

## Sorghum Tanzania



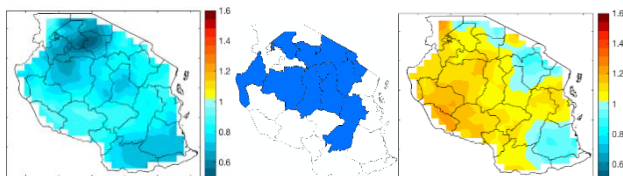
## Climate Change Risks and Opportunities

### Sorghum in Tanzania

In Tanzania, sorghum is grown in almost all the semi-arid areas by subsistence farmers for food, feed, and beer. A total of 6.2 million ha is used for cereal crop production, of which 0.9 million ha (15%) is under sorghum cultivation (FAOSTAT 2017). The major growing regions include Dodoma, Singida, Simiyu, Shinyanga, Tabora, and Mwanza, which together produce 50% of the country's commercial sorghum output. The planting session in these areas commence from mid-November to February. Local varieties are planted by most smallholder farmers due to their affordability. The improved varieties are more costly and also not easily accessible. The lack of a commercial market has limited farmer' interest in improving the management of sorghum, hence average yield has stagnated over the past 15 years despite an increase in area under cultivation. In Tanzania, over 70% of sorghum produced is used for flour and animal feed. Its production is forecasted to increase from the current levels of 1,000,000 metric tons up to 1,843,000 metric tons in the year 2025.

#### Past Trends in Temperature in Sorghum Growing Areas

The temperature trend (from 1961-2005) for the first rainy season (March, April, May) show that temperature has been increasing by about 0.6°C-1°C in most of the sorghum growing areas in Tanzania (Figure 1). During the second rainy season (October, November, December), temperature has been increasing by 1°C - 1.2°C in the central, north-east, south-east and western sorghum growing areas of the country.

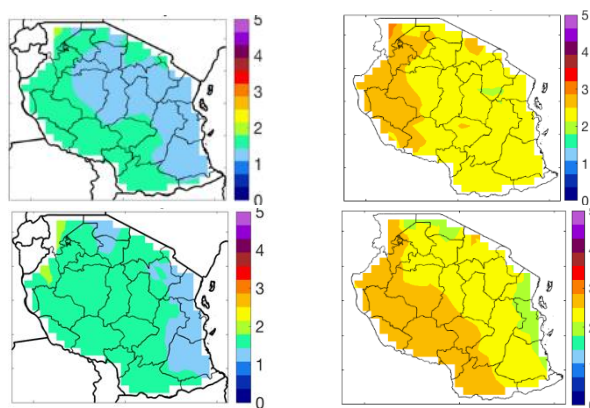


**Figure 1.** Temperature trend from 1961-2005 for the first rainy season (MAM, LEFT) and second rainy season (OND, RIGHT). **NOTE:** During both the first and second rainy season temperature in the sorghum growing areas of the country has increased by 1°C - 1.2°C.

For this work on climate change projections, dynamically downscaled daily rainfall, maximum, minimum and mean temperature from the Rossby Center (SMHI) regional climate model (RCA4) are used. The regional model (RCA4; Dieterich et al., 2013) was used to downscale four Global Circulation Models (EC-EARTH, MPI-ESM-LR) from the Coupled Model Inter-comparison Project Phase 5 (CMIP5). The regional model was run at a grid resolution of 0.44 x 0.44 over the African domain and all other details about the simulation can be found in Dieterich et al. (2013). The global models (GCMs) projections were forced by the Representative Concentration Pathways (RCPs), which are prescribed greenhouse-gas concentration pathways (emissions trajectory) and subsequent radiative forcing by 2100. In this study, we used RCP4.5 and RCP8.5, which are representatives of mid-and high-level of emission scenarios respectively.

