



From climate risk to climate resilience

How Zambian smallholders are using local knowledge and climate data to adapt their cropping strategies



The Irish Aid Climate and Development Learning Platform¹

This project was carried out as part of the Irish Aid Climate and Development Learning Platform. Irish Aid has made a policy commitment to put climate change at the centre of their development programming.^{2,3} The Learning Platform assists in this task through evidence collation, shared learning and support to country mission strategy development. IIED is providing technical support to enable this integration across different sectors and in all of Irish Aid's key partner countries. This includes:

- Developing a web-based portal for sharing experience and knowledge (the Platform)
- Supporting capacity development through training and the provision of learning resources
- Generating evidence through retrospective, real-time and prospective case studies, and
- Supporting country missions at critical points of the mission strategy development, implementation and review cycle.

Introduction

Zambia, like most of the Least Developed Countries (LDCs), is facing a future in which climate change will consistently negatively affect smallholder crop production. The effects are already being felt in this southern African nation, where smallholder farming is the norm.

Some national and international policy responses aim to integrate climate considerations into development programming, and so make it more sustainable. But the best intentions can remain on the drawing board: practical evidence of climate mainstreaming remains thin, especially for programmes assisting poor smallholder farmers in the LDCs.⁴

This case study considers one approach to making climate resilience an on-the-ground reality for smallholder farmers. As part of Irish Aid's Climate and Development Learning Platform, climate farmer field schools were established in Zambia's Northern Province in 2016.

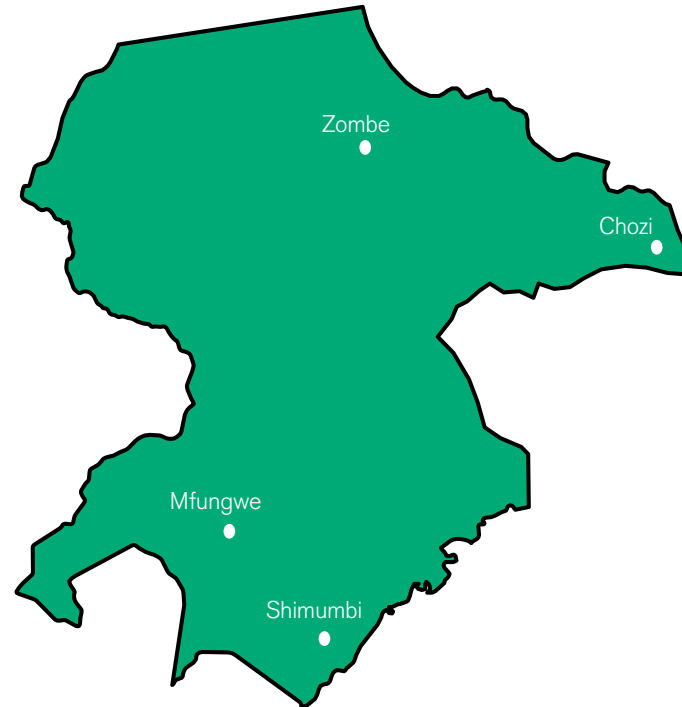
With thanks to Durton H. Nanja, project consultant

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Map sourced from: Zambia with Provinces by FreeVectorMaps.com

The schools provided experiential learning around locally relevant climate-resilient agriculture. Using farmer demonstration plots, smallholders were supported to systematically adjust business-as-usual cropping strategies according to calculations of climate risk. The approach — centred on gradual knowledge transfer to the poorest smallholders — is promising, but more seasonal cycles must be completed for a full set of results to be available.

We present details of the methodology in this case study to enable this work to be taken forward and replicated by local government and other institutions committed to climate-resilient smallholder farming over the medium- to long-term.



Northern Province, Zambia

Climate-driven threats to smallholders

Despite urbanisation and a growing range of possible livelihoods, agriculture remains the main means of income and subsistence for rural communities in the LDCs and the lower-middle income countries of sub-Saharan Africa. But in the near future, climate change will likely drive consistent and systemic reductions in the harvests of the poorest farmers.⁵ Even moderate warming scenarios will likely reduce the positive livelihood effects of development, with disproportionate impacts on the poorest.⁶

Among those affected, smallholder farmers reliant on rain-fed agriculture are the most sensitive to even small variations in climate.⁷ Zambia's rural communities fall into this category and have experienced significant warming — +1.3°C — since 1960.⁸ More erratic rainfall, shorter seasons and prolonged dry spells have been recorded, and are predicted to get worse over time.⁹ The threat has not gone unnoticed, but it has also not been resolved: sustainable approaches to adaptation for the poorest are still lacking.

