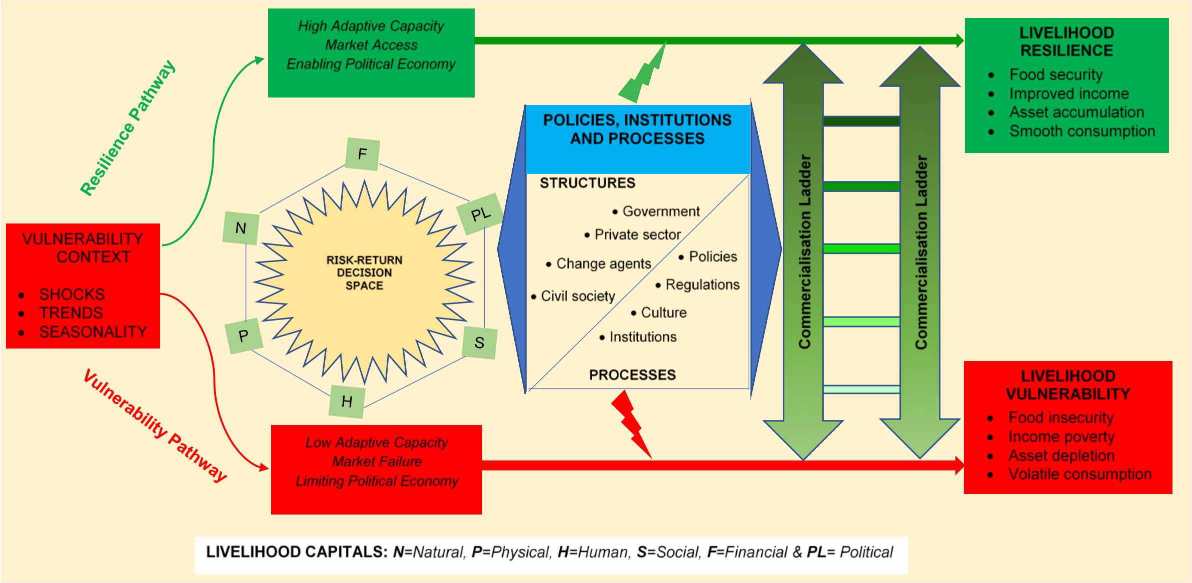
2 THEORY AND METHODS

2.1. Conceptual framework of the study

The study was broadly scoped within the Sustainable Livelihood Framework (SLF) pioneered by the UK Department for International Development (DFID). The basic tenets underlying the SLF are adapted to foster the conceptual scope of the paper (Figure 2.1). The SLF underpins how capital assets and entitlement are transformed into livelihood outcomes in the face of trends, shocks and seasonality given the political economy context (Baumann and Sinha, 2001; Suarez et al., 2021). The policies, institutions and processes create an ecosystem that moderate the performance of the society, government and other development players. Farmers' endeavours to commercialise and participate in agricultural exchange markets is part of the broader livelihood strategies (Manda et al., 2021). Farmers' commercialisation decisions under risks and uncertainties are made through trade-offs within the risk-return decision space. Commercialising farmers draw from the capital assets to adaptively undertake enterprises with varying riskiness and returns to end up at a particular height on a commercialisation ladder. The commercialisation pathway towards intended livelihood outcomes is path-dependent along either resilience and vulnerability paths. Contrary to farmers in the vulnerability path, farmers traversing the resilience path have better access to capital assets, risk-taking behaviour in enterprise choices, high adaptive capacity and market orientation that predestine them to higher steps on the commercialisation ladder.

The political economy – whether favourable to livelihood strategies including commercialisation or not – forges the state of political capital. In contrast with the vulnerability pathway, the livelihood outcomes of the resilience pathway, which envisages stepping up the commercialisation ladder, include food security, improved income, accumulation of assets and consumption smoothing. Furthermore, market and commercialisation actions can lead to livelihood resilience outcomes through increased production, increased income, livelihood diversification and risk reduction (Kuhl, 2018; Orr et al., 2021). However, with market failure, commercialisation may result in negative spirals that set unprecedented path towards vulnerability outcomes. Effective adaptation can lead to pathways toward resilience outcomes (FAO, 2014; Papaioannou and de Haas, 2017; Kuhl, 2018).

Figure 2.1: Conceptual scope of the paper



Source: Authors' construction of adapted SLF

2.2. Study area

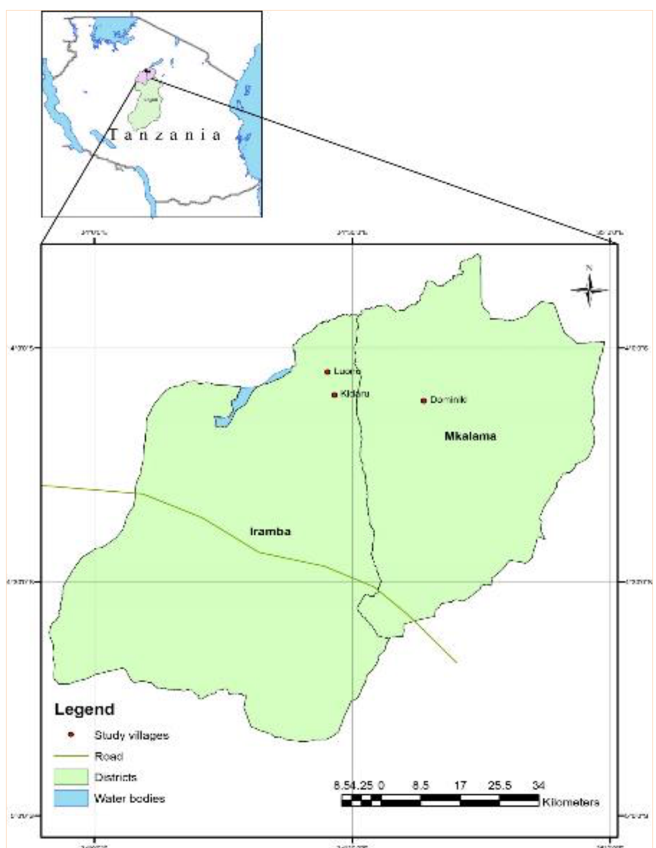
The study was conducted in the semi-arid dryland region of Singida in central Tanzania – covering the two districts of Mkalama and Iramba (Figure 2.2). The region was one of the two APRA programme study sites in Tanzania. The other site was the wetter sub-humid Kilombero in eastern Tanzania. The semi-arid site was chosen as it already faces adverse weather conditions related with climate variability and increasingly experiences weather extremes in the face of climate change.

Singida region experiences low and erratic uni-modal rainfall in the range of 500-800mm per annum (URT, 2019). The rainfall usually starts in November with an intermittent dry spell in mid-February before resuming in March to April followed by a longer dry season. Across different months in a year, day average temperatures vary between 15–35°C. Hydrologically, like in other semi-arid areas, the region has several ephemeral rivers and gullies draining into inland swamps and Lakes. The regional soils vary over vast lands including deep dark brown silt loam, brown or reddish-brown loamy sands to dark grey or black cracking clays in valleys and depressions.

Crop production is mainly rainfed, with some limited seasonal supplementary irrigation for paddy and horticulture production using dams, groundwater and runoff. Different crops are grown across different agro-ecological zones in the region. The major crops grown include maize, millet, sorghum, groundnuts, cassava, sweet potatoes, beans, paddy, chickpeas, sunflower and cotton. Onion is the major horticulture crop grown under the rainfed system in some areas of Singida region. Alongside crop agriculture, livestock keeping is largely practiced. In the semi-arid drylands of central Tanzania, the use of draught animal power in farming and rural transportation is a common practice.

In the two case study districts of Mkalama and Iramba, the rainfall season that marks the commencement of the farming season starts in late October or early November until a one- to two-week dry spell sets in around mid-February. The rains pick up again in March and continue through May. Recent historical trends of rainfall indicate that in both districts, the annual rainfall has been in the range of 400–1100mm. Average seasonal rainfall even in the peak rainy months of March and April has not exceeded 160mm per month. Crop yield depends primarily on rainfall distribution during the growth stages of the plant. However, rainfall patterns in the two districts showed the highest intra-

Figure 2.2: A map of Singida region showing study districts and villages



Source: Authors' own, using © ArcGIS

seasonal variation (in terms of coefficient of variation) in the range of 100–350 per cent.

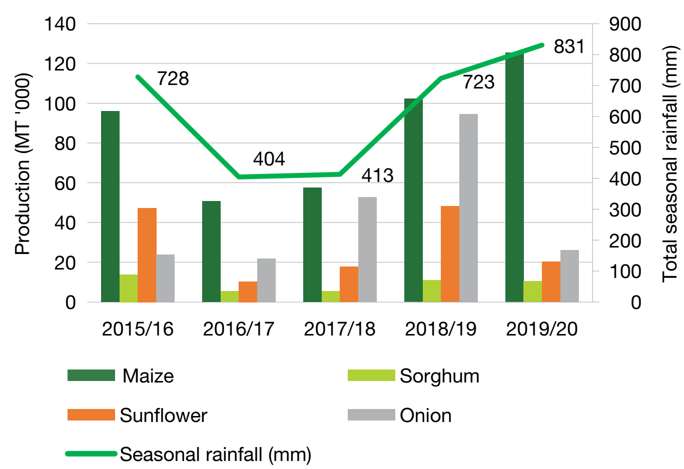
Furthermore, a graphical analysis for the two districts shows clearer overlap of the production of different crops with rainfall patterns (Figure 2.3). Rainfall-related production responses of crops differ. For example, sorghum, sunflower and onion, which are relatively tolerant to low moisture levels, show inconsistent production responses to rainfall patterns. This suggests that factors beyond rainfall variability such as crop management may influence productivity.

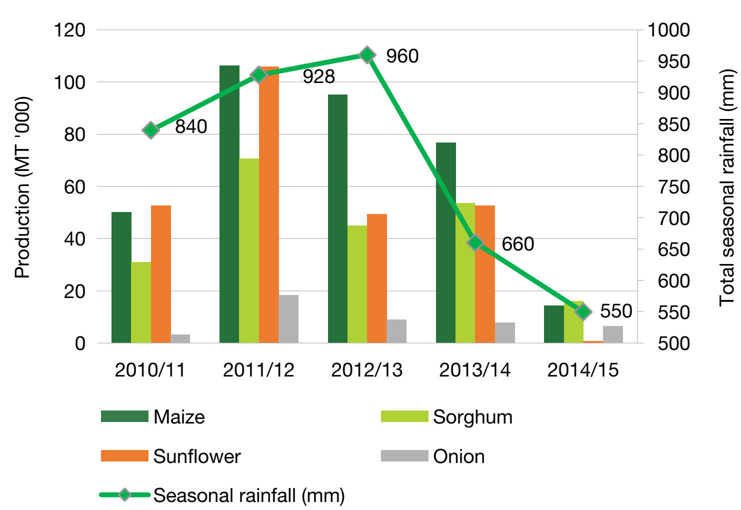
In addition, the study selected three case study sites covering three village communities (i.e., Luono, Kidaru and Dominiki) out of the 15 villages covered under an APRA household survey conducted in 2018 (APRA, 2019). The village communities were selected based on relative levels of commercialisation of the crop sub-sector. The main APRA household survey dataset was used to compute the crop commercialisation index – the ratio of the value of all crops sold over the value of all crops produced expressed as a percentage. The three commercialisation levels determined included: less commercialised, moderately commercialised and highly commercialised with commercialisation indices of less than 25 per cent, 26-50 per cent and over 50 per cent, respectively. Based on this criterion, Luono, Kidaru and Dominiki villages were chosen to represent less commercialised, moderately commercialised and highly commercialised villages, respectively. Luono and Kidaru are in Iramba district and Dominiki in Mkalama district.

2.3 Methods for data collection and analysis

The study applied a qualitative approach that was complemented by analysis of quantitative data sets from the APRA household survey of 2018 (APRA, 2019). The qualitative methods were adapted from the PVA toolkit (Ulrichs et al., 2015). The PVA toolkit presents different participatory tools (mainly qualitative) for assessing community-level food security and climate

Figure 2.3: Seasonal rainfall and crop production patterns in the districts





Source: Authors' own, using Regional Administrative Secretary Singida and DAICO office data change vulnerability. The qualitative tools from the PVA toolkit adapted in this study (see Appendix 1) include: 1) village mapping, 2) transect walks, 3) climate change trends and timelines, 4) wellbeing assessments, 5) seasonal calendar of livelihood strategies and weather, 6) individual life course assessments with respect to commercialisation and adaptation pathways, 7) assessment of farm-sector structural changes and related implications on commercialisation and resilience, and 8) institutional mapping and political economy context around commercialisation, adaptation and rural development in general. Some quantitative secondary data (rainfall and production) were sourced from the regional office of Singida and district offices of Mlalama and Iramba.

The adapted PVA exercises were carried out with different groups and individual farmers in the three village communities. The village mapping involved some village government members (5-8 per village) that also identified 2-3 members that participated in the transect walks. Individual life course histories (storylines) interviews in relation to commercialisation and adaptation to climate change were carried out with 6-12 individuals per village represented by sex, age and commercialisation levels. The rest of the exercises were carried out through focus group discussions involving 6-8 participants balanced in different aspects such as age, sex, and locality in the study villages.