#### Climate Change in the Future Temperature

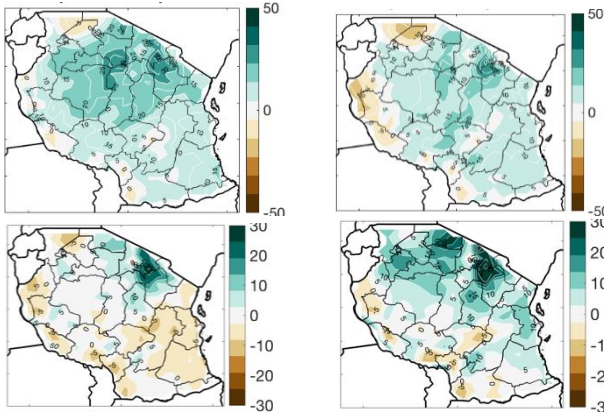
During the first rainy season, temperature in the 2030s is expected to rise by about 1.4°C in the central, north-eastern and south-eastern sorghum growing regions, and a 1.8°C increase is anticipated over western sorghum growing areas of the country (Figure 2). The seasonal mean temperature in the second rainy season of the 2030s is expected to rise by about 1.8°C in most of the sorghum growing areas of the country. The projection model also shows that temperature in the 2050s is expected to rise by about 2.4°C in the central, north-eastern and south-eastern sorghum growing areas, while an increment of 2.8°C is anticipated in the western sorghum growing regions during both the first and second rainy seasons (Figure 2). Figure 2 also demonstrates a rate of warming in sorghum growing areas, whereby temperature over the western growing region rises greater than the central, north-eastern and south-eastern by about 0.4°C.



**Figure 2.** Projected seasonal mean changes in temperature for 2030s (LEFT COLUMN) and 2050s (RIGHT COLUMN) under the RCP8.5 emission scenario, relative to the reference period (1961-2005). **NOTE:** In the 2050s, temperature in the western sorghum growing areas of Tanzania is likely to rise by about 2.8°C and by about 2.4°C in the central, northeastern and southeastern sorghum regions in the second rainy season (OND, BOTTOM RIGHT).

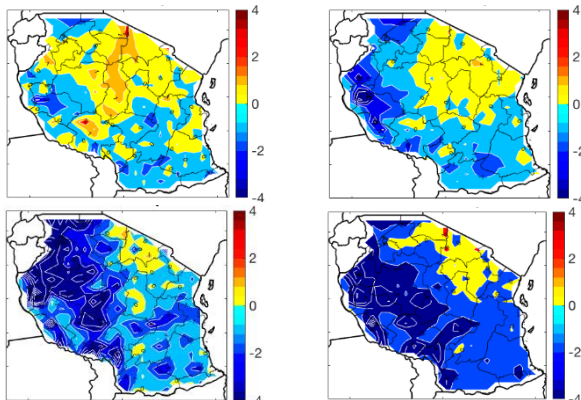
#### Precipitation

The seasonal mean rainfall in both the first and second rainy season is projected to increase in the central, north-east and south-east sorghum growing areas of Tanzania by as much as 10-30% in the 2030s and 2050s (Figure 3). However, the seasonal mean rainfall in both the 2030s and 2050s is expected to decrease slightly (by 5-10%) in the western sorghum growing areas, especially during the second rainy season (OND).



**Figure 3.** Projected seasonal mean changes in rainfall (in percentage) for 2030s (LEFT) and 2050s (RIGHT) under the RCP8.5 emission scenario, relative to the reference period (1961-2005). **NOTE:** In both the 2030s and 2050s, the mean rainfall in the second (OND; BOTTOM) and first rainy season (MAM; TOP) is projected to decrease in the western sorghum growing areas of Tanzania.

Similarly, the longest consecutive wet days in the central and north-east sorghum growing areas of Tanzania is expected to increase slightly by about 1 day (Figure 4) in both the first and second rainy seasons. However, the western, south-eastern and some parts of the central sorghum growing areas of the country will experience a decrease in the length of the longest wet spell (2-4 days), especially during the second rainy season.



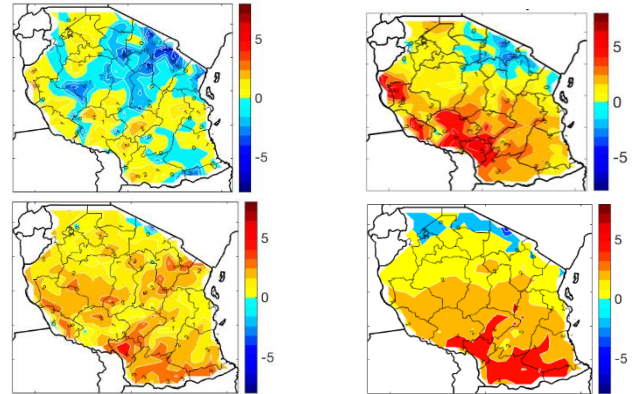
**Figure 4.** Projected seasonal mean changes in consecutive wet days (CWD) for 2030s (LEFT) and 2050s (RIGHT) under the RCP8.5 emission scenario, relative to the reference period (1961-2005). **NOTE:** The consecutive wet days are expected to decline significantly (2-4 days) in the western, south-eastern and some parts of central sorghum growing areas of Tanzania especially during the second rainy season (OND; BOTTOM).

