ESP issue brief #001

Climate Change in Ethiopia's Central Rift Valley: potential adaptation strategies for seed producers

WAGENINGEN
UNIVERSITY & RESEARCH

This issue brief provides insights to the effects of climate change in Ethiopia's Central Rift Valley and explores adaptation strategies for seed producers to enhance climate resilience. It draws on secondary research and interviews with seed companies involved in the Ethiopian Seed Partnership.

Key messages

- Climate change will alter rainfall and temperature patterns in Ethiopia's Central Rift Valley
- Both high- and low-emission scenarios predict less homogeneous rainfall, longer dry spells and rising temperatures. These shifts will increase water stress and create more favourable conditions for crop diseases, directly threatening agricultural productivity
- Seed producers face urgent adaptation challenges and opportunities, as many currently used crop varieties are not equipped to handle the abiotic and biotic stresses expected in the coming decades
- Crop-specific adaptation strategies are available for teff, wheat, and chickpea
- Technology and sustainable practices can boost climate resilience

1 Introduction

Ethiopia's economy relies heavily on agriculture, which accounts for more than a third of Ethiopia's national GDP and serves as the main source of income for 67% of the population (World Bank and OECD, 2025). The fact that agriculture is predominantly rainfed makes Ethiopia particularly vulnerable to the impacts of climate change. One of the most vulnerable areas to climate change in Ethiopia is the Central Rift Valley (CRV), an area 150km south of Addis Ababa encompassing four large lakes, and unique in its hydrological and ecological characteristics (Chimdesa, 2016). The valley with its chain of lakes forms one of the few freshwater ecosystems in Ethiopia and is crucial for the regional agriculture and domestic water supply (Musie et al., 2021). However, increased rainfall variability, rising temperatures, and altered growing seasons due to climate change are expected to decrease crop yields in the region (Ray et al., 2019). This threatens the economic stability and food security of CRV as well as areas supplied by produce from the area. Furthermore, agricultural actors in the region, including seed producers, are facing increasing challenges for their production, seeking climate resilience and adaptation strategies as well as ways to adapt to changing farmer demands. In this issue brief, we therefore explore the impact of climate change in Ethiopia's Central Rift Valley and the potential adaptation strategies seed producers can employ to become more climate resilient. This brief is prepared mainly based on a desk review of secondary literature and interviews with seed producing companies supported by the Ethiopian Seed Partnership.

2 Climate change in the Central Rift Valley

The CRV is a dryland area surrounding the four lakes of Ziway, Langano, Abiyata and Shala, with topographical variations and different elevations. The region has three different seasons: the Belg season, a short rainy season running from March to May; the Kiremt season, the second and main rainy season running from June to September, and the dry season Bega, running from October to February. The Kiremt is the key season for water provision in the region as it provides almost 70% of the annual precipitation (Abera et al., 2019).

In order to understand the future climate projections in the CRV, several climate models can be used. These models follow the greenhouse gas emission scenarios according to International Panel on Climate Change (IPCC) and consider the highly uncertain future evolution of greenhouse gas emissions. The scenarios cover multiple routes of how these future emissions may unfold, ultimately assisting in climate change analysis. Four storylines on emission driving forces and their evolution have been presented by the IPCC, which yields four scenarios: A1, A2, B1 and B2 (Pradhan et al., 2022). These scenarios differ in terms of future focus (see figure 1).

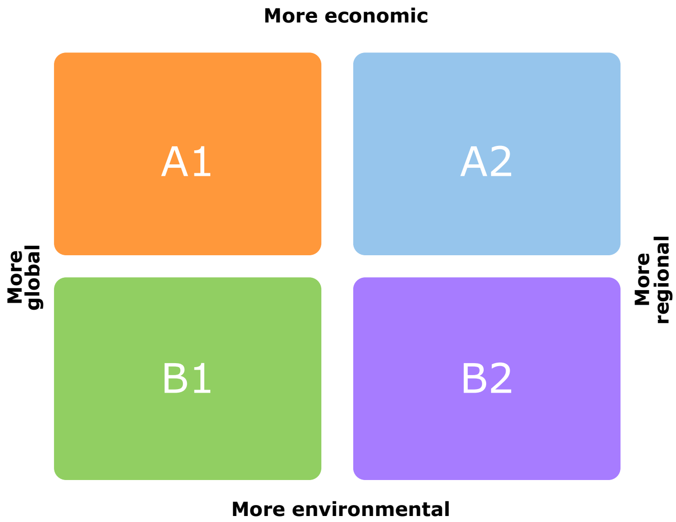

Figure 1 - The four major climate scenarios as developed in the special report on emissions scenarios (SRES) by the IPCC. Presented along two aces: a global/regional focus axis and an environmental/economic focus axis. Adapted from Iowa State University (Iowa State University, 2001)

First of all, the A-scenarios cover a world that is focussed on economic growth whilst in B-scenarios, the world primarily aims at environmental change. On the other axis, the 1-scenarios describe a converging, globalized world working together whilst the 2-scenarios describe a heterogenous world. In terms of emissions, the A2 and B1 scenarios cover the high and low extremes, respectively. The A2 scenario describes a heterogeneous world with a continuously growing population. Per capita economic growth and innovation are fragmented and slow. On the other hand, the B1 scenario describes a converging world in which the global population peaks in mid-century and subsequently declines. There is a focus on global solutions to sustainability and equity (Houghton et al., 2001). In other words, the A2 scenario describes the worst-case climate impacts in a high-emission scenario, and the B1 describes the best-case climate impacts in a low-emission scenario. Using these two scenarios provides an understanding of the range of impacts caused by climate change and we will further consider these two scenarios in the rest of this brief.