The data analysis approach used in this study can be summed up in two categories: 1) general qualitative and descriptive and 2) quantitative that generated some metric indices. The first category includes the analyses from the qualitative participatory tools adapted from the PVA toolkit. However, some metric analyses require further explanation, including the computations of commercialisation and the farm enterprise vulnerability indices. While commercialisation computation is common in the literature, farm enterprise vulnerability indices are a recent index measure of enterprise vulnerability deduced from qualitative data and information generated in this study.

As presented in Equation 1, the crop sub-sector commercialisation index (CCI) is computed as the ratio of total sales of all crops (Sc) to total value of crops produced. The CCI was computed for each farming household. The CCI ranges from 0–100 per cent, representing a commercialisation continuum from subsistence to highly commercialised farming household.

Based on the commercialisation index, the farming households were categorized into three commercialisation levels. First, subsistence to less commercialised (CCI= 0-25 per cent), moderately commercialised (CCI= 26-50 per cent) and highly commercialised (CCI > 50 per cent).

$$CCI_c = \sum_{c=1}^{n} S_c \Big/ \sum_{c=1}^{n} VP_c \quad (1)$$

The concept of vulnerability reflects the potential susceptibility of individual subjects or a system to a certain source of harm or downside risk (IPCC, 2018). The direct subjects for vulnerability can be individuals, communities, enterprises, infrastructure, technology, and even a system. We adopted the vulnerability computation assuming that exposure and sensitivity interact to have an impact on an individual or a system. The adaptive capacity is vested in available adaptations and their efficacy to reduce vulnerability and enhance resilience. This means that an enterprise vulnerability is a direct product of the enterprise's exposure and sensitivity resulting into an impact outcome that gets abated through adaptive capacity. When the product of exposure and sensitivity is greater than the adaptive capacity, the enterprise will be vulnerable and vice versa – hence the smaller the computed Vi value, the less vulnerable the enterprise. In this case, the subjects are the agricultural enterprises (both crops and livestock) undertaken by farmers. This relationship can be mathematically presented as shown in Equation 2.

$$\mathrm{V_i} = [E_e * S_e] - [A_e] \quad (2)$$

In this paper, we acknowledge that vulnerability of a farm enterprise to climate change and variability cannot be measured by a simple linear relationship as suggested in Equation 2. Vulnerability can be path-dependent (Klein et al., 2014) with current and future performance and resilience of an agricultural enterprise shaped by the past and current states of assets, structures and processes. We therefore used community-level input data to estimate composite measures of the vulnerability of crop and livestock enterprises to multiple climatic stressors. Understanding the current level and sources of vulnerability for agricultural enterprises is critical for devising effective adaptations to enhance resilience. Data and information about all the parameters were generated by focus group discussion participants in the three study communities. The participants evaluated a range of potential sources of production-related climatic risks including seasonal drought, dry spells, floods, and pest and diseases. Table 2.1 presents an iterated computational procedure used to estimate the vulnerabilities of different farm enterprises.

Table 2.1: Computational procedure of enterprise vulnerability to climatic risks

Parameters	Parameter in, Vi	Climatic risky events			
		Seasonal drought	Dry spells	Floods	Pests and diseases
Probability of occurrence [A]	Ee	x1	x2	x3	x4
Level of shock [B]	Se	y1	y2	y3	y4
Integrated impact [C]	Ee * Se	x1*y1	x1*y2	x1*y2	x1*y2
Intensity of adaptations [D]	Ie	z1	z2	z3	z4
Adaptation efficacy [E]	Fe	u1	u2	u3	u4
Adaptive capacity [F]	Ae=Fe/Ie	u1/z1	u2/z2	u3/z3	u4/z4
Enterprise vulnerability, *Vi*	(Ee*Se) – Ae	(x1*y1) -(u1/z1)	(x2*y2) -(u2/z2)	(x3*y3) -(u3/z3)	(x4*y4) -(u4/z4)

[A]=Community-reported probability of occurrence of a risky event; [B] Perceived level of shock/impact coded as 0= no impact, 1= small impact, 2= medium impact, 3= disastrous impact; [C]=multiplicative integrated impact outcome with embedded harm and sensitivity of the enterprise; [D]=total number of adaptations; [E]=total adaptations' efficacy scored as 3= most effective, 2= effective, 1= less effective, 0= not effective
Source: Authors' own

3 LIVELIHOODS, COMMERCIALISATION AND CLIMATE CHANGE IN SINGIDA REGION

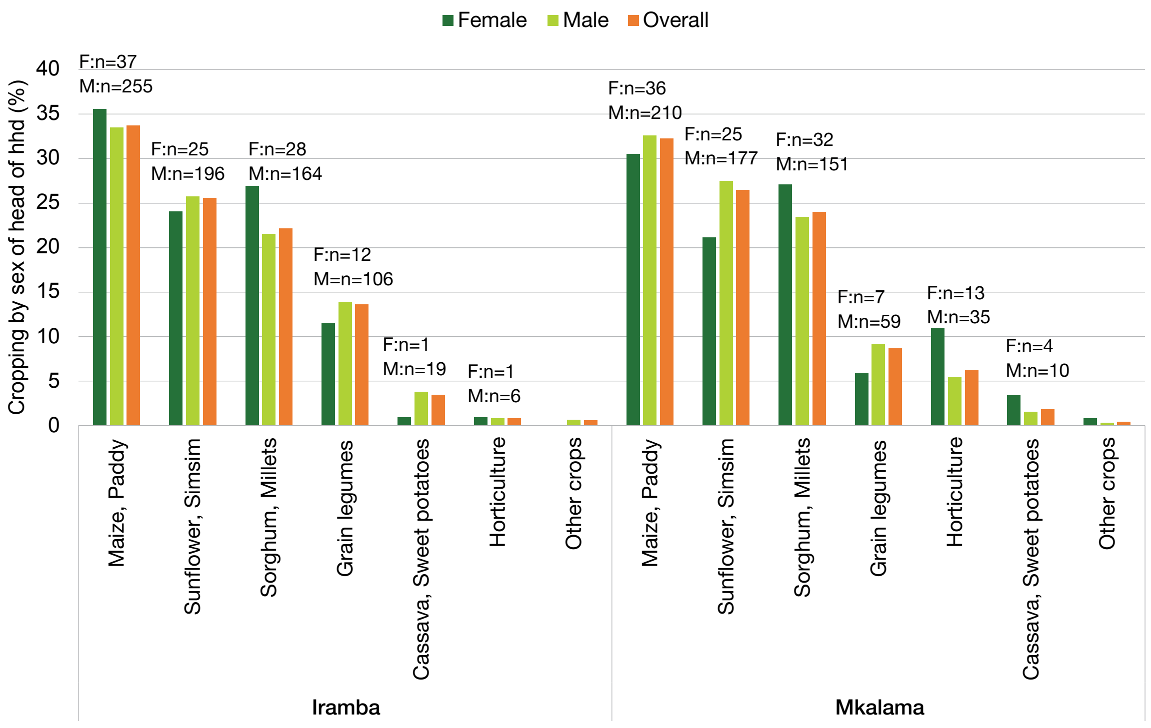
3.1. District-level agricultural commercialisation

The APRA dataset covering 600 households from 15 villages was used to generate district-level insights. The pooled analysis enabled statistically credible crosstabulations among variables of interest. The focal analysis at this level included distribution of crop enterprises by sex and age of head of household and farm size. The crop enterprise mix managed by the households was sex-disaggregated to explore gendered differences (Figure 3.1). In Iramba district, a relatively higher proportion of female-headed households managed the staple food crops maize and paddy, and sorghum and millet. A slightly larger proportion of households headed by men managed the commercial oil crops sunflower and sesame. In Mkalama, sorghum and millet, and root crops were mostly grown by female-headed households. In Mkalama, more female-headed households participated in horticulture production compared to their peers who grew grain legumes and root crops.

Across the two districts, commercial oil crops were predominantly grown in male-headed households.

The results in Table 3.1 compare commercialisation index by sex of household head. Gender-differential conditions in terms of access, ownership and control of productive resources may shape commercialisation decisions and related outcomes among women and men (Djurfeldt 2018). Both the mean and median CCIs indicate that female-headed households in Mkalama as opposed to Iramba, were slightly more commercialised than male-headed households. This difference may be due to the effects of higher participation of females in high-value horticulture production in Mkalama compared to Iramba district (see Figure 3.1). However, female-headed households falling within the 25th percentile in the two districts did not appear to be commercialised – at least for the reference season of 2018. Based on the Interquartile Range (IQR), the level of commercialisation inequality is much higher among female-headed than male-headed households. This suggests high disparity in access, ownership and control of the means of commercialisation among women.

Figure 3.1: Cropping mix and intensity by sex of household head in the districts



Data source: Authors' own, APRA Household Survey 2018

The position and role of youth in farming is a critical feature in the current discourse on the future of African agriculture (FAO, 2014; Abay et al., 2021). Table 3.2 presents the results of the commercialisation index, disaggregated by age categories of heads of households. The findings indicate that households led by younger heads (under 35 years of age) were more commercialised than those led by heads in the oldest age categories. Considering the medial measure, which is a less noisy central tendency statistic, the commercialisation level consistently declined with increasing age. However, the elderly respondents (over 60 years of age) in the 25th percentile are much less commercialised in Mkalama (at just 3.3 per cent) compared to Iramba (at 53.4 per cent). Onion, which is the predominant commercial crop in Mkalama, apart from being capital intensive, is also labour intensive in terms of management. This can be an exclusionary factor for elderly farmers.

Farm size can also impact on commercialisation in many ways. Farmers with access to more land can have more room to manoeuvre in terms of crop diversification (Djurfeldt et al., 2018), economies of scale and even rental income, part of which can be used to finance farming. However, there is evidence that farm size tends to have an inverse relationship with productivity in developing countries (Delvaux, Riesgo and Paloma, 2020). Based on the median statistics, the commercialisation level tended to increase with farm size across both districts with some inconsistency in the two middle farm size categories (Table 3.3). The findings suggest that increasing the farm size favoured the commercialisation of the typically subsistence farmers in the first quartiles.

Table 3.1: Commercialisation index by sex of household head in the districts

Statistics	Iramba		Mkalama		Overall	
	Female	**Male**	**Female**	**Male**	**Female**	**Male**
Number (N)	43	277	39	241	82	518
Mean	28.1	37.8	47.3	43.5	37.2	40.5
Std Deviation	25.9	27.7	35.5	32.7	32.1	30.2
Median	22.2	38.7	48.0	42.5	31.3	39.9
Inter quartile range (IQR)	48.5	42.5	76.1	53.1	64.5	47.2
1st quartile	0.0	14.7	0.0	14.8	0.0	14.9
3rd quartile	48.5	57.1	76.1	67.9	64.5	62.1

Source: Authors' own, APRA Household Survey 2018

Table 3.2: Commercialisation index by age of household head in the districts

District/Age	N	Mean	Std dev.	Median	IQR	Q1	Q3
Iramba District							
Under 35 years	87	43.6	29	44.7	47.4	19.3	66.7
36 – 60 years	168	33.7	27.2	33.2	53.4	0	16.3
Over 60 years	65	34.2	25.7	32.9	33.1	53.4	49.4
Mkalama District							
Up to 35 years	35	47.5	34.9	50.4	62.7	15.5	78.2
36 – 60 years	174	45.9	33.5	45.6	54.8	16.2	70.9
Over 60 years	60	35.9	29.3	38.1	52.3	3.3	55.6
Overall							
Up to 35 years	133	44.9	31.1	47.4	52.8	17.8	70.6
36 – 60 years	342	39.9	31.1	39.9	54.7	9.0	63.7
Over 60 years	125	35.0	27.4	35.2	39.9	10.3	50.2

IQR= interquartile range, Q1= first quartile/25th percentile, Q3= third quartile/75th percentile
Source: Authors' own, APRA Household Survey 2018

3.2 Local livelihoods, climate change and commercialisation

3.2.1. Profile of the case study village communities

The three village farming communities had populations ranging between 2400 and 7560 people. The average household size ranged from about five to 12 people. Dominiki was the most populous community with 7560 people, followed by Luono with 6000 people. Kidaru was the least populous community with only 2392 people. The common ethnic groups across the study communities include Nyiramba, Nyaturu, Taturu and Sukuma. The latter three ethnic groups practice pastoralism. The Sukuma people practice both extensive grazing and crop production (Figure 3.2). The agro-landscapes of the three villages are characterised by soils with varying qualities in terms of fertility and water holding capacity. Generally, the soil types differ with terrain entailing lowland fertile mbuga soils, low-midland moderately fertile clayey soils with patches of hardpan, and mid-upland less fertile sandy and red soils. Paddy, onions and chickpeas are grown in the lowlands. Sunflower, pearl millet and sorghum along with other crops are grown mainly in the mid-upland areas. Land productivity is critical for crop production and ultimately the potential to commercialise. It was noted during the transect walk that wellbeing levels overlapped with the land productivity gradient. Highly commercialised and better-off families tended to occupy the most productive land.

