On behalf of

Potsdam Institute for Climate Impact Research

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Federal Ministry for Economic Cooperation and Development

Policy Brief: Climate risk analysis for adaptation planning in Uganda's agricultural sector

An assessment of maize and coffee value chains

Overview

The climate crisis increasingly affects the productivity of **Uganda's agricultural sector**. Droughts and precipitation variability challenge livelihoods as well as economic prospects of entire value chains. Understanding climate risks and impacts is therefore crucial for effective adaptation planning. New research conducted by the Potsdam Institute for Climate Impact Research (PIK) in cooperation with the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH on behalf of the Federal Ministry for Economic Cooperation and Development (BMZ) analyses the **climate impacts** and **adaptation strategies** for two selected agricultural value chains: **maize**, a major food crop, and **coffee,** a major export crop.

Projected climatic changes

By 2050, **mean annual temperature** is projected to increase by 1.1 °C under the low emissions scenario and 1.5 °C under the high emissions scenario compared to 2004. Temperatures will stabilize under low future emissions after 2050 (blue) and will further rise until the end of this century under high future emissions (red) (Figure 1).

The number of **hot days** per year (>35 °C) and **hot nights** per year (>25 °C) is projected to steadily increase, with especially severe temperature extremes in the north of Uganda. South Uganda, which is currently experiencing no hot days, is projected to face hot days by the end of the century under the high emissions scenario. In the north-west, hot nights are projected to increase to 100 a year, compared to almost none at present.

The majority of models project slight future increases of **annual precipitation** (Figure 2). At the same time **heavy rainfall intensity** is increasing, which can cause severe flooding. However, precipitation projections are subject to high model uncertainties.

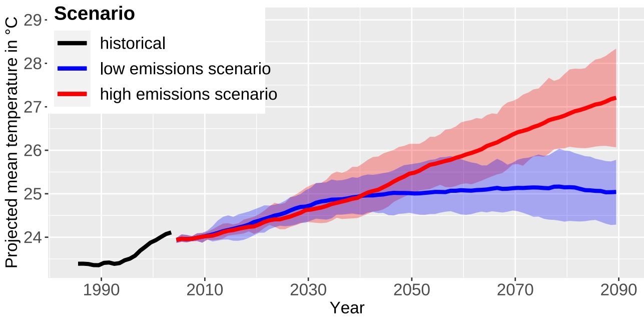

Figure 1: The 10-year moving average of historical and projected mean temperature in °C.

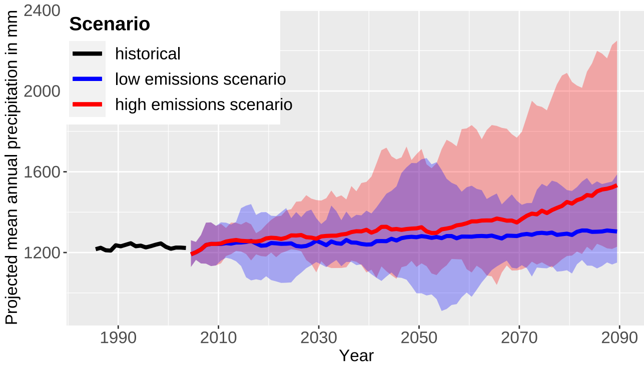

Figure 2: The 10-year moving average of historical and projected annual rainfall in mm per year.

	Climate impacts	Past trend	Future trend	Certainty
	Mean annual temperature	Increasing	Increasing	Very high
	Number of hot days & nights	Increasing	Increasing	Very high
	Mean annual rainfall sums	Increasing (not significant)	Increasing	High emissions: Medium Low emissions: Low
	Heavy rainfall intensity	Increasing	Increasing	High emissions: Very high Low emissions: Low

Methods

The study provides a detailed assessment of projected climate parameters and related impacts on agriculture under different climate change scenarios (called Representative Concentration Pathways (RCPs) and Shared Socioeconomic Pathways (SSPs)). In the **low emissions scenario** (SSP1-RCP2.6) global warming will likely be kept below 2 °C above pre-industrial temperatures. The **high emissions scenario** (SSP3-RCP7.0) builds upon the assumption of continuously high future greenhouse gas (GHG) emissions. **Suitability modelling** and **process-based crop simulation** show the impacts of climate change on agricultural production and the potential of selected adaptation strategies to buffer these impacts. Assessments are complemented with **cost-benefit analyses**, qualitative analyses of **interviews** and **focus group discussions,** and a **literature review**.

