

# Climate-Smart Agriculture in Tanzania

## Climate-smart agriculture (CSA) considerations

**A P M** Tanzania's agriculture sector is an important catalyst for economic growth, poverty alleviation, and food security. Nevertheless, the economic losses from climate change impacts on agriculture are estimated at US\$200 million every year. The scaling up of climate-smart agriculture (CSA) practices presents an opportunity to reduce such losses, build resilience in the agriculture sector, improve productivity and farmer incomes, and contribute to climate change mitigation.

**M** Estimates indicate that the livestock sub-sector contributes the most to agricultural greenhouse gas (GHG) emissions. An increased focus on the development and scale-out of livestock based CSA programmes are required in order to support the country along a low emissions development pathway.

**A P M** Viable CSA practices identified for the country include improved fodder production, grazing management, water harvesting, agroforestry, conservation agriculture, cover cropping, integrated aquaculture and integration of biogas energy into farms.

**I** Scant evidence of the impacts of various CSA practices in different agro-ecological zones and production systems challenges their promotion and on-farm adoption. Strengthening national and local knowledge, information and evidence on different CSA practices will be an important step towards better targeting and prioritisation of CSA investments and hence improved adoption.

**I \$** The government-led CSA Programme and the CSA Guideline provide favourable mechanisms to promote

CSA as well as to direct public, private and international funding towards CSA in the country.

**I** The Tanzania Climate-Smart Agriculture Alliance (TCSAA) represents a promising opportunity for improved coordination, dialogue and information sharing on CSA and there is need to ensure financial, administrative and technical support for the platform.

**A P M** Most of the CSA practices identified in the country are site-specific and hence understanding of the different socio-economic and environmental contexts across the country is crucial when designing scale-out strategies.

**I \$** Public-private partnerships and the organisation of farmers into cooperatives present good opportunities to enhance smallholders' access to credit for CSA investments, particularly from micro-finance institutions.

**A P M I** Wider adoption of CSA technologies and practices can also be facilitated through strengthening of the extension services on climate related matters, conducting of farmer field trials for various CSA practices and enhancing access to CSA related input and output markets.

**I** Capacity building on agricultural greenhouse gas inventories and use of improved GHG modeling tools could be an important step in helping the country to better monitor, report and verify GHG emissions in the agriculture sector.

**A** Adaptation    **M** Mitigation    **P** Productivity  
**I** Institutions    **\$** Finance

The climate-smart agriculture (CSA) concept reflects an ambition to further integrate agricultural development and climate responsiveness. CSA aims to achieve food security and broader development goals under a changing climate and increasing food demand. CSA initiatives sustainably increase productivity, enhance resilience, and minimise greenhouse gas (GHGs) emissions. Increased planning is vital in order to address tradeoffs and synergies between the three pillars: productivity, adaptation, and mitigation [1]. By addressing challenges in environmental, social, and economic dimensions across productive landscapes, CSA practices and technologies coordinate the priorities of multiple countries and stakeholders in order to achieve more efficient, effective, and equitable food systems. For

the Tanzanian context, CSA is agriculture that sustainably increases productivity and income, ability to adopt and build community resilience to climate change and enhances food and nutrition security while achieving mitigation co-benefit in line with national economic development priorities. While the concept is new and still evolving, many of the practices and technologies that make up CSA already exist worldwide and are currently used by farmers to cope with various production risks [2]. Mainstreaming CSA requires a critical mapping of successfully completed, on-going practices and future institutional and financial enablers. This country profile provides a snapshot of a developing baseline created to initiate discussion at national and global levels about entry points for investing in CSA at scale



# National context

## Economic relevance of agriculture

The agriculture sector contributed approximately 32% to the country's National Gross Domestic Product (GDP) in 2015 [3], mostly through food crop production, which accounted for approximately 65% of the agricultural GDP<sup>1</sup> [4]. Almost a third of the total export earnings come from agriculture [5]. The sector employs approximately 13 million people, the equivalent of 59% of the economically active population [3]. Roughly half of the agricultural labor force is represented by women who produce more than 70% of the country's food [4]. Approximately 7.2 million youth make a living from agriculture. Fresh water and marine fisheries also play important roles in Tanzania's economy and contribute to employment, food security and incomes. Low productivity has been linked to a combination of several factors, including: over-reliance on rainfall, utilisation of rudimentary and unsustainable production methods, poor access to inputs, and low extension service capacity to deal with climate change issues [2]. Closing the agricultural yield gap would offer opportunities for agricultural sector growth and livelihoods improvements throughout the county.

years, approximately 28% of the population lives below the poverty line [7] and about a half with less than US\$ 1.90/day. Unemployment rates amount to 86%. Tanzania has one of the lowest Human Development Indices in the world, currently at 0.521 [8]. Only 15% and 55% of the population have access to electricity and potable water, respectively [3]. Ownership of productive resources is skewed towards men; barely 20% of the women have ownership of agricultural land [3].

## People, agriculture and livelihoods in Tanzania <sup>[3, 5, 6]</sup>

### Demographics

53 million people live in Tanzania



### Distribution of wealth (Index)

0 = Absolute equality  
1 = Absolute inequality

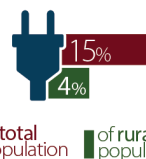


### Access to basic needs

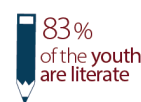
Potable Water



Electricity

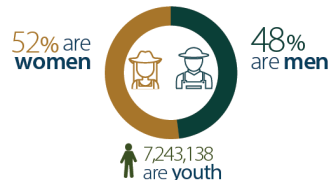


Education



### Jobs in agriculture

60% (13 million) people are employed in primary production agriculture



### People living below

US\$3.10/day



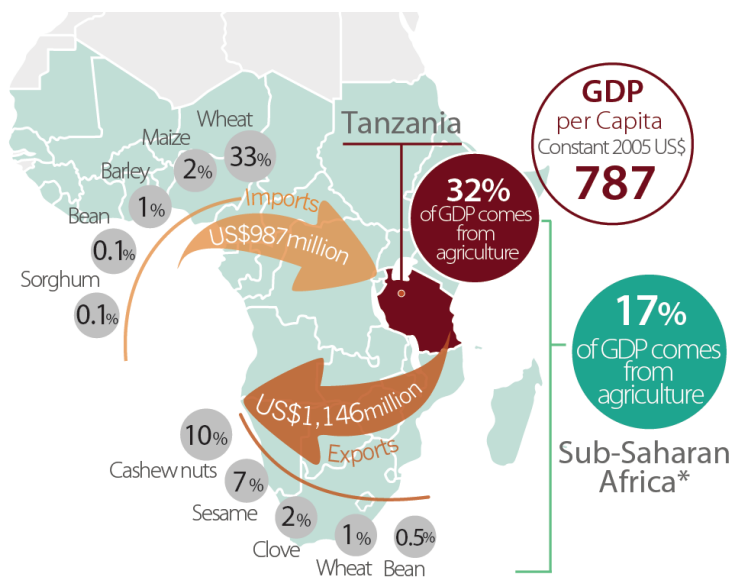
US\$1.90/day



National poverty line



## Economic relevance of agriculture in Tanzania <sup>[3, 5]</sup>

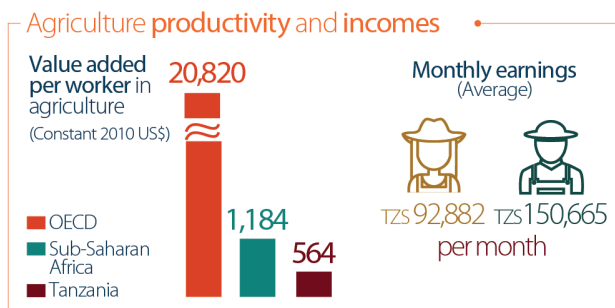
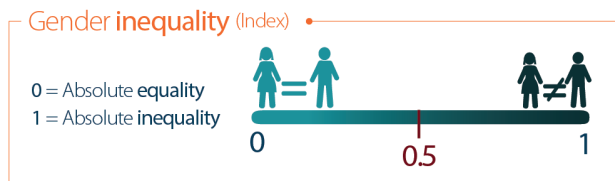


\*Sub-Saharan Africa: Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo (Brazzaville), Congo (Democratic Republic), Côte d'Ivoire, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gabon, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Réunion, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Western Sahara, Zambia, Zimbabwe

## People, agriculture, and livelihoods

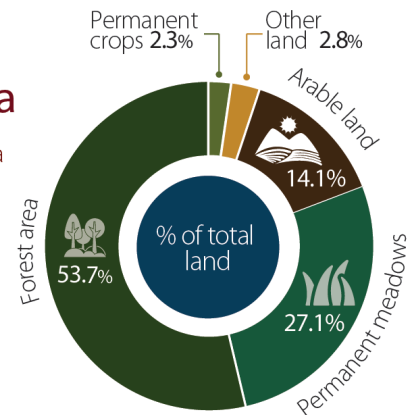
Tanzania's population was estimated at 53 million people in 2015, 68% of them residing in rural areas [3]. Despite the country's remarkable economic growth in recent

1 Maize share to agricultural GDP amounts to 20%.



## Land use in Tanzania [5]

**Agricultural area**  
**38,480,000 ha**  
= **43%** of total land area



## Agricultural production systems

The country is divided into 64 agro ecological zones (AEZs) based on rainfall patterns, altitude, soil water holding capacity, growing seasons and physiographic features [14] (See Annex 1). Key farming systems include plantations for tea, coffee and sisal and maize/legume systems in Shinyanga, Rukwa, Morogoro, Arusha, Kigoma, Kagera Iringa and Mbeya [15]. Agricultural production is dominated by small-scale, subsistence farmers [3], with average farm sizes ranging between 0.2 and 2 ha. Only 1.5% of the arable land is under irrigation [16, 17]<sup>3</sup>. Agricultural input utilisation is relatively low, compared to regional averages.

The main food crops cultivated in Tanzania are maize, rice, cassava, banana and potatoes, whereas major cash crops include coffee, tea pyrethrum, tobacco, cashew and sisal. Maize is grown throughout the country, despite unsuitable soils and climate in some areas.

The country has one of the largest livestock populations in Eastern Africa, though contribution of the livestock sector to agricultural GDP is relatively low, estimated at 7.4% in 2015 [13]. Indigenous breeds of cattle, sheep, goats, poultry and pigs are most common livestock types in Tanzania. Livestock production is mostly extensive, practiced by pastoralists and agro-pastoralists on natural pastures. Intensive and semi-intensive systems are common for improved crossed or pure livestock breeds. Pastoralism predominates in arid and semi-arid areas like Central Dodoma, Singida, Shinyanga, Simiyu, the north-eastern parts of the county such as Manyara, parts of Arusha and Northern Iringa.

Based on economic contribution, productivity and nutrition quality indicators, key production systems were selected for further evaluation and inclusion in the country CSA. More information on production system selection criteria is found in Annex 2.