3.2.2. Community wellbeing assessment

Subjective wellbeing was locally defined in terms of a number of indicators: production capability of food crops, income level, size of land owned, quality of housing and possession of livestock, particularly cattle (see Appendix 2). In Dominiki, the focus group discussion participants reported participating in the market economy by selling crops and livestock in local and distant markets as an indicator of improved wellbeing. Land ownership as well as the ability to rent in land were also indicators of wellbeing. Dominiki has a relatively developed land rental market due to the high demand for land suitable for onion production.

Based on these indicators, the focus group discussion participants identified four wellbeing groups – upper, middle-upper, middle-lower and lowest. Across the three communities, 50-80 per cent of the community members were perceived to fall in the two middle wellbeing groups. Only 10-20 per cent were in the upper richer wellbeing group. The Kidaru community appeared to have the majority of its population (40 per cent) in the poorest wellbeing group, while the remaining two villages had 10-20 per cent of their populations in this category. The Luono community had a sizeable wealth of cash income of TSh20-200

Table 3.3: Commercialisation index by farm size in the districts

District/Age	N	Mean	Std dev.	Median	IQR	Q1	Q3
Iramba District							
Up to 1.2ha	66	28.9	29.6	22.2	50.0	0.0	50.0
>1.2 to 2ha	79	34.8	25.4	37.6	53.9	0.0	53.9
>2 to 4ha	101	36.7	25.8	35.6	34.9	18.7	53.7
>4ha	74	44.8	28.9	47.9	42.1	24.1	66.2
Mkalama District							
Up to 1.2ha	73	33.9	36.5	27.0	64.2	0.0	64.2
>1.2 to 2ha	76	43.5	32.1	45.2	60.1	8.3	68.4
>2 to 4ha	75	52.9	30.7	50.9	44.9	30.0	74.9
>4ha	56	45.9	29.4	42.2	46.2	20.4	66.6
Overall							
Up to 1.2ha	139	31.5	33.4	22.3	50.9	0.0	50.9
>1.2 to 2ha	155	39.1	29.1	40.9	52.3	8.0	60.3
>2 to 4ha	176	43.6	29.0	41.6	45.6	20.4	66.0
>4ha	130	45.3	29.1	47.1	43.3	22.9	66.2

IQR= interquartile range, Q1= first quartile/25th percentile, Q3= third quartile/75th percentile

Source: Authors' own, APRA Household Survey 2018 million+ (US$8,695[1] – 86,957+) and cattle (500-1000+) for the upper and middle wellbeing groups which constituted 80 per cent of the community households. The Sukuma agropastoralists, who owned large herds of cattle and grew crops extensively had the highest income levels of other ethnic groups in the communities. In addition, the level of wellbeing tended to correlate with the level of production of food crops – hence higher potential to commercialise.

The participants of focus group discussions defined and characterized different groups of wellbeing in their communities. In addition, each individual participant was probed to ascertain his or her position on the ladder of wellbeing and the drivers of the path to that destination and foreseen futures. The possibility of growing highly commercialised crops such as paddy, sunflower and onion helped individual farmers to ascend the wellbeing ladder. Farmers that were able to access irrigation water were better-off. Livestock was also an important indicator of wellbeing. Depletion of livestock assets, whether due to climatic calamity or liquidation to meet other obligations such as paying dowry, reduced the level of wellbeing. The death of important family members, particularly husbands, placed the wellbeing of widowed women in jeopardy. For example, during a focus group discussion one participant widow recalled: 'after my husband passed

Figure 3.2: Extensive livestock and sorghum production systems in Luono village

©: APRA/Khamaldin Mutabazi

1 Exchange rate: US$1 = TSh2,300

away, I descended the wellbeing ladder, my husband's relatives confiscated all the cattle that we owned'. Another participant felt that traveling to other parts of the country helped him to learn new things which led to improving his wellbeing. Furthermore, droughts were widely reported to have caused stagnation or slowed the progress of many, as demonstrated in this quote from another participant farmer during a focus group discussion 'drought remains the greatest barrier to further success'.

3.2.3. Food security: key dimensions and risk factors

During the focus group discussions, participant farmers assessed the dimensions and threats of food security in their communities. Two important elements of food availability are local production and post-harvest handling. The risk factors in local food production include low and variable rainfall, flooding, and high infestation of pests and diseases. Only farmers with farms near the seasonal rivers accessed water for supplementary irrigation, mainly for paddy production and off-season irrigation for horticulture production. Farmers with farms characterised by less fertile sandy soils with limited water-holding capacity experienced low yields from those farms. Infestation of pests and diseases (see Figure 3.3) was a major biological production risk affecting local food security.

Furthermore, the focus group discussions assessed food access issues including food purchasing capacity, food prices and food safety nets to fall back on aftershocks. The risk factors undermining purchasing power included low income, lack of livestock and low or no production of cash-earning crops such as paddy, sunflower, onions and chickpeas. Other crops with relatively high local demand such as maize, pearl millet and sorghum may also be good sources of cash to farmers depending on the market forces of demand and supply. Unprecedented incidences of crop failures would still trigger hikes in food prices. The majority of rural households particularly in the semi-arid drylands are net buyers of food. At peak harvesting time farmers sell food crops at relatively lower prices and buy back later at unproportionally higher prices.

3.2.4. Community health in relation to agriculture

The focus group discussions covered the community-wide issues related with health. Health is an important human capital especially in labour-intensive farming systems because a healthy family workforce is needed to manage farm activities (Combary and Traore, 2021). The common diseases as reported by farmers in the three communities included malaria, tuberculosis, skin rashes, eye illness, stomach pain, diarrhoea, typhoid, urinary tract infection (UTI), coughs and flu and HIV/AIDS. Malaria incidences were reported to be common during the rainy months while other diseases occurred throughout the year. Most of the diseases were related to poor water sanitation and hygiene aggravated by the lack of access to safe water for drinking and washing. HIV/AIDS spreads relatively faster with high interactions of people from different places through activities like fishing and incoming traders.

The impacts of COVID-19 were not widely reported, despite social disruptions due to government-ordered school closures and restricted gatherings between mid-March and June 2020. Even after probing, farmers did not report any death they could associate with COVID-19 or any abnormal surge in deaths that would have alerted wider spread of the virus. However, marketing of some agricultural commodities was affected as reported by some farmers: 'we were

Figure 3.3: Sweet potato tubers infested by insect pests in Kidaru and Dominiki villages

©: APRA/Khamaldin Mutabazi

unable to sell our livestock as before. I sold my cattle for TSh150,000 (US$65) to a local butcher that I would have sold for TSh400,000 (US$174) at a weekly market that attracts many buyers but was closed because of coronavirus'. Another farmer reported COVID-19 related disruption in the marketing of sesame: 'this year of 2020 we have not seen buyers coming to our village to buy sesame. This may be due to coronavirus as we hear people saying'. Sesame is mainly grown for export (Lokina, Tibanywana, and Ndanshau, 2020). Commodity export trade was particularly affected in the first half of 2020 by COVID-19 driven disruptions of global value chains (UNCTAD, 2021).

3.2.5. Livestock and off-farm enterprises

During the focus group discussions, participants discussed commercialisation of livestock and non-farm livelihood enterprises as well. In the African rural context, the three sub-sectors – crop, livestock and non-farm – are interrelated. Cropping benefits from livestock through animal power for tillage, farm transportation and capital formation from animal sales. Livestock sales can also save farmers from distress selling crops, as one farmer pointed out: *'I normally sell some livestock to earn cash that allows me to store my paddy until the price is better'.* In the semi-arid drylands, farmers coped with the aftermath of crop failure by using income from livestock and off-farm activities to smooth consumption.

Across the study villages, traditional livestock production was found to be facing a number of challenges. Communal pasture and rangeland resources were on the verge of depletion, mainly from crop farming expansion and degradation. As a result, some pastoralists have permanently migrated to humid regions such as Morogoro and Mbeya. Off-farm livelihood activities included exploitation of natural resources for sale involving fishing, fetching firewood, collecting special sticks for making mats, baskets and granaries. Other off-farm activities pursued for livelihoods include petty business services such as food vending, local brewing and selling labour.

In Dominiki, seasonal employment in commercial onion farms is available for locals seeking jobs. Onion farming is labour intensive, involving a range of activities including sowing, transplanting, fertiliser application and spraying. During harvesting, paid activities include uprooting the bulbs, cutting, bagging and loading. The influx of onion buyers particularly during harvesting time attracts service-related businesses such as food vending, merchandize shops and haircutting.

3.3. Farm-sector vulnerability and structural changes

3.3.1. Important farm enterprises in the risk-return space

The commercialisation of the dryland farm-sector heavily depends on how vulnerable or resilient the farm enterprises are to climate change and variability. Farm enterprises vary in terms of potential risk and return on investment. The major farm enterprises across the study villages were explored for their riskiness and return potential that are central in farmers' commercialisation decisions. In the risk-return trade-offs, the risk aspect envisages how vulnerable the enterprise is to the vagaries of weather and other biophysical stressors – posing a high probability of production failure and/or costly management that diminish returns on investment. The climatic risk factors mainly include water stress, pests and diseases, and depleted pasture and fodder resources for livestock. Different crops and animal species are variably sensitive to such risk factors. The return component is associated with market value and tradability of enterprise commodity in the marketplace. Based on information drawn from the qualitative study, different enterprises that farmers identified as important were allotted to different positions in the risk-return space (Table 3.4).

Table 3.4: Risk-return trade-off decision space of agricultural enterprises across the villages

Risk-return scenario	Luono		Kidaru		Dominiki	
	Crops	**Livestock**	**Crops**	**Livestock**	**Crops**	**Livestock**
High-risk	Not reported	Cattle	Sesame, tomato	Cattle	Onion	Cattle
High–return	Maize	Sheep, poultry	Maize	Sheep, poultry	Maize	Sheep, poultry
High-risk	Paddy, sunflower, chickpea	Goat, pigs	Paddy, sunflower, groundnut, cotton	Goat	Sunflower, groundnut, chickpea	Goat, pigs
Low–return	Pearl millet, sweet potato	Not reported	Sorghum, sweet potato	Not reported	Sorghum, sweet potato	Not reported

Source: Author's own, Climate Change and Commercialisation Study 2020

3.3.2. Farm enterprises' vulnerability, impacts and adaptations

The vulnerability of any weather-reliant production system such as a farm enterprise depends on its exposure to climatic risk factor, sensitivity and adaptive capacity (IPCC 2018). Farmers' choices of farm enterprises to commercialise in are made within the risk-return trade-off space. We computed the composite vulnerability index for different farm enterprises defined in four categories of risk-return trade-offs. Metrically, vulnerability of a farm enterprise increases with magnitude of the index from negative to positive numbers (- ∞ to + ∞). From the findings on each category of enterprises we draw some talking points on commercialisation as summarised in the text boxes.

Vulnerability of low-risk low-return crops

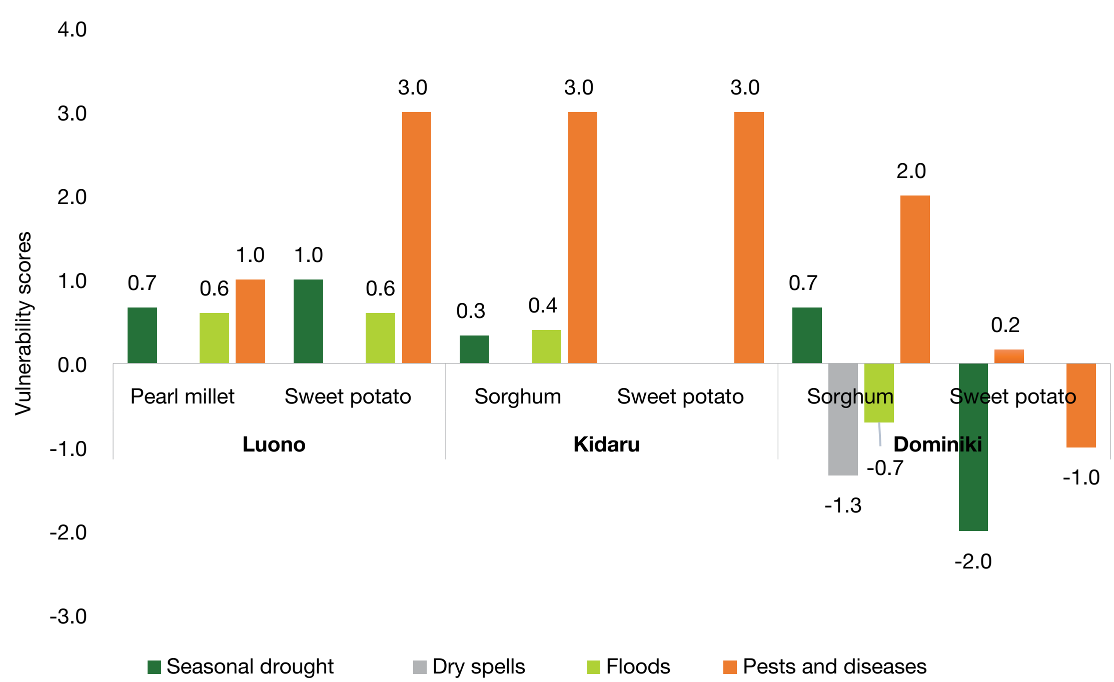
The major crops in the low-risk low-return bracket that were grown by farmers included pearl millet, sorghum and sweet potato (Figure 3.4). In Luono, pearl millet was vulnerable to seasonal drought, dry spells and occasional floods. Farmers did not devise any adaptation measure to safeguard pearl millet production. Sweet potato succumbed miserably to insect pests (weevils) that spoiled the tubers, but also to seasonal droughts and to some extent dry spells. In Luono and Kidaru villages, farmers did not have effective adaptation measures to manage the pest problem in sweet potato. Farmers in Dominiki, on the other hand, managed the pest problem by harvesting the tubers much earlier before infestation. However, such early harvesting may contribute to reduced yield when the growth period of the crop is shortened. The public extension system did not offer farmers any solutions for managing the sweet potato weevils. Sorghum was vulnerable to insect pests and diseases but less vulnerable to intra-seasonal dry spells. Choosing a proper planting window for sorghum – as practiced in Dominiki – was an effective adaptation to manage the intermittent dry spells. In Kidaru, sorghum was vulnerable to occasional floods and the same risk in Dominiki was avoided by not planting the crop in the floodplain.