The expected increase in the seasonal mean rainfall accompanied by an increase in the number of consecutive wet days in the north-eastern and in the adjoining areas of the central sorghum growing areas could translate into enhanced extreme rainfall in the region.

### Drought

The projection of the longest consecutive dry days (CDD) show that dry spells will last longer in the 2030s and 2050s in the western, south-eastern and some parts of the central sorghum growing areas. Longer dry spells (up to 5 days) are expected especially in the western and south-eastern sorghum growing areas in both the first and second rainy seasons by the 2050s (Figure 5). However, the CDD decreases (by about 1 day) in the north-east sorghum growing areas especially in the first rainy

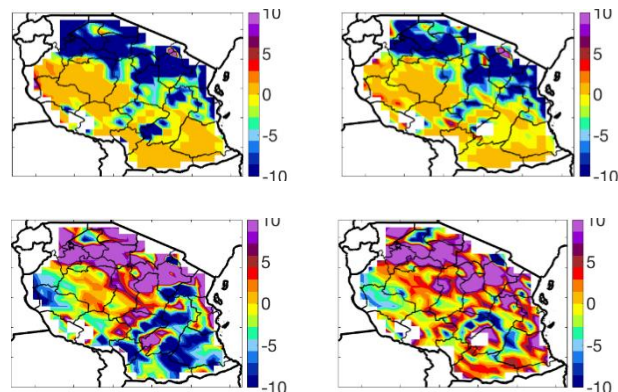
season. The projected increase in CDD in the western, south-eastern and some parts of central sorghum growing areas in both the 2030s and 2050s for the first and second rainy seasons along with the expected decline in wet spells (Figure 4) and seasonal rainfall (Figure 3) could lead to high incidence of drought, which would have a significant impact on the sorghum yield in the region.



**Figure 5.** Projected seasonal mean changes in consecutive dry days (CDD) for 2030s (LEFT) and 2050s (RIGHT) under the RCP8.5 emission scenario, relative to the reference period (1961-2005). **NOTE:** Dry spells will last longer (by about 5 days) in the 2030s and 2050s in the western and south-eastern sorghum growing areas of Tanzania in both the second (BOTTOM) and first (TOP) rainy seasons.

### Onset and Length of Growing Spell

The onset, cessation and length of the growing spell for the first rainy season (MAM) is estimated for the historical (1961-2005) and the 2030s and 2050s. Results show that early onset of the rainfall is expected in the north-east sorghum growing areas of Tanzania by about 10 days (Figure 6). On the other hand, onset of the rainfall is expected to be delayed (by about 1-3 days) in the western, south-eastern and some parts of the central sorghum growing areas of the country. Similarly, the length of the growing spell in the north-east and some parts of the central sorghum growing areas of Tanzania is expected to increase by about 10 days (Figure 6). However, the western and south-eastern sorghum growing areas of the country are expected to have a short growing spell especially in the 2030s.



**Figure 6.** Projected seasonal mean changes in onset for 2030s (TOP-LEFT) and 2050s (TOP-RIGHT) and length of growing spell for 2030s (BOTTOM-LEFT) and 2050s (BOTTOM-RIGHT) under the RCP8.5 emission scenario, relative to the reference period (1961-2005). **NOTE:** Early onset of rainfall is expected in the north-eastern sorghum growing areas in both the 2030s (TOP-LEFT) and 2050s (TOP-RIGHT). The length of the growing spell is also projected to be longer by about ten days in the north-eastern sorghum growing areas of the country.

In summary, during both the second (OND) and first (MAM) rainy seasons, the model projections for 2030s and 2050s show that temperature is expected to rise by about 1.4°C to 1.8°C and 2.4°C to 2.8°C in the sorghum growing areas, respectively. A likelihood of more dry spells and late onset of rainfall with an implication of more incidences of agricultural drought is expected over the western, south-eastern and some parts of the central sorghum growing areas while the north-east sorghum growing areas are expected to experience early onset and longer length of the growing spell, and more days of wet spells that could lead to excessive rainfall events or flooding in the region.

