Senior Expert Contributions to OneCGIAR Program Development

Strengthening the resilience of livelihoods in drylands

Netherlands-CGIAR Partnership

Prepared by: **Anton Vrieling** (University of Twente) and **Geert Sterk** (Utrecht University)

The aim of this two-pager[1] is to provide input for the OneCGIAR investment plan. Notably to identify key research challenges within the OneCGIAR impact areas, how these areas interact with Dutch policy priorities and how the challenges could be addressed / strengthened.

Key research challenges

Drylands are defined as regions where average annual precipitation does not exceed 65% of the potential evapotranspiration. Due to climatic shifts, their extent is increasing (Huang et al. 2016) and currently comprises about 45% of the global land area (Prăvălie 2016). Its population totals beyond two billion, many of which heavily depend on the ecosystem services provided by these drylands. While multiple challenges simultaneously affect livelihoods in these areas (e.g. conflict, land degradation, demographic change), year-to-year weather variability is an important driver of reduced food and forage production. Frequent occurrence of drought or extreme rainfall leading to flooding are the most destructive weather events that affect agriculture in drylands.

For smallholder farmers and pastoralists, adverse weather impacts can result in poverty traps, given that assets are either lost directly (e.g., livestock mortality), or need to be sold to feed their families. Changing rainfall regimes and resulting increased frequencies of droughts make that livelihood resilience is at risk in these fragile systems. Coping strategies to deal with these challenges include: 1) enhancing agricultural water use efficiency through provision of improved climate services and the implementation of water harvesting structures that mitigate the impacts of drought and flooding, and 2) financing mechanisms to help overcome adverse weather impacts. Climate services can assist in decision-making in the agricultural sector. Among the climate services, seasonal forecasts are especially important as these provide a growing season perspective on the water availability, relevant to short-term decision making and agricultural planning (Hansen et al. 2011). Rainwater harvesting (RWH) techniques can be used to cope with droughts. These measures either conserve soil moisture *in-situ*, or collect surface runoff, which is channelled directly to crops or stored for domestic use or supplemental irrigation. The technique fosters sub-surface storage of water, which decreases evaporation and soil erosion, and improves drought mitigation of agro-ecosystems. Moreover, the RWH measures can mitigate impacts of heavy rainstorms by reducing flood risks. RWH techniques have a proven potential to increase agricultural production and improve socio-economic conditions for dryland farmers (Biazin et al. 2012). Innovative financing mechanisms can contribute to increase the financial resilience to climate-related crises (World Bank Group 2016). These comprise insurance, credits, and contingency budgets, among others. Particularly index-based approaches have potential to reach scale; through the use of a transparent and objectively measured indicator climate-related economic losses can be tracked and consequently used to transfer the risk (Fava and Vrieling 2021).

[1] This two-pager is an initiative of Senior Experts within the NL – CGIAR research programme. This programme is funded by the Ministry of Foreign Affairs of the Netherlands as part of the Strategic Partnership between the Netherlands Government and the CGIAR and it is implemented by NWO-WOTRO Science for Global Development.
(January 2021)

While several CGIAR-institutes have advanced in designing, implementing, and evaluating climate risk coping strategies, many research challenges remain to effectively bring this to scale. These include:

- Climate services are an important source of information for agricultural management. The current services provided by the national meteorological agencies are often of low quality and do not fully meet users' needs. Increasing the reliability of especially seasonal forecasts is a challenge and can be achieved using novel techniques such as deep learning to improve the forecast skill. Another challenge is to effectively communicate the climate information with the users.

- Large-scale testing and modelling of RWH techniques in dryland agro-ecosystems. ICARDA has implemented and tested different RWH techniques in the Jordan desert. The RWH techniques improve agricultural water use efficiency by trapping surface runoff and making it available to vegetation growth in dry environments. To evaluate potential dryland sites for RWH implementation in larger areas, tools need to be developed using available datasets, remote sensing and modelling.

- The design and implementation of effective *in-situ* data collection protocols to measure the impacts of weather extremes across large areas to help design and validate models underlying index-based climate risk financing approaches. This comprises collection of location-specific longitudinal data on biomass, yields, and livestock mortality, but also on household-level outcomes, such as reduced income, food intake, or health. Innovative crowd-sourcing techniques could help in acquiring such data.

- The intelligent use of remote sensing and big data tools to design more accurate index solutions. While *in-situ* data are an important basis, new frequently-acquired high spatial resolution satellite data (e.g., Sentinel-1 and -2) can provide targeted and synoptic information on crop or forage losses.

- Improving the timeliness of innovative financing tools. Usually index-based approaches trigger when sufficient information about the seasonal drought outcome becomes available, for example through satellite-retrieved information on vegetation status. Seasonal forecasts have potential to provide similar information earlier, which can translate into earlier triggering of financing mechanisms.

- Evaluation of the impact and effectiveness of water harvesting and financing mechanisms on household resilience and environmental sustainability. For example, reduced herd losses due to insurance may result in higher grazing pressure (John et al. 2019), although it may simultaneously reduce the need to use livestock assets as precautionary savings (Matsuda et al. 2019).