Box 3.1: Commercialisation talking points for low-risk low-return crops

- Traditionally resilient dryland crops are increasingly vulnerable to climate variability and a surge in pest infestation while farmers lack effective adaptations
- Improving the returns of most subsistence dryland crops envisioned through improved market linkages and value addition must go together with promotion of effective adaptations and crop protection

Source: Authors' own, Climate Change and Commercialisation Study 2020

Figure 3.4: Vulnerability of low-risk low-return crops



Source: Authors' own, APRA Climate Change and Commercialisation Study 2020

Vulnerability of low-risk high-return crops

The crops falling under the low-risk high-return category included paddy, sunflower, chickpea, groundnut and cotton (Figure 3.5). In Luono, diversion of river flows for spate irrigation for lowland paddy production is relatively easy due to the shallow riverbanks as River Ndurumo drains further downstream with more water. Despite the associated diversion challenges, lowland spate irrigation (i.e., diverting seasonal runoff and river water by gravity onto the low-laying cropland) is still practiced in Kidaru, enabling farmers to mitigate production risk in paddy. In the upstream parts of the river such as Kidaru, the riverbanks tend to be deeper with low flows thus posing a significant challenge for farmers to divert water for paddy production. In Luono and Kidaru, sunflower was mainly vulnerable to incidences of floods. However, sunflower production in Dominiki was vulnerable to all risk factors, particularly pests and diseases and dry spells.

In Kidaru, farmers have resumed growing cotton following a recent improvement in prices after production halted a decade ago due to lower and fluctuating producer prices. Groundnuts, cotton and chickpea were vulnerable to different climatic risks particularly pests and diseases. Higher vulnerability scores mean that the enterprise is highly exposed and impacted by the climatic stressor in terms of productivity loss, and farmers have limited adaptive capacity or applied adaptations were less effective.

Vulnerability of high-risk low-return crops

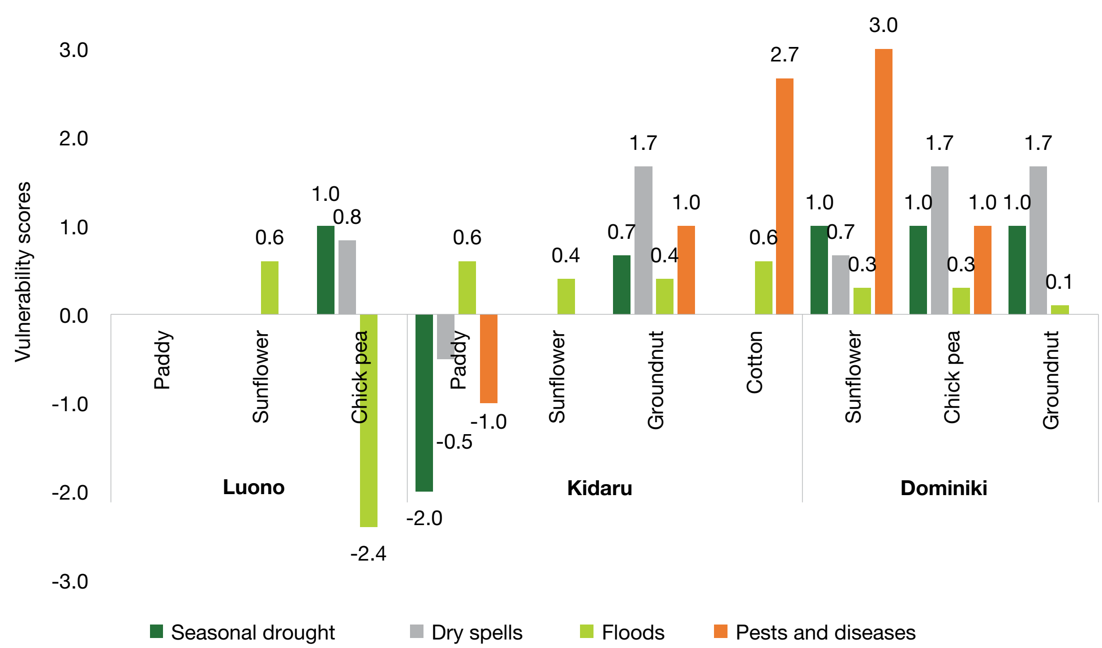
Maize was the only reported crop enterprise falling in the high-risk low-return category across the three study villages (Figure 3.6). Categorising maize as low-return in the dryland areas where it used to be a high-value crop needs further explanation. Local availability of improved maize varieties adapted for a range of agro-ecologies (Baffes, Kshirsagar and Mitchell, 2019) has increased maize production. This progress is mainly backed by political economy context regarding maize as a strategic crop for national food security and regional export trade. As a result, increased production has contributed to considerable suppression and stabilisation of maize prices in local markets. However, incidences of crop failures and changes in demand could still influence prices of maize in local markets.

Box 3.2: Commercialisation talking points for low-risk, high-return crops

- Emerging irrigation potential in some dryland areas due to increased runoffs and flows in rivers is curtailed by a lack of public investment in appropriate irrigation technology
- Conventionally high-return resilient crops are facing new threats from increased climate variability and crop pests and diseases that the majority of farmers lack the means to address.

Source: Authors' own, Climate Change and Commercialisation Study 2020

Figure 3.5: Vulnerability of low-risk high-return crops



Source: Authors' own, Climate Change and Commercialisation Study 2020

In Luono and Kidaru, maize production was more vulnerable to all climatic risk factors. In Dominiki, farmers tactically planted maize within the window that avoids the mid-February dry spell to coincide with the crop's growth stage which is sensitive to moisture stress. Relative to other villages, Dominiki had better physical access to agro-dealers supplying improved inputs including a range of adapted maize varieties.

Moreover, higher recurrence of dry spells (every season) aggravated the exposure component of the vulnerability index that combined with inadequate adaptive capacity to increase the vulnerability of the enterprise. In Kidaru and Dominiki, insect pests were managed through the application of insecticides, however these were not very effective. In Luono, farmers practiced late planting and manual killing of the insect pests as coping mechanisms. Farmers complained of surges in new crop pests and diseases unlike anything they had seen over the past decade. They also reported that the application of existing chemicals they knew and used before did little to control them. Climate and environmental changes seem to have altered the resurgence and ecological dynamics of crop pests and diseases and farmers are struggling to manage.

Vulnerability of high-risk high-return crops

The major high-risk high-return crops produced in the case study villages included tomato, sesame and onion (Figure 3.7). Onions were grown under rainfed conditions during the season while tomato was produced off-season under irrigation. Irrigated tomato farming was carried out by a few farmers who could afford motor pumps to lift water from sand river wells and boreholes.

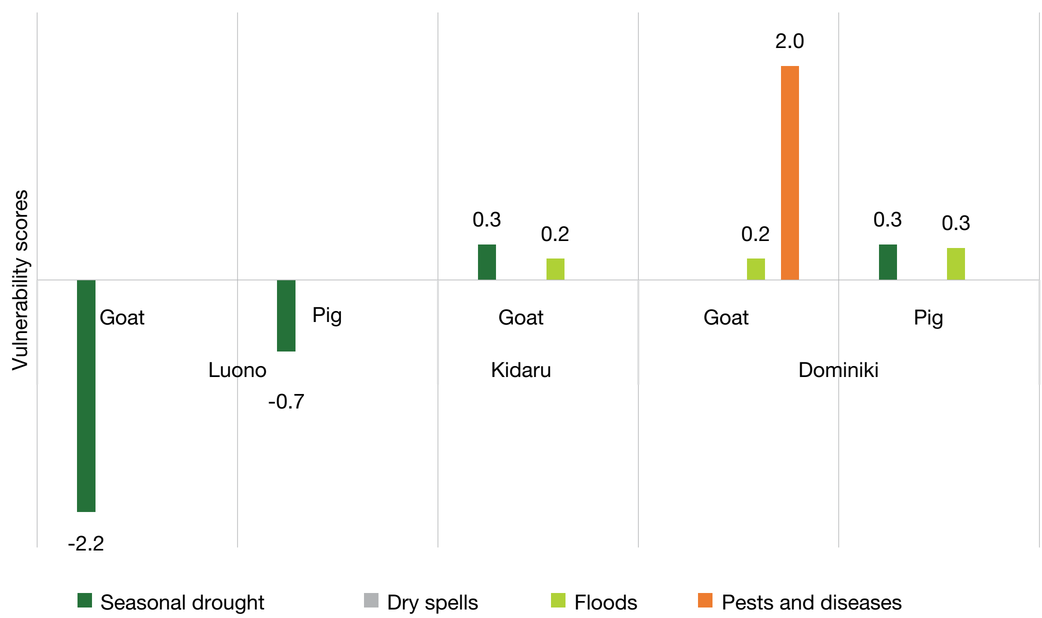
The high vulnerability of sesame resulted from its exposure to the impacts of the climatic risk factors. There was a lack of effective means of adaptation such as drought tolerant varieties and pest and disease management. Farmers practiced some adaptations in horticulture production that mitigated the enterprise vulnerability. Furthermore, off-season irrigation was used as an effective adaptation in tomato production and spraying for managing pests and diseases for both

Box 3.3: Commercialisation talking points for high-risk low-return maize

- Development in breeding for maize varieties adapted to a range of agro-climates including drylands and expansive rural networks of agro-dealers stocking these varieties has expanded the scope of production and commercialisation of maize
- A surge in pests and diseases infestation that farmers reported to be lacking means to address is becoming a major threat to production and commercialisation of maize in the dryland farming system

Source: Authors' own, Climate Change and Commercialisation Study 2020

Figure 3.6: Vulnerability of high-risk low-return maize



Source: Authors' own, Climate Change and Commercialisation Study 2020

tomato and onion production. Early planting during the first rains in onion production was an adaptation practice used to escape the mid-February dry spell.

Vulnerability of high-risk high-return livestock

Cattle was the only livestock enterprise classified as high-risk high-return. The riskiness of cattle production was associated with its vulnerability to seasonal droughts and extended dry spells that led to depletion of pasture and water resources (Figure 3.8). In response to such risks, farmers have been effectively coping by moving the animals to other areas endowed with such resources. Farmers used purchased veterinary drugs to treat the animals against incidences of animal pests and diseases. However, farmers in Dominiki complained about emerging parasitic insects and diseases that were hard to cure with normal vet drugs. Movement of cattle to less affected areas in cases of critical seasonal droughts which is traditionally regarded as an effective adaptation is no longer sustainable given shrinking pasture resources from degradation and farming expansion. Some promising sustainable adaptation pathways in the dryland cattle sector include: destocking to match available feed resources, genetic improvement, improved pasture and rangeland management, improved animal husbandry and modernisation of livestock markets.