Climate impacts and adaptation strategies for the maize value chain

Maize is the **most important staple crop** in Uganda. As most of Uganda's maize production is rain-fed and characterized by smallholder farming systems that use primarily manual inputs, the **maize value chain is particularly vulnerable to climate change**. Maize is cultivated by about 1.8 million farmers all over Uganda for food security, income and export. By now, Uganda has become Africa's third largest exporter of unprocessed maize and second-leading exporter of maize flour.

Climate change impacts on the maize value chain

Climate change will have **negative impacts on maize yields in Uganda, especially in high maize potential areas** such as parts of the Central and Eastern regions. The impacts worsen with time and GHG emissions scenario.

National-level maize yield projections:

- Low emissions scenario: **Yield losses of 6.2 % by 2030**, of **8.6 % by 2050** and of **8.8 % by 2090.**
- High emissions scenario: Losses are initially lower (**4.4 % by 2030**) due to the expected increase of rainfall in some parts of Uganda, but then increase to **14.3 % by 2050** and **26.8 % by 2090**

Sub-national level maize yield projections:

- **Highest yield losses** (over 30 %) are projected for the **West Nile, Teso, Lango and Western regions** under the high emissions scenario by the end of the century.
- Slight positive climatic impacts on yields for very limited areas in parts of the Central region of up to 7.8 % (low emissions scenario by 2030).

With continuing population growth, the projected declines in maize yields can exacerbate food and nutrition insecurity and lead to severe economic consequences for farmers. As farmers try to compensate for reduced yields, this can lead to expansion of agricultural land, exploitation of natural resources and biodiversity loss.

Interviews with maize processors, aggregators and traders have revealed that **climatic factors influence maize value chains also beyond production**. Climatic factors **significantly affect the products, activities and finances throughout the post-harvest steps** of the maize value chain with strong feedback loops between the different steps. For example, when a drought or extreme precipitation hit the production stage, their impacts trickle down to later stages of the value chain and can cause high fluctuations in maize supply and prices. These **impacts lead to changes in the value chain composition diverting financial and product flows**. They can also lead to a **change in attitudes of and relationship between the actors** involved, including a loss of motivation, fear, feelings of disadvantage and mistrust towards other value chain actors (see Figure 3).

1. Improved maize varieties as adaptation strategy: Increasing productivity and climate resilience

As one possible **adaptation strategy**, **improved maize varieties** have the **potential to buffer all yield losses projected for local varieties:** at national level, improved maize varieties will actually lead to 2.9 % (low emissions scenario) and 8 % (high emissions scenario) more yield by 2090 than today. The initial investment needed to switch from local maize varieties to improved maize varieties already **becomes economically beneficial after one year** with returns increasing in the future up to 133,85 %. The extent of these benefits may vary depending on a range of factors, such as the **agroecological conditions, farmer management practices and market demand for the crop.**

2. Improved storage as adaptation strategy: Effective solution for post-harvest losses

One important measure against post-harvest losses due to climatic factors such as increased pests and diseases are Hermetic Storage Technologies. Switching to **hermetic bags for post-harvest maize storage is highly profitable under both emissions scenarios**, generating **returns on investment of up to 67 %.** In addition, there are also health benefits for famer households using high-quality storage material, as it can help to mitigate the expected increases of mycotoxins and mold due to a changing climate.

