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CLIMATE SMART AGRICULTURE (P4S - CSA)

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Info Note

What is the evidence-base for climate-smart agriculture in Tanzania?

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Key messages

- Evidence exists to support CSA programming on the most widely cultivated crops (e.g. maize), and most common agricultural practices (e.g. fertilizer addition) in Tanzania
- However, products and places central to rural livelihoods such as livestock, coastal drylands, and humid regions near Lake Victoria are understudied.
- Data on how CSA changes agricultural productivity is widely available (77% of the data), while 20% of the data is related to resilience indicators, and only 3% deals with greenhouse gas mitigation outcomes.
- Practitioners should draw on this rich evidence base for CSA in Tanzania, while also prioritizing the generation of evidence for understudied products, agroecologies, and practices.

Climate-smart agriculture in Tanzania

The agricultural sector in Tanzania provides livelihoods to nearly three-quarters of the population and contributes nearly 95% of the country's food supplies (URT MALF 2017). However, climate change and land use change threaten food security through changing crop suitability, more frequent extreme events such as floods and droughts, increased pest and disease outbreaks, and land degradation (Figure 1). In response to food security and climate change challenges, the Government of the United Republic of Tanzania adopted the Climate-Smart Agriculture (CSA) Programme for Tanzania (2015-2025) in 2015 and launched the Tanzania Climate-Smart Agriculture Alliance in 2018. The CSA Programme aims to promote and enable the adoption of agricultural practices that achieve the three pillars of CSA: 1) sustainably increase agricultural productivity, 2) increase the resilience of agricultural systems, and 3) mitigate the effects of climate change where possible (FAO 2010).

Achieving widespread adoption of CSA practices requires that options be well-suited to the local agroecological and socioeconomic conditions, in order to deliver the multiple benefits promised by CSA. Decision-making for CSA requires evidence of what works where and for whom in order to make the best possible investments. But what information on CSA in Tanzania is available? And does that information match the actual farming systems that the population relies on?

In this brief, we compare the availability of scientific evidence of the impact of CSA management practices on the crops, livestock, and agroecologies of Tanzania with what crops Tanzanians are actually growing and where. The goal of this brief is to provide an overview of the evidence base for CSA in Tanzania: what options have been studied, in what agroecosystems, and what outcomes have been measured. By comparing the data with the composition of smallholder agriculture in the country, we identify key gaps in this evidence base that can serve to guide future research on CSA in the country.

Figure 1. Farmers in dryland areas of Tanzania, such as this village near Dodoma, will be subjected to increasingly erratic rainfall with climate change, making adoption of CSA a top priority. Photo: C. Schubert (CCAFS).

What is the evidence on CSA in Tanzania?

Using a systematic review protocol (Rosenstock et al. 2015), we searched for evidence in the peer-reviewed literature on over 100 potential CSA practices and more than 50 potential outcomes in Tanzania. For a study to be included in the resulting database, the TZ CSA Compendium, it had to contain primary, quantitative data on the change created by a CSA practice relative to a control (more conventional practice) for an outcome indicator relevant to at least one of the three CSA pillars: productivity, resilience, or mitigation (see in depth results in Lamanna et al. 2015).

Through our systematic review, we found 58 peer reviewed studies on potential CSA practices in Tanzania that fit our inclusion criteria. Of these, a little over half (55%) were conducted at research stations, while the other half were done in farmers' fields. While these studies have been conducted across the country, studies are generally clustered in a few locations and agroecological zones (Figure 2). In particular, the semi-arid zones around Dodoma and Morogoro, the Southern Highlands of Mbeya, and the Usambara Mountains of Kilimanjaro and Tanga regions have been well studied. This is not necessarily surprising as these areas have benefited from regionally-based agricultural research institutions in the area.

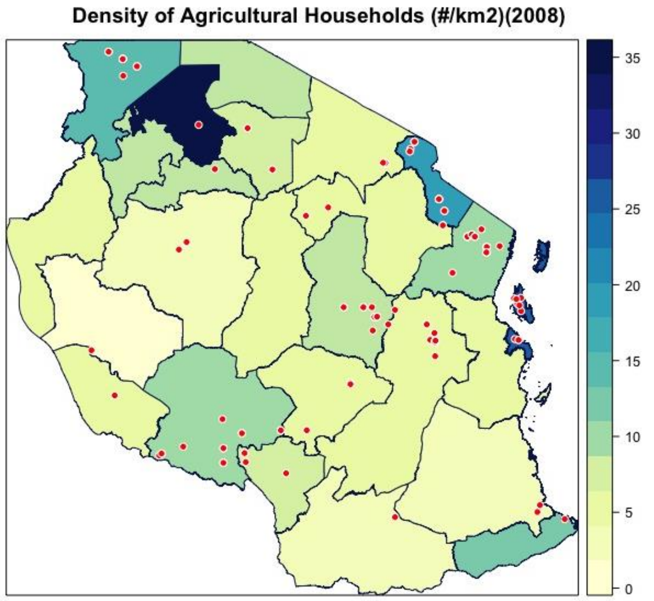

Figure 2. Location of studies on potential CSA practices in Tanzania in red, plotted on a map of the density of agricultural households in each of the 31 regions (URT MALF 2008).