At the national level, Zambian authorities have mainly addressed climate risks to smallholder production through agricultural extension, crop insurance and seasonal forecasts designed to anticipate climate hazards. But the probabilistic framework used to design seasonal forecasts represents a significant barrier to engagement for those farmers that most need to prepare for climate uncertainty.^{10,11,12}

National agricultural development agencies — including the Ministry of Agriculture, Department of Meteorology, the Pilot Programme for Climate Resilience and CGIAR Centres — are yet to find a way to systematically include climate information and local knowledge of climate hazards into the support of agricultural livelihoods. The methodology we describe here is a first step towards empowering the poorest smallholder farmers to integrate climate information effectively into their cropping strategies.

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Creating an opportunity to mitigate risk

Smallholder farmers have deep local knowledge and memory of climate variations. But they need the tools to practically apply climate information to a low-input and accessible approach to climate-resilient agriculture. To achieve this, partners working on Irish Aid's **Climate and Development Learning Platform** project in Zambia's Northern Province — Self-Help Africa, Ministry of Agriculture and Zambia Meteorological Department, and IIED — took part in a participatory process alongside community representatives and local farmers. Together, they made a collective decision to establish '**Climate Farmer Field Schools**' (CFFS) in four locations: Chozi, Mfungwe, Shimumbi and Zombe.

The schools are designed to engage local smallholders in experiential learning about climate-resilient agriculture, through farmer-led trials, evaluation and reflection. Participants were recruited from established local livelihood enhancement groups (LEGs), comprised overwhelmingly of women farmers. The LEGs provided an entry point to begin to integrate climate information into agricultural programming for smallholder farmers.²

Throughout the project, IIED and Irish Aid were keen to ensure that learning took hold



Back to school...

The CFFS model enabled the project partners and LEG farmers to conduct location-specific risk assessments for their 'business-as-usual' cropping strategies (see box).¹³ By applying tailored climate-risk calculations to each crop, smallholders and their support institutions — for example, the Ministry of Agriculture, Department of Meteorology and nongovernmental organisations (NGOs) — could develop 'risk-adjusted' cropping strategies that account for the likelihood of climate-related hazards.

The adjusted strategies, which remain low-input enough to work sustainably for even the poorest smallholders, were then tested and compared with business-as-usual scenarios through farmer demonstration plots, operated under the local Irish Aid Local Development Programme.

Crucially, the risk assessments provided a basis for the *systematic inclusion* of contextual knowledge of potential hazards and climate information by local people, a step that has so far remained an ambition for higher-level policy responses.

Throughout the project, IIED and Irish Aid were keen to ensure that learning took hold. The risk-adjusted cropping strategies can only pay dividends if they are applied; they can only be applied if the necessary know-how and skills are consistently transferred to smallholder farmers from locally based technical personnel.

'Business-as-usual' cropping strategies

The 'business as usual' approach is essentially 'what a smallholder typically grows'. This cropping strategy will be context-specific and include all a farmer's nutritional and market-based requirements — both of which are crucial for sustainability. These strategies will have developed over time and with good reason: climate integration exercises should only ever recommend *adjustments* to established local cropping strategies, avoiding sweeping or fundamental changes.

Assessing climate risk: our methodology

In February 2016, Irish Aid, IIED and partners began to trial the participatory CFFS methodology. This approach sought to increase cropping strategies' resilience to climate shocks and stresses, using two key inputs: **local knowledge** and the **seasonal forecast**.

An initial assessment process^{14,15} identified the specific climate risks to different crops by establishing:

- a) the thresholds where climate variability becomes hazardous to crops
- b) the magnitude of losses associated with the hazardous effects on crops, and
- c) smallholders' ability to apply micro-adaptions to crop production, and their success.