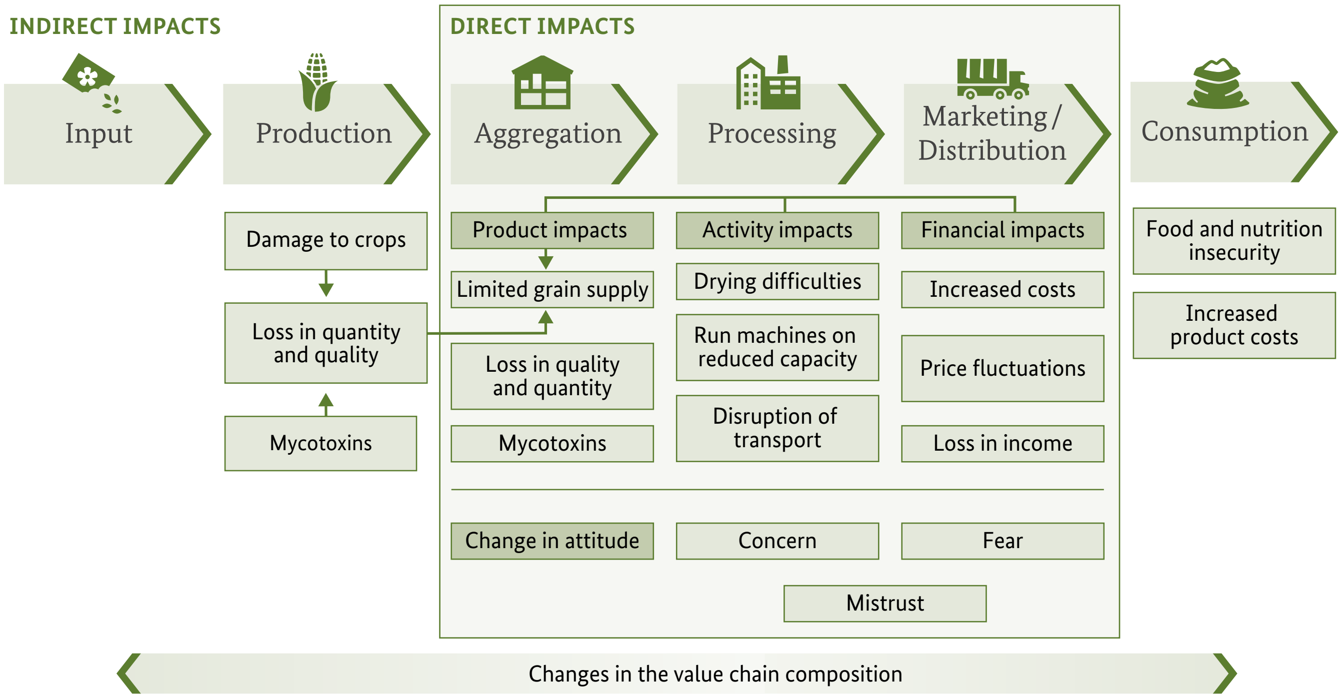

Figure 3: Climate impacts experienced by stakeholders working in the aggregation, processing and marketing and distribution of maize.

Policy recommendations for building a climate-resilient maize value chain

→ The study has demonstrated that **drought tolerant maize varieties** are one option to make maize value chains more resilient to climate change and should therefore be considered in agricultural planning.

→ Improved varieties are already available in the country, but there is a need for **strategic policy planning** to overcome the barriers to their adoption such as lack of resources, information asymmetry and high seed prices.

→ To accelerate the uptake of improved maize varieties, **rapid breeding cycles** that provide farmers with a steady stream of improved varieties, **information campaigns, access to inputs and credit** and a **seed systems model** that delivers new varieties to farmers quickly and cost-effectively are highly recommended.

→ **Research and promotion of alternative crops** that are naturally more nutritious and resistant to the effects of climate change than maize, such as sorghum, should be fostered.

→ **Improving post-harvest handling** is an often overlooked, but extremely important pillar of building climate-resilient agri-food systems. Improved storage, for instance, can have a strong impact against post-harvest losses.