Vulnerability of low-risk high-return livestock

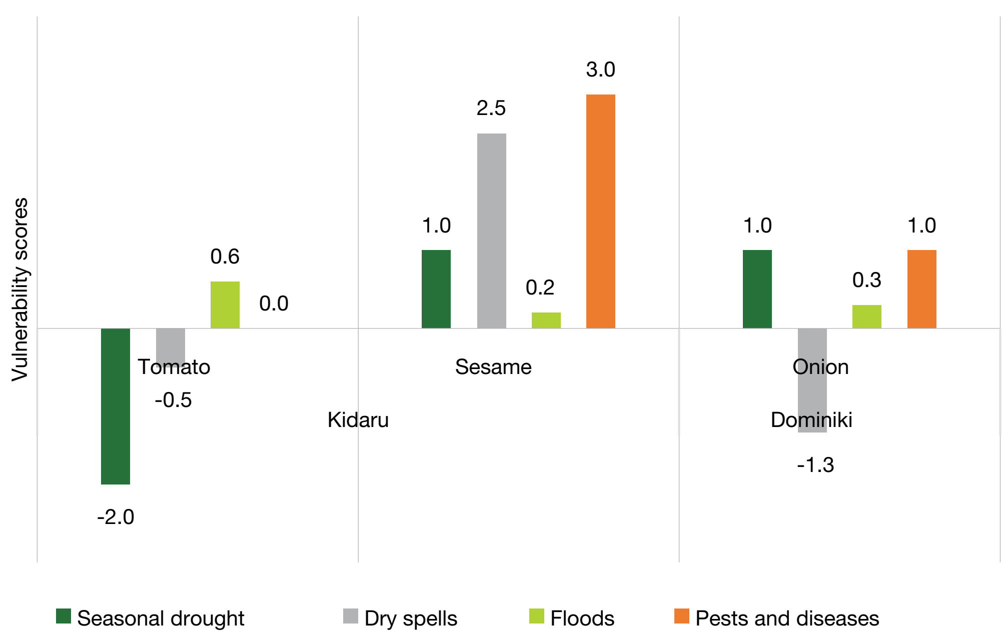
In addition, the livestock enterprises under the low-risk high-return category included goats and pigs (Figure 3.9). Goats were commonly reared across all the villages while pigs were raised in Luono and Dominiki. Both goats and pigs commanded a reasonably good market price. Production of goats and pigs in Luono was less vulnerable to seasonal droughts. Goats can thrive with limited availability of water and by browsing on remaining shrubs in times of seasonal droughts when grazing grasses are denudated. Pigs can be easily fed on locally available feed resources such as maize bran, sunflower seed cake and kitchen remains. In Dominiki, goats were highly vulnerable to animal pests and diseases. In Kidaru and Dominiki, goats and pigs were relatively vulnerable to droughts and floods. During excessive rains, goats like other hoofed animals suffer from foot and mouth diseases.

Box 3.4: Commercialisation talking points for high-risk high-return crops

- Dryland horticulture and oilseed sectors include high-value crops that can be successfully grown in the drylands with improved management of water such as storage-linked rainwater harvesting and infield water use efficiency.
- Promoting crop protection is critical for the development of sesame which has a huge potential as a dryland export crop.

Source: Authors' own, Climate Change and Commercialisation Study 2020

Figure 3.7: Vulnerability of high-risk high-return crops

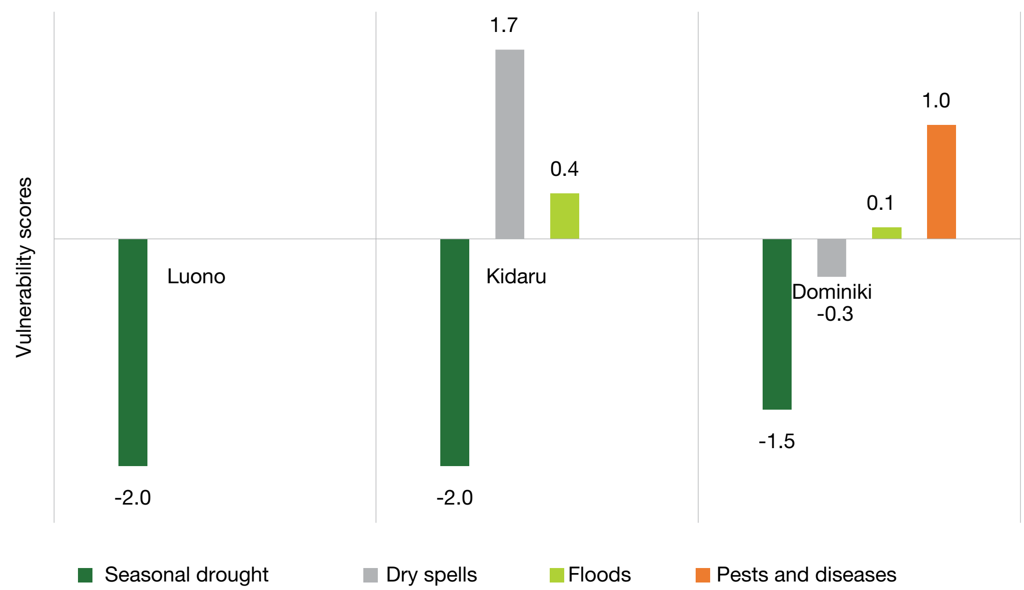


Source: Authors' own, Climate Change and Commercialisation Study 2020

Vulnerability of high-risk low-return livestock

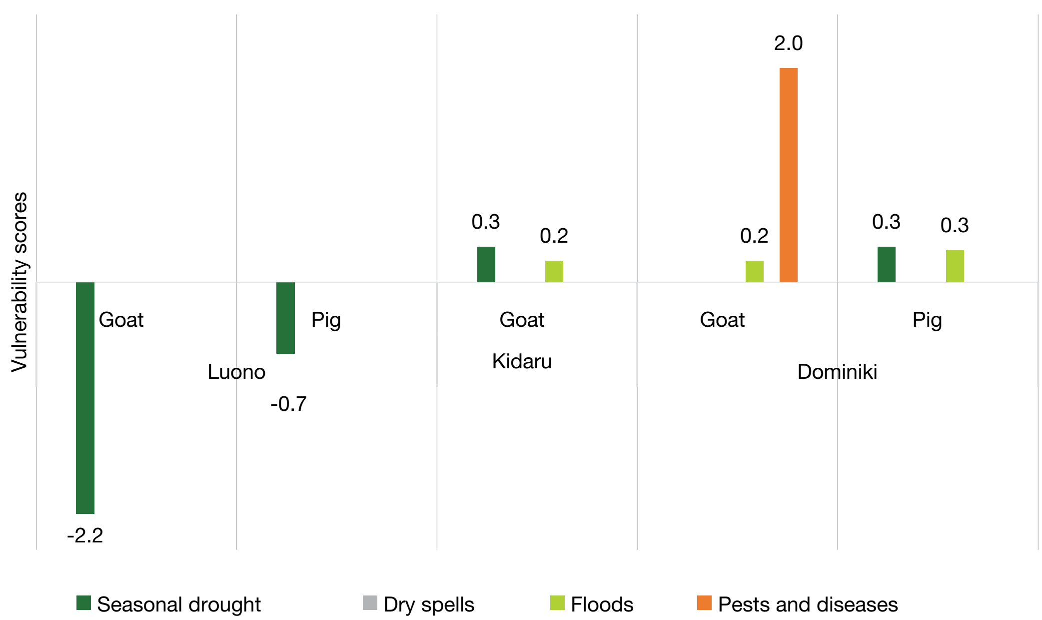
Poultry and sheep were categorised as high-risk low-return (Figure 3.10). In terms of return, compared to other animal species, poultry and sheep generated modest returns per animal based on market prices. The major threat to rural poultry production was the deadly Newcastle disease outbreak. Although most poultry diseases, including Newcastle, can be managed with an affordable vaccine, farmers were not vaccinating their birds due to lack of effective vaccination arrangements at the village scale. Rural chickens were reared in a free-range system causing poultry diseases to spread unchecked, making them difficult to control. Sheep, like cattle, are non-browsers and hence likely to suffer when grazable pasture resources are in short supply during seasonal droughts and extended dry spells. However, farmers in Luono village effectively safeguarded their sheep from seasonal droughts by moving animals to less affected areas. Given the high demand for local chicken meat, particularly in urban areas, the rural chicken sector has huge income potential if deadly diseases can be controlled and the marketing system improved.

Figure 3.8: Vulnerability of high-risk high-return cattle



Source: Authors' own, Climate Change and Commercialisation Study 2020

Figure 3.9: Vulnerability of low-risk high-return livestock



Source: Authors' own, Climate Change and Commercialisation Study 2020

3.3.3 Crop enterprise structural changes: dynamics, drivers and impacts

This section explores the long-term dynamics in the crop sub-sector (within the past decade), the drivers behind the changes, and related impacts on local livelihoods and commercialisation (Appendix 3). Sunflower and chickpeas were recently introduced crops in Luono village. Farmers' new interests in growing sunflower were mainly associated with the availability of improved seeds and its tolerance to droughts, and crop pests and diseases. Production of sunflower has enabled a local supply of edible oil. The uptake of chickpeas was driven by better market prices and low production costs. In Kidaru village, cotton has re-emerged after more than a decade of abandonment due to poor producer prices as a result of volatile global cotton prices. The major drivers of revived interest in cotton include better prices and the availability of a buying company in the village.

The crop enterprises that expanded in scale of production included paddy in Luono, and sweet potato and red onions in Dominiki. The expansion of paddy production was driven mainly by availability of water for irrigation, fertile lowland and improved seeds. Production of maize has been upended or contracted mainly due to low and unreliable rainfall. Moreover, changes in major dryland subsistence food crops – sweet potato, sorghum and pearl millet – include the involvement of many farmers, increased production mainly through area expansion rather than improved productivity, and scaled-up traditional processing of sweet potato tubers into dried grits.

The availability of buyers from Kenya and other domestic markets offering better prices for red onions was the major driver of scaled-up production through increased number of producers and farm size. Onion producers in Dominiki include both local farmers and external commercial farmers who hire land in the village.

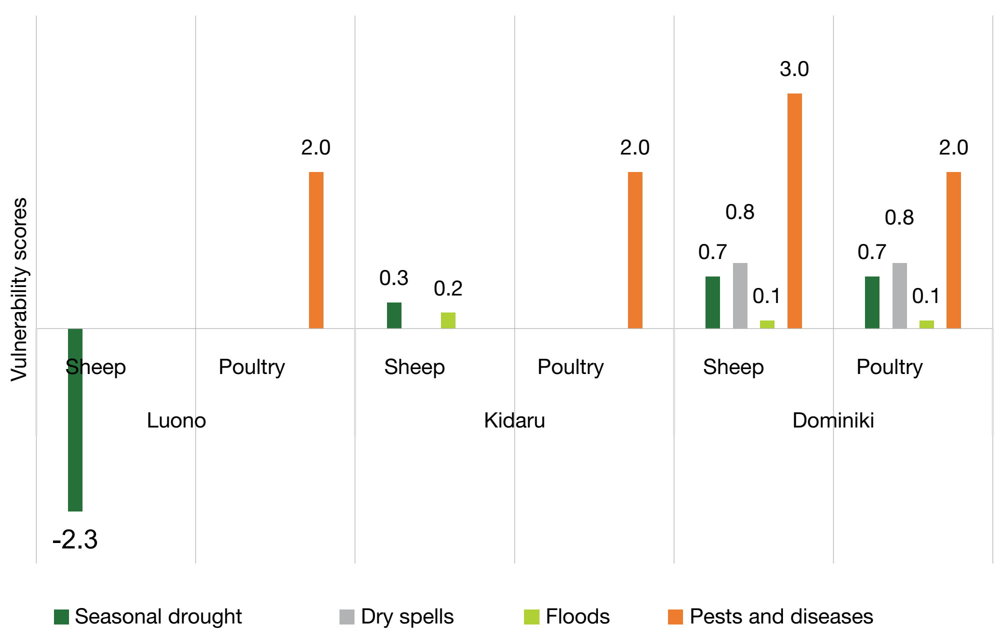
Furthermore, the findings of this study suggest that most of the positive changes in the major crop enterprises have resulted from the availability of improved seeds in the local markets. However, prospects for increased production and commercialisation of sorghum and pearl millet seem to have been crippled by an underdeveloped formal seed system. Farmers are seeking sorghum and pearl millet varieties that can withstand some level of excessive soil moisture and resist infestation by birds, but also have brewing quality for local beer. This needs a long-term breeding initiative to develop sorghum and pearl millet varieties adapted to a range of agro-climates including moisture regimes. A good case is the maize seed sector which offers a range of varieties that grow in different agro-ecologies.

3.4. Crop marketing system and commercialisation pathways

3.4.1. Crop marketing system

The findings from focus group discussions indicate that maize, sesame, cotton, paddy, chickpeas and pearl millet are the major crops marketed in the case study area. Cotton and sesame were mainly grown for export markets. Maize is a major cereal traded in domestic markets and exported to neighbouring countries –

Figure 3.10: Vulnerability of high-risk low-return livestock



Source: Authors' own, Climate Change and Commercialisation Study 2020

mainly Kenya and Rwanda (FEWS Net, FAO and WFP, 2020). Dominiki is renowned for producing onions and attracts many buyers from different regions in the country and traders from the neighbouring countries Kenya and Uganda. Paddy is traded widely in domestic markets and some is exported to neighbouring countries in the Eastern Africa sub-region. Chickpeas are grown for export markets with India being a major importer. Pearl millet is mainly grown for subsistence but is also locally traded in the villages.

