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Contents

1 Acknowledgments

The successful completion of this project was due to the commitment and dedication of a number of people apart from those identified as authors or contributors. This project was designed as a follow-up to the successful SRA, CSE/2013/189, which was designed to lead a process for developing a national farming systems analysis and prioritisation framework for Ethiopia, pursuant to the soon to be published update to the Pan African Farming Systems book. This extension of focus into planning and priority setting required extensive input from Tanzanian researchers, planners and policy makers from Government, University and local development partners. They helped us in identifying local collaborators, participated in discussions and deliberations at workshops and helped interpret field observations and adding insights relating to the local context. The research team gratefully acknowledges their support.
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2 Executive summary

Background

This report provides a record of outcomes from a Small Research & Development Activity (SRA) that extended the farming systems analysis and prioritisation framework developed in Ethiopia, as a pilot study in regional investment planning and priority setting in Tanzania. The activity aimed to develop local capacity to undertake FS-Based planning and help promote FS-Based planning approaches to enhance development effectiveness. The activity examined the context in which farm-level decision making takes place in rural Tanzanian households and the way in which external influences such as climate variability and change may impact on such decisions. To assess the influence of farm types on the exposure to climate hazards and the ways in which farmers can plan to adapt to mitigate such risks, the activity focused on three key farming systems in Tanzania, namely highland perennial, maize mixed and agropastoral systems. These were studied in terms of spatial delineation and characterization, including their key socio-economic characteristics, ecological productive potential and significance in supporting rural livelihoods. This understanding will provide an informed basis to support investment strategies, including agricultural development and research priority setting, infrastructure and land use planning, by helping to better understand the importance of context in determining interventions.

Despite significant growth in information and communications, construction, manufacturing and other services, agriculture remains the mainstay of the economy, contributing around one-third to the national GDP. It supports the livelihoods of 75 percent of the population, and agriculture is likely to remain a key growth sector, particularly in rural Tanzania. Hence, agriculture-led growth and economic development is crucial for meeting food security, income security and wealth creation objectives. In designing strategies for achieving these objectives the regional diversity in Tanzanian agriculture sector provides a useful basis to target interventions.

The process

The starting point for the process followed in this activity was that developed in Ethiopia, drawing on the outputs from the 2001 and 2015 Sub-Saharan Africa Farming Systems studies. It formed the foundation for identifying, delineating, and characterising farming systems for Tanzania, along with local contextual data gathered through a regional workshop. Targeted field visits to respective regions provided detailed insights. The consultative workshop and preparatory meetings held in Morogoro on 14th -18th September 2015 provided a forum for wider stakeholder consultation and assess data needs and availability to support FS based planning. Regional field visits were undertaken during 18-24 July 2015 in the Morogoro region, focusing on maize-mixed farming systems and during 31 March to 3 April 2016 in the Arusha-Moshi area, focusing on the highland perennial farming systems. No specific field visits were undertaken for agropastoral systems.

Output

The process described above resulted in an update of knowledge and data sets, that will help identify interventions to enhance viability and competitiveness of smallholder farming systems embracing principles for climate-smart agriculture. This analysis will be presented in a publication in preparation for *Agricultural Systems*. The research team is also working with the Pathways/SIMLESA team to develop a *Policy Brief* highlighting the key lessons drawn from the SRA, as a summary for policy makers.

The digital maps prepared for consolations reflected a snapshot of a complex socio-environmental system that we identify as farming systems. Hence, they need to be viewed in its path to long-term transition in the broader landscape, as influenced by a number of socio-economic factors that drive changes in the natural assets that underpin these farming systems. The process used for developing these maps was designed to capture the joint influence of Tanzania's natural geography, as it interacts with the evolving economic and social processes that continue to modify the landscape. The field visits that followed Rural Rapid Appraisal principles allowed a better appreciation of forces that influence this transition.

In relation to the adaptation of climate-smart practices, it was neither logical, nor feasible to relate any specific adaptation options that will ensure climate resilience. Rather, it was clear that farmers respond to changes in the environment in an indirect manner by adopting practices that meet their personal appeal, reflecting their own personal circumstances that define the level of asset holding, available labour and an enterprise mix that will help meet family requirements. Clearly, these farming units that characterise each of these farming systems operate as 'optimising agents', within a number of often overlapping constraints.