Using these baselines, a two-step exercise then guided the design of climate-risk assessments for LEGs:

Step 1a:

Identify previous climate hazards to business-as-usual cropping strategies over the past five years and establish the climate 'coping range' for crops, specify thresholds where variability becomes hazardous.

Step 1b:

Combine information on crop-hazard interactions with the seasonal forecast to calculate climate risk in the next season.

Step 2:

Use calculations of climate risk to adjust the business-as-usual crop planting preferences, and in doing so, establish the climate-resilient (risk-adjusted) cropping strategy.

**Probability of hazard occurring x loss
associated with crop-hazard
interaction = risk**



The calculation: elements and definitions

The **probability of a hazard** occurring in any year is the likelihood that 'normal variation' in climate becomes hazardous for a crop. This calls on both local knowledge and historical climate data. For example, certain varieties of beans may begin to suffer after an 16-day dry spell, which — from memory and available climate information — is likely to occur every 1-in-5 years (in which case the probability is 0.20).

The **magnitude of the loss** — measured in yield or monetary value — represents the typical scale of impact once the threshold of a particular hazard is breached for a particular crop.

Multiplying the probability of occurrence with the likely losses gives us the **level of climate risk** for that crop. The exercise provides a standard metric to compare crops according to climate risk; this appears in Step 2 of our worked example on page 11.

Integrating seasonal forecasts

The accuracy of our calculation can be increased if the likelihood of a hazard occurring is fine-tuned according to the best climate information available (this is indicated in Step 1 of the worked example on page 11).

For example, both farmer recall and historical climate data may suggest the probability of an 18-day dry spell is 0.20. But by looking at the likelihood of this hazard occurring in *below normal*, *normal* and *above normal* rainfall years, the probability can be adjusted upwards or downwards in line with the current seasonal forecast.

From theory to reality

After the assessment applies this risk calculation, smallholders will have a climate-resilient cropping strategy that mitigates the particular hazards they face. It will indicate which crops to plant, how much space to allocate each, and what micro-adaptations to apply at the point of land preparation and planting (see box).

However, an important final step *before* planting the demonstration plots is an open discussion between smallholder farmers and staff from the support institutions about the practicalities of the proposed strategy. Often certain crops are needed for family nutrition, regardless of climate risk, or market expectations may be such that the risk is worth taking, or some other reason specific to the context.

Any final changes to the climate-resistant cropping strategy are made through a collective decision-making process.

Small but mighty

'Micro-adaptations' are the more subtle changes to practice that farmers can apply alongside a revised cropping strategy to maximise its success. These are agricultural techniques, some already practised by LEG farmers, which are tried-and-tested ways to address climate hazards that stem from deep local knowledge. Micro-adaptations might take the form of changes in seed variety combinations, or the use of soil moisture retention techniques like mulching.



Working it out: example of a risk calculation

This diagram illustrates how the climate-risk assessment was applied to predict hazards and generate an appropriately adjusted cropping strategy.

- Step 1 uses the 0.35 probability of an 18-day dry spell, multiplied by the typical loss of US\$50, to come up with a (monetary) climate risk for maize of US\$17.5.
- In Step 2, that level of climate risk is then compared to other crops. Upward and downward adjustments are made to the business-as-usual cropping strategy, depending on whether the risk is greater or less than the spatial allocation.

In our example, the climate risk of maize (64 per cent) is larger than the proportion of land allocated to maize (50 per cent). When climate risk is disproportionately large, a reduction in the typical proportion of land devoted to that crop follows (in this case, -14 per cent).

The calculation is repeated for groundnuts and beans, and suggests an increase in space from that usually allocated of +8 per cent and +6 per cent, respectively.