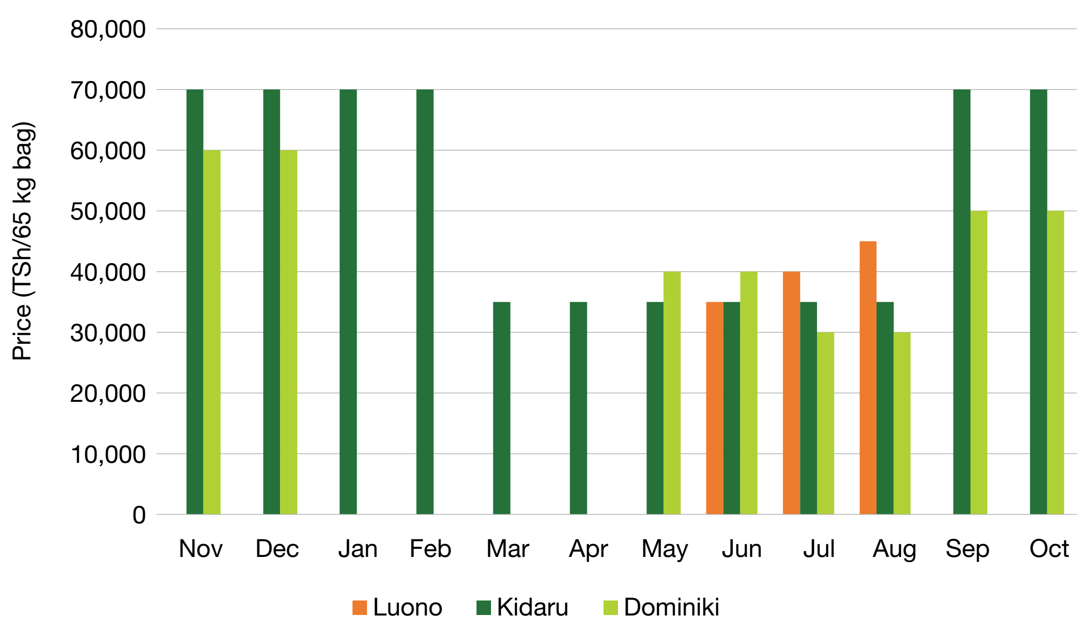
The producer price patterns throughout the year signal how commercialisation and engagement with markets would benefit farmers in terms of welfare. Most farmers sold their crops immediately after harvest when prices were lower and farmers were in a dire need of cash. Some farmers with alternative means of cash-in-flow such as livestock assets could afford to wait longer for better prices. However, farmers lacked appropriate technologies for extended storage. The seasonal price patterns were analysed across three villages for sunflower and other major commercial crops. Sunflower, which is widely grown across the villages, was harvested from April to June then traded during and after harvesting (Figure 3.11). Sunflower prices were relatively lower around harvesting months. In Kidaru, sunflower was traded throughout the year while the other villages only traded it for a few months. Sunflower prices were higher from September on until the start of the next harvests as oilseeds stocks receded. Deferring sunflower sales would therefore benefit farmers financially. However, cash flow problems and a lack of appropriate storage facilities remain stumbling blocks for deferring sales.

In addition, seasonal producer prices of major commercial crops in each study village reported by participant farmers during focus group discussions were plotted in Figure 3.12. In Luono village, paddy was marketed from June to September after harvesting, which begins in May. In Luono village, the marketing window of paddy was limited to a span of just four months. The shorter marketing window may be attributed to the lack of adequate and appropriate storage facilities as during transect walks huge heaps of harvested paddy were kept outside in the open. In Dominiki village, onions are also sold immediately after harvest due to lack of appropriate storage facilities as reported by farmers during the focus group discussions. The onions marketing shed available in Dominiki cannot accommodate all the produce and lack appropriate infrastructure for onion storage. In Kidaru village, sunflower was traded throughout the year following a year-round demand for edible oil – hence motivating farmers to keep stocks of oilseeds for processing over time.

3.4.2. Commercialisation pathways: individual farmers' life courses

This section explores the life course histories of the participants in this study. These life histories underscore the pathways through which individual farmers have commercialised their crops in the face of production risks aggravated by climate change. In our analysis, we categorised the life course responses of individual farmers into five commercialisation

Figure 3.11: Seasonal producer price of sunflower



Source: Authors' own, Climate Change and Commercialisation Study 2020

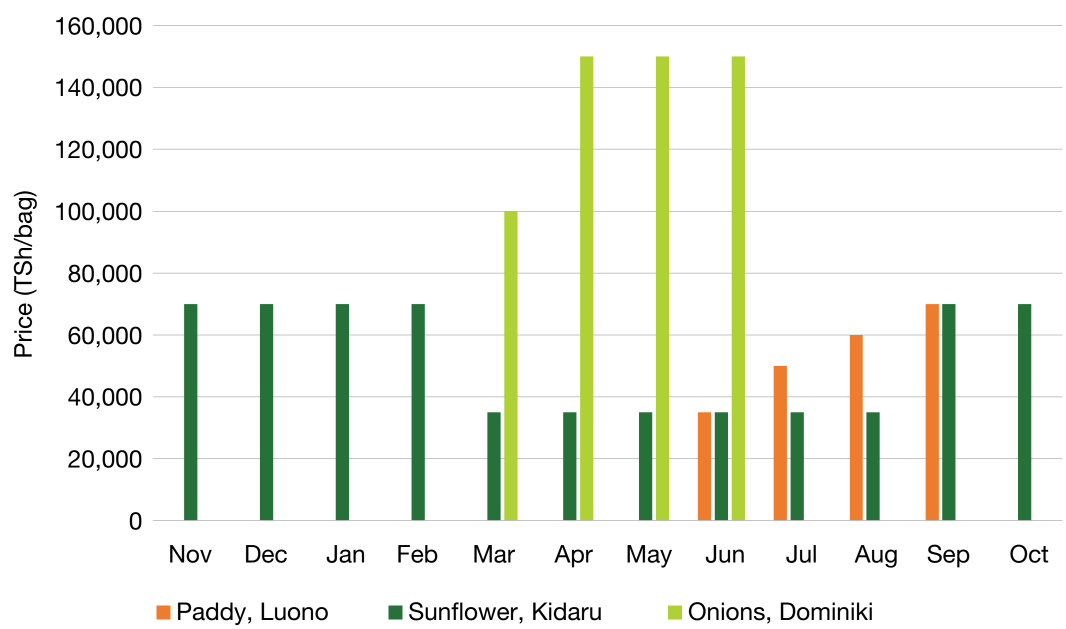
pathways: 1) agro-climatic conditions, 2) productive resource entitlement, 3) investment and financing capability, 4) return and resilience potential of grown crops, and 5) social capital entitlement. The farmers sharing their life course stories on commercialisation and adaptation are also described in terms of sex, age, wealth and level of commercialisation based on a 2018 APRA household survey.

Agro-climatic conditions driven pathway

In the agro-climatic conditions driven pathway, production-related climatic conditions were critical in determining the commercialisation pathways that some farmers pursued. Climatic and weather conditions related mainly with rainfall pattern impacted farmers differently. Varied farm conditions resulted in differential impacts from common climatic risks such as droughts and floods. Farms characterised by soils with high-water holding capacity would likely retain moisture to support plant growth even with little rains but suffered from waterlogging that reduced productivity in cases of excessive rains. The sensitivity of crops even to the same climatic stressors differed due to the embedded genetic trait of tolerance. Climate change and variability impacted crop production and ultimately the commercialisation potential. For example, one life history participant reported: 'I would have harvested 60 bags if my paddy farms would have not been affected by floods'.

In addition, climatic and weather uncertainty may undermine the decision of farmers to commercialise. This is demonstrated in a quote from one life history participant in the middle-lower wealth group and less

Figure 3.12: Seasonal producer prices of major commercial crop



Note: 1 bag of paddy and sunflower = 65 kg, 1 bag of onion = 120 kg
Source: Authors' own, Climate Change and Commercialisation Study 2020

Box 3.5: Production impacts of climatic risks

- "… 1.5 acre of sesame was devastated by insect pests, I harvested only 2 tins instead of 36 that would have earned me TZS 540,000…"A surge in pests and diseases infestation that farmers reported to be lacking means to address is becoming a major threat to production and commercialisation of maize in the dryland farming system
- "…I planted 5 acres of maize, but I harvested nothing because of drought…"
- "… I had all the means to produce crops, but drought ruined everything…"
- "…harvests were good because the rains were excessive, but only sorghum failed, I expect to sell more produce".

Source: Authors' own, Climate Change and Commercialisation Study 2020

commercialised group based on APRA's 2018 survey: 'I am always hesitant to sell food crops, because I am fearing how subsequent seasons might turn out'.

Productive resource entitlement driven pathway

In the productive resource entitlement driven pathway, access to a range of productive resources in terms of both quantity and quality backed commercialisation pathways. Key local productive resources in the study communities included agricultural land, water, oxen and labour. Access to adequate and quality land enhanced crop production and commercialisation. For example, one life history participant stated: 'my husband left me with a good farm that retains moisture for a long time. Even with low rainfall the farm gives me good harvests'. Farmers with farms closer to the river and who could afford motor pumps had an opportunity to practice supplementary and off-season irrigation. Some farms were more productive due to the natural fertility and moisture retention capacity of the soils. In contrast, some farmers were deprived of good quality land which seemed to limit their crop production and commercialisation potential as explained in this quote from a life history participant: 'I do not have enough good land, my farm is on sandy soil and cannot be irrigated, if one gets an irrigated farm, farming is profitable'.

In addition, access to multiple land parcels helped farmers to diversify crop production and hence spread the risk of crop failure. Farmers with access to oxen managed to cultivate large farms in time. Family labour was also critical particularly among poorer farmers who were unable to afford hired labour. Furthermore, farmers with more land could rent out a proportion of it for additional income and manage the remaining land. This quote from a life history interviewee indicates how land endowment can support production and commercialisation: *'I normally rent out grazing land to earn cash which allows me to store my paddy until the price is better to sell'*. Extreme rainfall and ephemeral river flows sometimes had devastating impacts on farmland as explained by a 62-year-old male farmer in the middle-lower wealth group and who was moderately commercialised in 2018: 'in 2007/08, I lost two acres (0.8ha) of my farm due to flash floods, that farm now is part of the River Ndurumo'. The fertile farmland was also lost through depositions of barren rocky and sandy material following periodic flash floods eroding degraded landscapes (Figure 3.13).

Investment and financing capability driven pathway

In the investment and financing capability driven pathway, the ability to finance crop farming and command a healthy cash-flow were important for commercial crop production and commercialisation. Production of some crops such as horticulture required high investment and reliable financing. For example, managing one hectare of onions commercially would cost a farmer about US$1,250, with crop management accounting for 43 per cent (US$533)

Box 3.6: Productive resource access

- "… I cannot grow any cash crop because I do not have capacity to access land and oxen…"
- "… having a fertile land and oxen has helped, I do not use any fertilizer but still get good harvests".
- "… my father-in-law gave me a large land which enables me to cultivate more than one crop".
- "… I have land, I cultivate many plots so that from each plot I get some crop harvests to sell…"
- "…I am working alone on the farm most of the time, one of my daughters is permanently sick …"

Source: Authors' own, Climate Change and Commercialisation Study 2020

Figure 3.13: Good soils buried from river floods related depositions in Kidaru

©: APRA/Khamaldin Mutabazi

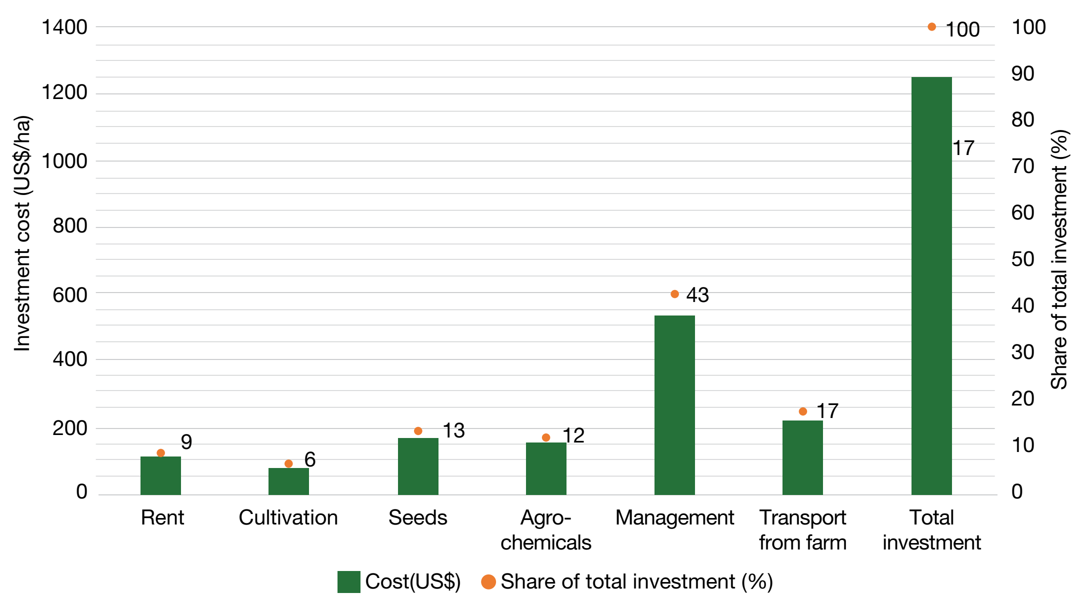
of the total cost (Figure 3.14). High investment costs limited the participation of resource poor farmers in the production of high-return crops such as onions as expressed by one 41-year-old female farmer in the middle-lower wealth group highly who commercialised in 2018: 'we are labourers on the farms of the rich, we cultivate only small pieces of land though we have large lands. Production costs of onions are very high, if we can get a loan with low interest, we can manage onion farming and get out of this circle of working for the rich'. In Dominiki village, the demand for land to grow onions by incoming commercial farmers has introduced new dynamics in the local land markets – increasing both rent and selling prices. However, the co-existence of commercial onion farmers and smallholders has enabled technological spill-over and labour employment opportunities that have contributed to the vibrancy of the local cash economy.

