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Enhancing smallholder credit access: De-risking farmers through climate adaptation measures in maize mixed systems.

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Leveraging climate adaptation measures for improved smallholder financial access

Smallholder farmers remain a critical part of the global food system. One-third of food supply around the world is produced by smallholders. The role of smallholders in Sub-Saharan Africa is even more crucial as these farmers are responsible for 70% of the agricultural production in the region. The effective functioning of the agricultural sector in the region is therefore heavily dependent on their performance. Regrettably, these farmers have persistently performed significantly below other regions due to various gaps in technology, and knowledge, among others.

A major constraint for smallholders to boost performance and bridge existing gaps is the limited access to formal financial services, particularly credit for production enhancing investments. This is due to a significant extent on the vulnerabilities and uncertainty that are typically associated with smallholder farming and its heavy dependence on the biophysical environment. Farmers grapple with erratic rainfall, prolonged droughts, and sudden, devastating floods, all of which pose substantial threats to their productivity and make financial institutions hesitant to engage in agricultural financing in the absence of adequate risk mitigation measures. Climate change is further intensifying these lending risks and necessitates urgent action towards de-risking farmers.

To address these issues and unlock financial opportunities, Alliance of Bioversity and CIAT, in partnership with Financial Access Consulting Services (FACS), have reviewed literature on smallholder maize farming and climate change to highlight key adaptation measures that can de-risk the sector and improve access to finance. This review forms part of a wider objective to develop climate "conscious" credit risk scoring system under the Ukama Ustawi initiative. By leveraging data analytics, this innovative system can assess climate-related risks and empower dairy farmers, making them more appealing to lenders and fostering the resilience and growth of the dairy sector in Africa. To achieve this the Ukama Ustawi initiative explores the integration of adaptation strategies into farmer credit scoring systems. This innovative approach directly quantifies the risk reduction achieved through these adaptation mechanisms, reflecting the de-risking efforts in the farmers' credit ratings. By embedding these strategies into the credit scoring process, lending institutions can more accurately assess the creditworthiness of dairy farmers who have adopted climate-smart practices. This not only makes smallholders more attractive prospects for loans but also promotes a proactive approach to climate resilience.

This innovation brief aims to highlight key adaptation mechanisms that can reduce farmer climate induced risks and foster interest of financial institutions to lend to the sector. The focus is to reflect on these mechanisms, and their potential as well as the factors that may drive or impede their uptake by smallholders. These reflections provide relevant insights towards the development of an effective smallholder financing ecosystem that enables smallholder farm and farmer investments.

Key messages

- **Crop Diversification and Intercropping:**

  Diversifying crops, especially through intercropping like maize with soybean or potato, significantly increases maize yield, residue, and pest management. Farmers' expertise is crucial for optimizing benefits.

- **Access to Resilient Varieties:**

  Access to climate-resilient maize varieties is pivotal. These varieties yield more under stress conditions, providing a dual advantage of building farmer confidence and reducing credit risk for financial institutions.

- **Effective Water Management Strategies:**

  In situ and ex situ water management practices, such as terraces and solar irrigation pumps, enhance smallholder farmers' adaptive capacity and attractiveness to lenders by mitigating climate risks.

- **Information Services and Systems:**

  Climate information services and extension programs empower farmers, making them less risky for financial institutions. Access to timely information aids decision-making and adaptability to climate challenges.

- **Unlocking Agricultural Insurance:**

  Agricultural insurance is underutilized due to limited understanding, cultural inhibitions, and financial constraints. Bundling insurance with credit presents an opportunity to mitigate risk for financial institutions.

- **De-risking through Collaborative Partnerships:**

  Collaborations between private entities and the government are crucial for tailored solutions, addressing behavioural barriers, and boosting education for effective risk mitigation.

Climate risks in maize farming in Zambia

Maize farming faces significant risk from climate change in terms of yield. This is impactful as maize is an important food and cash crop in Zambia. The literature highlights three main hazards that are likely to pose a threat to smallholder farmers in the country. These are higher temperatures, variable rainfall, and droughts.

Maize is climatized to 25°C for optimum maize-growing temperature (Liu et al., 2008). Each degree day spent above 30°C has been found to reduce final maize yield by 1% even under optimal rainfed conditions (Lobell et al. 2011). For every degree increase in global mean air temperature, maize yield is projected to reduce by 7.4% (Tigchelaar et al., 2018; Zhao et al., 2017). It is expected that increasing temperatures in Zambia due to climate change will impact current maize yield levels. Wineman and Crawford (2017) model a moderate maize yield change for Zambia based on climate projections with a decline by 2.24–12.55%.