Gender and other social factors

Gender and other social factors can influence the uptake of adaptation strategies such as improved varieties. Studies show, for example, that older, poorer, less educated or more socially isolated women tend to have low adoption rates of improved seeds. Furthermore, men tend to have better access to improved varieties via formal seed networks and extension services. Women are more likely to rely on local and more informal farmer-to-farmer networks, with poorer access to improved varieties or storage material. Consequently, **efforts aimed at strengthening resilience and enhancing adaptive capacity must take gender into account** and deal with root causes of vulnerability and tackle structural barriers such as **rights, representation** and access to **resources**.

Climate impacts and adaptation strategies for the coffee value chain

Uganda is **one of the most important coffee-producing countries worldwide**, placed among the top ten global exporters. Coffee is also the most important Ugandan cash crop. Uganda produces both, coffea arabica and coffea canephora (commonly referred to as Robusta). Robusta is more widely produced than Arabica coffee and contributes to 77 % of the national coffee production.

Climate change impacts on the coffee value chain

As a climate-sensitive perennial crop, **climate change** poses a serious threat to the quality and quantity of coffee production, including **declines in coffee yield, reduced bean quality** and the **loss of suitable land** for coffee production. In Uganda coffee is most commonly intercropped with banana. While **coffee-banana intercropping** provided many benefits (e.g. improved incomes, erosion control, provision of mulch, reduced pest and disease pressure, shading), bananas are also highly sensitive to weather shocks.

Arabica coffee suitability projections:

- Due to its specific environmental and ecological requirements, **Arabica** is particularly affected with projected suitability losses of up to 20 % until 2050.
- **Lowlands** which are currently suitable for Arabica coffee **will become unsuitable by 2090**. The West Nile region is particularly hard hit and will become unsuitable by 2090 under both emissions scenarios.
- The **area suitable to grow both, Arabica coffee and banana will progressively shrink over time** with the highest net reduction of 5 % of the current area in 2090 (high emissions scenario). The reduction is driven by the projected loss of banana suitability in the far south-western and west Nile regions where Arabica coffee is suitable.

Robusta coffee suitability projections:

- Robusta coffee will only **slightly**, but progressively **reduce over time**, with higher losses expected under the high emissions scenario of up to 5 % nationally until 2090. There are some areas that will experience better growing conditions for Robusta coffee and other areas (e.g. the southwestern and Acholi regions) where substantial losses are projected with serious implications on the livelihoods of coffee farmers living in those regions.
- The area suitable for **Robusta-banana intercropping will also continuously reduce under both emissions scenarios** until 2090.

Climate change does not only impact production but is **also felt at later stages of the value chain**. Direct impacts include **deterioration of the quality and quantity** of the coffee beans and **difficulties in drying coffee** due to increased humidity or a **change in quality of processed coffee** (both negative and positive). In addition, climate impacts can lead to a **non-linear value chain composition** with some actors leaving the value chain, while new actors join. At the same time, feelings of disadvantage and mistrust were observed, both in relation to business partners, e.g. farmers, as well as in relation to competitors, especially international companies operating in the country (see Figure 4).

1. Agroforestry as adaptation strategy: Long term investment with multiple benefits

Agroforestry practices can support adaptation to climate change in several ways: they can **save water, improve the microclimate**, and **enhance soil fertility.** Planting shade trees could potentially **buffer between 50–100 % of the reduction in suitable areas** for Arabica and Robusta coffee by the end of century. The results of the cost-benefit analysis show that **investments into agroforestry systems for coffee** (and banana intercropping systems) **make economic sense** for farmers, as benefits generated through agroforestry systems are more than 19 times higher than its costs. In the long run, agroforestry systems do not only have the potential to increase coffee and banana yields, but also create additional income streams for farmers. Several **co-benefits** make agroforestry a highly recommendable adaptation strategy for coffee production, for instance the **increase in biodiversity, the diversification of livelihoods** as well as **carbon sequestration**, which also supports climate change mitigation efforts. To foster the adoption of agroforestry by women, access to and ownership of land needs to be improved, in addition to greater decision-making power in the design and management of agroforestry systems.