The Tanzanian Agricultural Sample Census reports that smallholders produced 54 crops and 14 livestock products in the 2008 agricultural sample census (URT MALF 2008). While our database contains data on 28 of these agricultural products, not all of these products have been studied equally (Figure 3). Cereals make up the majority (60%) of products studied, with maize representing a full 55% of the database (and over 90% of the data on cereals). Animal-sourced products such as meat and milk make up only about 5% of the data.

Thirty-eight (38) different potential CSA practices have been studied in the TZ CSA Compendium. Fertilizer addition to crops is the most studied practice, with inorganic fertilizers comprising 34% of the data and organic fertilizers such as manure comprising a further 11% (Figure 4). Diversification practices including alleycropping with trees, green manure rotations, and intercropping are also represented in the dataset, as are soil water management technologies such as reduced tillage, *fanya juu/fanya chini,* zai pits, and mulching. Of the data on practices, 57% is from practices done in combination; that is, multiple CSA options implemented concurrently.

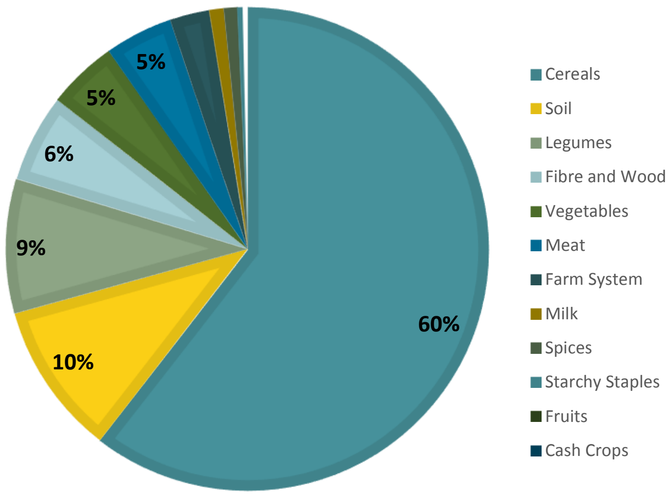

Figure 3. Representation of agricultural products in the TZ CSA Compendium. Cereals make up the majority of the dataset, while other nutritionally important products such as legumes (9%), vegetables (5%), and meat represents a much smaller proportion of data.

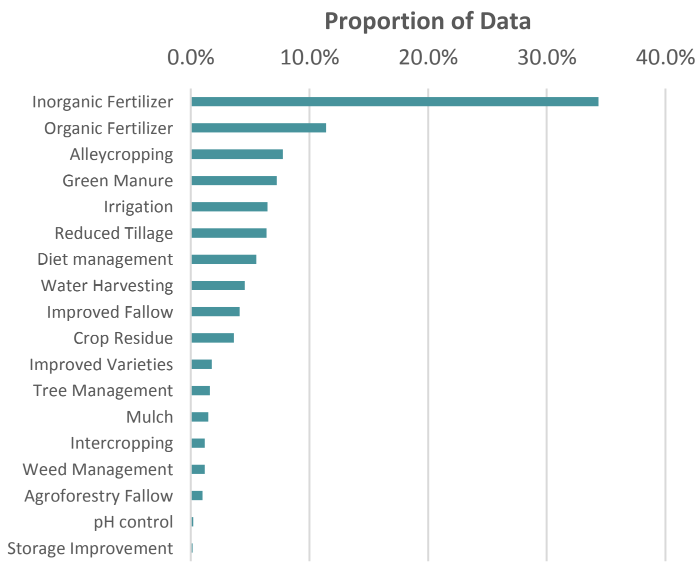

Figure 4. Distribution of data in the TZ CSA Compendium by practice/technology.

