Food and Agriculture Organization of the United Nations

Tackling climate change in Zambia and Malawi

Bringing together evidence and policy insights

KEY POLICY MESSAGES

- **Enable markets to enhance climate resilience.** Markets can reduce farmer's exposure to climate change, among others, by creating incentives to diversify agricultural practices and production, and by increasing off-farm income earning opportunities. Policies have a critical role to play in enabling market development.
- **Increase investments in livestock sector to stabilize productivity.** Livestock productivity is substantially more resilient to climate variability than crop productivity. However, only around 15 percent of agricultural budgets are dedicated to the livestock sector.
- **Increase public investment in agricultural research.** There is a high level of regional variation in how climate change will affect crop and grasslands production. Public investment to develop crop and grass varieties adapted to these changing conditions can enable farmers to manage risks and capture benefits associated with changing climate.
- **Target extension messages to specific populations and regions.** Farmers have different incentives and face different challenges due to their location and socio-economic conditions. Tailoring extensions message for specific household needs or for regionally appropriate crop varietal choices can increase adoption rates.
- **Modifying subsidy programmes.** Input subsidy programmes can be modified and bundled with targeted extension messages to better respond to emerging weather threats. This may include spatial targeting of specific crop varieties to specific region and more support to the livestock sector.

ECONOMICS AND POLICY INNOVATIONS FOR CLIMATE-SMART AGRICULTURE ◀ EPIC

Introduction

To respond to the diverse effects of climate change on food systems requires close dialogue and interaction between the research community and policy-makers. Strengthening this relationship will ensure that research findings are relevant to policy debates, and that policies are informed by up to date and rigorous analysis. This brief summarizes key findings from a multidisciplinary team of agronomists, livestock scientists, climatologists and economists for the Food and Agriculture Organization of the United Nations (FAO) working in Malawi and Zambia. The findings presented here seek to spark a fruitful continued discussions on how policies can make use of these findings, and how scientific research can respond to the future needs of policy-makers.

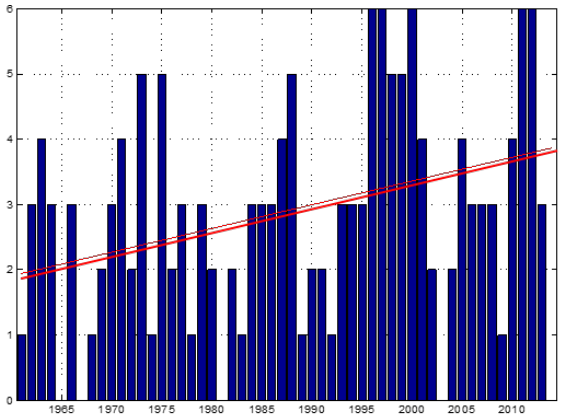
Examining climate trends through an agronomic lens

In order to identify and prioritize where public resources should be invested to support crop productivity growth and enhance resiliency to climate change, it is critical to move beyond the analysis of aggregate trends, and examine more closely how the climate is changing through an agronomic lens. Taking such an approach is particularly needed in locations dominated by rain-fed production systems, where changes in temperature and the timing and distribution of rainfall alter which crops, varieties and practices are most appropriate.

In Bvumbwe, Malawi, for example, average precipitation has not changed appreciably over the last several decades. However, as shown in Figures 1 and 2, the incidence of large rainfall events has increased significantly, with a less significant but important increase in the gaps between rainy days. Large storm events result in greater runoff, contributing to increased rates of soil erosion, especially topsoil, with less water infiltrating into the soil to support crop growth.

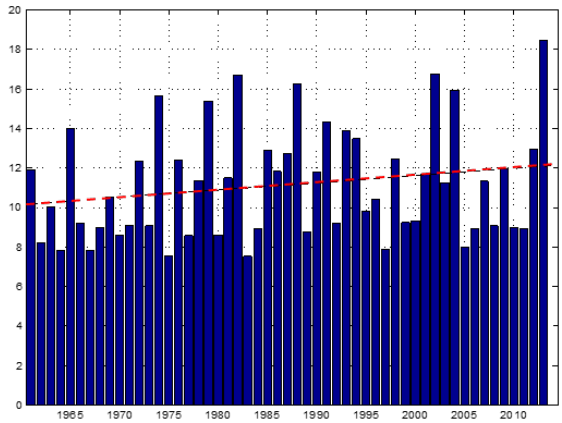
Negative effects of the loss of moisture retaining topsoil and reduced rainfall infiltration is further exacerbated by the widening gaps between rainfall events. As a result, even with annual rainfall amounts that are unchanged, the changes in rainfall intensity and distribution can reduce yields. In response, agricultural research and extension messages must be directed toward identifying and promoting practices for capturing and conserving more of the available rainfall and protecting the soil from erosion resulting from the combination of increasing heavy rains and intra-seasonal dry-periods. By considering more than one indicator, a clearer understanding can be gained as to where resources should be allocated.