### Climate Change Impact (Modelling Study)

Farmers in Tanzania have already been experiencing rising temperatures and erratic rainfall during the MAM season, which is the major rainy season (CRA workshop). In the coming decades, this is expected to worsen under both the business-as-usual climate change scenario (RCP 8.5) (Figure 7) and the more optimistic scenario in terms of interventions to reduce emissions (RCP 4.5). Despite these projections, the impact on sorghum yield is expected to be minimal irrespective of the climate change scenario. This is because unlike other crops sorghum is a hardy crop and relatively more tolerant to drought/water stress (Figure 8) than other crops (Tack et al., 2017). Currently, sorghum production systems in Tanzania are mainly rainfed with minimal pest and disease control and low productive inputs. Consequently, average production of farmers is about 1000 kg/ha (FAOSTAT, 2019). In the coming decades, many areas are unlikely to experience any yield change. And in the areas which are likely to experience yield changes, there are likely to be a mixture of yield gains and yield losses by not more than 250 kg/ha. Most of the areas that are likely to experience yield losses will be in Kigoma and Mwanza, whereas most of the areas that are likely to experience yield gains will be in southern Tabora.

Despite the current yields of 1000 kg/ha, there exist opportunities for farmers to more than double these yields with better agronomic practices such as a combination of soil testing and fertilizer application, pest, disease and weed control. The fact that climate change is unlikely to erode these opportunities in the future makes sorghum a potential vital crop in Tanzania.

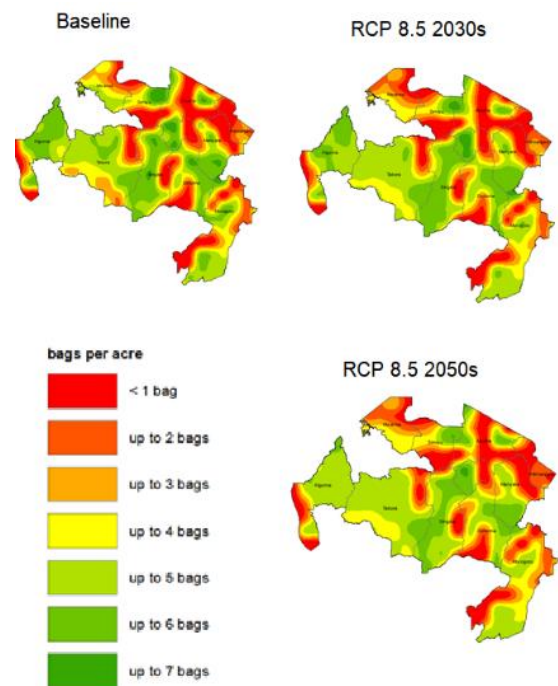


Figure 7. Modelled sorghum yields under current and future climates (RCP8.5)

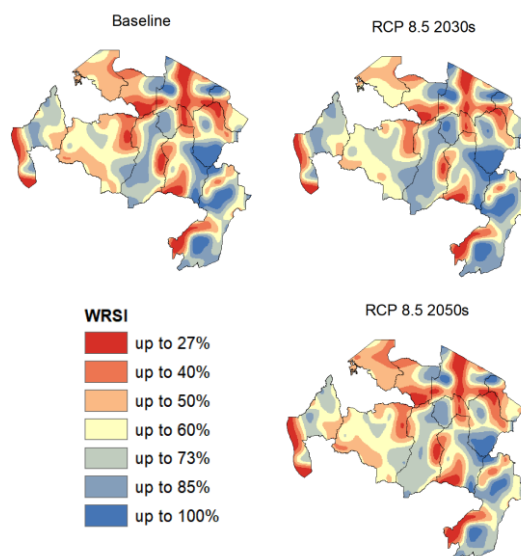


Figure 8. Water availability (WRSI) for sorghum production during the MAM season under current and future climates (RCP8.5)

### Climate Risk Assessment Workshop

Climate Risk Assessment workshop (CRA) for the sorghum value chain was conducted in Singida region. The CRA workshop aimed at increasing awareness about how climate change impacts the Sorghum subsector in the country. The workshop not only brought together relevant stakeholders in the sorghum growing areas, it also provided an opportunity for emerging new business ideas. Participants included; producers, input suppliers, aggregators, processors, financial institutions, retailers and government institutions. The workshop was officiated by the Administrative Secretary Singida Region.

## Climate Related Risks

With insight on how the climate is likely to change in future as well as on the effectiveness of current coping strategies, actors discussed the most important climate risks in relation to other risks affecting their business.