## Land use

Tanzania has a total land surface area of 885,800 square kilometres [Km<sup>2</sup>] [9], of which 44 million hectares (ha), (approximately 46%) has potential for crop production. However, a large portion of this land is only marginally suitable for agriculture, due to reduced soil infertility, erosion, degradation and proneness to drought. As a result, only approximately 32% of the land was cultivated in 2014, a significant increase from 2011, when this area was equivalent to about 23% of the arable land<sup>2</sup>[4]. The high population growth rate (about 2.7%) has contributed to significant land degradation and forest cover loss. The country has a deforestation rate of about 372,000 hectares per annum [10].

Roughly 9.1 million hectares (approximately 10.5% of the total land) are classified as rangeland [11, 12, 13]. Availability of pastures and water for livestock largely depend on seasonal rainfall thus making the livestock sub-sector vulnerable to drought. In the semi-arid areas, where over 90% of the traditional livestock are found, rainfall ranges between 400-600mm per annum.

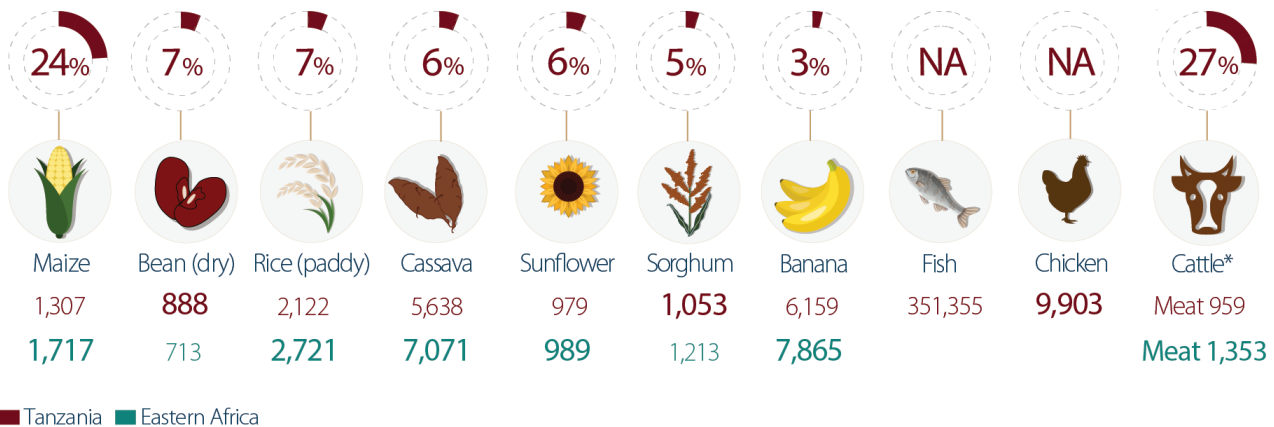
Fisheries represent the main livelihood source on the country's coastline (including Zanzibar and Pemba Islands), which stretches along approximately 1,424 km of the Indian Ocean.

2 This figure on total arable land differs slightly from FAO estimates [5].

3 The five-year average (up to 2013) reported by FAO-Aquastat estimates an area under irrigation of approximately 2.3% [17].

## Production systems key for food security in Tanzania<sup>[5]</sup>

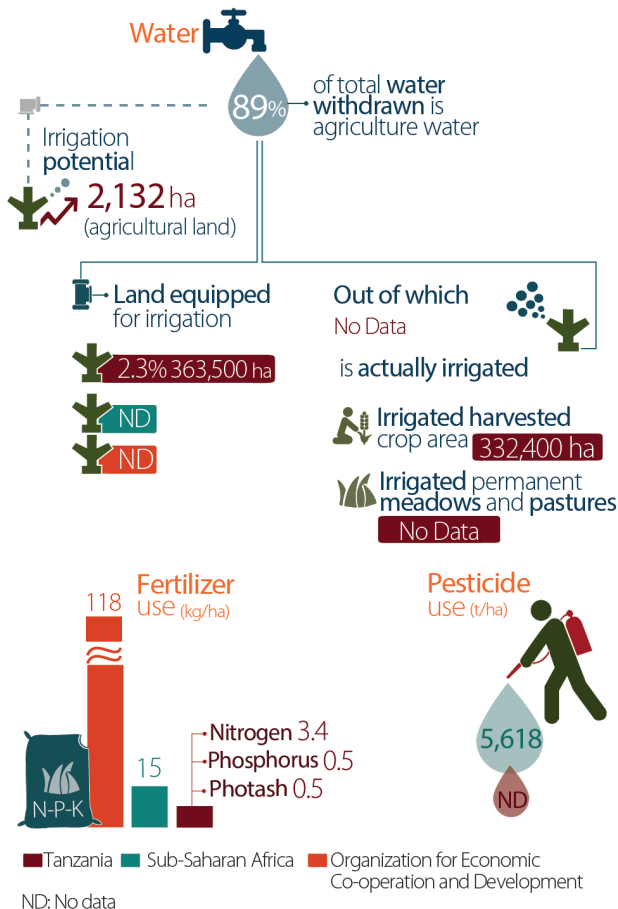
### Land use (% of total harvested area)



\* Permanent meadows and pastures as % of total land

### Yields (Crops: kg/ha, Cattle: hg/animal, Fish: Mt/year, Chicken: 0.1g/animal)

## Agriculture input use in Tanzania<sup>[3, 5, 17]</sup>



## Food security and nutrition

Tanzania ranks 94th out of 113 countries in the Global Food Security Index [18], indicating overall slow progress towards achieving food security targets [19, 20]. One-third of the population is undernourished, while underweight and wasting rates among children under the age of five remain high [3].

Food insecurity is prevalent in low-income households (particularly among people living below the poverty line), where there is high reliance on agriculture for subsistence. From a seasonal perspective, the people most exposed to food shortages are the ones located in the north, east, and northwest, where climate shocks (droughts) and changes (reduced rainfall) are more severe [19]. High food prices, pests and diseases that affect crop production, and low use of farm inputs, are other factors affecting population's food security.

Previous research has revealed that, while the quantity of food consumed by the population decreased (measured through calorie intake in the households), the diversity of the diets (referring to micronutrient intake) increased [19]. Middle- and high-income groups of the population are transitioning towards energy-dense diets, while people belonging to the low-income group, particularly those located in rural areas, remain highly food energy deficient.

However, updated information on the status of food security and nutrition in Tanzania is scarce and existing reports rely on data collected more than five years ago. This reiterates the need for strengthening national information systems in order to improve decision-making on targeted economic, development, and agricultural investments.



## Food security, nutrition, and health in Tanzania <sup>[3, 5, 18]</sup>

### Food security

Score 0-100\*

Global\*\* 57

Tanzania 37

Sub-Saharan Africa 36

1 of 3 people  
  
 is undernourished

\* Takes into account aspects of affordability, availability, and quality  
 \*\* Refers to the 113 countries included in the Index

### Food aid (2012)

42,109 metric tons  
 (cereals 83%)

Emergency  
 19,851 mt



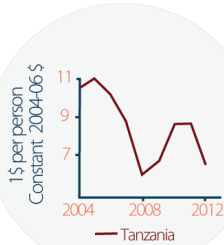
Project aid  
 22,258 mt

Programme aid  
 No data

Changes in total  
 food aid  
 (from 2012 to 2011)  
 -51%

### Food security indicators (selection)

#### Stability



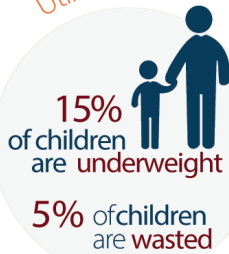
Per capita food production  
 variability

#### Availability

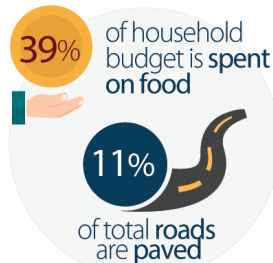


Calories available  
 (kcal/capita/day)

#### Utilization




#### Access



### Health

#### Access to clean energy sources

4%   
 of the population  
 has access to  
 clean energy  
 sources  
 (non-solid fuels)  
 for cooking

#### Child Mortality rate

Under-five mortality  
 rate (per 1,000 live  
 births):  
 53

#### Adolescent fertility rate

 123  
 births per  
 1,000  
 women,  
 ages 15-19

#### Prevalence of HIV infections

 5%  
 people  
 infected  
 with HIV  
 6%  
 are women  
 (age 15+)

## Agricultural greenhouse gas emissions

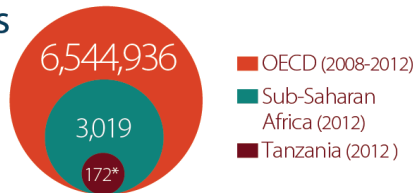
Accurate data on economy- and sector-wide greenhouse gas (GHG) emissions is relatively scarce for Tanzania. Notwithstanding, data for 2012 indicates an average of 171.73 tons of CO<sub>2</sub> equivalent [21] (including emissions from land use change and forestry sector [LUCF]) and per capita GHG emissions of approximately 2.7 tons of CO<sub>2</sub> equivalent [10], depending on the source and accounting methods. Agricultural emissions are mostly related to methane (CH<sub>4</sub>) emanating from enteric fermentation in livestock production.

Projections show a potential twofold increase in total emissions by 2030 [22], under a scenario of continuous population growth, increased deforestation, expansion of agricultural land and farming activities, free-range livestock keeping, continued use of biomass energy, and the current industrial development pathway the country is pursuing. As such, implementation of low-carbon options, such as energy-efficient stoves for reduction of wood fuel utilisation, manure management, and utilisation of biogas could support existing efforts to diminish emissions levels in the country. In addition, improved measurement of GHG emissions in the agriculture sector, particularly focusing on the emissions reduction potential of various CSA practices and technologies, can incentivise the adoption and scale-out of CSA practices and technologies that were originally targeted for adaptation and productivity objectives.