Though the impact of temperature rise may be moderate, the combination of increasing rainfall variability with rising temperatures is expected to be the main mechanism by which climate impacts maize yields in the country. Chisanga et al. (2020) find that projected changes in temperature and rainfall would adversely affect simulated maize yield in future depending on sowing dates, with models demonstrating increased risk of yield variability in response to climate change.

Rising incidence of drought as a result of climate change would also impact negatively on maize production. Drought affects the amount of soil water available for maize crops and depending on its severity can cause significant variation in maize yield, ranging from 21% to 77% of reduction (Thurlow et al., 2012). Dry periods and droughts can be particularly damaging during the flowering and early grain filling stages and can sometimes result in total crop loss or a need for replanting (Waldman et al., 2017)

Adaptation strategies for de-risking farmers

To enhance farmer attractiveness to financial institutions various measures can be adopted that reduce their associated climate risk:

Strategy 1: Farm management practices

Effective farm management is crucial for positioning farmers to mitigate climate risks and build resilience. One impactful strategy is crop diversification, which significantly enhances the overall security of farm income while concurrently reducing exposure to climate risks. This practice is particularly vital in the evaluation of smallholder farmers by financial institutions as diversified income reduces credit risk. By adopting diversification, farmers not only fortify their resilience but also contribute to the overall sustainability and stability of their agricultural enterprises.

Enhancing diversification can be effectively achieved through intercropping, such as combining maize with soybean or potato. Studies indicate that intercropping maize with legumes, like soybean, can lead to a notable increase in maize grain yield by 31–53%. Additionally, it leaves behind 70–170% more residue containing 113–230% more nitrogen, as highlighted by Punyalue et al. (2018). Beyond yield benefits, intercropping serves as a strategic pest management tool, offering protection against invasions. For example, intercropping maize with cowpea creates an environment that supports natural enemies of pests like the Fall Armyworm (FAW), bolstering insect biodiversity and enhancing the efficiency of pest control. Furthermore, cowpea's ability to retain moisture contributes to mitigating the impact of drought events on maize when intercropped.

The level of farmer expertise plays a crucial role in optimizing the potential benefits of intercropping, emphasizing the need for a delicate balance. Notably, research, such as that conducted by Borges et al. (2020), indicate that precise approaches in intercropping with tree crops are essential for achieving optimal maize yields as intended. Additionally, an understanding of how to bundle different practices with intercropping, is also an instrumental strategy. For instance, increasing water use efficiency in maize can be achieved through nitrogen application from leguminous crops and the utilization of irrigation, as highlighted by Hernández et al. (2015). Demonstrating this knowledge capacity becomes essential when engaging with financial institutions. Farmers can leverage information on past participation in Climate-Smart Agriculture (CSA) or similar training programs during credit screening processes.

Strategy 2: Access to resilient varieties

Access to resilient maize crop varieties is pivotal for effective climate risk management, particularly in the face of drought. Maize is sensitive to rising temperatures and reduced rainfall, resulting in lower yields under such conditions (Adhikari et al., 2015). Fortunately, recent developments in eastern and southern Africa (ESA) have introduced climate-resilient maize varieties that exhibit significant advantages. On-farm trials have demonstrated that these new varieties yield up to 20–25% more than commercial counterparts, especially in low-input and drought-stress conditions (Setimela et al., 2017). Notably, during the severe El Niño-induced drought and heat stress in southern Africa during the 2015–2016 crop season, climate-resilient maize outperformed key commercial hybrids, yielding twofold more in on-farm trials (Setimela et al., 2018). Crop modelling further supports the efficacy of these resilient varieties, projecting a yield advantage of 5–25% across many maize-growing areas in ESA (Shiferaw et al., 2014).

Access to locally available resilient crop varieties is a pivotal risk mitigation strategy for financial institutions. Integrating lending schemes with technical assistance that facilitates farmer access to resilient varieties proves to be an effective approach in attracting formal credit for farmers. In some instances, financial institutions allocate a portion of credit amounts explicitly for the purchase of resilient varieties within lending schemes. The impact of resilient varieties on financial institutions is two-fold. Firstly, it builds farmer confidence, mitigating the risk of farmers avoiding credit participation due to associated risks in rainfed farming systems. Secondly, the introduction of resilient crops reduces credit risk for financial institutions by enhancing crop resilience in the face of climatic challenges.

A key constraint of these approaches is the limited monitoring capabilities of financial institutions to ensure actual and appropriate use of seeds and seedlings by farmers. Partnerships with certified seed programmes and local NGOs that build farmer capacity can aid in overcoming these challenges and alleviate concerns of financial institutions.

Strategy 3: Water management

Smallholder farming is typically characterized by rainfall dependence which makes it highly exposed climate shocks. A shortage of soil moisture, particularly during the most sensitive growth stage of the maize crop results in poor growth and low grain yield (Oweis & Hachum, 2009). Access to water management facilities and equipment is thus crucial in enhancing farmer adaptive capacity.