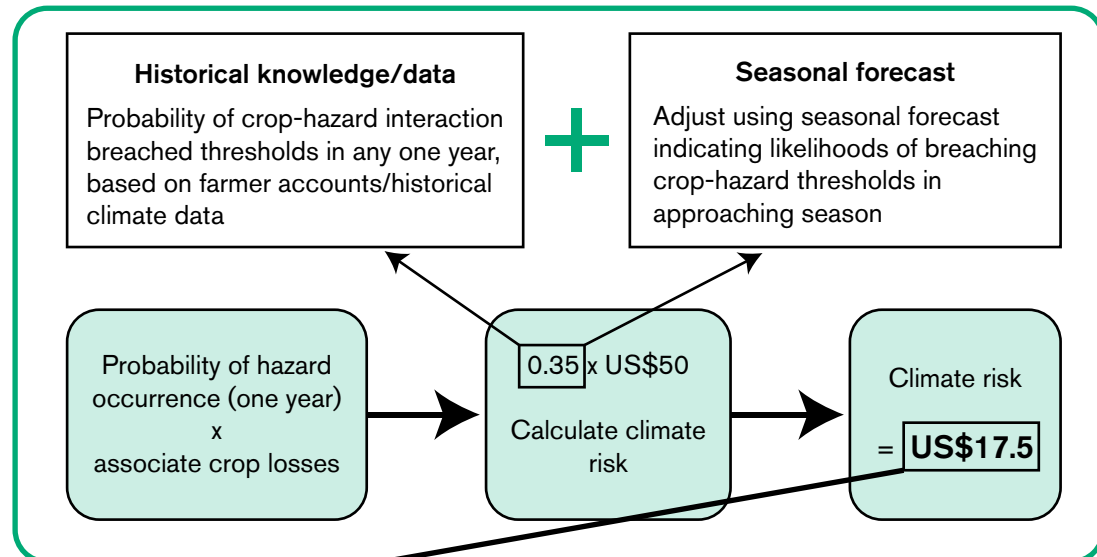
- When Step 1 and Step 2 are complete for all the crops that are routinely planted, the result is a climate-risk-adjusted cropping strategy that has systematically embedded both local knowledge and the current seasonal forecast.

For this methodology to deliver improved climate resilience, risk-adjusted strategies must be run over a number of consecutive harvests, of varying seasonal rainfall and temperature outcomes. Over time, the adjustments will offer an **overall reduction in losses** and the **maximisation of opportunities** in both good and bad years, relative to the business-as-usual strategy. This series of iterative steps mirrors what farmers do to adapt their crop husbandry — but often individually and too often in the absence of technical support.



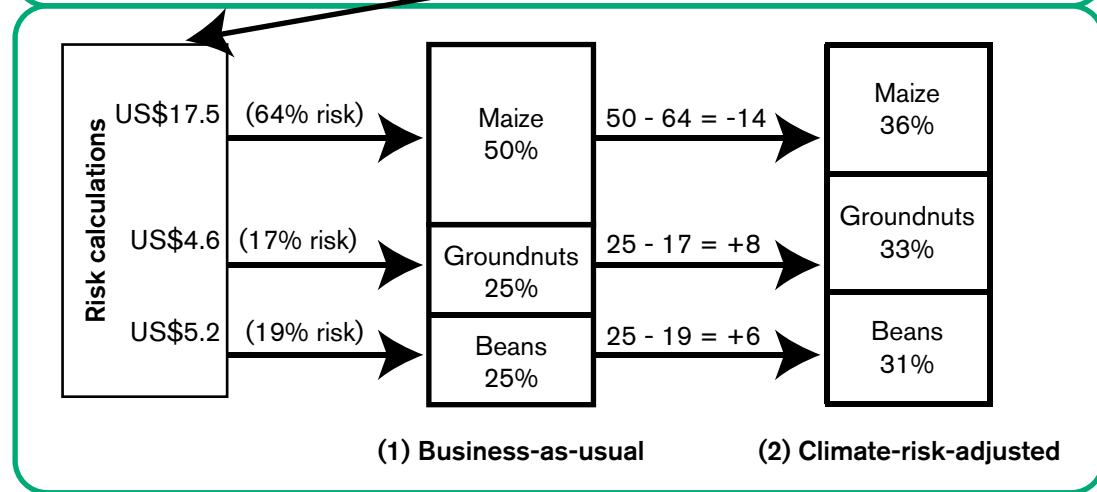
Step 1:

Climate-risk assessment with integration of seasonal forecast



Step 2:

Using climate-risk calculations to adjust business-as-usual cropping strategy



Reaping the results

Four LEGs and the support institutions applied the CFFS methodology in four areas: Chozi, Mfungwe, Shimumbi and Zombe.