## Greenhouse gas emissions in Tanzania [3, 5, 21]

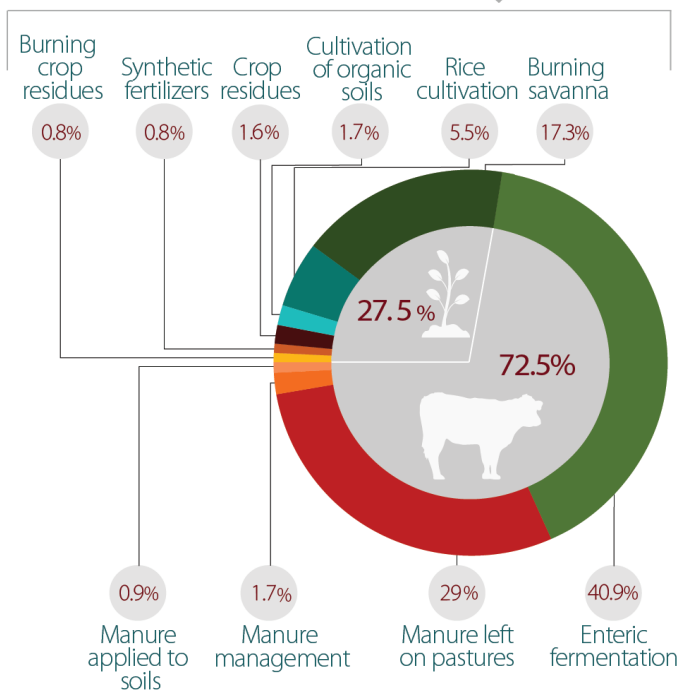
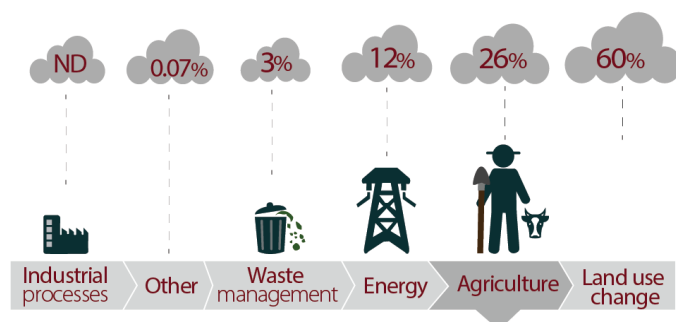
### Total emissions

Mt CO<sub>2</sub>e



\* Includes emissions from land use change and forestry

### Sectoral emissions (2012)



## Challenges for the agricultural sector

The agricultural sector has experienced a stagnant growth rate of 4.4% over the past years, compared to an expected rate of 6% as outlined in the Comprehensive Africa Agriculture Development Programme (CAADP) Framework [23]. This has been associated with continued soil degradation due to rapid population growth and poor implementation of existing policies, inappropriate use of technologies (such as increased use of fertilisers on mono-cropping systems), soil erosion due to poor livestock rearing practices and continued use of traditional cropping methods (hand hoes), among others. For livestock in particular, some of the main challenges include inadequate zoning for grazing land, poor infrastructure for livestock products marketing, as well as high incidence of livestock diseases and pests [24].

A low extension to farmer ratio and limited technical capacity of local governmental authorities to deliver agricultural information (particularly CSA-related) has slowed down the uptake of practices and technologies by small-scale farmers. Agricultural practices and their potential to increase productivity and climate resilience have been insufficiently documented; hence CSA has hardly been on the agenda of agricultural extensionists. Additionally, low budgetary allocation to the agriculture sector<sup>4</sup> has contributed to an understaffing of extension services and a reduced capacity to invest in climate adaptation and mitigation actions.

Poor road networks in the country hinder access to domestic input and output markets. Despite the country's membership to the East African Community (EAC), the Common Market for Eastern and Southern Africa (COMESA), and the Southern African Development Community (SADC), agricultural produce commercialisation on regional and international high-value markets remains a challenge, especially for horticulture and dairy farmers who lack the incentives to adopt productivity-enhancing technologies.

High crop post-harvest losses, which amount to 20-40% annually [25], and minimal value addition further hinder access to markets. The majority of farmers sell raw, low value produce to middle men who make most of the profit. Limited farmer organisation and low business and entrepreneurship skills, mean farmers lack collective buying and bargaining power related to commercialisation and credit access.

Dependence of agriculture on rainfall increases exposure to climate risks, particularly to frequent droughts and periodic flooding [26]. Drought is in fact the most problematic climatic hazard in the country, especially in regions like Dodoma, Singida, the northern parts of Iringa, north-eastern parts of Tabora, eastern areas of Shinyanga, Simiyu, south-eastern parts of Mara, parts of Manyara, north-western parts of Arusha and south-western parts of Kilimanjaro. In the event of extreme drought, it is estimated that pastures and water resources can only support 13% of all ruminants

4 In Tanzania, the agriculture sector receives less than 10% of the national budget, which is below the minimum allocation set in the 2014 Malabo Declaration of 2014 [9].

[13], leading to deterioration of livestock conditions and increases in livestock mortality. Roughly 400,000 cattle died during the 2009 drought [27].

Only 2.3% of a total of 15.8 million ha of land suitable for irrigation is currently equipped for irrigation. Lack of finances and technical know-how at the district level impair full exploitation of irrigation opportunities [4]. Weather variability and climate change have further diminished water volumes in many water bodies including the Ruaha and Ruvuma Rivers, which has challenged irrigation and contributed to increased livestock migration. High production and marketing risks linked with weather variability have also discouraged private sector investment in agriculture.

In addition, a number of crop diseases have increased in incidence, including coffee wilt, batobato (African Mosaic) in cassava, banana xanthomonas, elihuka, cassava mosaic, cassava root rot and maize streak. Such pests and diseases have particularly high occurrence near water bodies like Lindi, Kigoma, Mara, Mtwara and Mwanza [28].

Where subsidies were widely available for farmers, these have many times contributed to increases in productivity at the expense of natural resources availability and quality. For instance, fertilisers contributed significantly to environmental degradation, in the absence of preliminary soil tests and capacity building of farmers and extension workers to ensure appropriate fertiliser use.

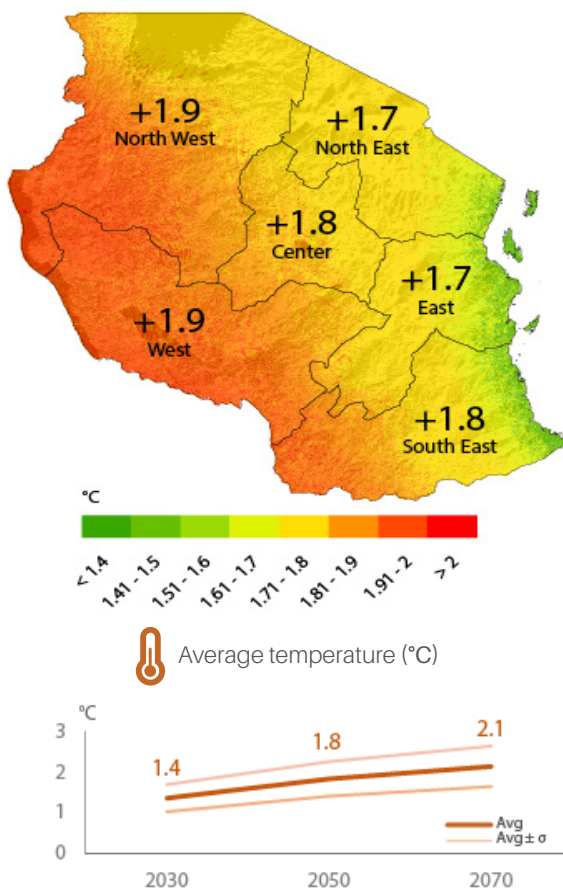
## Agriculture and climate change

The adverse effects of climate change in Tanzania have already been documented in several government reports [4, 9, 12, 23, 26, 29]. The observed impacts include increased rainfall variability, reduced water volumes in water bodies such as rivers and lakes [29], increased pest and disease incidence due to increased temperatures, salt water intrusion (common in the coastal areas and Zanzibar), geographical shifts of AEZs and ecosystems and replacement of perennial crops with annual crops owing to reduced crop cycles [26]. Small scale farmers are more likely to suffer the adverse effects, given their reduced adaptive capacity [4].

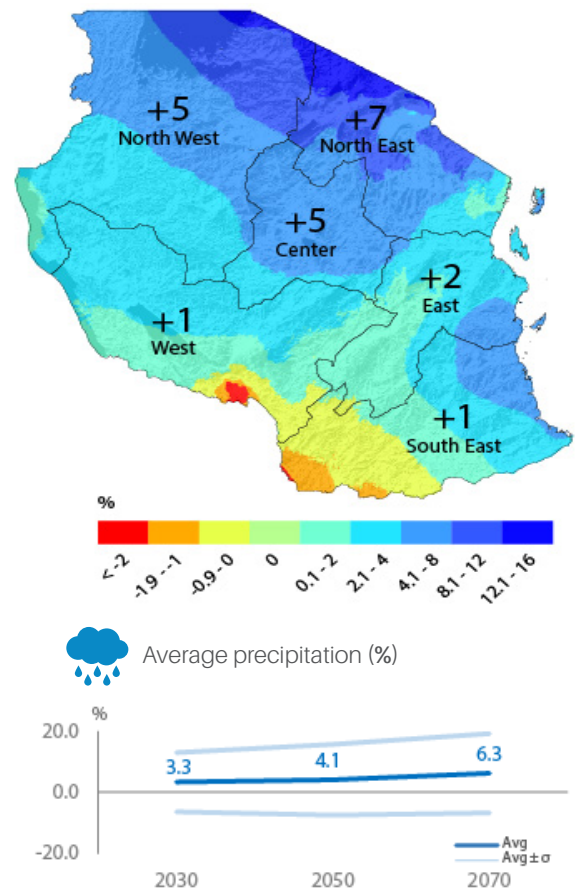
Climate projections indicate an increase in temperatures by 1.4°C by the 2030s and 2.1°C by 2070. The West and North-West will most likely experience faster warming (+1.9°C) relative to the coastal regions (+1.7°C). While historical rainfall trends have shown a decrease in precipitation [4] and climate models for future rainfall regime changes are rather uncertain, it is generally agreed that precipitation levels will increase throughout the country, with uneven regional distribution. The largest increases are most likely to occur in the North-West (+7%), Centre and the North-East. Nevertheless, rainfall variability is expected to increase and reliability to reduce, as extreme events (droughts) are expected to be more frequent and severe.