Figure 1. Number of Large Rainfall Days in 120-day Growing Season Bvumbwe Malawi



Source: Authors' calculations.

Figure 2. Average Gap between Rainfall Events in Growing Season, Bvumbwe Malawi

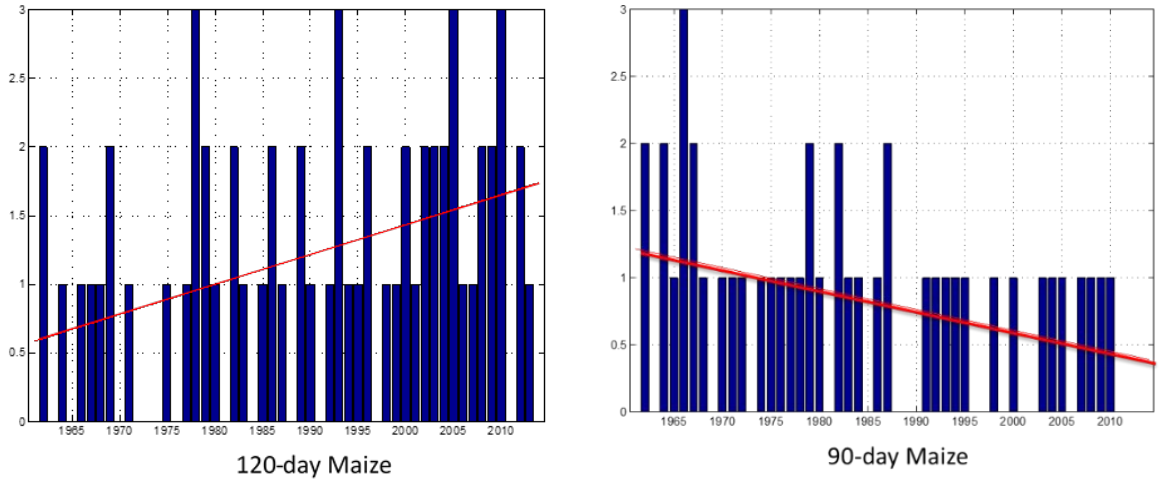


Source: Authors' calculations.

Different crops and varieties pass through critical stages of development at different times of the year, even when planted on the same date. As a result, changes in precipitation patterns can have dramatically different effects depending on varietal choice. For example, as shown in Figure 3, in Chitedze, Malawi, the number of dry-spells during the reproductive stage for late maturing 120-day maize has increased over time, while it has decreased for early maturing 90-day maize. Dry-spells during maize's reproductive stage can have significant negative effects on yields.

By promoting the use of early maturing varieties in this region, through extension messaging and targeted modification to subsidy programmes, policy makers can help improve household resilience and productivity in the context of climate change.

Figure 3. Number of dry-spells during the reproductive period of the 120-day and 90-day growing season, Chitedze Malawi



Source: Authors' calculations.