Each LEG took part in the experiential learning by adjusting their business-as-usual cropping strategy according to its climate-risk assessment, sometimes augmented by local or context-specific issues or micro-adaptations. Crops were planted in the demonstration plots in November 2016 and harvested in June 2017; this was a single above-normal rainfall season.

The performance of the risk-adjusted cropping strategy was then compared to the yield from the business-as-usual scenario. The table opposite shows the results from the Mfungwe demonstration plot when the yields from both strategies were converted into monetary values (Zambian Kwacha), using current market prices.

Overall, results were half and half when comparing risk-adjusted and business-as-usual scenarios: in Mfungwe and Chozi the risk-adjusted strategies out-performed business-as-usual (+177K and +53K, respectively), while Zombe and Shimumbi showed the opposite (-296K and -110K, respectively).

But looking at the results in more detail, the harvest was affected by the above average rainfall:

- While the risk-adjusted cropping strategies performed best when the focus on maize was maintained — but poorly when cassava replaced maize — the crop was not tested by an exceptionally dry season (during which maize suffers and cassava provides an important insurance). Testing over multiple seasons will demonstrate this insurance-based characteristic of the method
- The assessment signified disproportionate risk was often attributable to maize and, to a lesser extent, groundnuts
- Climate losses to maize are typically associated with drier years (eg longer dry spells or low aggregate seasonal rainfall), but rainfall was sufficient for an abundant crop.

One year's results are not conclusive. To more fully understand the performance of risk-adjusted cropping strategies, it is necessary to run and evaluate the method as an iterative process. One season cannot provide conclusive results, but the findings do indicate a methodology worth investigating further.

Mfungwe monetary value of crops (Zambian Kwacha)

Climate-risk-adjusted cropping strategy	Business-as-usual cropping strategy
Groundnuts (560 K)	Maize (164 K)
Cassava (30 K)	Groundnuts (296 K)
Beans (20 K)	Beans (42 K)
Maize (109 K)	Cassava (37.9 K)
Sweet potatoes (11 K)	Sweet potatoes (13.7 K)
Total: 730 K	Total: 553.6 K

To more fully understand performance of risk-adjusted cropping strategies, it is necessary to run and evaluate the method as an iterative process



A sustainable future for climate-resilient agriculture?

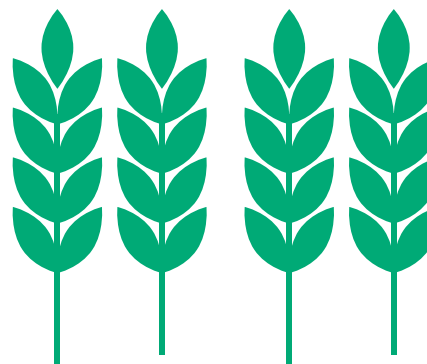
This case study offers a crash course in our approach to embedding climate-resilient agriculture practices with smallholders in Zambia.

Over a season, the assessment was developed and communicated to technicians and facilitators in local institutions. These personnel then worked with local farmer groups in trials of the adjusted cropping strategies. Now, to ensure that the learning from this project continues in a sustainable way, local government should own and direct the CFFS methodology as a long-term iterative approach.

Local governments, with adequate resources, can provide the recurrent engagement that smallholders need in order to learn the assessment method, reflect on practice, and appreciate the marginal benefits of systematically including local knowledge and climate information within their agricultural practices. In addition, local governments have the benefit of being a ready entry point, able to integrate these activities into ongoing work with smallholders.

Local governments could outsource this form of technical support to farmers to service providers and/or NGOs. Private sector involvement might be possible in more commercially oriented smallholder farming sectors.

Locally led work can be complemented by national and international policies that systematically include climate information and local knowledge of hazards in agricultural programme design.



Recommended next steps

1. Engage smallholders iteratively in the medium- to long-term

The work to date in the Northern Province was first and foremost a learning exercise: the engagement and shared learning of LEG farmers and support institutions was of paramount importance.

By design, risk-adjusted cropping strategies cover a range of climate outcomes. It takes implementation over multiple seasons (3–5 years) to demonstrate the marginal benefits of climate-resilient agriculture that are accessible to smallholder farmers. This methodology calls for a medium- to long-term iterative engagement with rural communities — testing, reflecting and building trust takes time.