### Projected changes in temperature and precipitation in Tanzania by 2050 [31, 32, 33]

Changes in annual mean temperature (°C)

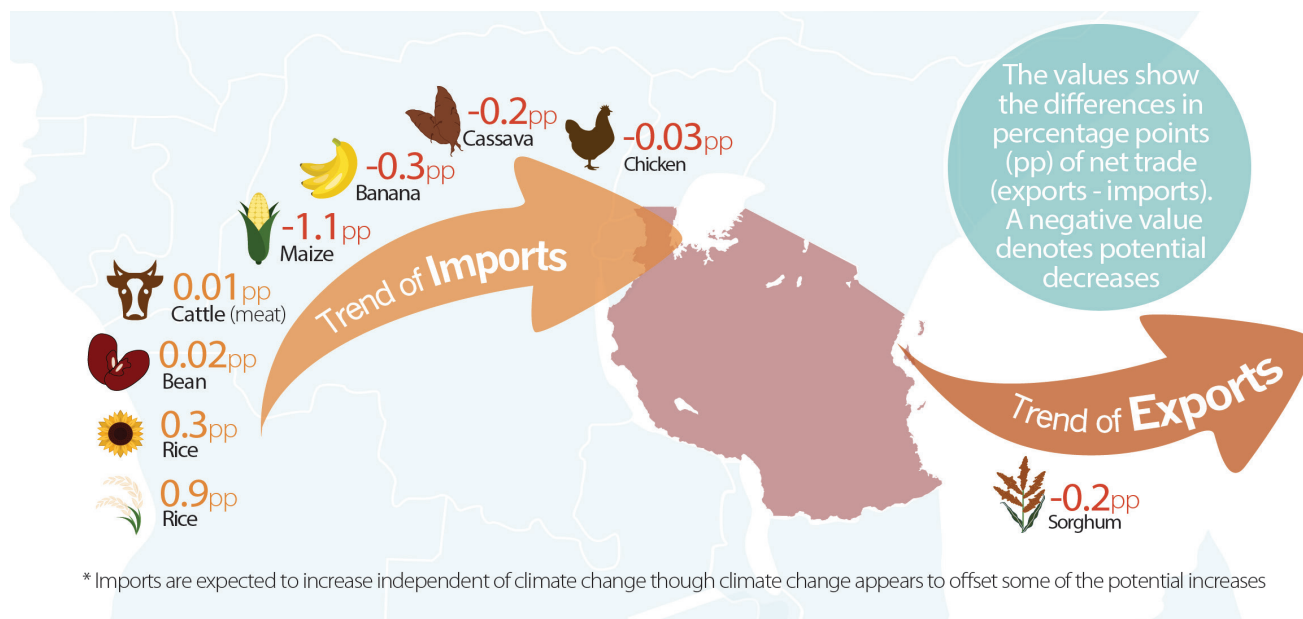


Changes in total precipitation (%)



## Potential economic impacts of climate change

### The impact of climate change on net trade in Tanzania (2020-2050) [35]



The International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT<sup>5</sup>) was used to analyse the effects of climate change on agriculture in the country<sup>6</sup>. This assessment focused on the three parameters, namely net trade, crop area (or livestock numbers) and yields, for scenarios with and without climate change (CC and NoCC).

Results on the impact of climate change on crop area are heterogeneous, showing an increase in banana, cassava, sorghum and rice cultivated area by 2.49 percentage points (pp), 0.51pp, 2.32pp, 1.93pp, and 1.09pp respectively by 2050 under the CC scenario. Maize area will likely decrease even under the NoCC scenario, as also observed in previous studies [4, 26, 28, 33]. The same impact is also expected for sunflower areas.

While all crops are likely to experience an increase in yields over the 2020-2050 period, the IMPACT model indicates that these will be affected by climate change. Specifically, yield increases for banana, beans, cassava, rice, sorghum, and sunflower are expected to be lower by 2.67pp, 2.49pp, 0.59pp, 0.14pp, 4.1pp, and 5.4pp respectively compared to a scenario without any further changes in climate. Maize yields, on the other hand, are projected to decrease under both scenarios.

The impact of climate change on livestock is anticipated to vary with the livestock type. The projections for 2050 show an increase in chicken numbers and egg production by 0.17pp and 0.43pp respectively, less under CC than under the NoCC scenario. Notwithstanding, the livestock sector will be adversely affected by increased rainfall, which

may result in increased incidence of livestock pests and diseases<sup>7</sup>, while droughts will result in a decline in carrying capacity and a reduced quantity and quality of forages. Forage scarcity has already been witnessed in parts of Arusha, Dodoma, Kilimanjaro, Shinyanga, Mara, Mwanza, Iringa, and Tabora [34].

Given that climate change will influence yields of various production systems, agricultural trade will be affected by a combination of supply and demand factors and commodity prices on global and national markets. Lower import dependency is expected for banana, cassava and maize (by 0.29pp, 0.24pp, and 1.13pp respectively), while rice and sunflower imports (by 0.92pp and 0.29pp) will likely increase under the climate change scenario. The results also suggest that Tanzania will be able to increase sorghum exports under both CC and NoCC.

## CSA technologies and practices

CSA technologies and practices present opportunities for addressing climate change challenges, as well as for economic growth and development of the agriculture sector. For this profile, practices are considered CSA if they enhance food security as well as contributing to at least one of the other objectives of CSA (adaptation and/or mitigation). Hundreds of technologies and approaches around the world fall under the heading of CSA.

Support through government programmes, international organisations and NGOs, as well as traditional knowledge have enabled the implementation of various CSA practices

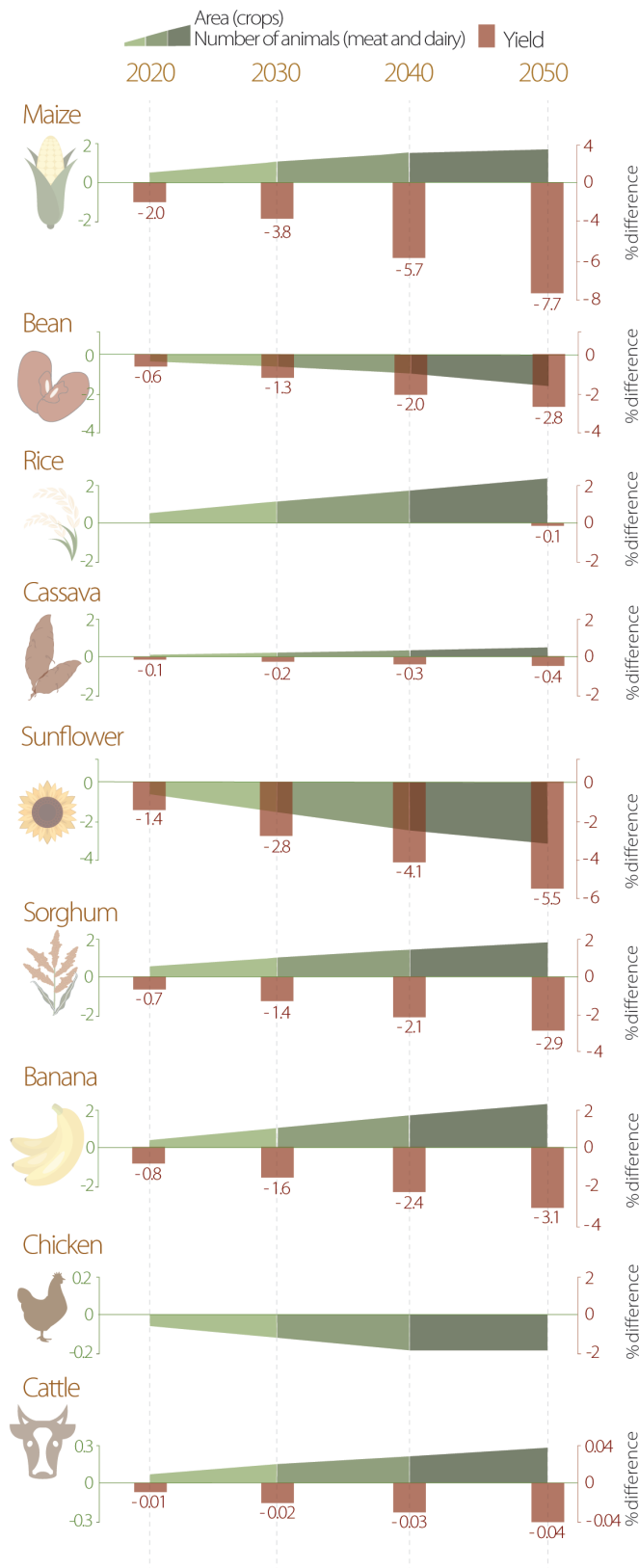
5 Parameterised by the SSP2, a conservative scenario that is typically considered business as usual and using the gfdl, hadgem2, ipsl, miro GCMs.

6 For this study, some key crops were assessed individually, while cassava and sunflower were assessed under the category of tubers and oil crops respectively due to unavailability of data. An analysis for fish was not possible owing to the nature of the production system and also unavailability of information.

7 Diseases likely to increase in incidence include Trypanosomiasis, East Cost Fever (ECF) and Rift Valley Fever (RVF) [34].



## Climate change impacts on yield, crop area and livestock numbers in Tanzania <sup>[35]</sup>



\*A negative value denotes potential decreases in area and yield expressed as percentage change in a climate change scenario vs. non climate change

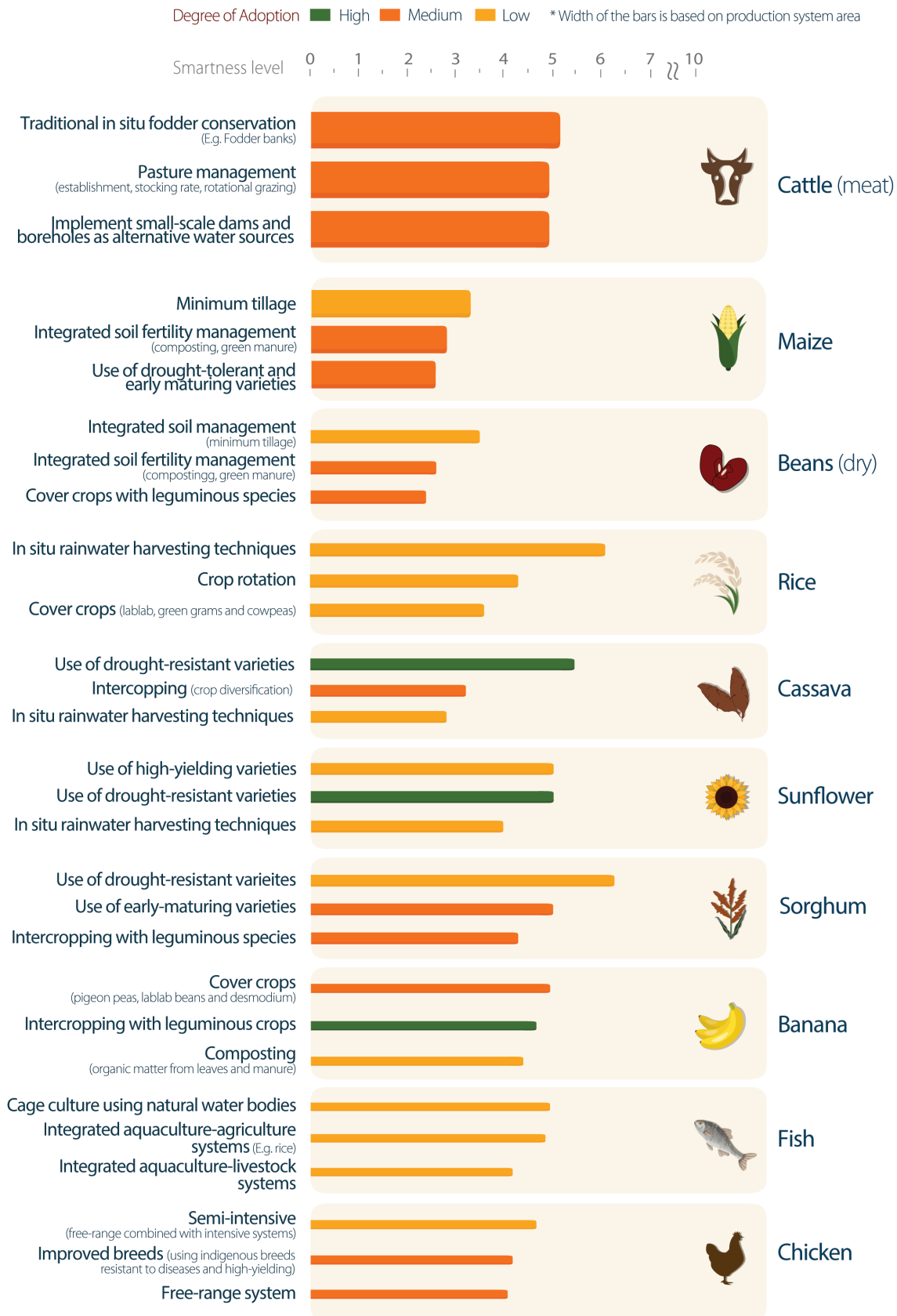
throughout the country. For crops production systems, these practices include agroforestry, improved seed varieties (drought resistant and early maturing), cover cropping, in-situ rainwater harvesting, composting, intercropping (mostly with legumes), organic fertiliser, conservation agriculture, crop diversification and irrigation [4, 11, 34, 36, 37] among others. For livestock-based production systems, CSA practices include in-situ fodder conservation, pasture management and water harvesting using small dams and wells. Traditional chicken breeds are usually kept for increasing household resilience, while integrated aquaculture systems are regarded as an effective household food security and alternative income source for many farmers.