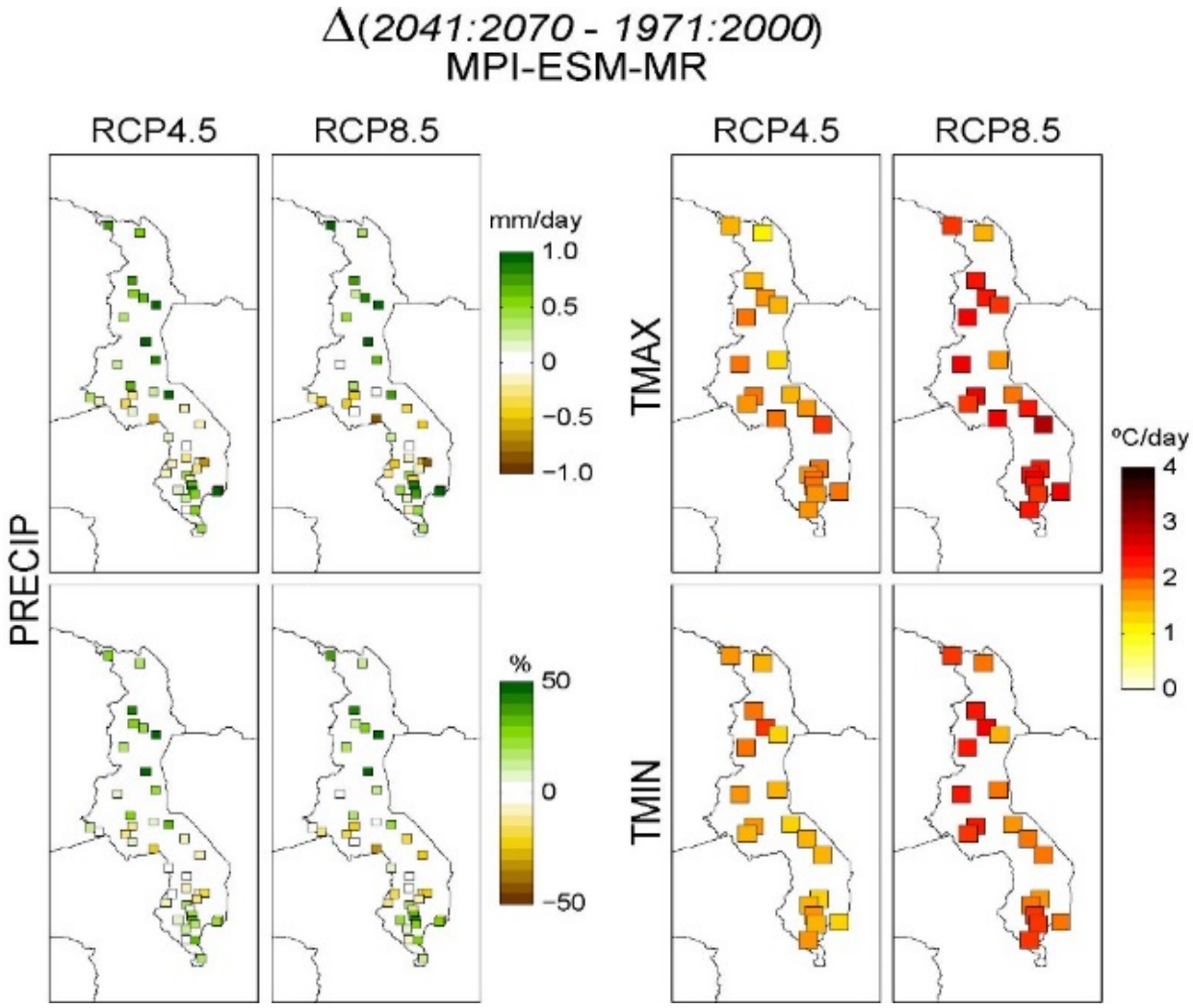
How will climate change in the decades to come?

Anticipating how climate will change in the coming decades is critical for making long-term public investments to help minimize its detrimental effects and capture benefits where possible. Figures 4 and 5 use multiple Global Climate Models and Representative Concentration Pathways (RCPs), to generate downscaled projections of precipitation and temperatures for Zambia and Malawi for the period 2041-2070.

There is considerable spatial variability in climate change impacts in the two countries. While both countries are expected to see rapidly rising temperatures, changes in precipitation will vary widely depending on location. In Malawi, for example, total precipitation is expected to increase over the coming years. However, in southern parts of the country, where much of the rural population resides, precipitation is expected to decline. In Zambia, much of the country will likely see declining precipitation levels. However, portions of the central, northern, and eastern parts of the country may see increasing or unchanged rainfall.

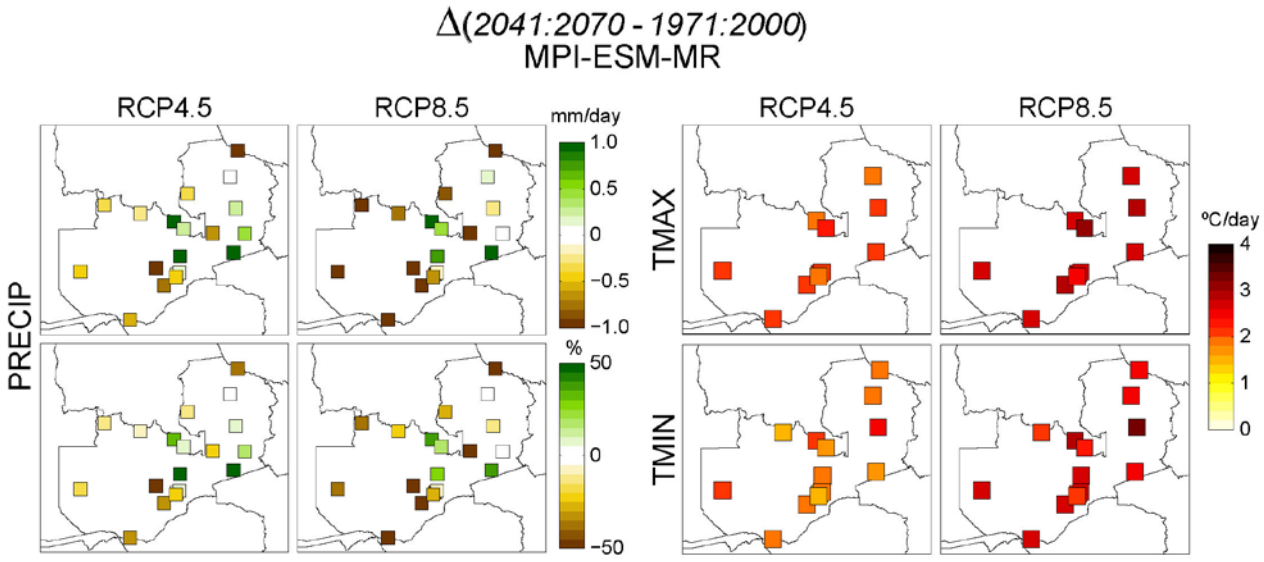
If distributed favourably, stable or increasing precipitation may produce benefits in terms of rain-fed crop production. In these areas investment to support crop intensification and improved market functioning can help countries to take advantage of these potential benefits. Conversely, in drying areas investments to enhance household resilience, including the promotion of improved livestock systems (see below), investments in irrigation infrastructure, and the development and promotion of more drought tolerant farm technologies and practices will be critical.