2.1. Rainfall trends

The annual precipitation of the whole CRV varies greatly, from less than 700 mm in the valley floor to about 1,100 mm in the highlands (Abera et al., 2019; Hailesilassie et al., 2022). Based on the annual climate bulletin from 2014 – 2023, released by the National Meteorology Agency of Ethiopia, the annual precipitation has shown a decreasing trend in the past decade. Looking at the climate scenarios, both A2 and B1 scenarios show a trend towards drier conditions from April to September and slightly wetter conditions from October to March. The majority of the literature agrees that there will be a decreasing trend for rainfall in the Belg season and an increasing trend of rainfall in the dry season, especially in November and December, for both low emission and high emission scenarios (Abera et al., 2019; Hailesilassie et al., 2022; Muluneh et al., 2015).

However, the results for the Kiremt season exhibit more variability, with most projections indicating a decreasing trend in Ziway by 2080. Another future projection ofprecipitation in Asella and Adama for the period 2020 - 2049, focusing on the change on Kiremt and Belg rainy seasons, shows a decrease in rainfall in the Belg season while the Kiremt season is getting wetter in both scenarios and both locations. The differences in results indicate the importance of climate assessment at different spatial and seasonal scales (Muluneh et al., 2017). Additionally, a higher rainfall variability and more frequent and intense climatic extremes, like a high-intensity rainfall, are also expected under the changing climate.

2.2. Temperature

The mean annual temperature for the whole CRV is estimated at 18.9°C, with mean minimum and maximum temperatures of 12°C and 26°C, respectively. The region has been showing a warming trend ranging from 0.12 to 0.54°C per decade. While projected rainfall shows variability in its results, studies on future temperatures in the CRV generally suggest an increasing trend in both A2 and B1 emission scenarios, with the rate of temperature increase expected to accelerate in future projections (Kassie et al., 2014; Muluneh et al., 2015). The rising temperature will increase the rate of evapotranspiration (i.e. water evaporation from soil surface as well as water transpiration from the crop) and crop water requirements, which further exacerbates the water stress of crops that some regions will already face because of the decreasing rainfall trend (Kassie et al., 2014).

3 Seed production and climate change

The outlined scenarios show that climate change will have a significant impact on temperature and rainfall conditions in the CRV. These changes will furthermore have implications for the growing season and intermittent dry spells in the region and therefore on the future of seed production as well.

3.1. Growing season

The general growing season in the CRV lasts from March to September, with the mean length varying between 161 and 197 days, highly correlated to the onset of rainfall. In an analysis of the growing season length in the period from 1970-2010, a short growing season was often explained by late onset of the season, while no correlation was found between the cessation date and the length. When looking at the A2 and B1 scenarios using different climate models, large discrepancies can be found, stressing the uncertainty in implications of future climate change in the CRV. In general, however, the models predict a slight shortening of the growing season (Kassie et al., 2014).

3.2, Dry spell analysis

Within the rainy season, severe damage can be done to crops when dry spells occur during sensitive stages of the crop development. These stages include the first 30 days after sowing, during the establishment of seedlings, and 60-90 days after sowing, when flowering and grain filling occur (Muluneh et al., 2015). In the current climate, the Belg season has a higher probability of dry spells than the Kiremt season, although the probability of dry spells longer than 5, 7 or 10 days in the Kiremt is also not zero (Kassie et al., 2014). For this reason, Muluneh et al. (2015) also investigated the impact of the different climate change scenarios on the mean dry spell length in the CRV.

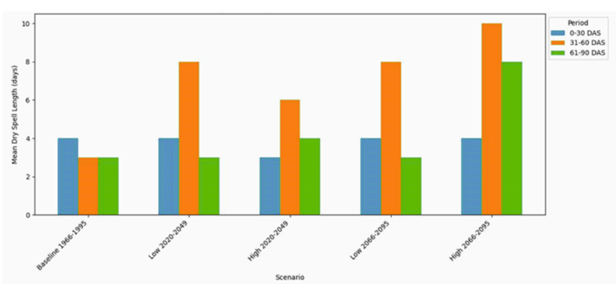

Figure 2 - The mean dry spell length during the first 90 days after sowing for wheat in the CRV. Results were obtained for the baseline period and two future timeframes under the A2 and B1 scenarios using the ECHAM5 model. Adapted from Muluneh et al. (2015)

Using again the A2 and B1 scenarios, in the first 30 Days After Sowing (DAS), the results predict no significant changes in mean dry spell length. Figure 2 shows that changes in mean dry spell length are predicted especially in the period of 31 to 60 days after sowing. In both scenarios, the mean dry spell length is expected to at least double in the coming 25 years compared to the baseline period, and it may even triple on the longer term. Dry spell length in the flowering stage (61-90 DAS) is only expected to increase in the A2 scenario with only a significant increase towards the second half of this century. Looking at these scenarios, in particular the 30-60 DAS period will thus face most impact compared to current situation and will therefore be critical for seed producers to adapt to.

