CRAFT
Climate resilient value chains for improved livelihoods

Potatoes Tanzania

Climate Change Risks and Opportunities

Potatoes in Tanzania

Tanzania is the Sixth largest producer of potatoes in Africa. They are generally grown in regions having an elevation of 1,800 and 2,700 meters above sea level. About 70 - 80% of the potatoes are produced in the Southern Highlands, particularly in the Iringa, Njombe and Mbeya regions. SAGCOT reported an annual potatoes production of over 1.7 million metric tons in the year 2017 (SGCOT, 2017). Average yield of potatoes ranges between 10 – 25 tons per hectare (Netherlands Enterprise Agency, 2017). Potato is also grown in Arusha, Eastern and in Kagera regions. In the Southern Highland, farmers grow two crops a year, in the short rainy season (Sept–Jan/Feb) and in the long rainy season (Feb-June/July). In the Eastern and Northern Zones, farmers grow one crop per year only (March - June/July). Potatoes are among the leading cash crops for smallholder farmers with about 88% of the potatoes grown sold for cash income (compared to 40 - 50% for beans, maize and rice). Potatoes are more profitable compared to cereals (especially in the highlands); with experts estimating three (3) fold higher incomes from potatoes (KilimoTrust, 2016). The area under potato production has increased exponentially over the years, as well as the production. Yields, however remain relatively low (Snyder et al., 2019), primarily due to low availability and use of quality seed, as well as limited knowledge of good agricultural practices. These – together with poor marketing structures, unstable prices, unspecified weights and measures, limited value addition and lack of crop promotion – restrict potato profitability among smallholder farmers.

Past Trends in Temperature in Potato Growing Areas

The temperature trend (from 1961-2005) for the first rainy season (March, April, May) show that temperature has been increasing by about 1°C in both the north-east and south-west potato growing areas (Figure 1). During the second rainy season (October, November, December), temperature has been increasing by 1°C - 1.2°C in north-east and south-west potato growing areas.

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.

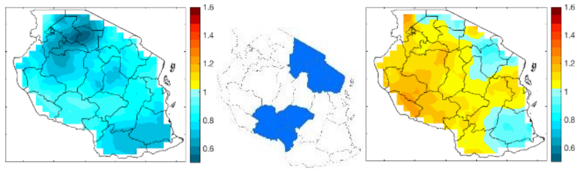

Figure 1. *Temperature trend from 1961-2005 for the first rainy season (MAM, LEFT) and second rainy season (OND, RIGHT).* ***NOTE****: During both the second and first rainy season temperature in the potato growing areas of the country (MIDDLE) has increased by* 1°C - 1.2°C.

Climate Change in the Future

Temperature

During both the first and second rainy seasons, temperature in the 2030s is expected to rise by about 1.4°C and 1.8°C in the north-east and south-west potato growing areas of Tanzania, respectively (Figure 2). The projection model also shows that temperature in the 2050s is expected to rise by about 2.4°C and 2.8°C in the north-east and south-west potato growing areas, respectively, in both the first and second rainy seasons. Figure 2 demonstrates a rate of warming in Tanzania, whereby temperature over the south-west potato growing areas rises greater than the north-east by about 0.4°C.

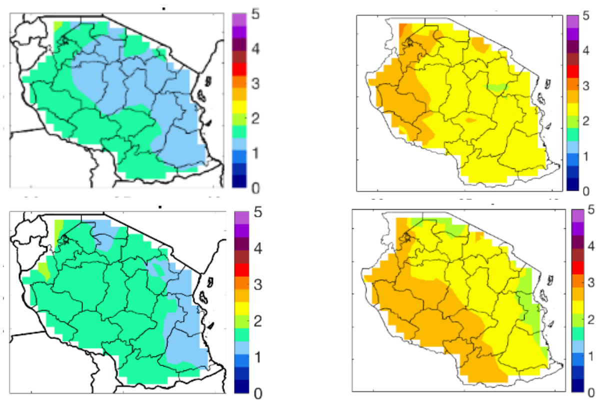

Figure 2*. Projected seasonal mean changes in temperature for 2030s (LEFT COLUMN) and 2050s (RIGHT COLUMN) under the RCP8.5 emission scenario, relative to the reference period (1961-2005).* ***NOTE:*** *In the 2050s, temperature in the south-west potato growing areas of Tanzania is likely to rise by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

Precipitation

The seasonal mean rainfall in both the second and first rainy seasons is projected to increase in the north-east potato growing areas by as much as 20-30% in the 2030s and 2050s (Figure 3). However, the seasonal mean rainfall in both the 2030s and 2050s is expected to slightly decrease (by 5-10%) in the south-west potato growing areas of the country, especially in OND.