Representing their resource allocation mechanisms in a formal planning model, such as a mathematical programming formulation to assess investment feasibility, was not attempted in this activity. Gathering data for a such an exercise was impractical, as even the well-informed local counterparts only realised the complexity of the task during field visits. In the absence of some form of record keeping, data collected from interviews based on recall would incur large margins of error. The broader characterisation of farming systems as offered in this study nevertheless provide useful guidance, in the absence of quantitative approaches to represent meaningfully the multiple criteria that define their 'optimal' choices.

Outcome

The SRA demonstrates how a complex web of factors that relate to the resource endowments, organising abilities and connectivity of the farming units that represent these farming systems determine the ability to factor in the knowledge, technologies and processes needed to become climate-smart. Primarily, the interactions between nature and society shape the underlying factors that contribute to vulnerability as well as adaptation strategies to mitigate those vulnerabilities. In that the productive assets have a bigger influence on responsiveness, by allowing to generate food supplies or cash flows conducive to taking advantage of new economic opportunities, or overcoming region-specific or broad constraints that impede change.

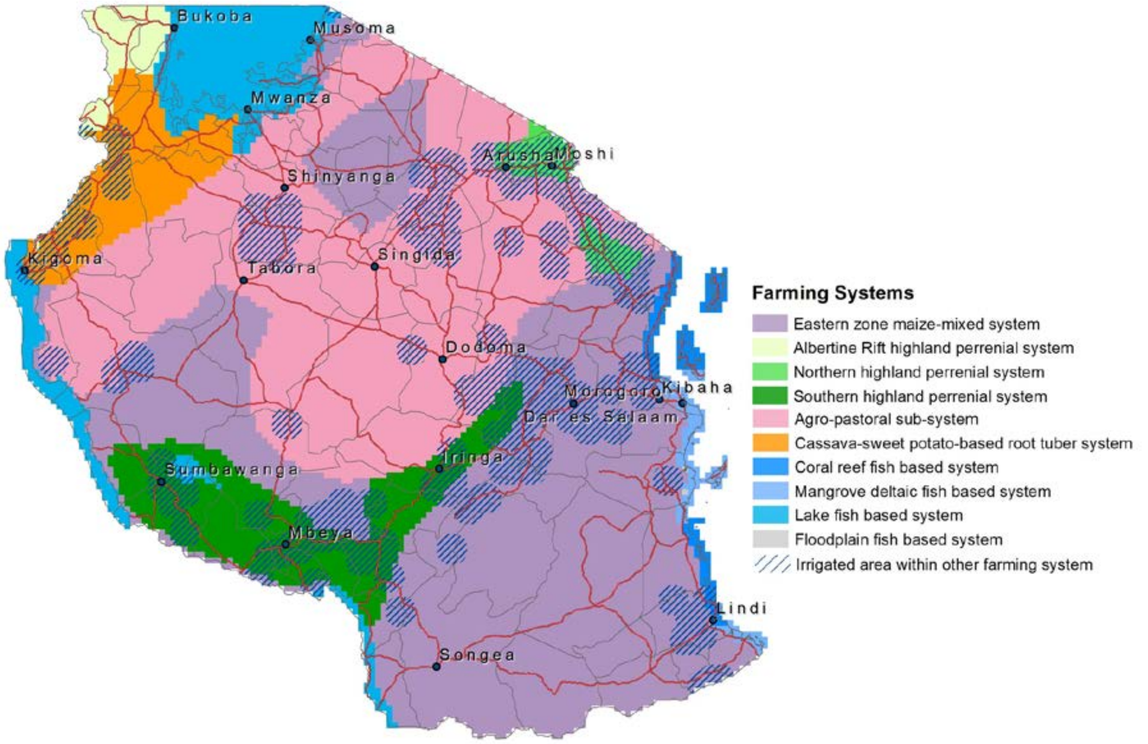
The study offered an avenue to emphasise to national, regional and local planners and policy makers, to whom this study was targeted, the importance of understanding the local context for successful policy planning and implementation. Smart interventions that take note of the local context and the evolutionary path of current farming systems could better address limitations in the current context that limits farmers' capacity for developing their livelihoods. Interventions, such as improved access to infrastructure stimulates income and wealth creation opportunities, as has been achieved in Chagga Farming Systems with good success show particular promise. It is important to note that the clear differences in the level of apparent productivity between Chagga Farming Systems in the Highlands and those of the maize-mixed systems in the lowlands owe largely to the differences in the ecology of underlying farming systems. In the absence of improved management, ecological settings limit the natural productivity of land, and returns to investment both on- and off-farm. Returns to labour and cash outlays associated with managing land with low natural productivity will be lower, unless scale economies can be achieved, an option unavailable to smallholder farmers lacking large areas of land. Agroforestry—the use of trees in farming, or intercropping—the practice of planting two or more crops in close in proximity, could benefit both farmers and the environment, and make them climate-smart.