4 Challenges and opportunities for seed producers

Climate change has and will have a significant impact in Ethiopia and is one of the major concerns for local seed companies to grow their business. Local seed companies supported by the Ethiopian Seed Partnership (ESP) already observe rain shortage and uneven rainfall distribution. They are concerned about the effects of these on the quality and quantity of seed production.
As discussed in the previous section, the CRV will face less homogeneous precipitation throughout the growing season (Kassie et al., 2014). These projections, together with higher temperatures throughout the year, will result in increased water stress to the crops. Additionally, favourable conditions will be created for new diseases to arise, such as Dry Root Rot (DRR) of chickpea, or for already established diseases to become worse, as is the case of wheat stem rust (Rai et al., 2022).

As discussed in the previous section, the CRV will face less homogeneous precipitation throughout the growing season (Kassie et al., 2014). These projections, together with higher temperatures throughout the year, will result in increased water stress to the crops. Additionally, favourable conditions will be created for new diseases to arise, such as Dry Root Rot (DRR) of chickpea, or for already established diseases to become worse, as is the case of wheat stem rust (Rai et al., 2022).
The local varieties of chickpea, teff and wheat (i.e. the focus crops in this brief) that are currently used by seed producers and farmers may not be suited to withstand projected abiotic and biotic stresses, as we will explore further in this brief. In the Ethiopian formal seed sector, improved varieties have replaced local varieties because of their higher yield potential. However, most of the chickpea, teff and wheat varieties that are now produced by private seed companies have been introduced in Ethiopia in the early 2000s. These varieties have not been developed to withstand the type of water stress,

temperatures and diseases that are expected in the not-so distant future. In other words, even though these varieties have a higher yield (potential yield), the same cannot be said on the maximum yield restricted by water availability (potential water-limited yield) (Anderson et al., 2016).

4.1. Adaptation strategies

To maintain the potential water-limited yield of rainfed crops in the future, it is essential for seed producers to continuously adjust their crop variety portfolio with new, Climate-Smart (CS) crop varieties. Particularly, with the projections on climate change varying between the different altitudes of the Rift Valley, it is important to be aware of which traits will be most relevant in the future for the higher and the lower altitudes. This section will therefore concentrate on adaptation strategies for three crops: the cereal crops wheat and teff, and the legume crop chickpea. This focus is based on crops that are important for seed producers located in the CRV, and supported by ESP. Several seed producers in the area use teff, wheat and chickpea in their portfolio as current conditions in the CRV are conducive for their production. It is key to note that the recommendations provided serve as general guidelines for the CRV as a whole. However, location-specific characteristics of each Agro-Ecological Zone (AEZ) and farm-specific factors, such as soil composition and management practices, should ultimately be considered when adopting a variety.

4.2. Teff

Teff (Eragrostis tef) is an important crop in Ethiopia with 70% of Ethiopians using it as a primary food source. The crop is nutritious and safe to consume for people with celiac disease since it does not contain gluten, and it is high in protein and mineral content (W. Kebede et al., 2022).

4.2.1 Climate change impact on teff production

Teff is sown early to mid-July and grown during the Kiremt rainy season. It has an average growing season of 17 weeks, meaning that the harvest season starts in the beginning of October and can last up till the end of January, depending on the region, rainfall, and altitude of the area (Laterite, 2023). The optimal temperature for the development of teff is between 15°C and 21°C. Temperatures below 10°C result in no seed germination or seedling development (Barretto et al., 2021). The most crucial developmental stages of teff, including flowering and yield formation, normally occur during the late-season dry spells, at the end of September. During these spells, it is common to use irrigation for the optimal growth and development. Expected longer dry spells may therefore have an impact on teff production and require more moisture stress tolerance and lodging tolerance of varieties.

4.2.2 Teff variety recommendations

Looking at the climate change impacts in the study area, key traits that seed producers should look at to make their teff variety portfolio climate-smart are lodging tolerance and resistance to rust. Teff is a natural moisture stress tolerant crop which will be a helpful trait in the expected rainfall variability. Over the past 50 years, Bishoftu Agricultural Research Centre (BARC) has been breeding new and improved teff varieties that are stable and result in high yields. The most recently released teff variety is named Kulle, which is a high yielding and stable brown teff variety. Kulle is relatively tolerant to lodging during heavy rainfalls and is preferred by farmers and consumers in Ethiopia, especially in areas where there is high rainfall and moisture (Jifar et al., 2023). Other teff varieties, like Dagim and Tesfa, are also lodging tolerant, making it possible to cultivate these varieties under irrigation and harvest them mechanically. Their main advantages are the high yielding potential and stable performance in different areas. Besides high grain yield, both these varieties have high straw yields which can be used as cattle feed (Chanyalew et al., 2017; G. Kebede, 2018). Given the impact on agriculture due to climate change, using an early maturing teff variety could be beneficial to achieve high yields. Boni is such an early maturing variety able to grow in dry areas with low rainfall and moisture content. This variety would be a valuable addition to a climate smart portfolio (W. Kebede et al., 2022).