*"The untapped potential in the sorghum value chain is the availability and distribution of improved seeds. This is the area that needs investments", Scolar Hall, Managing Director of Adorable Food Product, Processor and Trader of sorghum, cassava and maize, Dodoma region.*

*Over the years, we have been experiencing drastic climatic change that has affected the supply chain of my business, leading to a decrease in my profit margin. If the duration of wet spells increases by even a week due to climate change, it will negatively affect my business. For example in 2017, heavy rainfall caused rotting of the purchased sorghum, and despite my effort to dry it, it smelt bad and I lost some potential customers. On top of that, roads were not accessible leading to an increase in transportation costs. The price per kilo from farmers/agents shot up as well, which reduced my profit margin.*

*If dry spells would take place more often and last longer due to climate change, this also leads to poor quality of sorghum in most of the areas where I am sourcing.*

*To deal with the negative impacts of climate change, I am always changing buying sites. For example in 2018 there was poor productivity in Dodoma, so I shifted to Tanga and Mererani-Manyara regions, where there was optimal harvest.*

*"Extreme rainfall in 2018 led to an increase in productivity from 10 to 3-5 bags/ acre," Sophia Mumba a sorghum farmer in Kondo*

*Nowadays we experience more extreme rainfall than in the past especially in the last three years though in 2019 there was below average rainfall distribution.*

*The heavy rainy seasons decreases my productivity. Prolonged rainfall after flowering negatively affects seed development. Rainfall during maturity turns the colour of the seeds black, which the majority of buyers do not like and even if they buy, their price will be lower. On top of this, floods destroy my farm. This year (2019), 2 acres were washed away by floods.*

*Apart from climate change, absence of reliable sources of seeds contribute to the reduced productivity. The same applies to absence of buyers.*

Actors	Most important perceived climate risk	Other (related) risks affecting actors' business
Smallholder farmers (male)	- Poor distribution of rainfall - Increased drought	- Low productivity, low yield - Decrease in selling price due to lower quality of produce
Smallholder farmers (female)	- Floods - Winds	- Low productivity, low yield - Falling of plant stem leading to poor quality of produce
Village agents, researcher, ICT service provider	- Raise in temperature - Unreliable rainfall	- Unreliable access to certified seeds
Processors, banks, agro-dealers	- Uneven rainfall distribution - Floods	- Low productivity - Poor availability of certified seeds

## Adaptation Strategies (Examples)

To better deal with climate change in future, adaption strategies were identified and discussed in terms of factors hindering the uptake and/or implementation of adaptation strategies. Some of these adaption strategies were considered **potential business ideas** to be further explored such as cold storage units for cooperatives or processors, and supply of certified seeds by agro-dealers.

Adaption strategies (examples)	Factors hindering uptake or implementation of adaptation strategies (examples)	What can be done? (examples)
<ul style="list-style-type: none"> <li>- encourage index-based insurance</li> <li>- introduce water harvesting technology</li> <li>- proper usage of insecticides</li> <li>- tree planting campaign</li> <li>- capacity program on agronomic practices</li> </ul>	<ul style="list-style-type: none"> <li>- lower capital to afford purchase of insecticides and improved seeds</li> <li>- weak agronomic skills attributed by fewer number of knowledgeable extension workers</li> <li>- high salty content in the soil</li> <li>- absence of improved seeds and those of economical trees</li> <li>- high investment cost in introducing irrigation scheme</li> </ul>	<ul style="list-style-type: none"> <li>- program targeting specific actors should enrich the grassroots actors</li> <li>- facilitate bylaws that binds each village/ward to establish and implement tree planting program</li> <li>- knowledge development on market and good farming practices, including use of improved seeds</li> <li>- increase collaboration between research centres, seed companies and processors</li> <li>- access to adequate finance (loans), e.g. via farmer cooperatives (facilitated by CRAFT)</li> </ul>

## References

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## Acknowledgement

This document was developed by CCAFS (Teferi Demissie), Wageningen Environmental Research (Confidence Duku, Annemarie Groot), and SNV-Tanzania (Godfrey Kabuka), with contributions from John Recha and Joab Osumba (CAFS), Agriterra and Rabobank Partnerships B.V. It highlights activities and examples of results of a climate risk assessment for the sorghum value chain implemented in the period August – December 2019. The assessment was carried out in the context of the Climate Resilient Agribusiness for Tomorrow (CRAFT) project.

## Project Information

*The Climate Resilient Agribusiness for Tomorrow (CRAFT) project (2018 - 2023), funded by the Ministry of Foreign Affairs of the Netherlands, will increase the availability of climate smart foods for the growing population in Kenya, Tanzania and Uganda. The CRAFT project is implemented by SNV (lead) in partnership with Wageningen University and Research (WUR), CGIAR's Research Program on Climate Change, Agriculture and Food Security (CAAFS), Agriterra, and Rabo Partnerships in Kenya, Tanzania and Uganda.*

## For More Information:

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