To make these technologies accessible to more smallholder farmers, a concerted effort would be needed, such as to create off-farm income opportunities to supplement farm incomes. All the farms we visited have benefited from off-farm income at one stage or other. Off-farm income provides a sure pathway to allow farmers earn the necessary cash outlays to support intensification strategies such as artificial fertilizer, improved seeds and intercropping options to boost maze system productivity. However, if the frequency of unfavourable events such as droughts were to increase in par with climate change projections, maize-based farming systems and agropastoral farming systems could become increasingly more vulnerable and ineffective in providing year-round support for improving food security. Because these farming systems are highly diverse, prospects for commercialization opportunities for different farming systems needs to be further evaluated at a level of sub-systems and local organisation to identify location-specific opportunities. Such further analysis will help determine appropriate investment strategies and identify effective policy instruments that will drive efficient utilization of natural resources, including conservation where appropriate.

3 Introduction

Governments, multi-lateral development agencies and African regional organizations, e.g., Forum for Agricultural Research in Africa (FARA), the Comprehensive Africa Agricultural Development Program (CAADP) of NEPAD, World Bank, USAID and CGIAR centres are working to facilitate effective policies and strategies to drive agricultural growth and productivity. Identifying priorities for rural development in a landscape dominated by smallholders operating a multitude of farming systems has been an ongoing challenge. The growing diversity in farming conditions induced by climate change and globalisation exacerbates this challenge. Enhancing the adaptability of traditional smallholder production systems to function profitably under variable conditions is becoming crucial in creating a more sustainable and commercially oriented agriculture that can address food security and social development objectives. The SIMLESA and Pathways projects are developing important partnerships and providing research and analyses. But their focus is on ways to sustainably intensify maize-legume farming systems. To make the most from this investment, it is imperative to develop planning capability at the landscape scale where the farming system diversity is a key natural advantage, which is hitherto less well recognised in development targeting.

ACIAR-AIFSC has also supported the update and refinement for Sub-Saharan Africa of Dixon et al. (2001) global analysis of farming systems (FS). Outcomes of this FS regional analysis are being utilized for addressing a range of policy and research challenges in African agriculture through initiatives led by NEPAD/CAADP, FARA, and the CGIAR. ACIAR SRA in Ethiopia (CSE 2013/189) applied a national-level spatial FS classification for planning and priority setting (Amede et al., 2015). This activity extends the approach to Ethiopia in an attempt to building capacity in other countries and demonstrate its merits



and implementation challenges.

Figure 1: Key farming systems in Tanzania, identified following criteria used in Dixon et al 2001.

The SRA was set up in Tanzania, as a country with high agricultural diversity and rapidly evolving infrastructure and policy settings for agricultural development in alignment with CAADP. The activity was based around highland farming systems featuring the multi-storeyed agro-forestry cropping system on Mt. Kilimanjaro, and maize-mixed farming system in the southern plains and agropastoral farming systems that lie between these two systems (Figure 1). The purpose was to provide a useful contrast to the work concluded in Ethiopia. It will also highlight opportunities to integrate the FS approach into agricultural investment planning processes at the national level. The activity will showcase a FS-based approach to planning for application in other African countries and elsewhere in the developing regions.