In addition to the maturity of teff, another concern for farmers in Ethiopia is the emergence of teff diseases. The teff variety Dursi is tolerant to major teff diseases like head smudge and teff rust. Other benefits of this variety are that it has good tillering capacity and is tolerant to lodging (Lule et al., 2019). Seed companies are therefore recommended to include Dursi, Bonim, Dagim and Tesfa varieties in their portfolio. In addition to working with these varieties, seed producers can also use several agricultural practices that would be supportive to maintaining yield levels. Crop rotation with legumes combined with irrigation during flowering and yield formation are the two most highly recommended practices in this regard.

4.3 Wheat

Ethiopia is a leading region for wheat cultivation in the African continent, serving as the major wheat producer in sub-Saharan Africa (Senbeta & Worku, 2023). In terms of production area, wheat ranks fourth among grain cereals, comprising 15% of the total crop area, following maize, sorghum and teff (CSA et al., 2021). As a staple food in Ethiopian households, wheat accounts for 14% of the total caloric intake (Senbeta & Worku, 2023).

The country's diverse topography supports the cultivation of both bread wheat (Triticum aestivum) and durum wheat (Triticum durum). These crops are primarily grown in Ethiopia's highlands, at altitudes ranging from 1,400 to 2,700 m.a.s.l., and rely on rainfall for irrigation (CSA, 2021). The optimal temperature range for wheat growth is between 6°C and 23°C, with precipitation between 45 and 175 mm per month. The CRV (1,400-2,500 m.a.s.l.) has long been favorable for wheat production due to suitable temperatures and average rainfall during the growing season. Additionally, the average soil acidity in this region meets the requirements for wheat cultivation, which thrives in neutral pH levels (5.5-7.0) (Jimma et al., 2024). In the CRV, wheat is cultivated during the Kiremt rainy season, which lasts from June to September. The Kiremt season is historically preferred over the shorter Belg rainy season (March to May) due to the Belg's less reliable precipitations (White et al., 2001). Both bread and durum wheat are sown from mid-June to the end of July, with harvesting dates varying among different cultivars. In the area, early maturing and intermediate maturing varieties are favored (Ethiopian Agricultural Authority (EAA), 2022).

4.3.1 Climate change impact on wheat production

As highlighted earlier, it is essential to distinguish between the lower altitudes (Bishoftu and the Valley floor) and the CRV highlands when considering future rainfall projections. In the Valley's lowlands, a shorter growing season is expected due to reduced precipitation in June (Kassie et al., 2014). Additionally, a decreasing trend in rainfall is predicted for the Kiremt season by the 2050s, while precipitation during the dry season will increase significantly (Hailesilassie et al., 2022). However, the absolute amount of rainfall in the dry season will still be too small to impact crop suitability and agricultural practices. On the other hand, the Valley's highlands are expected to experience a longer growing season with increased average rainfall during the Kiremt(Muluneh et al., 2015). The general increase in temperature predicted by all climate models will impact the lowlands and highlands differently in terms of the water-limited potential yield of wheat. In the lowlands, the temperature increase will shift conditions from optimal to suboptimal for wheat, with maximum temperatures exceeding the crop's optimal range. Higher temperatures will also lead to increased evapotranspiration rates (Kassie et al., 2014), exacerbating the water stress on the crop due to the reduction of rainfall during the Kiremt growing season.

4.3.2 Wheat variety recommendations

Given the differing future trends between the highland and lowland regions in the CRV, specific recommendations are necessary for each area. In the lowlands, the anticipated shorter growing season and decreased precipitation suggest the need for drought-tolerant, early maturing wheat varieties. These varieties would reach maturity before the rainy season ends, avoiding drought stress during the critical grain-filling period. An example of a suitable bread wheat variety is Biftu, which has been released in 2022 in the Ethiopian market by the Kulumsa Agricultural Research Centre (KARC) (Sime et al., 2023).

Besides tolerance to abiotic stress, rust resistance should not be overseen. In fact, even though the disease pressure is predicted to get overall lower in the lowlands, the less homogeneous rainfall could concentrate in periods critical to the pathogen's development. In the highlands, wheat stem rust will be the primary challenge due to the projected increases in temperature and rainfall, which will favor the pathogen's development. Jaleta et al. (2019) recommend host resistance as the most effective measure against Puccinia graminis f. sp. tritici in Ethiopia. A suitable variety meeting these requirements would be Digalu. However, it is crucial for seed companies to stay updated with new resistant varieties, as the pathogen can overcome resistance over time (Meyer et al., 2021). These varieties should have high resistance gene diversity, ensuring that if one resistance gene becomes ineffective, others can still provide protection. Additionally, with water stress not predicted to be a future issue, more productive intermediate and long-maturing varieties, could be a viable option.

Similar to seed producers of chickpeas, wheat seed producers may also employ several agricultural practices: rotation with pulses, better soil organic matter management, such as using cover crops and minimizing tillage, as well as harvesting rainwater, can support in becoming even more climate resilient.

4.4. Chickpea

Chickpea (Cicer arietinum) is a widely cultivated pulse crop, valued worldwide as a balanced source of carbohydrates, fibers, and high-quality proteins (Jukanti et al., 2012). Ethiopia is the largest chickpea producer in Africa and ranks fourth globally, following India, Australia, and Turkey (Negusse et al., 2025).

Notably, the Oromia region contributes to 50% of Ethiopia's annual chickpea yield. In this context, the CRV present a higher-than-average chickpea productivity compared to other regions in Ethiopia, which is attributed to its favorable climate and clay loam soil texture (Mengistu et al., 2024).