Farmers can mitigate climate risks through a combination of in situ and ex situ water management strategies. In situ methods alter the rainfall dynamics within agricultural fields, including the use of terraces, ditches, stones, vegetative bunds, mulching, and conservation tillage. These techniques enhance yield by promoting increased soil infiltration and reducing evaporation (Temesgen, 2012). Additionally, the adoption of ex situ water management practices has proven effective in mitigating the impact of dry spells across sub-Saharan Africa (Makurira, 2010; Barron, 2004). Ranging from basic water harvesting to advanced technologies like solar irrigation pumps, ex situ approaches make farmers more appealing to lenders, as access to these assets significantly influences lending risks. Collaborations with asset providers further open avenues for innovative financing schemes in this sector.

Strategy 4: Information services and systems

Climate risk is intensified by the uncertainty resulting from limited access to information. Climate information services encompass the production, transfer, and utilization of climate data to assist individuals in preparing for and adapting to an increasingly variable and unpredictable climate. Access to information on weather patterns, climate-smart technologies like improved varieties and irrigation pumps, plays a pivotal role in enhancing farmer resilience and adaptation. This extends beyond mere top-down information transfer, encompassing horizontal dissemination at the farmer or cooperative level. Mechanisms for information dissemination, whether through digital technologies like local radio programs or physical community information centers, can significantly contribute to farmer knowledge and awareness regarding key aspects of climate variability and relevance.

Farmers equipped with timely and accurate climate information can make better decisions in agricultural planning, thereby increasing farm productivity and adaptability. Access to extension services is a crucial component of the information services ecosystem, addressing direct farmer needs and enhancing capacity through training. Farmers with such access are perceived as less risky by financial institutions. An essential advantage of information access is its dual nature – being preventative through features like early warning systems and enabling farmers to be more adaptive in managing unfolding climate challenges. For financial institutions, a key consideration in assessing the derisking impact of information services on smallholder farmers is the degree of contextualization the service offers.

Strategy 5: Insurance

Agricultural insurance represents an underutilized tool for derisking smallholder farmers, attributed to factors such as limited understanding of its operation, religious and cultural inhibitions, and financial constraints for premium payments. Despite these challenges, insurance offers substantial benefits to farmers engaged in high-risk agricultural activities and situated in vulnerable locations. Weather and yield index insurance, in particular, play a pivotal role in mitigating potential shocks from productivity-impacting events like extreme and erratic weather, safeguarding farmers from losses. With changing rainfall patterns posing challenges for primary crop cultivation, especially maize, farmers in such regions face increased lending risks.

The prospect of bundling insurance with credit presents an opportunity to mitigate the risk faced by

financial institutions due to yield losses, directly impacting a farmer's ability to repay loans. However, this strategy may introduce moral hazard issues, where farmers might engage in riskier behaviour, possibly leading to deliberate default, given the availability of insurance coverage. Additional challenges include increased costs for farmers, and the realization by financial institutions that insurance claims do not necessarily translate into farmer repayment of outstanding debts.

In response, Shee et al. (2015) propose risk contingent credit products that seamlessly integrate insurance into the loan product. These are any credit instrument that embeds within its structure a contingent claim or insurance which, when triggered transfers part or all of the borrower's liability to the lender or integrator/counterparty (Shee and Turvey, 2012). Further advancements in this area could see significant derisking impact on smallholders and an increased incentive for the supply of credit into the sector.

In conclusion

Maize farming in Zambia faces significant challenges due to climate change, primarily manifested through heightened temperatures, variable rainfall, and droughts. These factors collectively pose a risk to the yield and sustainability of maize, a critical food and cash crop in the region. Research indicates that maize yields decrease with each degree day over 30°C and are projected to decline further with global temperature increases. This is compounded by the increased likelihood of drought, which drastically reduces available soil water, crucial during the critical stages of maize growth.

In response to these challenges, various strategies have been proposed to enhance the resilience of maize farming and to make farmers more attractive to financial institutions. These include effective farm management practices like crop diversification and intercropping, which not only increase yields but also improve soil fertility and pest control. Access to climate-resilient maize varieties is another key strategy, with new breeds demonstrating significantly higher yields, especially under stress conditions. Water management techniques, both in situ and ex situ, are crucial in mitigating the impact of dry spells, making farmers more appealing to lenders.

Furthermore, providing farmers with access to climate information services and systems enhances their capacity to make informed decisions, thereby reducing risks associated with climate variability. Lastly, agricultural insurance, particularly weather and yield index insurance, is identified as a critical tool for derisking smallholder farmers, though it comes with challenges such as the potential for moral hazard and increased costs for farmers.