Access to additional income sources enabled farmers to avoid "distress crop sales" particularly at peak harvest periods when producer prices were significantly lower and financial obligations were at a higher stake. Distress selling at peak harvest w0as mainly due to accumulated debt incurred during the production season. With limited rural micro-finance, the findings indicate that farmers had an array of local means for capital formation and sustaining liquidity. For example, in a life history interview, one participant stated: 'I am also running a business of buying and slaughtering goats that gives me an income which I use to buy seeds and manage my farms'. Farmers who did not have access to these forms of finance were unlikely to be able to afford farm investments such as buying improved seeds and hiring paid labour. Thus, the development of inclusive rural micro-finance would complement local financing means to enhance capital formation for farm investments and improved cash flows.

Return and market potential of grown crops driven pathway

In the return and market potential of grown crops driven pathway, farmers faced a portfolio of crops varying in commercial potential and resilience to production-

Figure 3.14: Distribution investment costs in onion production



Source: Authors' own, Climate Change and Commercialisation Study 2020

Box 3.7: Means of capital formation and liquidity

- "…I normally sell some livestock and rent out grazing land to earn cash that allows me to store my paddy until when the price is better…"
- "…due to cash problem, I cannot wait to sell my crops at a good price, I cannot also afford improved seeds".
- "…in the past, I had a small restaurant, that used to give me an income that I used to purchase inputs, hire tractor and pay for different costs involved in farming".
- "… my pension payment helps me in farming…"

Source: Authors' own, Climate Change and Commercialisation Study 2020

Box 3.8: Pathways to grow commercial crops

- "… paddy has good yields of about 30 bags per acre and fetches good price also, this year I have harvested 300 bags…"
- "… the problem here is unpredictable rainfall, it is hard to cultivate horticultural crops such as onions…"
- "…I cultivate more sunflower to be able to earn more income..."
- "… I put more efforts on sunflower as a commercial crop, I sell sunflower to avoid selling sorghum that we use for food…"
- "…I did not afford improved sunflower seed this season; good seed can take us far…"

Source: Authors' own, Climate Change and Commercialisation Study 2020

Box 3.9: Social capital erosion and upheavals

- "…my parents also separated when I was very young, they came back together at very old ages and I am taking care of them now. I have no plan to sell the pearl millet I have harvested because it is even not enough to take us to the next season, my father sold all the land during his younger age…"

Source: Authors' own, Climate Change and Commercialisation Study 2020

related climatic and environmental risks. Farmers needed to choose which crop to grow depending on their underlying livelihood objectives and available means. By managing associated production risks from the start, farmers were likely to commercialise by choosing high-return crops with high-market potential. In contrast, farmers with limited means to manage production risks were likely to opt for low-risk low-return crop production and hence remain locked in a "subsistence trap" with limited prospects for commercialisation.

The following life history quote illustrates how growing cotton has increased this farmer's potential to increase income and commercialise: 'I started growing cotton this year after realising that a fellow farmer who grows it gets good income from it. I expect to earn TSh1,000,000 (US$435) from cotton this year'.

On the other hand, this life history quote highlights how not being able to afford sunflower crops hindered this farmer from commercialisation: 'I grow only pearl millet – a lack of money has limited me from commercialising by growing sunflower'.

Engaging in the production of high-return crops can also help generate income and hence increase the capacity of the farmer to invest in other crops.

Social capital entitlement driven pathway

Finally, in the social capital entitlement driven pathway, social capital is acquired through the fabrics of culture, relations and norms of families and society. The role played by social capital in rural family farming is indispensable. The results of the life histories indicate that strengthened social capital positively impacted on family farming while weakened or eroded social capital typically did the opposite. Generally, social capital served as safety nets among poor and vulnerable farming families. An erosion of the same capital through social and family upheavals pushed some individuals into destitution, particularly those marginalised by societal institutions, such as women, as illustrated by this life history quote: 'after the death of my husband, his relatives confiscated all the cattle including oxen, leaving us with nothing; now I cannot grow any cash crop because I do not have oxen'.

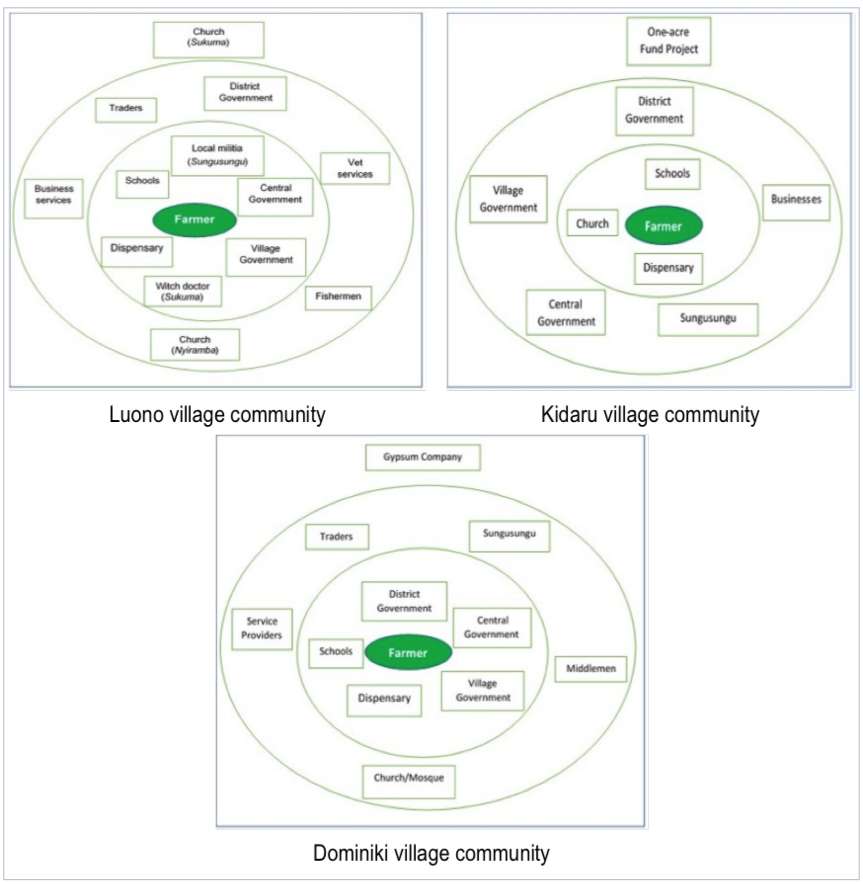
Nevertheless, the entitlement to such capital helped some farmers deprived of other means of capital to engage in production and attain some level of commercialisation. During the life history interviews, several farmers spoke about how they were supported in farming through family-based social capital: 'my son who left the village to work as a casual labourer there, sends me money – about TSh300,000 (US$130) every season that I use to rent in 1.5 acres (0.6 ha) of land, buy seed and pay for labour'.

4 INSTITUTIONAL ROLES AND POLITICAL ECONOMY

Internal and external institutions in the broader sphere of political economy play a critical role in supporting local livelihood activities including agricultural commercialisation. Market participation and commercialisation are dependent on other supportive development initiatives such as public infrastructure, and social and economic services. Regulations and bylaws enforced by the institutions of the state and society can help maintain orderly life in the community. Venn diagramming conducted by the participants during the focus group discussions visualised the roles and centricity of the institutions to farmers. Institutions that were more supportive to farmers were centrically located and those less supportive were gradually positioned to the periphery in the Venn diagram (Figure 4.1).

Figure 4.1 indicates that some institutions were viewed differently along ethnic lines of participants of focus group discussions. The church was an important institution for Nyiramba while it was not considered important among the pastoral tribes. The Sukuma valued the local militia (*sungusungu*) as an important institution enforcing societal norms, order and security. The local private businesses were also important in the villages from supplying merchandize goods and services including agricultural inputs. A non-governmental organisation (NGO) called One Acre operated in Kidaru village and was badly rated mainly because of the lack of transparency in its poultry improvement project. The NGO supplied improved cocks (fast growing and meaty) to just five people for improving the genetic pool of rural chickens. Farmers expected the NGO's initiative would have covered more people in a more transparent manner.

Figure 4.1: Institutional Venn Diagrams for the village communities



Source: Authors' own, Climate Change and Commercialisation Study 2020

The participants of focus group discussions perceived the village and district governments were perceived to play the local governance role of overseeing law and order, and rural development (Appendix 4). Such local government institutions have a potential role to play in enhancing the resilience of farming communities through planned adaptations including sustainable management common pool resources such as water and fisheries. However, there were no effective planned adaptations promoted by the village and district governments. The local communities felt that the district local government has failed to deliver services that would have effectively supported resilience and commercialisation including delivery of extension services, investment in agricultural water management (irrigation, drainage and flood protection) and farm access roads specifically in onion-growing areas.

Furthermore, the public sector through central and local governments in collaboration with village government can embark on transformative public investment to build resilience and support commercialisation. Onion farming in Dominiki village makes an exemplary case for such an initiative. Onion production in this village involves smallholder and medium-scale commercial farms consolidated into a block farm of around 2000ha. Farmers in this area plant within the same window and grow the same red onions demanded in the market, hence operating as a community block farm. However, onion production in this area is constrained by unpredictable rainfall manifesting as prolonged dry spells and sporadic floods (Figure 4.2). Major onion marketing constraints include poor farm-access roads during harvesting and lack of appropriate fresh produce market infrastructure (see Box 4.1). Solutions to such constraints are “public goods” in nature, hence requiring public investments. However, onion production in this area has the potential to generate the wealth needed to support such investments.

In Tanzania, local governments collect produce cess (local tax on crops and livestock) as the main source of revenue. Such local taxes are charged on produce during marketing at the roadblocks as loaded trucks pass by while exiting the district jurisdiction. Onion related cess is the major source of revenue for Mkalama district. In 2019/20, the district netted in about TSh800 million (US$347,826) from onion cess. According to the DAICO, about 80 per cent of the onions sold in the district comes from this village – which is equivalent to around TSh600 million (US$260,870) in onion cess per year. The district can strategically invest back some of the cess money over a number of seasons to address the stipulated constraints and even expand its tax revenue base further.

Box 4.1: Onion production constraints and public investment opportunities

- Three major constraints limiting onion production and marketing worth public investments to address include: 1) lack of water for supplementary irrigation in cases of prolonged dry spells – this can be addressed through investment in rainwater harvesting with storage dams, 2) proneness of the farm block to floods coupled with poor drainage – this can be tacked through installation of flood protection and drainage infrastructure, 3) poor farm access roads as harvest is done during rainy season – an investment is needed to construct a network of graded farm access roads, 4) lack of designated fresh produce market infrastructure to handle onions – investment should involve construction of state-of-the-art fresh produce market integrated with market information system to facilitate trade.

Source: Authors’ own, Climate Change and Commercialisation Study 2020

Figure 4.2: Onion field affected by flood and poor farm access road in Dominiki

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5 CONCLUSIONS AND IMPLICATIONS FOR POLICY

This study shows that dryland farmers are pursuing their livelihood strategies, including agricultural commercialisation, amidst increasing production-related risks associated with climatic and environmental changes. Dryland farmers have historically lived with climate variability as a major driver defining a feasible range of crops and production practices. As a result, weather perturbations that still oscillate within the local 'coping bandwidth' can be dealt with, albeit not without losses. However, climate change associated with increasing incidences of weather extremes are aggravating production risks, in turn overwhelming coping and adaptive capacities of smallholder farmers. Despite being shaped by climate change and variability, commercialisation of dryland agriculture does strengthen farmers' livelihood resilience.

Over time, smallholder farmers have made coping and adaptative decisions involving structural changes and shifts of the dryland crop sub-sector that have shaped the commercialisation pathways. Such changes include adoption of new crops and crop varieties, and reviving production of some crops such as cotton abandoned some years ago because of a lack of market incentives.

Farmers' commercialisation decisions, including the choice of agricultural enterprises to engage in, are made within the risk-return decision space. The findings indicate that the resilience in the face of climate related production risks was a key aspect of farmers' choices of crops to grow. However, in some cases, the market demand played a role in crop choice as well.

The study also showed how farmers devise risk management strategies to foster local adaptive capacity and mitigate production risks. Such traditional adaptations, including tactical choice of planting window, farm diversification (crops and farms) and some irrigation practices, seem to be less effective with increasing climate and weather uncertainties and extremes, however. Market failure and underdevelopment of rural microfinance sector has left dryland farmers with limited means of accessing investment capital and risk management products such as crop insurance.