In the CRV, both Desi and Kabuli types of chickpeas are cultivated. These types mainly differ in seed size and seed coat thickness. Historically, Ethiopian farmers have preferred the Desi type. However, the recent introduction of profitable improved varieties of the Kabuli type, has gained popularity due to its high export demand. Chickpea now constitutes around 2% of Ethiopia's agricultural export earnings (CSA et al., 2021). Despite this, the local market continues to favor the Desi type, which remains a staple in Ethiopian culinary traditions (Fikre & Bekele, 2020). Chickpea is cultivated in rainfed systems that exploit the residual moisture from the Kiremt rainy season (Korbu et al., 2022). Sowing occurs between September and October, with harvests taking place from December to February, depending on the sowing date and variety (Mengistu et al., 2024). Chickpea grows at altitudes between 1,500 and 2,800 m.a.s.l. and thrives in temperatures ranging from 18°C to 25°C degrees. Clay loam soils are preferred due to their higher water retention, crucial for crops grown on residual moisture, slightly alkaline soils with a pH range of 6 to 9 are optimal (Bekele et al., 2021).

4.4.1 Climate change impact on chickpea production

Drought stress poses a significant challenge for rainfed chickpea cultivation in the CRV. Although chickpea is considered drought-tolerant amongst pulses, it is particularly vulnerable to dry spells during the final stages of its growth. Prolonged water stress during flowering, and pod and seed setting occurring between 60 and 90 DAS substantially reduces seed yield (Pang et al., 2017). This type of water stress, referred to as terminal drought, is already a concern in the CRV (Korbu et al., 2022). With rising temperatures and insufficient rainfall expected outside the rainy season, the severity of terminal drought in chickpea cultivation is bound to increase in the future (Fikre & Bekele, 2020).

4.4.2 Chickpea variety recommendations

Choosing an early maturing variety can help the crop avoid later stages of water stress, a strategy known as "heat escape". This approach is particularly beneficial in the CRV highlands, where rainfall is less homogeneous and might concentrate before chickpea sowing. In such cases, a later sowing date is recommended, as chickpea is susceptible to high moisture, which can lead to soil-borne fungal infections, such as Wilt Root Rot (WRR) and Ascochyta blight (AB). Among early maturing varieties, it is crucial to consider drought tolerance when updating the varietal portfolio. Although the chickpea variety Ararti is a currently popular variety and produced by seed companies, it has shown poor performance in drought tolerance according to Korbu's study on Ethiopian chickpea varieties (Korbu et al., 2022). Fortunately, Koka (released in 2019) for the Kabuli type and Dimtu (released in 2016) for the Desi type demonstrated better performance. Additionally, Arriagada's research highlighted the Desi type Geletu (released in 2019) as effective under terminal drought (Arriagada et al., 2022).

Ararti's continued use is partly due to its tolerance to WRR. However, research in India indicates that drought-tolerant varieties outperform wilt-resistant ones under combined water stress and Fusarium oxysporum f. sp. ciceris (Foc) presence (Chilakala et al., 2023). This finding is particularly relevant given the current lack of Dry Root Rot-resistant varieties in the Ethiopian market. Despite this, resistance to AB and WRR will remain critical traits for chickpeas in the CRV through the first half of the century, based on past trends and epidemiological data.

In addition to recommendations on crop traits to look for in varieties, producers can also adopt certain agricultural practices to limit the impact of climate change. Firstly, the recommendation is to irrigate at the later stages of maturation, if possible, especially for Kabuli type which responds better to irrigation. Furthermore, crop rotation may reduce the pressure of the soil-borne fungal pathogens. Lastly, if the rainy season is particularly wet and the soil has retained too much moisture, postponing sowing dates and considering a raised-bed system is recommended.

4.5. Technology adoption

Together with the use of varieties that are more resilient to biotic and abiotic stresses, the application of seed technologies can also help alleviate the negative effects of those stresses by improving seed germination and uniformity. Germination and early seedling growth are the most sensitive stages throughout plant life since these are easily disrupted by many factors, both biotic and abiotic, affecting the final yield (Gong et al., 2023). Seed priming and seed coating are two seed enhancement technologies that can enhance seed germination and uniformity, protect the seed, and increase seed tolerance against both biotic and abiotic stresses (Jarrar et al., 2023).

4.5.1 Seed priming

Seed priming is a technique which uses controlled hydration of seeds to remove primary dormancy and increase the uniformity of seed germination (Bradford & Bello, 2022; Sher et al., 2019). The removal of the primary dormancy will help the seeds to germinate more easily and uniformly. Priming can be done via several methods, including hydropriming, osmo-priming, halopriming, and bio-priming. The method of priming depends on the seed quality and the specific stress that needs to be overcome (Sher et al., 2019). Some priming methods are simple and low-cost, while other methods need chemical solutions or microorganisms. Hydropriming, a method involving soaking the seeds in water before sowing, is one of the simplest and low-cost method. After priming, the seeds must be surface-dried and completely dried back to their original weight. Given the simplicity and low costs of this method, it could be easily adopted by seed producers to promote rapid and uniform germination and eventually resulting in better yield and plant performance amongst farmers. However, some drawbacks of seed priming must also be highlighted. Over-priming of seeds is possible, after which seeds cross the critical threshold of irreversible germination. Furthermore, after priming seeds have a more limited shelf-life, resulting in decreased seed viability and longevity. The high relative humidity in the CRV makes it challenging to store and transport primed seeds, leading to reduced longevity and viability. If primed seeds are not sown directly after priming, their viability will decrease rapidly. Due to the climate conditions in Ethiopia, it is not beneficial for seed companies to apply seed priming unless they store their seeds properly after priming. This would mean that seeds are stored at low humidity and low temperature.