Figure 4. Projected changes of precipitation and temperature variables for the period 2041-2070 (with respect to 1971-2000), Malawi



Source: Authors' calculations.

Figure 5. Projected changes of precipitation and temperature variables for the period 2041-2070 (with respect to 1971-2000), Zambia



Source: Authors' calculations.

Strategies to enhance farmer's resilience to climate change

There are a number of farm practices and technologies that may help to build the resilience and productivity of smallholder farm systems in the context of climate change. These include sustainable intensification techniques, such as intercropping, minimum soil disturbance (MSD), and crop rotations, as well as strategies, such as crop and livelihood diversification. Socio-economic analysis can help shed light on the trends in adoption of these practices, the types of households that are likely to adopt them, and their effects on welfare.

What are the adoption trends for sustainable intensification practices?

Table 1 uses data collected from the same households at different periods of time to show the adoption dynamics for three important intensification practices: intercropping, MSD, and crop rotations. Of these, only intercropping is observed in both countries in all survey waves. Intercropping adoption dynamics are very different in Malawi and Zambia; in Malawi, 23 percent of the survey population was a consistent adopter of legume intercropping, whereas in Zambia only 1 percent of households were consistent adopters. . Zambia has seen an increase in intercropping between the two years, with 7 percent of the surveyed households adopting intercropping between 2012 and 2015, yet these new adopters are partially off-set by 3 percent of the surveyed households dis-adopting the practice over the same time period. By contrast, Malawi results show that 26 percent of surveyed households were new adopters of intercropping between 2011 and 2013, and 10 percent dis-adopted.

Pro-legume policy or lack thereof is one of the reasons for the difference in the rates of adoption (and dis-adoption) between the two countries. In Malawi, legume sector development is an important part of the country's Growth and Development Strategy (MGDS) II (2011-2016). To contribute to the sector's development, legume seeds are included in the country's input subsidy programme. Moreover, Malawi is a major exporter of pigeon peas and groundnuts. Conversely, in Zambia legumes have historically been a low policy priority (although this is now changing), with the country's subsidy programme focused almost exclusively on supporting access to maize inputs.

Table 1. Adoption and dis-adoption dynamics of practices in Zambia and Malawi

	Legume intercropping		MSD	Crop rotations
	Malawi 2011-2013	Zambia 2012-2015		
Never adopted	41	88	87	23
New adopter	26	7	20	19
Dis-adopter	10	3	2.9	18
Consistent adopter	23	1	0.1	40