We draw the following conclusions and implications for policy with respect to the pre-stated research questions:

The effects of farm-level decisions on commercial crops, and the commercialisation pathways they are part of, on current and future resilience to climate change: Farmer's decisions on which crops to commercialise in are still dictated by the ability of those crops to perform under current climate variability. Farmers have also adjusted accordingly to tap emerging opportunities such as irrigated paddy and horticulture production where ephemeral river flows have increased and prolonged. The majority of farmers have stuck with low-risk low-return dryland crops such as sorghum, pearl millet and sweet potato that were basically bred for drought tolerance. However, with increasing incidences of above-average rainfall in some locations, such dryland crops have suffered from excessive moisture. Arguably, widening the scope of dryland crops' varieties that grow successfully in elevated moisture conditions through breeding programs is necessary to foster future resilience. A good example in this regard is the relatively developed maize seed sector which supplies varieties suited for a range of agro-climatic conditions.

The role and importance of climate change among the local and external factors driving farm level decisions on commercialisation: Climate change is among the major drivers of commercialisation pathways shaping farmers' choice of crop enterprises that differ in the level of riskiness and associated returns on investment. Some farmers limit the sales of food crops for safeguarding food security, mainly due to production uncertainties associated with climate change.

Uncertainties faced by farmers and role climate shocks and stressors: Apart from direct climatic shocks (e.g., droughts, dry spells and floods), production uncertainty is aggravated by surges in pests and diseases that seem to be intricately linked with climate and environmental changes.

Farm level strategies for tackling climate-related uncertainties: Selection of drought-resilient crops has been the major strategy that dryland farmers have depended on to address climate-related uncertainty. Drought resilience of crops to climatic uncertainties is central even in the choice of crops grown with market orientation such as sunflower, cotton, onions and chickpeas. Such dryland crops are sporadically devasted by incidences of increased rainfall above the normal range. In general, farmers lack the effective means for crop protection against resurging pests and diseases.

Barriers and opportunities for changing crops in response to changing climate signals: Changes in the crop sub-sector in response to the changing climate are associated with limits and opportunities varying across time and locations. Where crops with high marketability such as sunflower, chickpeas and paddy were introduced or scaled-up as deemed fit in the changing climate, commercialisation opportunities expanded. In two locations out of three, maize production has been scaling down due to uncertainties in rainfall. However, farmers fixated on subsistence production of low-risk low-return crops have limited potential for commercialisation. Traditional drought-resilient crops, particularly cereals and roots, have underdeveloped and less commercialised value chains.

The political economy is key: Smallholder commercialisation is intricately driven by the institution of the state and political economy at large. Public investments in public goods such as farm infrastructure, services and systems are needed to transform and build resilience of dryland farm-sector. Public extension services are not widely accessible to farmers despite emerging new challenges associated with climatic and environmental changes. Addressing such challenges would require improving delivery of extension services to farmers

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Appendix 1: Adapted elements of the PVA Toolkit

Days	Exercise [with whom]	Approach	Objective	Adaptations for this study
Day 1	Transect [Local informants]	Participatory Rural Appraisal (PRA)	Get to know the community and the main social and ecological characteristics.	Check features of commercialisation, adaptations, agro-ecological conditions, livelihood features etc.
	Village map [Focus group discussion participants]	PRA	Identify the main features and households of the community.	Locate commercial activities.
	Semi-structured interview [Village authorities]	Checklist-guided interviews	Understand local governance institutions, the political economy, development, climate change and social protection actions.	Address issues related with local governance of commercialisation. Planned adaptations, vulnerability reduction and social protection actions.
Day 2	Historical timeline and climate trends [Focus group discussion participants]	PRA	Identify the main historical and climatic events/weather extremes in the past and the consequences/ responses.	Integrate the commercialisation trends (relate with APRA commercialisation timelines already captured).
	Wellbeing ranking and assessments [Focus group discussion participants]	PRA	Identify local indicators and categories of wellbeing. Identify how different households access food. Identify households that are food insecure and elements that increase their vulnerability to being food insecure. Analyse how these factors are related to climate impacts	Relate wellbeing categories with commercialisation levels and agricultural enterprises they commercialise in over time. What is the probability/likelihood of households in different wellbeing categories to advance on different commercialisation fronts: stepping in, stepping up, stepping out, hanging in and stepping down; and why? Find out if there is any relationship between vulnerability to food insecurity and limited access to food markets
Day 3	Livelihood strategies and seasonal calendar [Focus group discussion participants]	PRA	Identify the main livelihood strategies and whether they are dependent on certain types of climate. Identify periods of limited access to food and causes for shortage.	Trace any long-term shifts/extremes in the seasonal calendar due to altered climates (especially rainfall – onset, end, drought, rainstorms, dry spells). Identify how such climatic shifts/extremes have impacted the local food system (food system processes and outcomes: production, processing, storage, marketing and consumption, and food and nutrition security). Capture food price seasonality (including the selling and buying price).
	Changing farming practice Crop preference ranking [Focus group discussion participants]	PRA	Identify how farm practices have changed and why. Identify different types of crops and reasons for preferring some over others.	Underscore abandoned/new commercialisation (including abandoned and new commercial crops, livestock and other commodities). Capture implications of changing farming practices on livelihood outcomes: especially income, food and nutrition security, and environmental sustainability. Trace climate adaptation and resilience signatures across practices.

Days	Exercise [with whom]	Approach	Objective	Adaptations for this study
	Semi-structured interview [Health service provider key informants]	Checklist-guided interviews	Identify the main health issues in the community.	Relationships of health outcome with climate change and variability, and agriculture commercialisation.
Day 4	Climate risk ranking and coping mechanisms matrix	PRA	Identify the main climate impacts in the community. Identify how they impact on different livelihood strategies, as well as on access to food. Identify local capacity to adapt and limits to adaptation.	Include impacts on commercialisation process and related outcomes. Include tactical coping and strategic adaptations in context of commercialisation/market participation.
	Food markets diagram [Focus group discussion participants]	PRA	Identify the causal links between internal and external actors and assess their role in food markets. Analyse production processes and how these are vulnerable to climate impacts.	No suggested adjustment at the moment.
	Semi-structured interviews [Households: household heads/ spouses and informed members]	Check-list guided interviews [Drawn from the APRA dataset with a dbase/ dataset linking ID)	Understand the situation of most vulnerable households in terms of livelihood strategies and food security.	Note: the households should be drawn from the quantitative datasets of on-going APRA study maintaining the linking IDs to link the qualitative information with quantitative information of the households.
	Venn diagram	PRA	Identify the main internal and external actors that influence decision- making within the community.	Include actors with influences on commercialisation.

Source: Adapted from Ulrichs et al. (2015)

Appendix 2: Community-based wellbeing assessment

Wellbeing characteristics	Measure	Wellbeing categories			
		Upper (20%)	Middle upper/ Middle (30%)	Middle lower/ Lower (30%)	Lowest (20%)
Luono community					
Own food production (bags)	number	70-100	50-70	30-49	10-20
Cash income	TSh	200 million+	50-100 million	15-20 million	150,000-10 million
Quality of housing (roof, wall, window, ceiling, furniture)	Qualitative	Coloured iron roof, cement wall, glass window, gypsum, sofa	Plain iron roof, cement/non-cement wall, cement floor	Plain iron roof, brick-fitted windows, mud wall, mud floor	Mud roof, mud wall, mud floor
Owned cattle	Number	1000+	500-900	100-499	< 100
Kidaru community					
Own food production (bags)	number	100+	30-99	16-29	8-15
Land owned	Acres	20-30	11-19	4-10	0-3
Cash income	TSh	9 million+	5-8 million	2-4 million	0.5 to 1 million
Quality of housing (size, roof, wall, floor, window, toilet)	Qualitative	5 rooms, iron roof, cement painted wall, cement floor, nice well-ventilated windows, modern toilet inside/ outside	Iron roof, non-cemented brick walls, earth floor, poorly ventilated windows, pit latrine outside with a door	Iron roof one direction slope, non-cemented brick wall, earth floor, poorly ventilated windows, pit latrine outside with a door	Mud/grass roof, mud wall, earth floor, poorly ventilated windows, pit latrine outside without a door
Owned cattle	Number	100-200+	30-99	20-29	5-9
Dominiki community					
Own food production (bags)	Number	50-200	25-100	10-50	0-5
Land owned	Hectares	8-40	8-20	1.2-2	0.4
Rented in land affordable	Hectares	20	rent out some land to rise capital	rent out most of the land	cannot rent in or out any land
Income level	TSh	0.5-10 million	0.4-3 million	0.3-0.5 million	0-0.05 million
Quality of housing (roof, wall, floor and lighting)	Qualitative	Iron roof, cement wall, cement floor, solar power	Iron roof, burnt brick wall, cement floor	Iron roof, raw brick /clay wall, earth floor	Grass/clay roof, clay/grass wall, earth floor
Owned cattle	Number	50-200	20-50	2	0
Market participation	Type of commodity exchange	Selling crops, buy and sell livestock to distant markets (e.g., Dar es salaam, Arusha)	Selling crops, buy and sell livestock in local market, may have a shop	Stress-selling of crops, run some petty business, barter trade exchanging commodities with maize	Have nothing to trade

Source: Author's own, Climate Change and Commercialisation Study 2020

Appendix 3: Crop enterprise structural changes: dynamics, drivers and impacts

Crop	Major change	Major drivers of change	Impacts
Luono village			
Paddy	Increase in production Increased number of farmers More land under paddy	Ndurumo River flows Fertile lowland Availability of improved local seeds	Good harvests
Maize	Decreased production	Increasing droughts	Low production
Sunflower	Emerged as new cash crop	Tolerance to droughts and diseases Availability of improved seeds	Local edible oil production
Chickpea	Emerged as new cash crop	Good price Low production cost	Income generation
Kidaru village			
Crops	**Major change**	**Major drivers of change**	**Impacts**
Sorghum	New local variety (*Mkombituna*) replaced landraces More farmers grow sorghum Declining productivity	Increasingly low and unreliable rainfall Better brewing quality Local demand of new variety	Increased sorghum farming
Maize	Stopped and scaled down production Replaced landraces with new improved Some irrigation	Increasingly low and unreliable rainfall	Decreasing maize yield Some maize produced under irrigation
Pearl millet	Serena variety disappeared Use new drought tolerant varieties Increased production through area expansion	Increasing droughts Proneness of Serena to bird pests	Yields of new varieties still low
Sunflower	New seeds introduced that are widely grown	Increasing droughts Availability of improved seeds More farmers grow it Availability of market and processing facilities	Improved yields
Cotton	Starting to grow it again Decline in productivity Increased use of insecticides	Improving prices and existence of buyers Increasing infestation of insect pests	Declined yields
Sesame	Decline in productivity Shift to sunflower	Increasing droughts Increasing pests and diseases	Decline in yields

Dominiki village			
Sorghum	Abandon Mesia sorghum variety that was drought tolerant Increase in bird pests Change in planting date to avoid birds Decrease in price	Mesia produced stronger brew that caused headache to drinkers who also misbehaved Decrease in yield	Mesia is no longer grown Decrease in yield
Sweet potato	Increased production through area expansion Processing of tubers into dried grits	Tolerant to variable weather Hunger/famine	Improved food security
Onion	Scale of production has increased Red variety replaced Khaki/pale variety that gave more yield	Improved market access (buyers from Kenya, Uganda) Better price for red onions	Improved yields Expansion of area under onion cultivation Abandonment of pale onions
Sunflower	Decrease in production	Emerging crop diseases Increasing droughts Expansion of onions production	Decreased yields and production

Source: Author's own, Climate Change and Commercialisation Study 2020

Appendix 4: Institutional structures and functions

Institution	Potential roles	State of access	Potential to enhance resilience [high, medium, low]	Relationship with community [good, medium, bad]
Village government	Oversee law and order at local level Local development	Community can access governance services	**High**, inadequate to support resilience through planned adaptations	Good, maintain orderly life **Medium**, in Kidaru village due to poor governance
Local government authority (LGA)	Rural development Agricultural extension Irrigation infrastructure	Inadequate extension services Lack of irrigation, drainage and flood protection infrastructure	**High**, but lack targeted planned adaptations	**Good**, delivery of education, health, rural road **Bad**, lack of extension, irrigation, drainage, flood protection and farm access roads
Dispensary/ Health	Health services	Medium, pastoralist families use it after trying natural medicines	**High**, human capital for farm work	**Good**, delivery of health services
Primary school/ education	Education services	Accessible to community but poor enrolment and attendance among pastoralists	**High**, improve human capital in a long-run	**Good**, delivery of child education
Church	Religion	Accessible, with exception of pastoralist that naturalists	**Low**, can mislead farmers only praying to get rid of pests	**Good**, build community morals **Bad**, divide community by not allowing marriages with other religious sects
Private sector/ businesses	Business services	Accessible with cash income	**High**, exchange of goods and services	**Good**, supply of goods and services
Pearl millet	Serena variety disappeared Use new drought tolerant varieties Increased production through area expansion	Increasing droughts Proneness of Serena to bird pests	Yields of new varieties still low	Good
Local militia (sungusungu)	Social security	Accessible by the community	**Low**, helps avoid unrest and theft	**Medium**, relationship is mainly based on fear

Source: Author's own, Climate Change and Commercialisation Study 2020

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