4.5.2 Seed coating

Seed coating is a technique for applying active ingredients, such as fungicides or microbial inoculants, to seeds to improve seed quality. The improved seed quality includes germination enhancement, greater tolerance to environmental stress, improved uniformity, and protection of the seed. Furthermore, seed coating alters the size of seeds, especially small one, to allow for easier or mechanical sowing.

Several seed coating methods exist, such as film coating, seed encrusting, seed pelleting, dry powder coating and seed dressing. Most critical in seed coating is the choice of active components, which ranges from fungicides, insecticides, bio-stimulants and plant nutrients to microorganisms. Each crop seed requires a specific product, so the appropriate materials must be selected and applied in the optimal dosage to deliver acceptable qualities (ISF & CropLife International, 2019). This is because different crops may react differently to certain ingredients, emphasizing the need for careful selection and application. For seed companies in Ethiopia, adopting inoculant seed coating using rhizobium (for chickpea producers) may be interesting, as it can help seed germination under biotic and abiotic stresses, and helps to fix nitrogen in the soil. Phosphorous seed coating could furthermore improve seedling emergence and shoot and root dry weight.

5. Conclusion

Climate change will significantly impact seed production in the CRV, where we will see less homogeneous precipitation and longer dry spells, coupled with higher temperatures. This will increase water stress, create favorable conditions for new diseases to arise and exacerbate existing diseases. To maintain potential water-limited yields of rainfed crops, seed producers must continuously update their variety portfolios with new climate-smart varieties, adjusted to the diverse climate projections across different altitudes in the CRV and. Moreover, there is a lot of potential for using more appropriate (sustainable) agricultural practices. Soil is the foundation of crop production, and making sure practices that improve soil health to create more resilient soils are used, will be an important factor in adapting to climate change. Furthermore, companies can adopt several seed technologies such as seed coating and seed priming. However, the biggest insecurity for seed companies, and all other agricultural actors, remains what the exact impact of climate change will be. Receiving information on climate change prospects by optimizing and expanding the existing climate information services and networks will be of great importance to producers.

Reference

Abera, D., Kibret, K., & Beyene, S. (2019). Tempo-spatial land use/cover change in Zeway, Ketar and Bulbula sub-basins, Central Rift Valley of Ethiopia. Lakes & Reservoirs: Science, Policy and Management for Sustainable Use, 24(1), 76–92. https://doi.org/10.1111/lre.12240

Alimagham, S., van Loon, M. P., Ramirez-Villegas, J., Adjei-Nsiah, S., Baijukya, F., Bala, A., Chikowo, R., Silva, J. V., Soulé, A. M., & Taulya, G. (2024). Climate change impact and adaptation of rainfed cereal crops in sub-Saharan Africa. European Journal of Agronomy, 155, 127137.

Anderson, W., Johansen, C., & Siddique, K. H. M. (2016). Addressing the yield gap in rainfed crops: A review. Agronomy for Sustainable Development, 36(1), 18. https://doi.org/10.1007/s13593-015-0341-y

Araya, A., Vara Prasad, P. V., Ciampitti, I. A., Rice, C. W., & Gowda, P. H. (2022). Using Crop Simulation Models as Tools to Quantify Effects of Crop Management Practices and Climate Change Scenarios on Wheat Yields in Northern Ethiopia. In Enhancing Agricultural Research and Precision Management for Subsistence Farming by Integrating System Models with Experiments (pp. 29–47). John Wiley & Sons, Ltd. https://doi.org/10.1002/9780891183891.ch3

Arriagada, O., Cacciuttolo, F., Cabeza, R. A., Carrasco, B., & Schwember, A. R. (2022). A comprehensive review on chickpea (Cicer arietinum L.) breeding for abiotic stress tolerance and climate change resilience. International Journal of Molecular Sciences, 23(12), 6794.

Barretto, R., Buenavista, R. M., Rivera, J. L., Wang, S., Prasad, P. V., & Siliveru, K. (2021). Teff (Eragrostis tef) processing, utilization and future opportunities: A review. International Journal of Food Science and Technology, 56(7), 3125–3137.

Bekele, D., Tesfaye, K., Fikre, A., & Cook, D. R. (2021). The extent and association of chickpea Fusarium wilt and root rot disease pressure with major biophysical factors in Ethiopia. Journal of Plant Pathology, 103(2), 409–419. https://doi.org/10.1007/s42161-021-00779-4

Bradford, K. J., & Bello, P. (2022). Applying population-based threshold models to quantify and improve seed quality attributes. https://library.oapen.org/handle/20.500.12657/61526

Chanyalew, S., Assefa, K., Asfaw, M., Genet, Y., Tolossa, K., Kebede, W., Fikre, T., Hussen, N., Jifar, H., & Fentahun, A. (2017). Tef (Eragrostis tef) Variety" Dagim". Ethiopian Journal of Agricultural Sciences, 27(2), 131–135.