These strategies collectively aim to mitigate the impact of climate change on maize farming in Zambia, enhancing yield stability and making the sector more resilient and sustainable in the face of climatic uncertainties. Integration of these strategies with financial institutions' lending practices can provide a holistic approach to managing climate risks and ensuring the viability of maize farming in the region.

References

Adhikari, U., Nejadhashemi, A. P., & Woznicki, S. A. (2015). Climate change and eastern Africa: a review of impact on major crops. *Food and Energy Security*, *4*(2), 110-132.

Shee, A., Turvey, C. G., & Woodard, J. (2015). A field study for assessing risk-contingent credit for Kenyan pastoralists and dairy farmers. *Agricultural Finance Review*, *75*(3), 330-348.

Barron, J. (2004). *Dry spell mitigation to upgrade semi-arid rainfed agriculture: Water harvesting and soil nutrient management for smallholder maize cultivation in Machakos, Kenya* (Doctoral dissertation, Institutionen för systemekologi).

Borges, W. L. B., Juliano, P. H. G., Rodrigues, L. N. F., de Freitas, R. S., & da Silva, G. S. (2020). Soybean and maize in agrosilvipastoral system after thinning of eucalyptus at seven years of implantation. *International Journal of Advanced Engineering Research and Science*, *7*(6).

Chisanga, C. B., Phiri, E., Chinene, V. R., & Chabala, L. M. (2020). Projecting maize yield under local-scale climate change scenarios using crop models:

Sensitivity to sowing dates, cultivar, and nitrogen fertilizer rates. *Food and Energy Security*, *9*(4), e231.

Liu, J., Fritz, S., Van Wesenbeeck, C. F. A., Fuchs, M., You, L., Obersteiner, M., & Yang, H. (2008). A spatially explicit assessment of current and future hotspots of hunger in Sub-Saharan Africa in the context of global change. Global and Planetary Change, 64(3-4), 222-235.

Lobell, D. B., & Field, C. B. (2007). Global scale climate–crop yield relationships and the impacts of recent warming. *Environmental research letters*, *2*(1), 014002.

Makurira, H. (2010). *Water productivity in rainfed agriculture: redrawing the rainbow of water to achieve food security in rainfed smallholder systems*. CRC Press.

Oweis, T., & Hachum, A. (2009). Water harvesting for improved rainfed agriculture in the dry environments. In *Rainfed agriculture: unlocking the potential* (pp. 164-181). Wallingford UK: CABI.

Punyalue, A., Jamjod, S., & Rerkasem, B. (2018). Intercropping maize with legumes for sustainable highland maize production. *Mountain Research and Development*, *38*(1), 35-44.

Setimela, P. S., Magorokosho, C., Lunduka, R., Gasura, E., Makumbi, D., Tarekegne, A., ... & Mwangi, W. (2017). On-farm yield gains with stress-tolerant maize in Eastern and Southern Africa. *Agronomy journal*, *109*(2), 406-417.

Setimela, P., Gasura, E., Thierfelder, C., Zaman-Allah, M., Cairns, J. E., & Boddupalli, P. M. (2018). When the going gets tough: Performance of stress tolerant maize during the 2015/16 (El Niño) and 2016/17 (La Niña) season in southern Africa. *Agriculture, ecosystems & environment*, *268*, 79-89.

Shiferaw, B., Tesfaye, K., Kassie, M., Abate, T., Prasanna, B. M., & Menkir, A. (2014). Managing vulnerability to drought and enhancing livelihood resilience in sub-Saharan Africa: Technological, institutional and policy options. *Weather and climate extremes*, *3*, 67-79.

Temesgen, B. B. (2012). *Rainwater harvesting for dryland agriculture in the Rift Valley of Ethiopia*. Wageningen University and Research.

Thurlow, J., Zhu, T., & Diao, X. (2012). Current climate variability and future climate change: estimated growth and poverty impacts for Zambia. *Review of Development Economics*, *16*(3), 394-411.

Tigchelaar, M., Battisti, D. S., Naylor, R. L., & Ray, D. K. (2018). Future warming increases probability of globally synchronized maize production shocks. *Proceedings of the National Academy of Sciences*, *115*(26), 6644-6649.

Waldman, K. B., Blekking, J. P., Attari, S. Z., & Evans, T. P. (2017). Maize seed choice and perceptions of climate variability among smallholder farmers. *Global environmental change*, *47*, 51-63.

Wineman, A., & Crawford, E. W. (2017). Climate change and crop choice in Zambia: A mathematical programming approach. *NJAS-Wageningen Journal of Life Sciences*, *81*, 19-31.

Zhao, C., Liu, B., Piao, S., Wang, X., Lobell, D. B., Huang, Y., ... & Asseng, S. (2017). Temperature increase reduces global yields of major crops in four independent estimates. *Proceedings of the National Academy of sciences*, *114*(35), 9326-9331.

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