CSA is based on the idea that appropriate agricultural practices can deliver multiple benefits, particularly across the three pillars of productivity, resilience, and mitigation. The TZ CSA Compendium contains data on 10 different outcomes of CSA and 19 specific indicators. However, the majority of the data comes from the productivity pillar: 77% of the data is on a component of productivity, such as product yield or net returns, and nearly all of this data is on yield (Figure 5). Only 20% of the data is related to resilience indicators, such as soil health or input use efficiencies, while only 3% deals with mitigation outcomes such as GHG fluxes or soil carbon stocks. The majority (72%) of studies in the TZ CSA Compendium contain data on only one pillar, while 26% have measured outcomes in two pillars (typically productivity and resilience). Only one study in our dataset addressed all three pillars of CSA.

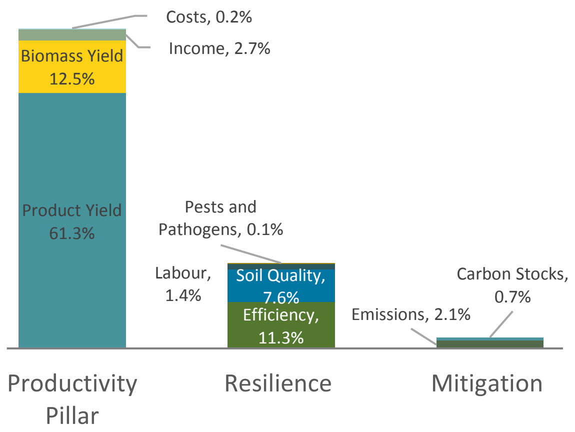

Figure 5. Distribution of data in the TZ CSA Compendium across the three pillars of CSA, and their individual indicators.

Key Knowledge Gaps

Compared to other countries in Africa, Tanzania ranks 5th in terms of the number of agricultural research studies on potential CSA practices and technologies that have been published. This relative wealth of agricultural research provides a rich evidence base for decisions. Yet there are still some key gaps in the evidence base, particularly when we compare the available evidence to actual Tanzanian farming systems. In this section, we compare the distribution of data available on CSA from the TZ CSA Compendium above with the characteristics and distribution of Tanzanian smallholder farming households, based on data from the latest Tanzanian Agricultural Sample Census (URT MALF 2008).

Products: The majority of smallholder farmers (69%) in Tanzania grow maize, however this varies from more than 95% of farmers in Tabora and Iringa regions to less than a third of farmers in coastal regions such as Dar es Salaam and Pwani (URT MALF 2008). The majority of CSA research in the country has been done on management options for maize, and thus creates useful information for the majority of farmers in the country. One key mismatch between the available data and actual farming systems, though, is with **livestock** (Figure 6a). About one-third (31%) of smallholder farmers in Tanzania keep livestock along with their crops, varying from a low of 11% in Lindi to a high of 53% in Singida (URT MALF 2008). However, only 5% of agricultural research in Tanzania has been conducted on livestock, and even less on crop/livestock integration. While the majority of the livestock data we do have is on cattle, small stock and chickens are important livestock species particularly in the more coastal regions (in Lindi <2% of households have cattle).