Chilakala, A. R., Pandey, P., Durgadevi, A., Kandpal, M., Patil, B. S., Rangappa, K., Reddy, P. C. O., Ramegowda, V., & Senthil-Kumar, M. (2023). Drought attenuates plant responses to multiple rhizospheric pathogens: A study on a dry root rot-associated disease complex in chickpea fields. Field Crops Research, 298, 108965.

Chimdesa, G. (2016). Climate change impacts and adaptation actions in Central Rift Valley of Ethiopia. Journal of Natural Sciences Research, 6(3), 84–93.

CSA, Development Research Institute, Statistical Agency of the Federal Democratic Republic of Ethiopia, & International Food Policy Research Institute. (2021). Atlas of the Ethiopian Rural Economy. www.cgiar.org

Ethiopian Agricultural Authority (EAA). (2022). Crop variety register, issue no. 25.

Fikre, A., & Bekele, D. (2020). Chickpea breeding and crop improvement in Ethiopia: Past, present and the future. Universal Journal of Agricultural Research, 8(2), 33–40.

Gong, M., He, J., Kong, M., Huo, Q., Jiang, Y., Song, J., Han, W., & Lv, G. (2023). A microencapsulation approach to design microbial seed coatings to boost wheat seed germination and seedling growth under salt stress. Frontiers in Plant Science, 14, 1283590.

Hailesilassie, W. T., Goel, N. K., Ayenew, T., & Tekleab, S. (2022). Future precipitation changes in the Central Ethiopian Main Rift under CMIP5 GCMs. Journal of Water and Climate Change, 13(4), 1830–1841.

Houghton, J. T., Ding, Y., Griggs, D. J., Noguer, M., van der Linden, P. J., Dai, X., Maskell, K., & Johnson, C. A. (2001). Climate change 2001: The scientific basis: contribution of Working Group I to the third assessment report of the Intergovernmental Panel on Climate Change. Cambridge university press. https://shorturl.at/hSx5k

Iowa State University. (2001). Images for 1-14 Global Warming Potential. https://meteor.geol.iastate.edu/gccourse/gwpotential/images/images.html

ISF & CropLife International. (2019). Stewardship-Guidelines-on-Seed-Treatment-and-Handling-of-Treated-Seed_Final-1.pdf. https://croplife.org/wp-content/uploads/2019/01/Stewardship-Guidelines-on-Seed-Treatment-and-Handling-of-Treated-Seed_Final-1.pdf

Jarrar, H., El-Keblawy, A., Ghenai, C., Abhilash, P. C., Bundela, A. K., Abideen, Z., & Sheteiwy, M. S. (2023). Seed enhancement technologies for sustainable dryland restoration: Coating and scarification. Science of the Total Environment, 904, 166150.

Jifar, H., Kebede, W., Fikre, T., Ashe, G., Tadesse, M., Demissie, M., Assefa, K., Chanyalew, S., Belay, N., & Bekana, G. (2023). Kulle: A New Brown Seeded Tef Variety Released to Address the Emerging Demands of Growers and Consumers. Ethiopian Journal of Agricultural Sciences, 33(2), 41–55.

Jimma, T. B., Chemura, A., Spillane, C., Demissie, T., Abera, W., Ture, K., Terefe, T., Solomon, D., & Gleixner, S. (2024). Coupled impacts of soil acidification and climate change on future crop suitability in Ethiopia. Sustainability, 16(4), 1468.

Jukanti, A. K., Gaur, P. M., Gowda, C. L. L., & Chibbar, R. N. (2012). Nutritional quality and health benefits of chickpea (Cicer arietinum L.): A review. British Journal of Nutrition, 108(S1), S11–S26.

Kassie, B. T., Rötter, R. P., Hengsdijk, H., Asseng, S., Van Ittersum, M. K., Kahiluoto, H., & van Keulen, H. (2014). Climate variability and change in the Central Rift Valley of Ethiopia: Challenges for rainfed crop production. The Journal of Agricultural Science, 152(1), 58–74.

Kebede, G. (2018). Morpho-agronomic performance of vetch species and their accessions grown under nitosol and vertisol conditions in the central highlands of Ethiopia. Agriculture & Food Security, 7(1), 90. https://doi.org/10.1186/s40066-018-0243-8

Kebede, W., Chanyalew, S., Fikre, T., Tolosa, K., Genet, Y., Demissie, M., Assefa, K., Jifar, H., Mitiku, S., & Gebremeskel, K. (2022). Boni: Improved tef variety for drought-prone areas of Ethiopia. Ethiopian Journal of Crop Science, 10(1), 1–15.

Korbu, L., Fikre, A., Tesfaye, K., Funga, A., Bekele, D., & Ojiewo, C. O. (2022). Response of chickpea to varying moisture stress conditions in Ethiopia. Agrosystems, Geosciences & Environment, 5(1), e20234. https://doi.org/10.1002/agg2.20234

Laterite. (2023). Teff-farming-in-Ethiopia-background-brief-vf.pdf. https://www.laterite.com/wp-content/uploads/2021/09/Teff-farming-in-Ethiopia-background-brief-vf.pdf

Lule, D., Chemeda, G., & Birhanu, C. (2019). Registration of "Dursi" Newly Released Tef (Eragrostis tef (Zucc.) Trotter) Variety. Ethiopian Journal of Crop Science, 7(1), 99–103.