Many practices identified in this study, such as crop rotation, use of manure, cover cropping, mulching, and intercropping do not require high initial cost and present an opportunity for widespread adoption. On the other hand, water harvesting and minimum tillage are knowledge-intensive and require high initial capital investment. CSA practices and their expected benefits are also very site-specific; therefore scale-out strategies require careful consideration of socio-economic and environmental contexts. Moreover, most of the CSA investments analysed did not specifically target issues related to reduction in post-harvest losses, indicating a need for further research and development of value-chain approaches to CSA. Biogas production, though not considered a CSA practice on its own, was identified as having great potential in the country due to its ability to link mitigation of methane emissions from livestock manure with increases in agricultural productivity through application of biogas slurry.

A key factor that has hindered dissemination and promotion of CSA practices is the shortage of quantitative, empirical evidence of the CSA practices' impacts on crop yields, soil and water conservation, farm incomes and GHG mitigation for different production systems. Additionally, many farmers lack adequate technical and financial capacity to implement knowledge- and capital-intensive practices, especially where initial costs for infrastructure construction and equipment are needed. Scaling out results from farm-field trials is oftentimes challenged by limited monitoring support from extension workers. The time lag between initial investments and benefits also constitutes a factor hindering adoption of some practices.

The following graphics present a selection of CSA practices with high climate-smartness scores according to expert evaluations. The average climate-smartness score is calculated based on the practice's individual scores on eight climate-smartness dimensions that relate to the CSA pillars: yield (productivity); income, water, soil, risks (adaptation); energy, carbon and nitrogen (mitigation). A practice can have a negative/positive/zero impact on a selected CSA indicator, with 10 (+/-) indicating a 100% change (positive/negative) and 0 indicating no change. Practices in the graphics have been selected for each production system identified as being key for food security in the country. A detailed explanation of the methodology can be found in Annexes 3.

## Selected CSA practices and technologies for production systems key for food security in Tanzania



## Case study: Linking agricultural mitigation, resilience and productivity through biogas production

Mr. Aloyce Mhamilawa is a 32-year old farmer living in Itulike village (Njombe). Together with his family — a wife and four children — he produces apples, avocado, peas and papaya seedlings at small scale, and pine and other tree seedlings for commercial purposes. Under normal circumstances, they would produce about 50,000 tree seedlings of different varieties every year, as well as some vegetables for family consumption. Like most low-income farmers in Tanzania, more than a third of their household income is usually spent on wood fuel for cooking and lighting purposes. This example demonstrates the value in partnerships, various dissemination channels and local participatory knowledge for scaling out and adopting CSA practices. In 2012, through the Sokoine University, Aloyce's family benefited from a biogas subsidy project which allowed the building of a biogas digester, with the aim to completely replace wood fuel and paraffin and to provide sufficient liquid and composted slurry (over two tons every month) for farming activities. Following the introduction of the digester, the family can now produce over 250,000 tree seedlings a year and earn six times more income, given the use of bio slurry in the nurseries. Moreover, the family is now able to sell surplus vegetables on the market.



A farmer in Njombe mixing cow dung before discharging it into a digester while a researcher from Sokoine University looks on. ©DW/K. Makoye

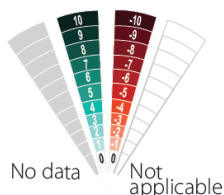
Bio-slurry can retain moisture, enabling seedlings to grow fast and remain healthy, even during harsh climate conditions. Composted slurry is also be used as an effective fertiliser for crop cultivation, while liquid slurry is applied as a top dressing fertiliser and insect repellent, significantly reducing demand for chemical fertilisers. By using these techniques, Mr. Aloyce has been able to reduce fertiliser consumption from six bags to one bag per year, saving over Tsh 300,000 seasonally. Additional household savings of about Tsh 35,000 per month have come from a reduction in firewood and charcoal use, traditionally needed for daily farm activities such as warming water for cows and boiling of milk. Mr. Aloyce's family also noticed an improvement in the household environment, mostly a reduction in charcoal powder, ash and smoke owing to use of biogas energy as opposed to wood.

This initiative is part of an emerging national effort to provide cheap, clean and sustainable energy to vulnerable households in Tanzania, in a context where more than 94% of the country's energy requirements is met by biomass (primarily wood fuel), contributing to increasing deforestation and soil degradation rates, especially in rural areas, where 80% of the energy is consumed. At the moment, 12,000 biogas digesters have been built with support from the Netherlands Development Organisation (SNV) and in collaboration with the Centre for Agriculture Mechanisation and Rural Technology (CARMATEC). An additional 10,000 biodigesters are planned to be built by 2017, with finance from the Norwegian Embassy in Dar es Salaam. Engaging private sector and conducting capacity building on design, manufacture, use and repair of biogas digesters will be key components in the sustainability of the programme. This is particularly pertinent given that the biogas programmes have been largely driven by support from national and international development organisations.

Since the technology provides simultaneous benefits to multiple sectors (energy supply, agriculture, health, sanitation, environment, and gender) and links with the country's goals to reduce poverty and stimulate growth of Small and Medium Sized Enterprises (SMEs), biogas digesters are now the core of many integrated farming system strategies. Biogas provides an excellent opportunity to link manure management and controlled grazing of livestock with improved crop production and productivity, the livestock and crop production aspects being linked by the integration of biogas digesters. The technology supports the reduction of methane emissions from manure left on pastures, although no quantitative analysis of the exact emissions reductions has been conducted insofar.

**Table 1.** Detailed smartness assessment for top ongoing CSA practices by production system as implemented in Tanzania.

CSA practice	Region and adoption rate (%)	Predominant farm scale S: small scale M: medium scale L: large scale	Climate smartness	Impact on CSA Pillars
	<30 30-60 60>			
<b>Maize</b> (24% of total harvested area)				
Minimum tillage	Bahi <30%	M		<p><b>Productivity</b> Leads to increased yields and income.</p> <p><b>Adaptation</b> Enhances crop root development and conserves the soil structure and biodiversity, Increases soil moisture retention.</p> <p><b>Mitigation</b> Promotes carbon sinks through increased accumulation of dry matter. Reduces GHG emission related with soil tillage.</p>
	Songea <30%	M		
Integrated soil fertility management (composting, green manure)	Bahi <30%	S M		<p><b>Productivity</b> Improves yield per unit area hence increasing household incomes.</p> <p><b>Adaptation</b> Promotes soil and water conservation, hence less use of inputs such as fertilizers. Reduces incidences of soil borne pests and diseases.</p> <p><b>Mitigation</b> Increases above- and below-ground carbon storage. Reduces the need of synthetic fertilizers and related GHG emissions.</p>
	Songea 30-60%	M		
<b>Bean</b> (7% of total harvested area)				
Integrated soil management (minimum tillage)	Karagwe <30%	M		<p><b>Productivity</b> In specific contexts, increases crop productivity.</p> <p><b>Adaptation</b> Promotes soil biodiversity and moisture conservation. Promotes crop root penetration/development. Reduces soil erosion.</p> <p><b>Mitigation</b> Promotes carbon sinks through increased accumulation of dry matter. Reduces GHG emission related with soil tillage.</p>
	Chamwino <30%	M		





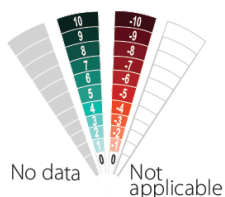
CSA practice	Region and adoption rate (%)	Predominant farm scale S: small scale M: medium scale L: large scale	Climate smartness	Impact on CSA Pillars
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Integrated soil fertility management (composting, green manure)	Chamwino <b>&lt;30%</b>	S		<p><b>Productivity</b> Increases crop yields and income.</p> <p><b>Adaptation</b> Builds soil fertility by improving physical and biochemical soil characteristics. Reduces soil erosion and improves moisture content avoiding water stress during dry seasons.</p> <p><b>Mitigation</b> Increases carbon storage in soils. Reduces the need of synthetic fertilizers and related GHG emissions.</p>
	Karagwe <b>&gt;60%</b>	S M		

**Rice**(7% of total harvested area)

Increases carbon storage in soils. Reduces the need of synthetic fertilizers and related GHG emissions.	Shinyanga <b>&lt;30%</b>	M L		<p><b>Productivity</b> Increases crop and labor productivity per unit area.</p> <p><b>Adaptation</b> Improves water availability enabling production during the dry season. Reduces the time spent by women in fetching/ searching for water. Reduces soil erosion during the rainy season.</p> <p><b>Mitigation</b> Reduces energy needs for irrigation especially when it is integrated with alternative energy sources (E.g. solar energy), thereby reducing related GHG emissions.</p>
	Morogoro <b>&lt;30%</b>	M L		

Crop rotation	Morogoro <b>&lt;30%</b>	S		<p><b>Productivity</b> Increases yields due to fertility restoration. It also increases farm incomes.</p> <p><b>Adaptation</b> Helps in breaking diseases cycles and resurgence and build up of pests. Improves on-farm diversification and prevent soils erosion.</p> <p><b>Mitigation</b> Reduces the need for nitrogen fertilizers application when leguminous crops are introduced. Maintains and/or improves soil carbon stocks.</p>
	Shinynga <b>&lt;30%</b>	S		