4 Information needs for planning Climate-Smart Agriculture

Farm selection and characterisation
Key informants (extension officers or knowledge-able farmers) assisted in developing an initial list of farmers who were 'good' and 'poor' soil fertility managers (about 30 per site, 90 in total; Tittonell, 2003). Information on number and distribution of production units, components of the farm system, farm assets and infrastructure, management practices, labour supply and family composition was gathered at 20 farms per sub-location (60 in total) by means of a semi-structured questionnaire and by drawing farm transects together with the farmers. Their answers were triangulated by asking the same questions in several ways or during different visits to the farms, by confirming with other family members, other farmers and with extension officers. In farms headed by men, women were also interviewed and the information cross-checked, as women were involved in most activities regarding crop and soil management (Tittonell et al., 2005)
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The results
Interactions between nature and society shape the underlying factors that contribute to vulnerability. In that productive assets have a bigger influence on responsiveness, but perceptions did not influence responsiveness (Mudombi-Rusinamhodzi et al., 2012)

CSA

CSA seeks to support countries in securing the necessary policy, technical and financial conditions to enable them to sustainably increase agricultural productivity and incomes, build resilience and the capacity of agricultural and food systems to adapt to climate change, and seek opportunities to reduce and remove GHGs in order to meet their national food security and development goals. CSA is site specific and takes into consideration the synergies and trade-offs between multiple objectives that are set in diverse social, economic, and environmental contexts where the approach is applied. CSA builds upon sustainable agriculture approaches, using principles of ecosystem and sustainable land/water management and landscape analysis, as well as assessments of resource and energy use in agricultural and food systems. Innovative financing mechanisms that link and blend climate and agricultural finance from public and private sector are a key means for implementation of CSA, as are the integration and coordination of relevant policy instruments. The adoption of CSA practices at scale will require appropriate institutional

and governance mechanisms to facilitate the dissemination of information and ensure broad participation (FAO, 2012).
Add the improved stove

5 The agropastoral farming system

1. General Characteristics

The agropastoral farming system is identified as Livelihood Zone no. 4 and labelled "Semiarid sorghum livestock zone" in FAO (2012). The farming system is primarily found in the Singida, Dodoma and southern Manyara regions in the semiarid central zone of Tanzania.

Natural resource context
Rainfall in the drought-prone agropastoral system is unimodal and highly unreliable; it varies between 500 and 800 mm but can be as low as 400 mm. A long dry period occurs between May and November. The rains start in December and can be interrupted by a short dry spell between January and February. When this dry spell extends, crops planted at the onset of the rains fail resulting in food shortages. Low and unreliable rainfall is therefore one of the major constraints to agricultural production in these areas (Liwenga, 2008).

The landscape is made up of undulating plains at altitudes of 1,000 to 1,500 m above sea level with rocky hills and broad seasonal sand rivers. The resource base is generally limited. Soils are well-drained sandy loams of low fertility and deficient in organic matter content and as a result they are extremely erodible. The dominant natural vegetation is bush land with trees such as Acacia sp., *Combretum sp.* and *Commiphora sp.* There are also Miombo woodlands of *Brachystegia sp*. and baobab (*Adansonia digitata*), wooded grassland including bushland and thickets as well as grasslands found in depressions with black or grey alluvial seasonally water-logged cracking soils.

Production systems
The agropastoral farming system traditionally relies on mixed crop and livestock production. The main crops grown in this farming system include sorghum, finger millet, groundnuts, Bambara nuts, and cassava. Cropping is practiced in at least two types of fields. Fields located near the homestead are intensively managed, fertilised with manure from existing cattle pen or from the pens of old homesteads. Secondly, a system of shifting agriculture is practiced in bush fields located further away from the homestead where sorghum and millet fields are cultivated in a more extensive manner for two to three years before being left fallow. Farmers keep cattle, goats, and sheep. Livestock provides a means of adaptation to the harsh climatic conditions in case of crop failure. During the rainy season, cattle are kept near homesteads, and then driven away from homesteads in search of grazing during the dry season. Some private fields and communal grazing areas are purposefully set aside to serve as grazing reserves for the dry season. Major constraints to the livestock production systems include poor infrastructure, unfavourable land tenure, erratic rainfall, poor animal nutrition, shortage of water, animal diseases, low genetic potential of the animals and poor marketing structures.

The relative importance of non-farm activities for generation of cash income including the sale of forest products, weaving, knitting, pottery, small businesses, and wage employment is lower (34%) than in other farming systems. Subsistence is the primary orientation of 90% of farmers in the system, with only about 10% of emerging households aiming to produce a marketable surplus (FAO, 2012). Poverty prevalence (69%) in this farming system is also among the highest in Tanzania (Mnenwa and Maliti, 2010). Chronic food insecurity can affect about half of villagers in the most underserved villages of the Dodoma region (Msaki et al., 2013).