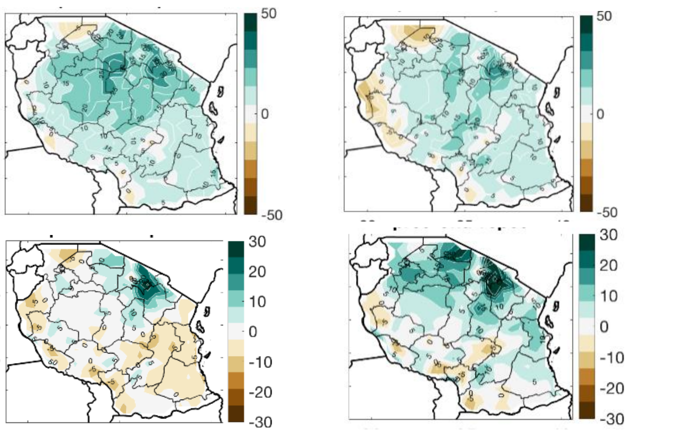

*Figure 3. Projected seasonal mean changes in rainfall (in percentage) for 2030s (LEFT) and 2050s (RIGHT) under the RCP8.5 emission scenario, relative to the reference period (1961-2005). **NOTE**: In both the 2030s and 2050s, the mean rainfall in the second (OND; BOTTOM) and first rainy season (MAM; TOP) is projected to increase in the north-east potato growing areas by 20-30% for the 2050s.*

Similarly, the longest consecutive wet days in the north-east potato growing areas is expected to increase slightly by about 1 day (Figure 4) in both the second and first rainy seasons. However, the south-west potato 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.

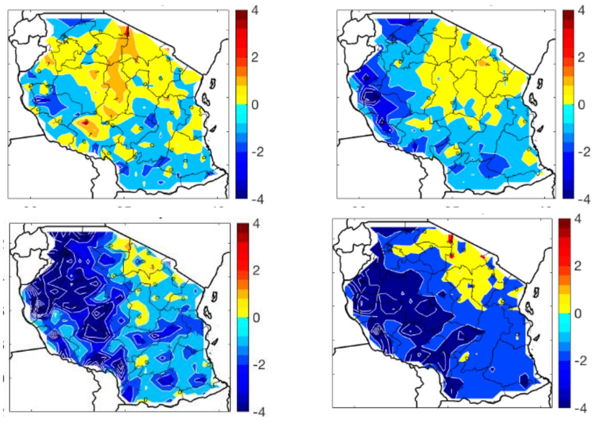

*Figure 4. Projected seasonal mean changes in consecutive wet days (CWD) for 2030s (LEFT) and 2050s (RIGHT) under the RCP8.5 emission scenario, relative to the reference period (1961-2005). **NOTE:** The consecutive wet days are expected to significantly decline (2-4 days) in the south-west potato growing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

The expected increase in the seasonal mean rainfall accompanied by an increase in the number of consecutive wet days in the north-east potato growing areas of Tanzania 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 south-west potato growing areas with much longer dry spells projected (by about 5 days) in both the second and first rainy seasons of the 2050s (Figure 5). However, the CDD decreases (by about 1 day) in the north-east potato growing areas of the country especially in the first rainy season. The projected increase in CDD in the south-west potato growing areas of the country in both the 2030s and 2050s for the second and first rainy seasons along with decrease 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 potato yield in the region.

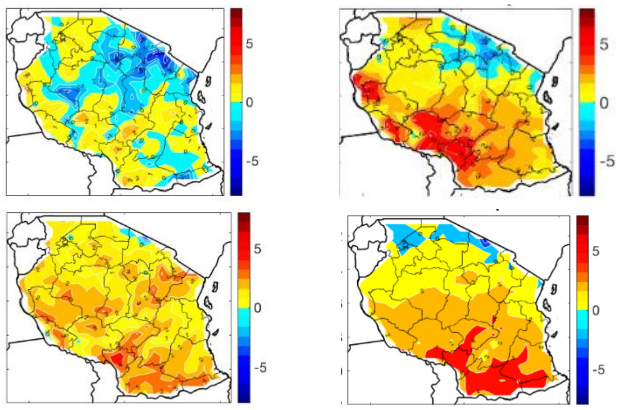

*Figure 5. Projected seasonal mean changes in consecutive dry days (CDD) for 2030s (LEFT) and 2050s (RIGHT) under the RCP8.5 emission scenario, relative to the reference period (1961-2005). N**OTE**: Dry spells will last longer (by about 5 days) in the 2030s and 2050s in the south-west potato growing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

Onset and Length of Growing Spell

The onset, cessation and length of 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 potato growing by about 10 days (Figure 6). On the other hand, onset of the rainfall is expected to be slightly delayed (by about 1-3 days) in the south-west potato growing areas of the country. Similarly, the length of the growing spell in the north-east potato growing of Tanzania is expected to increase by about 10 days (Figure 6). And, the south-west potato growing areas of the country is expected to have a short growing spell (by about 10 days) especially in the 2030s.