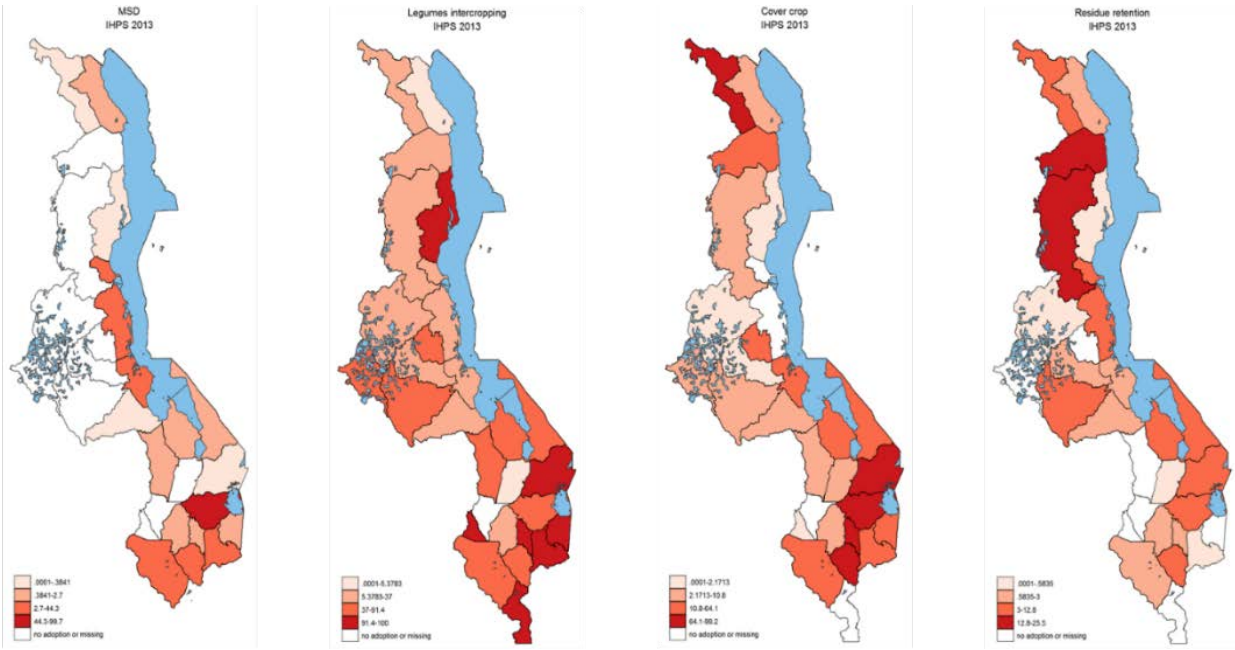
Source: RALS 2012 and 2015; IHPS 2011 and 2013.

Although the majority of farmers (87 percent) have not practiced MSD in the two survey years in Zambia this low adoption rate seems to be changing. Between 2012 and 2015, 20 percent of surveyed households were new adopters of MSD. This is an impressive rate of change, and is likely influenced by the government's policy focus on promoting MSD, and the numerous activities and projects promoting its adoption. Finally, crop rotation in Zambia are found to be relatively common, with 40 percent of households consistently practicing some form of rotation. However, there is very little evidence of change, with the rate of new adoption roughly equal to the rate of dis-adoption. This may be because crop rotation are difficult to sustain on small farms that often prioritize staple food production.

The geographic distribution of the adoption of sustainable intensification practices in Malawi and Zambia show several important patterns for consideration in developing polices to encourage adoption. In Malawi the adoption of MSD is concentrated in the south of the country, where precipitation levels are more erratic and population densities are higher (Figure 6). This is likely the result of a concentration of MSD promotion in those regions, as well as autonomous adoption by farmers to improve the climate resilience of their farms. Legume intercropping and the use of cover crops are also more concentrated in the south, although some adoption is observed in the central and northern regions. Conversely the highest rate of residue retention is observed in central and northern parts of the country, where land sizes are larger and population densities lower.

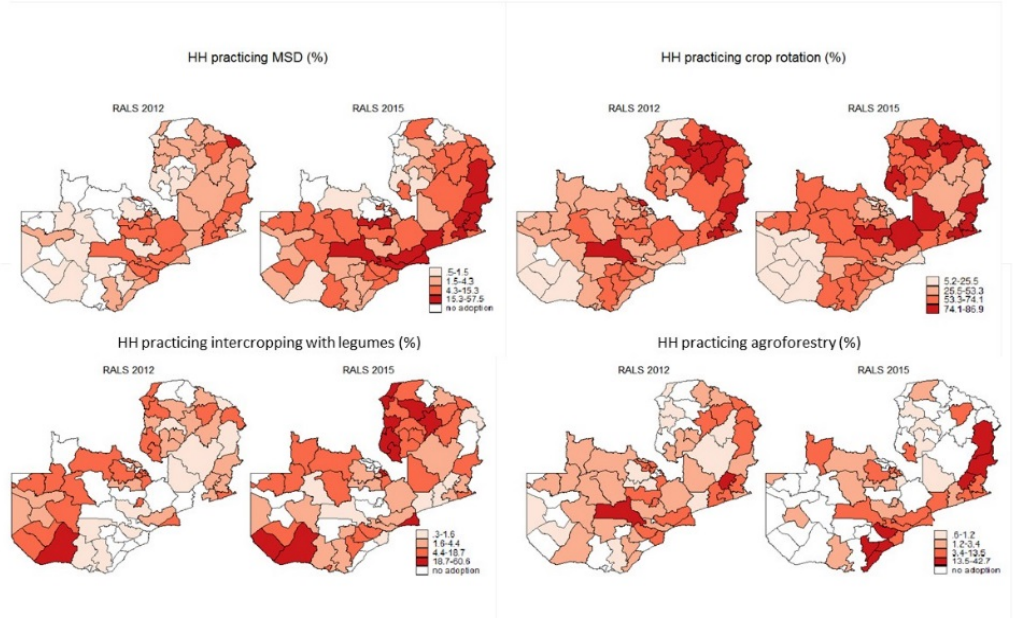
In Zambia adoption rates of MSD have expanded spatially in many parts of the country, with the greatest rates of adoption concentrated in Eastern and Central Provinces (Figure 7). Crop rotations and agro-forestry have also increased in these regions. This may be driven by the increased private investment in agricultural commodity markets in these regions, and the linking of extension services to crop purchasing.