Trends and drivers of change

Despite food self-sufficiency at the national level, one third of the population is unable to meet their dietary energy requirements (Haug and Hella, 2013). Population density in the system is generally moderate (30 per sq. km). Government policies, economic factors, population growth, and changes in land tenure arrangements all have significantly influenced local livelihood patterns. In the agro-pastoral system, high veterinary input prices compelled farmers to diversify their livelihood activities by increasing the proportion of small ruminants (goats and sheep) that are more disease resistant than cattle, and engage in more crop-related livelihood activities (Mdoe et al., 2015).

Natural pastures in semi-arid central Tanzania are characterised by very rapid growth during the short rainy season, resulting in early maturity and rapid deterioration in nutritive value as the dry season sets in. Therefore, feeds available to the ruminant livestock during the dry season are in short supply and of low quality (Rushalaza and Kasonta, 1992). Livestock competition for available pastures leads to overgrazing and overstocking. The management of pasture reserves is constrained by land and water shortages, trespassing, uncontrolled fires and bush encroachment. The communal ownership of grasslands has contributed to deterioration and low investment in this resource (Kusekwa et al., 2000).

Increase in population generally leads to expansion in cultivated areas, and often causes conflicts between the different users of land and water resources.

Agriculture in this area is climatically stressed; being located in semi-arid areas, this farming system is predicted to be most affected by increased global warming. For Tanzania, the nationally projected impact of a 2°C seasonal temperature increase is an 8.8% reduction of sorghum yield and 13% for maize by mid-century (Rowhani et al., 2011). Thornton et al. (2009) ran the biophysical crop model CERES-Maize with a fine spatial resolution (10 arc-minute grids or ~18 km resolution) across East Africa, and predicted that maize yields in the semiarid region in Tanzania, of which this farming system is part, are likely to be reduced by 20% or more.

2. Investment potential

FAO (2012) indicates that even though irrigation farming is not common in this zone, its potentiality and feasibility are high, reducing the adverse impacts of droughts on farmer livelihoods. Water harvesting techniques can also be used. The incomes and standards of living of the smallholder agropastoralists of central Tanzania can be improved through introduction of improved genetic material of livestock coupled with improved feeding and general management.

Interventions promoting market orientation in this farming system have been shown to transform subsistence farming into commercial farming. The Expanded Market-Led Agriculture Programme (EMLAP) implemented by Farm Concern International in collaboration with World Vision Australia worked to empower small scale farmers to understand market demand, market linkages and production of agricultural products that are market led. In a span of less than two years, the key objective of this programme looks to have been achieved if not surpassed. EMLAP impacted a total of 5,260 smallholder farmers exceeding the set target by 260 farmers. Farmers were structured into Commercial Villages (CVs) across the region. Training was provided to these CVs on such thematic topics as savings, financial management, book keeping, post-harvest management, trade timing, bargaining skills and collective marketing. The training on various approaches led to the buying of about 14MT of different varieties of seed, purchase of 150 liters of fertilizer and 52 demo farms set up. Training on savings ensured that 80% of the members of commercial producer groups are now actively saving and savings are now worth $313,500. Through this initiative over 978.47 MT of assorted commodities valued at Tshs 750,449,600 (USD 469,031) were collectively sold through the commercial village model. Prior to the intervention more than 80% of sales happened at farm gate.

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Declining soil fertility, climatic extremes, high costs of inputs and poor extension services are critical problems in Sub-Saharan Africa and are strongly associated with declining agricultural productivity and increasing rural poverty. Increasing population has also led to conflicts between farmers and pastoralists as crop production continues to encroach on tradition grazing areas. Intensification of agriculture is one of the options to address these problems. Development of a sustainable agro-ecosystem requires an integration of productive (e.g. crop yield & fuelwood supply) and ecological functions of agro-ecosystems as well as enabling policies and markets. Trees/shrubs are an integral component of small-scale farming systems in the region, often retained or planted by farmers and thus contributing to increase production and resilience of farming systems. However, the contribution of tree/shrub-based technologies to sustainable agricultural intensification has not received due attention (Kimaro et al., 2012).

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10 Conclusions and recommendations

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Conclusions

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Recommendations

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11 References

References cited in report

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List of publications produced by project

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12 Appendixes

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