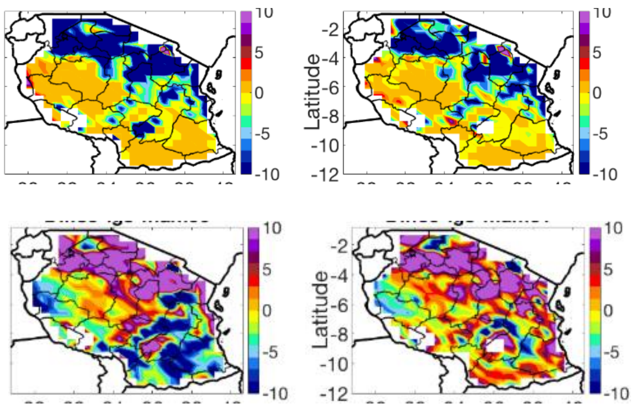

*Figure 6. Projected seasonal mean changes in onset for 2030s (TOP-LEFT) and 2050s (TOP-RIGHT) and length of growing spell for 2030s (BOTTOM-LEFT) and 2050s (BOTTOM-RIGHT) under the RCP8.5 emission scenario, relative to the reference period (1961-2005). **NOTE**: Onset of rainfall in the south-west potato growing areas is expected to be delayed and the length of the growing spell is projected to be short by about ten days.*

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 2.8°C in the potato growing areas. A likelihood of more dry spells with an implication of more incidences of agricultural drought is expected over the south-west potato growing areas while the north-east potato growing areas are expected to experience excessive rainfall events that leads to flooding.

Climate Change Impact (Modelling Study)

In the coming decades, climate change is likely to result in reduction in potato yields during the MAM season, which is the major growing season. The impacts on potato yields are likely to worsen with time. The worst affected areas are expected to be Mbeya, Njombe and Iringa regions. In these regions, by the period 2051 to 2060, large areas that currently produce up to 20 tons per hectare are likely to experience yield losses of between 4 – 8 tons per hectare under the business-as-usal climate change scenario i.e. RCP8.5 (Figure 7). Yield losses are also expected under the more optimistic scenario in terms of mitigation interventions i.e. RCP4.5. However, the magnitude of yield losses is likely to be lower than under RCP8.5.

The major factor for the expected decrease in potato yield in the future will be due to unreliability of rainfall and rising temperature. These effects were captured and expressed using the Water Requirement Satisfaction Index (WRSI), which is an indicator of crop performance based on the availability of water to the crop during the growing season. High values indicate more water available and hence less potato water stress. The WRSI results (Figure 8) for potato show that increasingly less water (rainfall and soil moisture) will be available to meet potato crop water requirements during the MAM season resulting in the aforementioned yield losses. In Manyara and Tanga, yields are relatively lower compared to Mbeya even though the WRSI is higher than in Mbeya. This indicates that in these two regions, other factors such as floods, pests, and diseases are more determinative of the yields or yield losses than droughts.

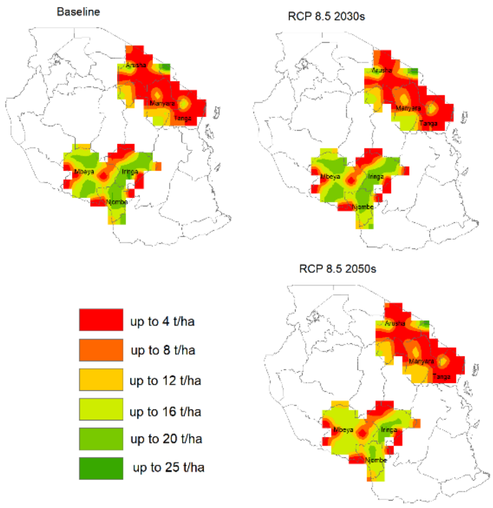

Figure 7. *Modelled potato yields under current and future climates (RCP8.5)*

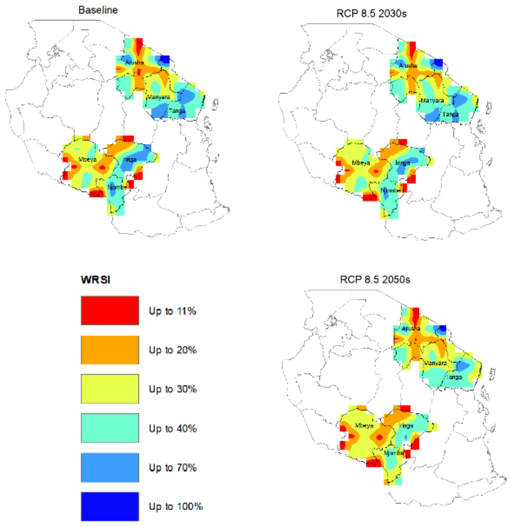

Figure 8. *Water availability (WRSI) for potato production during the MAM season under current and future climates (RCP8.5)*