Figure 6. Adoption of practices in Malawi



Source: Authors' elaboration based on IHPS 2013 data.

Figure 7. Adoption of practices in Zambia



Source: Authors' elaboration based on RALS 2012 and 2015 data.

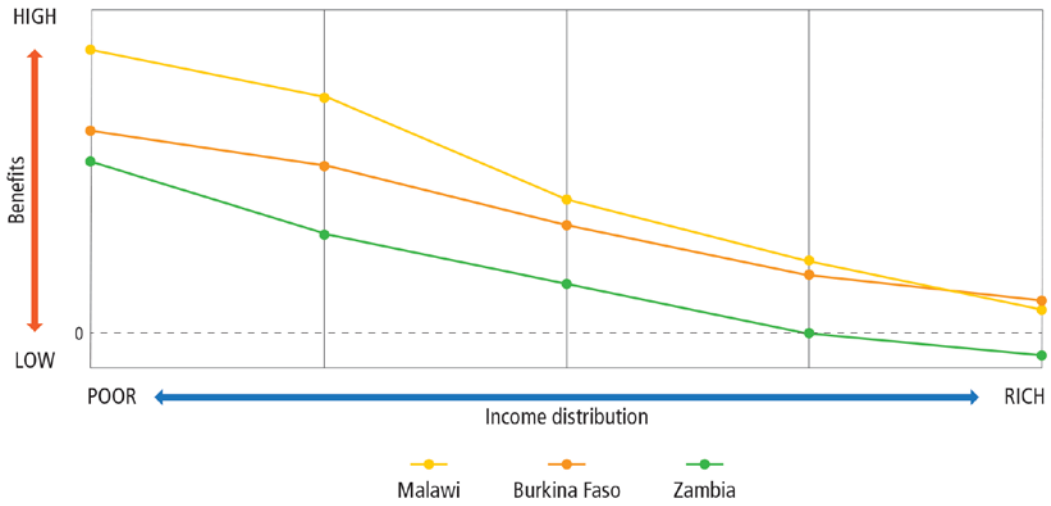
Crop and livelihood diversification

The diversification of crops and sources of income can help households to buffer the effects of climate change. Growing a diverse range of crops, with different growth cycles and tolerances, helps to minimize the chance that a single weather threat will impact the entire farming system. Diversification also helps households to minimize their exposure to financial risk due to market price fluctuations. Sources of income that are outside of the agricultural sector, can help to de-link households from climate change shocks.

Crop and income diversification are inversely and significantly associated with market access conditions. Households in more remote areas are significantly more likely to diversify their crop production. Yet, for these households, non-farm income opportunities are more limited. As a consequence, income diversification declines in areas further from established market centres. This may expose those households to greater risk of welfare loses when weather related shocks occur.

Both crop and income diversification are found to have a positive effect on households' per capita income. However, only income diversification is found to lower poverty levels. Moreover, the benefits of crop diversification are conditioned by household income status. In Zambia, Malawi, and Burkina Faso it is found that the effect of crop diversification on incomes is highest for poorer farms and lowest for better off farms. For better off farms, which typically have greater access to land, labour, and capital, crop specialization is often more welfare enhancing than diversification. Despite the potential significant gains from crop diversification, the poor households tend to diversify less.

Figure 8. Poor farmers have higher benefits from crop diversification



Source: Authors' calculations.

Enhancing crop productivity and climate change resilience: Diversification through green manure cover crops

Six green manures and grain legumes have been identified as being well adapted to the growing conditions in southern Africa. These species can be planted alone or as intercrops (i.e. cowpeas, velvet beans, pigeonpea, lablab, sunnhemp and jack bean). Data from 18 researcher-managed participatory on-farm trials and 300 farmer-led plots show that the use of green manures increased groundcover thereby reducing moisture loss, controlling weeds and increasing soil fertility, without dependency on mineral fertilizer. These species also suppressed crop pest and diseases, and increased human and animal nutrition. Most importantly, these benefits were achieved without compromising maize yields if green manure crops were established in a timely manner and well synchronized with maize production.