- Yield
- Income
- Water
- Soil
- Risk/Information
- Energy
- CO<sub>2</sub> Carbon
- N<sub>2</sub>O Nutrient

CSA practice	Region and adoption rate (%)	Predominant farm scale S: small scale M: medium scale L: large scale	Climate smartness	Impact on CSA Pillars
	<30   30-60   60>			

**Cassava** (6% of total harvested area)

Use of drought-resistant varieties	Pwani >60%	S		<p><b>Productivity</b> Increases productivity per unit area especially when rain is inadequate. Contributes to reductions in production costs.</p> <p><b>Adaptation</b> Enables production and yield stability even when there is water scarcity.</p> <p><b>Mitigation</b> Increases and/or maintains above- and below-ground biomass during drought periods.</p>
	Lindi >60%	S		

Intercropping (crop diversification)	Pwani 30-60%	S		<p><b>Productivity</b> Enhances production per unit area hence promoting sustainable utilization of resources such as land and water. Diversify income sources.</p> <p><b>Adaptation</b> Contributes to soil health by improving physical, chemical and biological characteristics. Contributes to spread crop failure risk as well as availability of food due to weather shocks.</p> <p><b>Mitigation</b> Maintains or improves soil carbon stock or organic matter content. Reduces the need for synthetic fertilizers.</p>
	Lindi 30-60%	S		

**Sunflower** (6% of total harvested area)

Use of high-yielding varieties	Dodoma <30%	S		<p><b>Productivity</b> Promotes high yields per unit area hence an increase in income.</p> <p><b>Adaptation</b> Enhances water use efficiency. Increases resilience to moisture stress and other climate shocks. The practice also enhances women empowerment.</p> <p><b>Mitigation</b> Provides moderate reduction GHG emissions per unit of food produced.</p>
	Singida <30%	S		

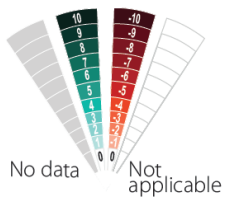


CSA practice	Region and adoption rate (%)	Predominant farm scale S: small scale M: medium scale L: large scale	Climate smartness	Impact on CSA Pillars
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Use of drought-resistant varieties	Dodoma >60%	S	5.0	<p><b>Productivity</b> Increases productivity per unit area especially during the dry period.</p> <p><b>Adaptation</b> Enhances water use efficiency. Drought-tolerant varieties cushions farmers from losses due to crop failure.</p> <p><b>Mitigation</b> Provides moderate reduction GHG emissions per unit of food produced.</p>
	Singida >60%	S	4.9	

**Sorghum** (6% of total harvested area)

Use of drought-resistant varieties	Dodoma 30-60%	S	6.3	<p><b>Productivity</b> Increases the yield per unit area, especially during the dry periods hence insuring income for the farmers.</p> <p><b>Adaptation</b> Enhances water use efficiency. Increases resilience to moisture stress and other climate shocks.</p> <p><b>Mitigation</b> Leads to reduction in emissions due to lower fuel/electricity consumption for irrigation.</p>
	Mara 30-60%	S	6.3	
Use of early-maturing varieties	Dodoma <30%	S	5.0	<p><b>Productivity</b> Increases in productivity especially during the dry seasons.</p> <p><b>Adaptation</b> Increases farmer resilience to climate shocks.</p> <p><b>Mitigation</b> Reduces energy consumption and GHG emissions per unit of food produced.</p>
	Mara <30%	S	5.0	



CSA practice	Region and adoption rate (%)	Predominant farm scale S: small scale M: medium scale L: large scale	Climate smartness	Impact on CSA Pillars
	<30   30-60   60>			

**Banana** (3% of total harvested area)

Cover crops (pigeon peas, lablab beans and desmodium)	Kilimanjaro <b>30-60%</b>	S		<p><b>Productivity</b> Increases productivity per unit of area.</p> <p><b>Adaptation</b> Enhances soil moisture and fertility. Reduces soil erosion and increases biodiversity.</p> <p><b>Mitigation</b> Increases carbon storage in soils. Reduces use of synthetic fertilizers and related GHG emissions.</p>
	Kagera (Lake zone) <b>30-60%</b>	S		

Intercropping with leguminous crops	Kilimanjaro <b>&gt;60%</b>	S		<p><b>Productivity</b> Increases yields and quality. Promotes food security and income.</p> <p><b>Adaptation</b> Contributes to soil health by improving physical, chemical and biological characteristics. Reduces soil erosion.</p> <p><b>Mitigation</b> Maintains or improves soil carbon stock or organic matter content. Reduces the need for synthetic fertilizers.</p>
	Kagera (Lake zone) <b>&gt;60%</b>	S		

**Fish** (NA)

Use of high-yielding varieties	Mwanza <b>&lt;30%</b>	S		<p><b>Productivity</b> Increased productivity per unit of area. Increases in income.</p> <p><b>Adaptation</b> Proper management contributes to sustainable use of resources such as water and land.</p> <p><b>Mitigation</b> Can reduce the energy required in harvesting and related GHG emissions.</p>
	Dar es Salaam <b>&lt;30%</b>	S		





CSA practice	Region and adoption rate (%) <30 30-60 60>	Predominant farm scale S: small scale M: medium scale L: large scale	Climate smartness	Impact on CSA Pillars
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Integrated aquaculture-agriculture systems (E.g. rice)

Mwanza  
30-60%



Dar es Salaam  
30-60%



**Productivity**

Increases yields and income. Reduces economic vulnerability by diversifying production.

**Adaptation**

Improves water use efficiency. Contributes to livelihoods diversification. Potential use of effluents and sediments in agricultural processes.

**Mitigation**

Efficient transportation of aquaculture and agricultural produce can reduce the emission per unit of produce.

**Chicken (NA)**

Semi-intensive (Free-range combined with intensive systems).

Singida  
<30%



Dar es Salaam  
<30%



**Productivity**

Increases animal quality and productivity. Increase in income.

**Adaptation**

Improves climate resilience. Reduces animal stress and could reduce use of antibiotics.

**Mitigation**

Contributes to long-term reduction in GHG emissions per unit of produce.

Improved breeds (Using indigenous breeds resistant to diseases and high-yielding)

Singida  
30-60%



Dar es Salaam  
30-60%



**Productivity**

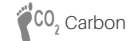
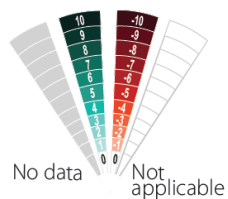
Increases quality and stability of the food production. Reduces production costs.

**Adaptation**

Local breeds can present greater resistance to diseases and other abiotic stress conditions, reducing animal mortality.

**Mitigation**

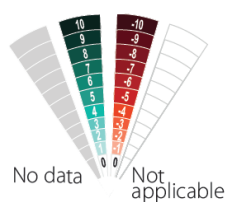
Reduced inputs could reduce GHG emissions per unit of produce.



CSA practice	Region and adoption rate (%)	Predominant farm scale S: small scale M: medium scale L: large scale	Climate smartness	Impact on CSA Pillars
	<30   30-60   60>			

**Cattle (NA)**

Traditional in situ fodder conservation (E.g. Fodder banks)	Simiyu <span style="background-color: green; color: white; padding: 2px;">&gt;60%</span>	S M		<p><b>Productivity</b> Increases productivity per unit of area.</p> <p><b>Adaptation</b> Enhances soil moisture and fertility. Reduces soil erosion and increases biodiversity.</p> <p><b>Mitigation</b> Increases carbon storage in soils. Reduces use of synthetic fertilizers and related GHG emissions.</p>
	Manyara <span style="background-color: orange; color: white; padding: 2px;">&lt;30%</span>	S M		
Implement small-scale dams and boreholes as alternative water sources	Simiyu <span style="background-color: orange; color: white; padding: 2px;">30-60%</span>	S M		<p><b>Productivity</b> Increases yields and quality. Promotes food security and income.</p> <p><b>Adaptation</b> Contributes to soil health by improving physical, chemical and biological characteristics. Reduces soil erosion.</p> <p><b>Mitigation</b> Maintains or improves soil carbon stock or organic matter content. Reduces the need for synthetic fertilizers.</p>
	Manyara <span style="background-color: orange; color: white; padding: 2px;">30-60%</span>	S M		

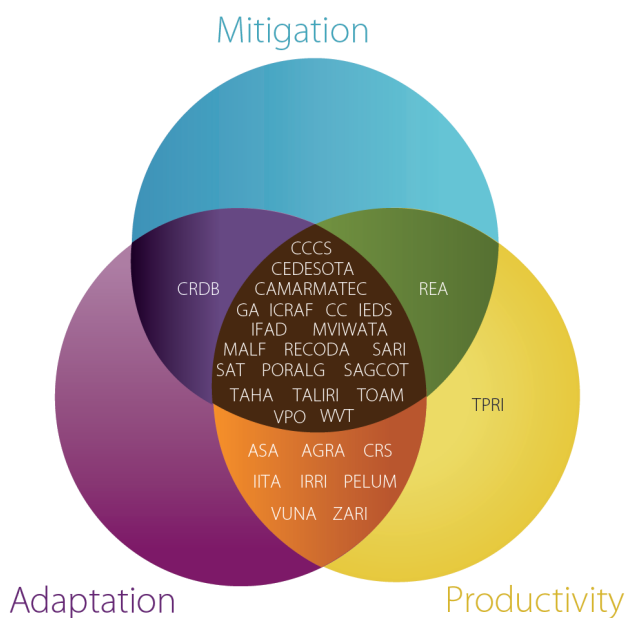


- Yield
- Income
- Water
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## Institutions and policies for CSA

A number of institutions are involved in promoting CSA in Tanzania. Most of their work is focused on improving productivity and enhancing adaptation and resilience of small-scale farmers, in a context where half of the population still suffers from poverty and one-third is undernourished. With the exception of the Institute for Environment, Climate and Development Sustainability (IEDS), who allocates approximately 35% of the budget to mitigation activities, most actors view mitigation as a co-benefit of adaptation interventions rather than a stand-alone objective of their work. The following graphic highlights key institutions whose mandated actions and investments promote — directly or indirectly — one, two or all CSA pillars (productivity, adaptation and mitigation).