Mengistu, D. K., Terefe, H., Teshome, T., Garamu, T., Lakew, B. F., & Fadda, C. (2024). Chickpea production restored through upscaling crowdsourcing winner varieties and planting date adjustments in the Ada'a district, East Shoa zone, Ethiopia. Heliyon, 10(11). https://www.cell.com/heliyon/fulltext/S2405-8440(24)08300-2

Meyer, M., Bacha, N., Tesfaye, T., Alemayehu, Y., Abera, E., Hundie, B., Woldeab, G., Girma, B., Gemechu, A., & Negash, T. (2021). Wheat rust epidemics damage Ethiopian wheat production: A decade of field disease surveillance reveals national-scale trends in past outbreaks. PLoS One, 16(2), e0245697.

Muluneh, A., Bewket, W., Keesstra, S., & Stroosnijder, L. (2017). Searching for evidence of changes in extreme rainfall indices in the Central Rift Valley of Ethiopia. Theoretical and Applied Climatology, 128(3–4), 795–809. https://doi.org/10.1007/s00704-016-1739-4

Muluneh, A., Biazin, B., Stroosnijder, L., Bewket, W., & Keesstra, S. (2015). Impact of predicted changes in rainfall and atmospheric carbon dioxide on maize and wheat yields in the Central Rift Valley of Ethiopia. Regional Environmental Change, 15(6), 1105–1119. https://doi.org/10.1007/s10113-014-0685-x

Musie, M., Momblanch, A., & Sen, S. (2021). Exploring future global change-induced water imbalances in the Central Rift Valley Basin, Ethiopia. Climatic Change, 164(3–4), 47. https://doi.org/10.1007/s10584-021-03035-x

Negusse, H., Haileselassie, T., Geleta, M., & Tesfaye, K. (2025). Genetic variability of Ethiopian chickpea (Cicer arietinum L.) landraces for acid soil tolerance. Plants, 14(3), 311.

Pang, J., Turner, N. C., Khan, T., Du, Y.-L., Xiong, J.-L., Colmer, T. D., Devilla, R., Stefanova, K., & Siddique, K. H. (2017). Response of chickpea (Cicer arietinum L.) to terminal drought: Leaf stomatal conductance, pod abscisic acid concentration, and seed set. Journal of Experimental Botany, 68(8), 1973–1985.

Pradhan, P., Shukla, P. R., Skea, J., Buendia, E. C., Masson-Delmotte, V., Pörtner, H.-O., & Roberts, D. C. (2022). Summary for Policymakers: IPCC Special Report on Climate Change and Land. https://research.rug.nl/en/publications/summary-for-policymakers-ipcc-special-report-on-climate-change-an

Rai, A., Irulappan, V., & Senthil-Kumar, M. (2022). Dry Root Rot of Chickpea: A Disease Favored by Drought. Plant Disease, 106(2), 346–356. https://doi.org/10.1094/PDIS-07-21-1410-FE

Ray, D. K., West, P. C., Clark, M., Gerber, J. S., Prishchepov, A. V., & Chatterjee, S. (2019). Climate change has likely already affected global food production. PloS One, 14(5), e0217148.

Senbeta, A. F., & Worku, W. (2023). Ethiopia's wheat production pathways to self-sufficiency through land area expansion, irrigation advance, and yield gap closure. Heliyon, 9(10), e20720. https://doi.org/10.1016/j.heliyon.2023.e20720

Sher, A., Sarwar, T., Nawaz, A., Ijaz, M., Sattar, A., & Ahmad, S. (2019). Methods of Seed Priming. In M. Hasanuzzaman & V. Fotopoulos (Eds.), Priming and Pretreatment of Seeds and Seedlings (pp. 1–10). Springer Singapore. https://doi.org/10.1007/978-981-13-8625-1_1

Sime, B., Solomon, T., Alemu, G., Dabi, A., Geleta, N., Duga, R., Delasa, A., Zegaye, H., Asnake, D., & Asefa, B. (2023). Registration of New Bread Wheat Variety (Biftu) for Low to Mid-Altitude Wheat-Producing Areas of Ethiopia. Journal of Global Agriculture and Ecology, 15(4), 1–9.

White, J. W., Tanner, D. G., & Corbett, J. D. (2001). An agro-climatological characterization of bread wheat production areas in Ethiopia. https://repository.cimmyt.org/bitstream/10883/1022/1/74272.pdf

World Bank and OECD. (2025). Share of GDP from agriculture. World Bank and OECD. https://ourworldindata.org/grapher/agriculture-share-gdp?tab=chart&country=~ETH

Acknowledgment: I would like to express my gratitude to the students of Wageningen University, namely xxxx, xxxx, and xxxx, for their invaluable support and contributions to this research.

Citation: Zonnenberg M.J., 2025. Climate Change in Ethiopia's Central Rift Valley: potential adaptation strategies for seed producers. Stichting Wageningen Research Ethiopia, Addis Ababa. SWRE-ESP-25-002

This issue brief can be downloaded for free at https://doi.org/10.18174/704865

For more information on ESP please contact either:

Mohammed Hassena

Stichting Wageningen Research Ethiopia
mohammed.hassena.swr@gmail.com

www.esp-seed.com

Joep van den Broek

RSLNC Consultancy PLC
joep@resiliencebv.com

www.resiliencebv.com