The green manure species included in the study have different attributes, which may make one more attractive than another depending on the local agro-ecology and farmer preferences. For example, grain legumes such as pigeonpea can provide an immediate cash return through grain sales, while crops such as lablab (Figure 9) provide more groundcover, and thus can reduce weeding burden. Extension messages to promote the use of green manure should highlight the different attributes of alternative species to support farmers in selecting the species that best fits their adaptation needs and preferences. In addition to information on the use of green manures, seed availability is also important for adoption. Simultaneous public support for tailored extension messages on the use of green manures, combined with support for seed multiplication is critical for scaling up adoption.

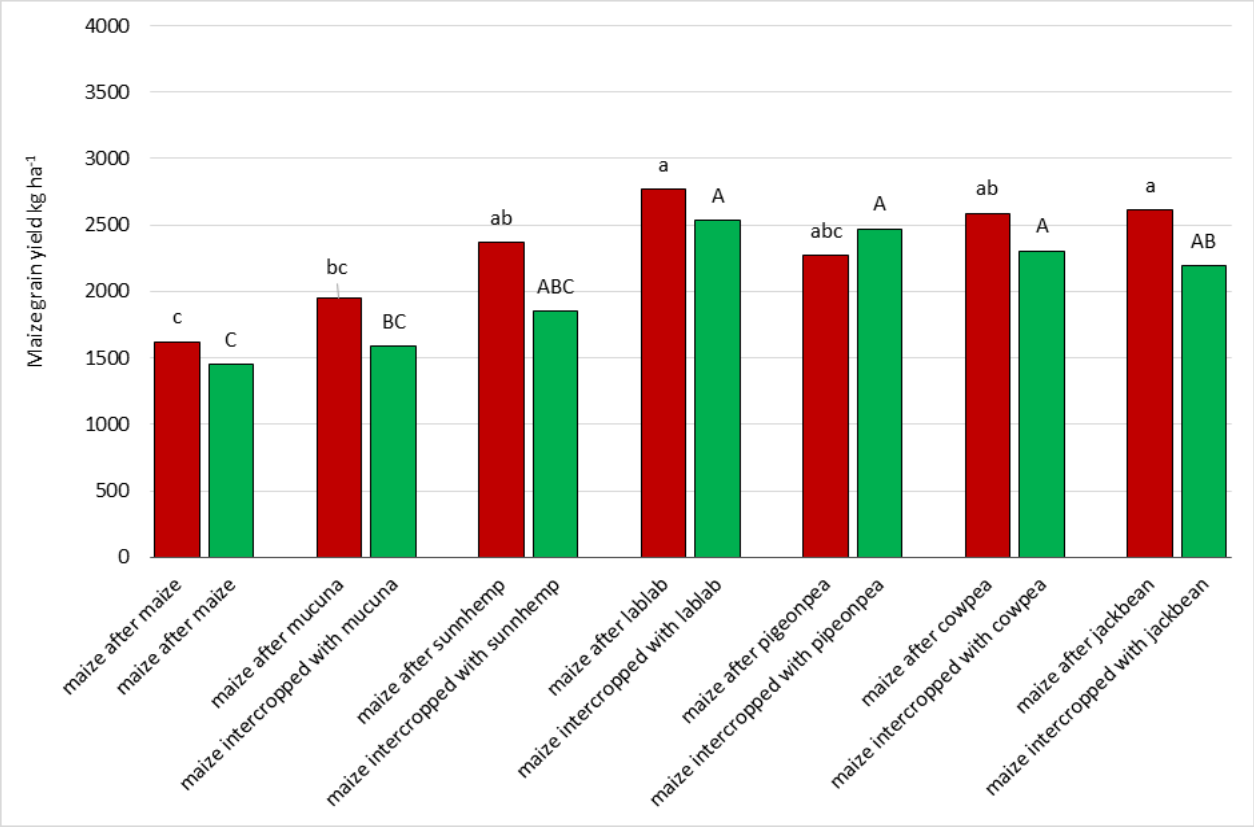
How farmers incorporated green manure crops into farm systems was found to be a function of land size. For land abundant farms, full rotation of green manures with maize is feasible. However, for more land-constrained households, which make up the majority of farming households in Zambia and Malawi, intercropping is the preferred planting method, as it makes greater use of scarce land resources.

Figure 9. Maize Lablab Intercrop System

The benefits to maize yields of using green manure vary depending on planting method and the species used. As shown in Figure 10, maize yield response to green manures in Chipata, Zambia were higher for rotations than intercrops for all green manures, except pigeonpeas, which performed very well in intercropped systems without yield penalty.

Source: Photo taken during field trials in Chipata, Zambia.