### Institutions for CSA in Tanzania



**AGRA** Alliance for a Green Revolution in Africa **ASA** Agricultural Seed Agency **CC** Tanzania Civil Society forum for Climate Change **CCCS** Centre for Climate Change Studies **CEDESOTA** Community Economic Development and Social Transformation **CRDB** Commercial Bank **CRS** Catholic Relief Service **ICRAF** World Agroforestry Center **IEDS** Institute for Environment, Climate and Development Sustainability **IFAD** International Fund for Agricultural Development **IITA** International Institute of Tropical Agriculture **IRRI** International Rice Research Institute **MALF** Ministry of Agriculture, Fisheries and Livestock **MVIWATA** National Networks of farmer groups in Tanzania **PELUM** Participatory Ecological Land Use Management Tanzania **PORALG** President's Office Regional Administration and Local Government **REA** Rural Energy Agency **RECODA** Research Community and Organization Development Associates **SAGCOT** Southern Agriculture Corridor of Tanzania **SARI** Selian Agricultural Research Institute **SAT** Sustainable Agriculture Tanzania **TALIRI** Tanzania Livestock Research Institute **TAHA** Tanzania Horticultural Association **TOAM** Tanzania Organic Agriculture Movement **TPRI** Tropical Pesticides Research Institute **VPO** Vice President Office Division of Environment **WWT** World Vision Tanzania **ZARI** Zanzibar Agriculture Research Institute

At the national level, environmental planning and policy formulation are under the mandate the Division of Environment of the Vice President's Office (VPO), as outlined in the Environmental Management Act (EMA) of 2004. The VPO also provides guidelines to various sectors, raises awareness, and coordinates climate activities in the country.

In collaboration with the President's Office, Regional Administration and Local Government (PO-RALG), the Ministry of Agriculture, Livestock and Fisheries (MALF) promotes CSA practices such as irrigation and utilisation of improved varieties. PO-RALG acts as a policy implementation bridge between sector ministries, government institutions and local government authorities, being mandated to implement policies, build capacity, as well as to monitor, evaluate and provide technical backstopping of CSA activities at local levels. However, weak coordination still presents a challenge for efficient technology dissemination.

Together with the VPO, MALF has also formulated CSA policy documents, such as the National CSA Programme (2015) and the CSA Guideline (2017). A National Climate-Smart Agriculture Task Force (NCSATF) was also established and later transformed into the broader Tanzania Climate-Smart Agriculture Alliance (TCSAA). The TCSAA is expected to coordinate CSA initiatives within the framework of the National CSA Programme.

Non-Governmental Organisations (NGOs) are supporting CSA promotion mostly through awareness raising on climate change; policy advocacy (for example through the Tanzanian Civil Society Forum on Climate Change [Forum CC], the National Networks of Farmers' Groups in Tanzania [MVIWATA] and Mazingira Network [MANET]<sup>8</sup>); as well as through on-farm implementation of agricultural practices through field trials and farmer trainings (NGOs like CARE and Sustainable Agriculture Tanzania [SAT]). Catholic Relief Services (CRS) and Human Network International (HNI), both international NGOs, have been piloting the use of cellphones to facilitate farmer access to information on climate-smart agriculture as a means of enhancing knowledge and adoption. The Alliance for a Green Revolution in Africa (AGRA) funds CSA interventions, conducts research on stress-tolerant seeds and has also played an important role in advocating for private sector participation in policy-making (such as the Seed Policy).

A number of research organisations provide support for CSA adoption and scale out, including: the International Rice Research Institute (IRRI), working on development and promotion of rice varieties tolerant to abiotic stresses as well as practices that enhance water conservation); the International Institute of Tropical Agriculture (IITA) (which works on enhancing farmer adoption of stress-tolerant varieties), the World Agroforestry Centre (ICRAF), the Tanzania Horticulture Association (TAHA) (with a focus on sustainable water management, IPM and agroforestry), the Zanzibar Agricultural Research Institute (ZARI) (working on drought-tolerant and salt water-tolerant seeds and short-lived varieties in Zanzibar), among others. Academic

<sup>8</sup> Other than policy advocacy, MVIWATA and MANET also work on enhancing collective action among farmers in accessing markets, environmental conservation and technology adoption.

institutions such as the Sokoine University of Agriculture and University of Dar es Salaam are also actively engaged in research on CSA practices and technologies.

In terms of private sector, The Southern Agriculture Growth Corridor of Tanzania (SAGCOT) is a private-public regional partnership that promotes CSA-related agribusiness development among small scale farmers, as an avenue for improving food security, reducing rural poverty, and ensuring environmental sustainability. Organisations such as the Tanzania Horticultural Association (TAHA) are involved in climate change related dialogue at national level. The Centre for Agriculture Mechanisation and Rural Technology (CARMATEC) is involved in various initiatives related to CSA including biogas, solar vegetable driers and rainwater harvesting among others.

International organisations supportive of CSA in the country include United Nations bodies and international development agencies. Through its new Social, Environmental and Climate Assessment Procedures (SECAP) IFAD incorporates climate change into its projects' design. IFAD's key projects related to climate change in Tanzania include the Southern Highlands Milk Sheds Development Project and the Drylands Development Project.

Lack of financial and human resources was reported to be the biggest institutional challenge for CSA scale-out. Evidence also points to little collaboration and coordination among institutions in undertaking CSA interventions, as a significantly large number of organisations were not aware of the work of other organisations carrying out similar activities in the field.

At the policy level, Tanzania adhered to several international and regional initiatives on climate change, including the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol, the Comprehensive Africa Agriculture Development Programme (CAADP), the East Africa Community Food Programme of 2011 and the East African Community Climate Change Policy of 2009. In 2015, Tanzania submitted its INDC to the UNFCCC, specifically targeting "Increasing yields through inter alia climate-smart agriculture", as a key strategy for climate change adaptation.

There were about 25 national documents that make reference to climate change adaptation and mitigation in Tanzania in 2015 [9], including agriculture, forestry and environmental policies.

The National Adaptation Programme of Action (NAPA) of 2007 was the first document to acknowledge climate change as an important threat to the economy, providing a first stimulus for sectoral intervention to address climate impacts. However, the implementation of NAPA was hampered by the lack of a clear funding strategy to finance the identified interventions. The roadmap for climate change action in the agricultural sector was consolidated in the National Climate Change Strategy (NCCS) of 2012 and the Agriculture Climate Resilience Plan (ACRP) formulated in 2014, which mainly aimed at improving water use efficiency and promoting land, soil and water management, climate

resilient crop varieties, and disaster risk management strategies, among others. Nevertheless, only 20% of the finances required to implement the plan have been coming from the government, challenging the financial sustainability of the interventions.

Complementary to these, the National Agricultural Policy (NAP) from 2013 seeks to increase productivity and farmers' adaptive capacity through reduced dependency on rainfall, increased private sector investment in agriculture, improvement of road infrastructure problems and promotion of new energy sources, such as biofuels. The more recent CSA Programme and the CSA Guideline represent innovative policy mechanisms to advance CSA on the public agenda, tracing a variety of potential CSA technologies and practices applicable to various AEZs in the country, as a first step towards more comprehensive, evidence-based analysis and prioritisation of interventions.

Other policy frameworks, programmes and strategies supportive of increased productivity and resilience in the agriculture sector include:

- The Agricultural Sector Development Strategy (ASDS) (2001), designed to increase farm incomes, and reduce poverty through increasing productivity. The major areas of intervention included institutional framework strengthening, increased private sector engagement and streamlining of agricultural marketing to enhance commercialisation.
- The Agricultural Sector Development Programme (ASDP) I and II (2006 and 2015), which sought agricultural sector growth particularly through development of irrigation infrastructure, investments in research (science and technology), value addition and mechanisation.
- The Tanzania National Strategy for Growth and Reduction of Poverty (NSGRP) I and II (2005/2006-2009/2010 and 2010/2011-2014/2015), aimed at improving living standards, reducing poverty, increasing economic growth and enhancing good governance.
- Kilimo Kwanza (Agriculture First) of 2009, an initiative to accelerate modernisation and commercialisation in the agricultural sector.
- The Southern Agricultural Growth Corridor of Tanzania (SAGCOT), initiated in 2010 to increase farmer incomes, reduce poverty, promote food security, and ensure environmental sustainability through agribusiness.
- The Livestock Sector Development Strategy of 2010, which contributed to the development of plans to settle pastoralists, the establishment of disease-free zones, and rehabilitation of livestock-holding grounds, among others.
- The Livestock Sector Development Programme (LSDP) launched in 2011, which targeted increased incomes

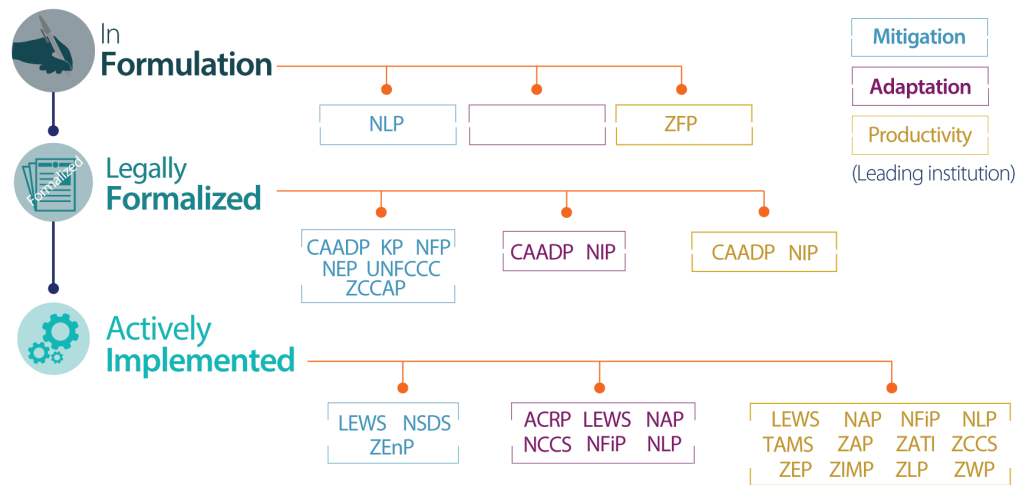


from the livestock sub-sector through improved input and service delivery and enhanced marketing infrastructure, among others. In addition, in the livestock sector,

- The Tanzania Livestock Master Plan of 2016, which seeks to increase red meat, milk, poultry and pork productivity through addressing environmental conservation issues.

At times, despite the wealthy policy framework, the lack of a clear development pathway for the agriculture sector has resulted in inconsistent growth. Furthermore, coordination of policies and interventions remain a challenge, often resulting in a sectoral manner of policy development and implementation as well as a project rather than a programmatic approach to implementation of interventions on the ground.