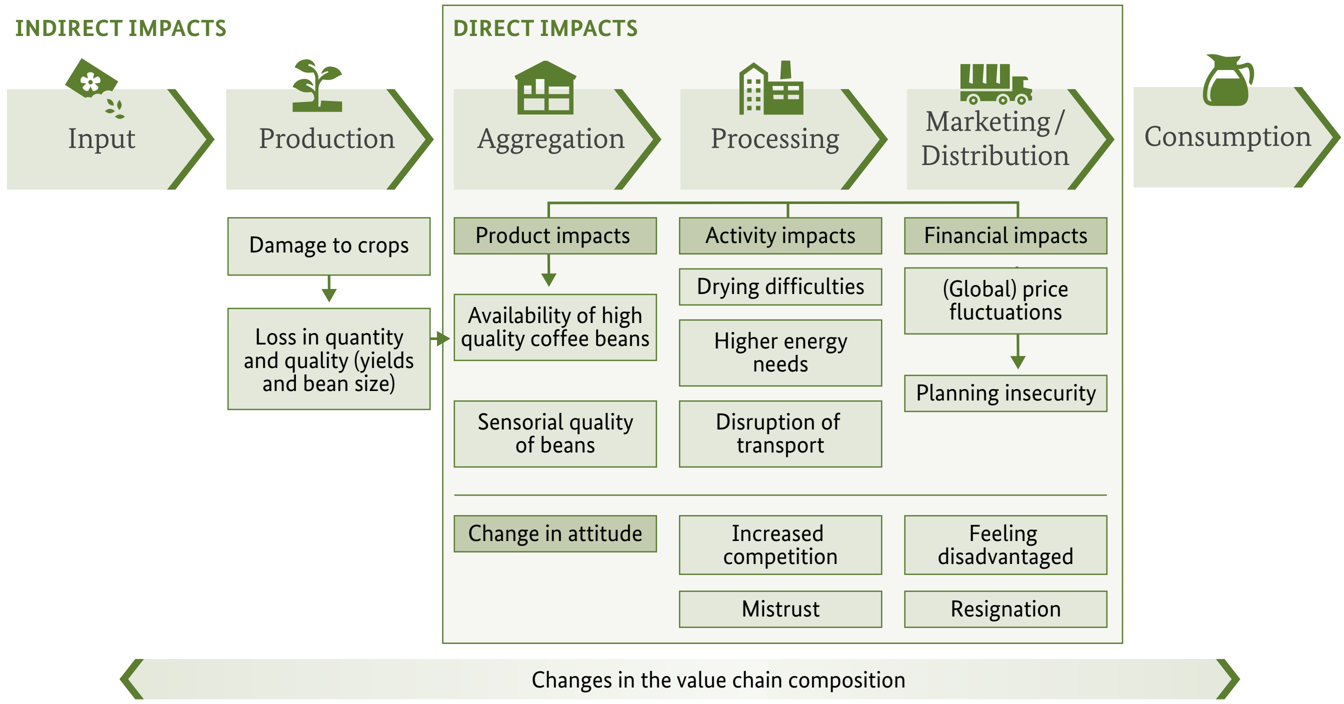

Figure 4: Climate impacts experienced by stakeholders working in the aggregation, processing and marketing and distribution of coffee.

2. **Improved post-harvest storage as adaptation strategy: Low hanging fruit**

Since climate change is expected to make storing coffee increasingly difficult, investing in improved storage will help to adapt the coffee value chain to these impacts. **Exchanging poor quality storage material, i.e., bags and pallets, against high quality ones in an on-farm storage facility** can significantly reduce post-harvest losses due to environmental factors and generate returns of up 60 %. It is comparatively **simple and cheap to implement** and therefore a good option also for smallholder farmers.

Policy recommendations for building a climate-resilient coffee value chain

→ **Agroforestry practices** offer multiple benefits in the context of Ugandan coffee production. Tree species however need to be chosen in accordance with local needs and benefits provided, as well as regarding their suitability to grow under a changing climate.