2. Enable local government institutions to lead engagement

The CFFS methodology must be delivered by institutions that have a permanent mandate to develop the capacity of smallholder farmers, especially as they approach a future of fundamental change to climate conditions. Resources could be effectively directed through existing local government structures — including the Ministry of Agriculture and Meteorological Departments — which are able to facilitate collaboration and incentivise personnel with the necessary technical background to stay involved (see step 3).

Institutional learning is a prerequisite, but knowledge has little worth unless successfully passed on to the most climate-vulnerable smallholder farmers: those most at risk from climate change should always be the focus of the initiative.

3. Create incentives for technical personnel to stay involved

Climate information is inherently technical. The highest capacity technical personnel available to the smallholder LEGs — likely to work in local government or NGOs — should continue to be identified, trained in the methodology and incentivised to maintain a knowledge transfer programme that prioritises reaching the poorest smallholders. Enabling knowledgeable local facilitators, able to build long-term relationships with farming communities, is key for sustainability.

4. Include tried-and-tested smallholder micro-adaptations

The principal differentiator in the CFFS trial in the Northern Province was the amount of space afforded to different crops. However, to make best use of local knowledge, smallholder farmers' nuanced and location-specific micro-adaptations must be integrated into the final climate-resilient cropping strategies, alongside other assessments and inputs.

Notes

¹ www.climatelearningplatform.org

² Irish Aid (2013) One World, One Future: Ireland's Policy for International Development. Government Publication, 1–12.

³ Irish Aid (2017) Climate Resilient Agriculture in Smallholder Farming: Issues for Development Programming. Policy Briefing, 1–14.

⁴ See: http://iea.cgiar.org/wp-content/uploads/2016/09/CCAFS_Final-Report-Volume-1.pdf

⁵ Porter, JR *et al.* (2014) Food security and food production systems. In: IPCC (2014) *Climate Change 2014: Impacts, adaptation, and vulnerability. Part A: Global and sectoral aspects*. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, pp. 485–533. Cambridge, UK and New York, USA, Cambridge University Press.

⁶ Plambeck, EL and Hope, C (1996) PAGE95: An updated valuation of the impacts of global warming. *Energy Policy* 24, 783–793.

⁷ Bosello, F, Eboli, F and Pierfederici, R (2012) Assessing the economic impacts of climate change. *FEEM (FondazioneEni Enrico Mattei), Review of Environment, Energy and Economics (Re3)*.

⁸ Government of Zambia (2015) Intended Nationally Determined Contributions. *UNFCCC Document*, 1–12.

⁹ Smith, B (2015) Climate change in Northern Zambia: Implications for Irish Aid Programmes. *IIED Consultancy Report*, 1–15.

¹⁰ Patt, A (2009) Learning to crawl: how to use seasonal climate forecasting to build adaptive capacity. In: Adger, N, Lorenzoni, I and O'Brien, K (eds) *Adapting to Climate Change: Thresholds, Values and Governance*. Cambridge University Press.

¹¹ Patt, A, Suarez, P and Gwata, C (2005) Effects of Seasonal Climate Forecasts and Participatory Workshops among Subsistence Farmers in Zimbabwe. *Proceedings of the National Academy of Sciences of the United States of America* 102, pp. 12623–12628.

¹² Anderson, S, Khan, F, Fikreyesus, D and Gomes, M (2014) Forwards and backwards evidence-based learning on climate adaptation. IIED, London.

¹³ Irish Aid Climate and Development Learning Platform (2016) Guidance note: Integrating climate change into development programming. IIED, Irish Aid.

¹⁴ Adapted from: Willows, R, Reynard, N, Meadowcroft, I and Connell, R (2003) *Climate adaptation: Risk, uncertainty and decision-making*. UKCIP Technical Report. UK Climate Impacts Programme, 70–89.

¹⁵ Ozor, N and Cynthia, N (2011) The role of extension in agricultural adaptation to climate change in Enugu State, Nigeria. *Journal of Agricultural Extension and Rural Development* 3, 42–50.





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Knowledge Products

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Case study

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