### Policies for CSA in Tanzania



**ACRP** Agriculture Climate Resilience Plan (2014) (Ministry of Agriculture Livestock and Fisheries) **CAADP** Comprehensive African Agriculture Development Programme (xxx) (African Union, Ministry of Agriculture, Vice President's Office) **KP** Kyoto protocol (2002) (Vice president's Office) **LEWS** Livestock Early Warning Systems (2000) (Ministry of Agriculture Livestock and Fisheries) **NAP** National Agricultural Policy (2013) (Ministry of Agriculture) **NCCS** National Climate Change Strategy (Mainland) (2014) (Vice President's Office) **NEP** National Environmental Policy (1997) (VPO) **NFP** National Forestry Policy (1998) (Ministry of Natural Resources and Tourism) **NFIP** National Fisheries Policy (2015) (Ministry of Agriculture Livestock and Fisheries) **NIP** National Irrigation Policy (2009) (Ministry of Water and Irrigation) **NLaP** National Land Policy (Zanzibar) (2017) (Ministry of Lands Water Energy and Environment) **NLP** National Livestock Policy (2006) (Ministry of Agriculture Livestock and Fisheries) **NSDS** National Spatial Development Strategy (Zanzibar) (2013) (Ministry of Lands Water Energy and Environment) **TAMS** Tanzania Agricultural Mechanization Strategy (2006) (Ministry of Agriculture Livestock and Fisheries) **UNFCCC** United Nations Framework Convention on Climate Change (1996) (Vice president's Office) **ZAP** Zanzibar Agriculture Policy (2003) (Ministry of Agriculture Natural resources, livestock and Fisheries) **ZATI** Zanzibar Agriculture Transformation Initiative (2010) (Ministry of Agriculture Natural Resources, Livestock and Fisheries) **ZCCAP** Zanzibar Climate Change Action Plan (2016) (Zanzibar Climate Change Action Plan) **ZCCS** Zanzibar Climate Change Strategy (2014) (Ministry of Lands Water Energy and Environment) **ZEP** Zanzibar Environmental Policy (2013) (Ministry of Lands Water Energy and Environment) **ZEnP** Zanzibar Energy Policy (2009) (Ministry of Lands Water Energy and Environment) **ZFP** Zanzibar Fisheries Policy (2016) (Ministry of Agriculture Natural resources, livestock and Fisheries) **ZIMP** Zanzibar Irrigation Master Plan (2010) (Ministry of Agriculture, Natural Resources Livestock and Fisheries) **ZLP** Zanzibar Livestock Policy (2011) (Ministry of Agriculture Natural Resources, Livestock and Fisheries) **ZWP** Zanzibar Water policy (2004) (Ministry of Lands Water Energy and Environment)

## Financing CSA

Every year, the economic costs of climate change on the agriculture sector amount to US\$ 200 million [38], a much greater sum than that required for building resilience of the sector, estimated at US\$ 100-150 million per year [39]. The economic losses from climate change are estimated to be eight times more than the sum needed to implement the ACRP [4].

Despite these factors, national expenditure on climate change and CSA in particular remains low. Only a few actors, namely the Rural Energy Agency (REA), the Tanzania Agriculture Development Bank (TADB), the Private Agricultural Sector Support (PASS), and the Tanzania Commission for Science and Technology (COSTECH), have reportedly received public finances for climate change interventions in recent

years. Notwithstanding previous policy commitments, there is no direct involvement of the Ministry of Finance and Planning in the design of governmental CSA interventions and no national climate funding mechanisms has been established so far. Moreover, private sector engagement in CSA financing is minimal, possibly due to a perceived risk and lack of profitability of funding agricultural adaptation and mitigation programme.

As a result, most of the current climate funding (78%) comes from development partners [40], yet access to funds is still limited by stringent criteria and complex application procedures, as well as limited awareness of available funds [41]. Despite this, between 2003 and 2014, Tanzania managed to solicit over US\$ 200 million through international climate financing instruments [28]. Most recently, the Green Climate Fund Board approved the US\$ 109 million Climate Resilience project focusing on sustainable land and water management in agriculture in the Simuyu region.

## Potential Finance

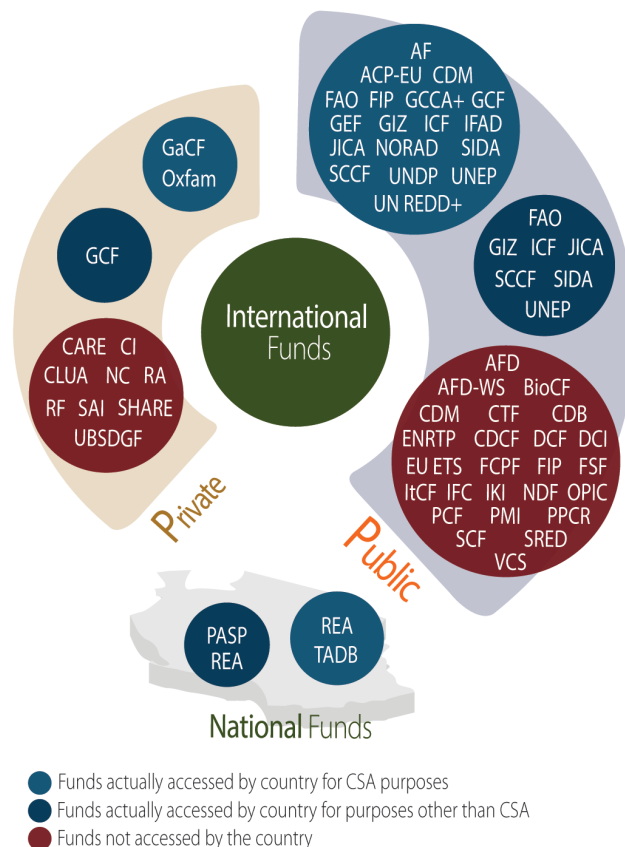
Tanzania has done good work to lay the foundation for attracting large scale finance for climate-smart agriculture in the country with the development of the National CSA Programme and National CSA Guideline. However, more finance needs to be directed towards addressing CSA adoption barriers. The promotion of farmers groups and cooperatives, complemented by capacity building on financial and business management could enhance smallholders' access to credit, particularly from micro-finance institutions. This could add to the existing domestic funding sources such as the TADB, which mostly finances large-scale agricultural investments in the country.

Stronger public-private partnerships, from policy formulation to activity implementation so as to ensure ownership and sustainability, can also increase the availability of CSA funds. Engagement of such actors in new areas, such as renewable energy services, input supply, and post-harvest activities (processing/value-addition and commercialisation) can complement existing efforts focused on the production stage, thereby contributing to a more comprehensive agricultural sector growth strategy.

Additional sources for international climate financing need to be explored. For instance, Tanzania has yet to access funds from the Africa Climate Change Fund (ACCF) and the Adaptation for Smallholder Agriculture Programme (ASAP) both of which the country is eligible.

Most importantly, domestic budget allocation towards CSA will be an important catalysing instrument for agriculture and climate change related financing in the country. Some countries in Eastern Africa are setting up national climate change funds (FONERWA in Rwanda) which aim to merge finances from various sources, for enhanced coordination and targeting purposes. Such initiatives can serve as a model for a potential national climate change financing mechanism in Tanzania.

## Financing opportunities for CSA in Tanzania



ACP-EU African, Caribbean and Pacific-European Union Energy Facility AF Adaptation Fund AFD French Development Agency AFD-WS French Development Agency- Water and Sanitation BioCF World Bank BioCarbon Fund CARE Cooperative for Assistance and Relief Everywhere CDB China Development Bank CDCF Community Development Carbon Fund CDM The Netherlands Clean Development Mechanism CI Conservation International CLUA Climate and Land Use Alliance CTF Clean Technology Fund DCI Development Cooperation Instrument DCF Danish Carbon Fund ENRTP Environment and Sustainable Management of Natural Resources Thematic Programme EU ETS European Emissions Trading System FAO Food and Agriculture Organization of the United Nations FCPF Forest Carbon Facility FIP Forest Investment Program FSF Japan's Fast-Start Financing GaCF Gatsby Charitable Foundation GCCA+ Global Climate Change Alliance GCF Green Climate Fund GEF Global Environment Facility GIZ German Society for International Cooperation ICF United Kingdom International Climate Fund ITCF Italian Carbon Fund IFAD International Fund for Agricultural Development IFC International Finance Corporation IKI International Climate Initiative JICA Japan International Cooperation Agency KfW German Development Bank International Climate Initiative NC The Nature Conservancy NDF Nordic Development Fund NORAD Norwegian Agency for Development and Cooperation PASP Private Agriculture Sector Support PCF Prototype Carbon Fund PMI Partnership for Market Initiatives PPCR Pilot Program for Climate Resilience RA AXA IM - Real Assets Forest Investment REA Rural Energy Agency RF Rockefeller Foundation SAI Sustainable Agriculture Initiative Platform SCCF Special Climate Change Fund SCF Spanish Carbon Fund SHARE Sending Help and Resources Everywhere SIDA Swedish International Development Cooperation Agency SREP Scaling Up Renewable Energy in Low Income Countries Program TADB Tanzania Agricultural Development Bank UBSDGF Union Bank of Switzerland Dutch Green Fund UNDP United Nations Development Programme UNEP United Nations Environmental Programme UN REDD United Nations Programme on Reducing Emissions from Deforestation and Forest Degradation VCS Verified Carbon Standard

## Outlook

Tanzania's efforts to advance climate change on the public agenda has been notable, as evident in the numerous policies, strategies and programs that the government has put in place for increasing farmers' resilience and productivity and promoting CSA adoption. Nevertheless, policy and institutional alignment and coordination have yet to be fully achieved, and there is absence of a functional mechanism to incentivise and enhance collaboration among different actors. The Tanzania Climate-Smart Agriculture Alliance represents a critical opportunity to provide such space for dialogue; therefore, more efforts to support the operation of such a platform, both financially and technically, are needed. Development of a comprehensive database of CSA actors and their interventions could be a first step towards improved coordination on CSA in the country.

CSA scale-out also requires an operational financing strategy to ensure continuity and sustainability of current initiatives. While exploring new international funds may increase the CSA financing basket, a stronger engagement

of national public and private sector actors in enabling long-term financing for small-scale farmers is crucial for the development of a robust agricultural sector.

Ensuring gender equity in implementation of CSA interventions will also contribute to increased resilience of the population. Research on the gendered impacts of climate change as well as the appropriateness and adoption constraints of different CSA technologies and practices by gender, can be a good starting point in ensuring that identified practices benefit and can be easily adopted by both men and women.

Moreover, further investments in collecting, analysing and disseminating evidence of the impacts of CSA practices in relation to CSA goals are needed, in order to inform more targeted, relevant interventions for the different production systems and AEZs. Such evidence would also create further incentives for increased private sector engagement in CSA, including micro-finance institutions.

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For further information and online versions of the Annexes

**Annex 1:** Tanzania's agro-ecological zones

**Annex 2:** Selection of agricultural production systems key for food security in Tanzania (methodology)

**Annex 3:** Methodology for assessing climate-smartness of ongoing practices

**Annex 4:** Institutions for CSA in Tanzania (methodology)

**Annex 5:** Policies for CSA in Tanzania (methodology)

**Annex 6:** Assessing CSA finances in Tanzania (methodology)

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