→ Building a **climate-resilient coffee value chain requires a system change.** In addition to agroforestry, other strategies that cater to the preferences and needs of the entire value chain should be considered.

→ Agricultural production systems that facilitate farmers' compliance with the requirements of the new Deforestation Regulation of the European Union (EUDR) should be promoted.

→ **Promoting high quality storage equipment**, including gunny (jute) bags and pallets is key to maintain the quality of coffee and helps to guard it against unfavorable climatic conditions. Climate-smart storage and processing practices such as solar drying and eco-pulpers can also reduce GHG emissions and improve energy efficiency.

Conclusion

The presented climate change impacts on the agricultural value chains of maize and coffee require strong adaptation efforts to support the transformation of Uganda's agricultural sector towards climate-resilient agri-food systems. To ensure sustainable agricultural development, these efforts should be anchored in a **science-based approach to adaptation planning**. Climate projections demonstrate that national agricultural development and intensification goals cannot be achieved without building resilience of agricultural value chains. **Adaptation needs to be mainstreamed across sectoral policies.** Results from this analysis can feed into further development and implementation of adaptation policies and agricultural development planning.

Generally, there is no single adaptation strategy that is suitable for the whole country or can "fix" one specific value chain, since their effectiveness and co-benefits ultimately depend on the projected climate impacts which differ by region, as well as on the concrete design tailored to the local context and specific needs of different value chain actors. The actual climate change impacts are not only shaped by the intensity of the projected changes, but also by the vulnerability and exposure of the affected farming communities or agricultural businesses. Differing social characteristics such as gender, age, education and health can substantially shape farmers' vulnerability and therefore their exposure to climate change. The ability of a company to withstand climate shocks can be influenced by its size and market power. Taking these characteristics into consideration is an important prerequisite to build resilience across agricultural value chains.

A value chain approach allows for the wider integration of the various actors involved in bringing a product from its initiation to the sale. However, value chains should not be considered in isolation, but as part of wider agri-food systems. While it is more complex to take different, often heterogonous actors into consideration, there is also a great opportunity that by joining forces, the transition to climate-resilient, inclusive and sustainable agricultural systems can be accelerated.

Creating an enabling environment to scale up adaptation efforts

- Next to the adaptation strategies which are presented and analysed within the framework of this study, there are of course further strategies to adapt agricultural value chains to climate change, which might be even more suitable, cheaper or better implementable, depending on the given circumstances. Agricultural value chains and especially farms are complex systems that require a targeted and tailored design of management practices. Regardless of the specific climate risks addressed, **combinations of adaptation strategies are often more effective** than single approaches.
- Farmers and agricultural businesses need support in **bridging the financing gap** between investments and the break-even point when the adaptation strategy becomes profitable. This requires transitional financial support. Developing financing mechanism, such as access to loans or credits can support farmers transition to resilient farming systems.
- **Context is key:** investing in adaptation strategies should be regionally specific. For instance, the Northern region will be hit particularly hard and should therefore require special attention.
- **Women and other marginalized groups should be moved to the center** of these processes, both as a target group and leaders of action, so that agricultural systems can be transformed towards greater gender equity, inclusion and climate resilience.
- Adaptation strategies should not be developed in isolation, but rather in collaboration with stakeholders across the value chain. This would ensure that the **strategies are context-specific, inclusive and sustainable**, and can increase their chances of success.

The policy brief is based on the Scientific Report *Climate risk analysis for adaptation planning in Uganda's agricultural sector* prepared by the Potsdam Institute for Climate Impact Research (PIK) together with the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ), in cooperation with the National Agricultural Research Organization (NARO), the HFFA Research GmbH and stakeholders from local and national governmental institutions, civil society, academia, the private sector, practitioners and development partners. The analyses have been conducted as part of the as part of the project AGRICA - Climate risk analyses for adaptation planning in sub-Saharan Africa.

For more information and further study results, please visit www.agrica.de

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