Climate Risk Assessment Workshop

The Climate Risk Assessment workshop brought together 30 participants representing the different actors of the potato value chain. The majority of the participants were male and female smallholder farmers. Stepwise they shared and discussed experiences with climate change, its impact on their business and the effectiveness of current coping strategies. Some of the participants were interviewed prior to the event. They shared their story about climate change and how it impacts their business with other participants.

"Over the last years rainfall patterns have become more unreliable. We also experience an increase in excessive rainfall," Mashamba, a seed dealer in Mbeya city, involved in manufacturing, packaging and distribution of potato seed.

I experience a change in weather due to climate change. Over the last years rainfall patterns have become more unreliable and we also observe an increase in excessive rainfall. Unreliable rainfall patterns delay farm activities like planting, whereas too much rainfall requires farmers to apply a lot of pesticides and other agro-chemicals.

In 2016, heavy rainfall destroyed our road and bridges. Truck owners did not want to take their tracks to the farms due to poor infrastructure and potato buyers could not buy the produce in time. This led to a reduction in income for farmers, which in turn resulted into low income of agro-dealers because farmers could not purchase significant amount of potato seeds. Heavy rainfall in 2016 also caused low production of potato seeds by our own company. I expected to harvest 50tonnes of potato seeds, but I harvested 30 tonnes only.

" In future, I will need to invest more in irrigated farming and use resilient seed varieties that are temperature, frost and humidity resistant," Augusta Dominicius Madembwe a crisps processor from Njombe region, who has been farming potatoes for over 20 years.

Since I started farming I have experienced weather fluctuation especially precipitation, frost and extreme cold temperature. All of these negatively affect the potatoes yield.

Wet spells has caused higher incidents of pest attacks and reduce the quality of the potatoes resulting in poor selling of the crisps and small or no margins. I have constructed a warehouses for storing of both raw and processed potatoes as my coping strategy to the extreme rain. I also use varieties fairly resistant to extreme precipitation. But in future I will need to invest more in irrigated farming and use more resilient seed varieties that are temperature, frost and humidity resistant.

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.

Actors	Most important perceived climate risk	Other (related) risks affecting actors' business
Smallholder farmers (male)	– uneven rainfall distribution?	– low productivity, low yield
Smallholder farmers (female)	– increase in temperature prolonged sunlight – unpredictable rainy seasons – fog	– low productivity, low yield – unstable market, too many middle men – policies
Village agents, researcher, ICT service provider	– raise in temperature – unreliable rainfall	– low productivity leading to low savings – unstable potato market – unreliable access to certified seeds
Processors, banks, agro-dealers	– uneven rainfall distribution	– 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 and what could be done to support adoption. 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)
– good farm management practices (rotation, fertilizers, manure) – Improved /certified seeds – cold storage units – planting trees – affordable irrigation	– land tenure system (rented plots) – lack of knowledge (technical, market) amongst various actors – lack of sufficient and adequate finance – poor potato network – user unfriendly packaging material	– knowledge development on market and good farming practices, including use of improved seeds – target messages for farmers (seeds, fertilizers, agrochemicals) – establish potato forum and strengthen collaboration in potato value chain (with assistance from CRAFT) – access to adequate finance (loans), e.g. via farmer cooperatives (facilitated by CRAFT)

References:

- KilimoTrust, 2016, Calories and Household Incomes from Potatoes sub-sector in Tanzania, Dar-es-Salaam, Tanzania
- Southern Agricultural Growth Corridor of Tanzania (SAGCOT), Dar- es-Salaam, Tanzania
- Snyder, K.A., Sulle, E., Massay, D.A., Petro, A., Qamara, P. and Brockington, D., 2019. "Modern" farming and the transformation of livelihoods in rural Tanzania. *Agriculture and Human Values*, pp.1-14.
- Netherlands Enterprise Agency, 2017. Seed Potatoes Tanzania, The Hague, Netherlands

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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 (CCAFS), Agriterra, and Rabo Partnerships in Kenya, Tanzania and Uganda.

For More Information:

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