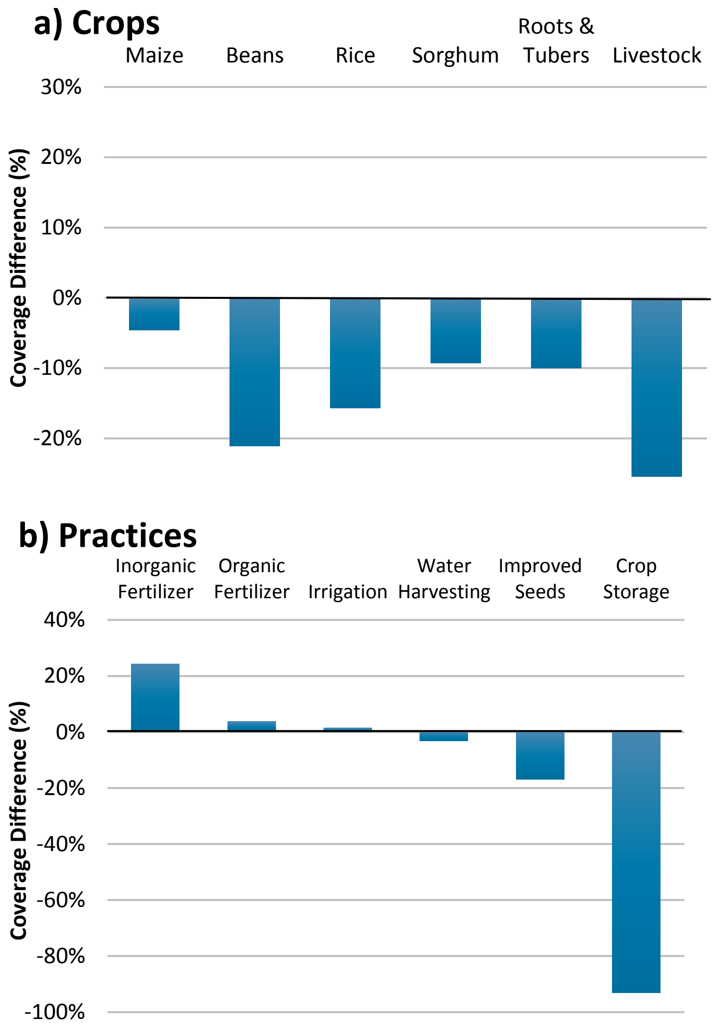

Figure 6: Comparison of coverage of a) agricultural products and b) practices in the database (% of data) with frequency of that product or practice being utilized in Tanzania (% smallholder households). Positive values mean that product or practice is relatively overstudied, while negative values mean it is relatively understudied.

Key crops that are critical to food and nutrition security in Tanzania are under-represented in the literature on CSA. **Beans**, which are the second most important crop in TZ grown by 30% of farmers, and provide key dietary protein for many Tanzanians, only make up 9% of the database. Additionally, **starchy roots and tubers** such as cassava, a potentially important crop for increasing food security in times of drought, are understudied.

Practices: Compared to their prevalence in Tanzania, the addition of fertilizers and irrigation are well studied (Figure 6b). Contrastingly, nearly every household in Tanzania practices some form of **crop storage** (93%), but only one study in our dataset addressed crop storage, accounting for <0.1% of the data in the dataset. Similarly, nearly all households report soil erosion problems in Tanzania (91%), but specific practices used to combat erosion such as **contouring** make up less than 5% of the data available. Thus, there are potential CSA practices with wide adoption potential and impact that have been neglected in formally-published agricultural research in the country.

Agroecological Zones: When we compare where agricultural research has been conducted with where smallholder farmers live (Figure 2) and the corresponding agroecological zones, some key gaps emerge. One of the most densely populated areas of Tanzania is the region surrounding **Lake Victoria** in the Northwest. Nearly 26% (over 1.5 million) of Tanzania's smallholder farming households lives in the regions bordering the lake, but less than 10% of the research in our database took place there. Not only does this region support a large proportion of Tanzania's households, it also has unique agroecologies, such as humid forest supporting highland perennial agriculture, and sub-humid savannahs, which are the country's main region for root and tuber production.

Coastal communities are also underrepresented, despite the fact that they support nearly 20% of the country's smallholder farmers. Although there is some research on the uniquely coastal spice agroforestry, the most common staple crops grown in sub-humid coastal agroecosystems are unstudied. In Zanzibar the most common agricultural crops are rice, sweet potato, maize and cassava in that order. Coastal areas also provide unique agricultural systems, such as seaweed cultivation, which are important for income, diversification and nutrition, that have not been given research attention.

Outcomes: Finally, there are also gaps in our knowledge of what outcomes can be expected from implementing CSA in Tanzania. Although **mitigation** of climate change through reduced emissions or carbon storage is one of the three pillars of CSA, there is virtually no evidence on how various CSA practices *change* greenhouse gas emissions, soil carbon stocks, or aboveground carbon storage incountry (but see Kimaro et al. 2015 for an example). While we have ample evidence of how CSA options influence yield (particularly for maize), there is little accompanying **economic information**, which is critical to building business models for successfully scaling up CSA adoption. Lastly, there is a lack of data on the impact of CSA adoption on gender-differentiated outcomes such as labor, income, or decision-making, which can be critical to improving food and nutrition security and increasing the resilience of smallholder households to shocks.

Conclusions and policy implications

The results of this exercise show that there is a wealth of information on potential CSA practices in Tanzania. However, this evidence base isn't comprehensive. In particular, key gaps exist for livestock, non-cereal crops, humid and coastal agroecologies, and crop storage. Agricultural research and development in the country should consider expanding activities in these sectors and regions in order to build a more complete picture of climate change and agriculture in Tanzania.

Further Reading

- Lamanna, C. *et al.* 2015. Evidence-based opportunities for out-scaling climate-smart agriculture in East Africa. CCAFS Working Paper no. 172. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security.
- Rosenstock, T.S., *et al*. 2015. The scientific basis of climate-smart agriculture: A systematic review protocol. CCAFS Working Paper no. 136. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security.
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- Kimaro et al. 2015. Is conservation agriculture climate-smart for maize farmers in the highlands of Tanzania? *Nutrient Cycling in Agroecosystems*.

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