Relevance

An integral programme on resilience in drylands is much needed, given the specific challenges in this fragile system. Drylands cover many developing countries where a large fraction of households is poor and largely depends on agriculture. The projected population increase in vulnerable drylands, by around 40% to 50% by 2050, is much faster than the 25% in non-drylands. This particularly concerns parts of Africa and South Asia. These drylands are inherently vulnerable to land degradation, often face water shortages and lack fertile soil (PBL 2017). Given the expected increase in drought severity and changes in precipitation as predicted by IPCC (2014) it is necessary that agriculture in the drylands adapts to increased climate variability and change. If not, it will become extremely difficult to keep feeding the growing population.

Approach

Given the extent, fragility, challenges, and importance of drylands to a large and increasing part of the global poor population, as well as the specific challenges in drylands that are forecasted, we advocate for an integral CGIAR initiative on strengthening the resilience of rainfed dryland systems. We note that the regional integrated initiatives, proposed by the 2022–2024 Investment Plan, comprise large regions with substantial climatic and agricultural diversity, whereas important synergies exist between the various global vulnerable drylands. Stronger integration of research programmes within these drylands would facilitate testing and scaling of interventions.

Synergies

The strengthening of resilience of livelihoods in drylands, as outlined in previous sections, strongly links to the (draft) CGIAR 2030 research and innovation strategy. Within the Action Area on Resilient Agrifood Systems, solutions for strengthening resilience and risk management for sustainable small-scale agriculture is an important pathway towards the Impact Area on Poverty Reduction. Moreover, climate-smart solutions, resilience to floods and droughts, and innovative finance are important elements of the Impact Area on climate adaptation and mitigation within the Systems Transformation Action Area. Also, the use of remote sensing and big data tools is mentioned as a CGIAR research priority in both mentioned Action Areas.

The scaling of options for enhanced agricultural water use efficiency and financial solutions matches Dutch policy priorities on scaling and anchoring of proven techniques. The integration of multiple coping strategies to enhance resilience in dryland systems relates to the Systems Approach, whereby multiple options need to be assessed holistically for their effectiveness in different parts of the drylands. Our proposal provides ample scope for private sector engagement, e.g. for delivery of climate services and financial products.

CG-centres like ICARDA, ICRISAT, and ILRI have performed relevant research and implementation initiatives to build upon. Dutch Universities (e.g., Twente, Utrecht) already closely collaborate in these initiatives. Eight CG-centres also support a more holistic programme on scaling of systemic innovation across the rainfed drylands in Africa and Asia, addressing multiple thematic opportunities through the DryArc Initiative. Our focus on enhancing agricultural water use efficiency and financial mechanisms complements this initiative. Besides research, local and possibly Dutch private partners have a strong role to play in providing climate and financing services. For example, several Dutch companies have expertise in providing climate and remote sensing-based services. Public engagement (national government) is required to set regulatory frameworks for financial services and to facilitate *in-situ* data collection efforts (Hazell and Varangis 2019).

References

Biazin, B., G. Sterk, M. Temesgen, A. Abdulkedir and L. Stroosnijder (2012). Rainwater harvesting and management in rainfed agricultural systems in sub-Saharan Africa: a review. *Physics and Chemistry of the Earth, 47-48*, 139–151

Fava, F., and A. Vrieling (2021). Earth observation for drought risk financing in pastoral systems of sub-Saharan Africa. *Current Opinion in Environmental Sustainability, 48*, 44–52

Hansen, J.W., S.J. Mason, L. Sun, and A. Tall (2011). Review of seasonal climate forecasting for agriculture in sub-Saharan Africa. *Experimental Agriculture, 47*, 205–240

Hazell, P., and P. Varangis (2019). Best practices for subsidizing agricultural insurance. *Global Food Security*, 100326

Huang, J., H. Yu, X. Guan, G. Wang, and R. Guo (2016). Accelerated dryland expansion under climate change. *Nature Climate Change, 6*, 166–171

IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects.* Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press

John, F., R. Toth, K. Frank, J. Groeneveld, and B. Müller (2019). Ecological vulnerability through insurance? Potential unintended consequences of livestock drought insurance. *Ecological Economics, 157*, 357–368

Matsuda, A., K. Takahashi, and M. Ikegami (2019). Direct and indirect impact of index-based livestock insurance in Southern Ethiopia. *Geneva Papers on Risk and Insurance: Issues and Practice, 44*, 481–502

PBL (2017). *Exploring future changes in land use and land condition and the impacts on food, water, climate change and biodiversity: Scenarios for the Global Land Outlook.* The Hague, Netherlands: PBL Netherlands Environmental Assessment Agency

Prăvălie, R. (2016). Drylands extent and environmental issues: a global approach. *Earth-Science Reviews, 161*, 259–278

World Bank Group (2016). *Disaster risk finance as a tool for development: a summary of findings from the Disaster Risk Finance Impact Analytics project.* Washington DC: World Bank