Figure 10. Response of maize to green manures and cover crops in the second year of practice, Chiparamba, Chipata, Zambia, 2015–2016

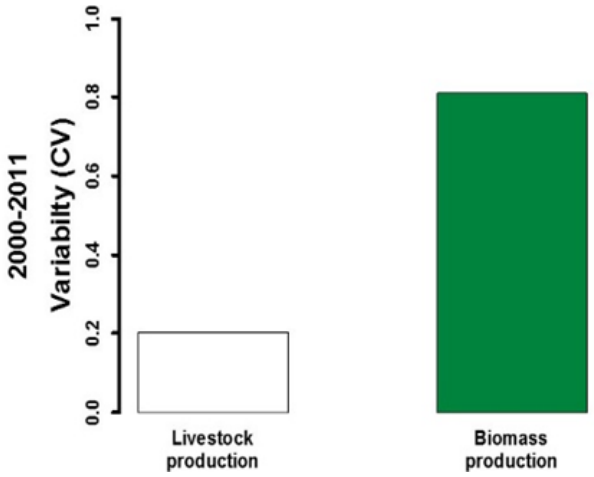


Source: Authors' calculations.
Note: means followed by a different letter in column are significantly different at P<0.05 probability level.

Building resilience and capturing mitigation benefits through improved livestock management

Ruminant livestock can serve as an important option for helping rural households to lower their vulnerability to climate change. While climate change may lower livestock productivity, through the effects on fertility, disease prevalence and forage availability, the sensitivity of livestock to rainfall-related shocks is lower than for crop systems. Livestock mobility also provides another means of avoiding climate changes stresses. Figure 10 shows that in Zambia over the period 2001 to 2011, biomass productivity, including natural vegetation and crops, exhibited a coefficient of variation (CV) of 0.80. By comparison, livestock production (energy content of feed rations used as proxy) over the same period was substantially less variable, with a CV 0.20. This difference is due to the ability of livestock to make use of a range of natural vegetation types and crop residues as feed sources. It is estimated that livestock in Zambia and Malawi acquire 67 to 93 percent of their total dry matter from browsing natural vegetation, and 7 to 27 percent from crop residues. If crop biomass production is low due to drought or flooding, livestock farmers can replace part of the missing forage by using alternative sources, including natural vegetation, leading to more stability in production.

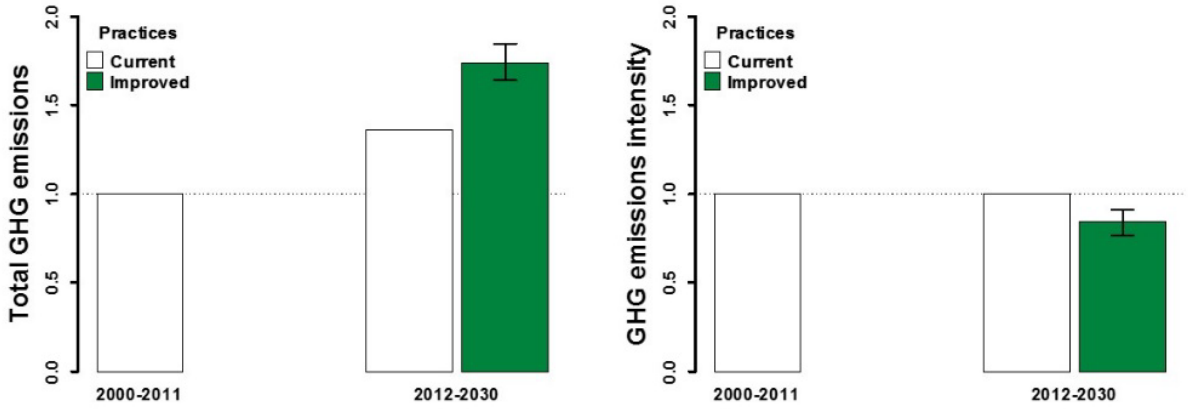
Figure 10. Inter-annual variability (coefficient of variation) of livestock production (GLEAM) and biomass production in Zambia)



Source: FAO-Global Livestock Environmental Assessment Model (GLEAM), ESA-Copernicus Global Land service.

Improved livestock management can also contribute to a reduction in the GHG emission intensity from livestock. As shown in Figure 11, absolute GHG emissions are expected to increase in the future due to the growth of the sector in Zambia, and improved livestock management could actually lead to more emissions too since they would improve fertility. However, the quantities of GHG emitted per unit of livestock output (intensity) is substantially lower with improved practices. Given the current demand growth for livestock products in the region, adoption of improved management will be critical for countries to simultaneously meet their Nationally Determined Contributions (NDCs) for GHG mitigation and keep pace with increasing demand for livestock products.

Figure 11. Impact of improved livestock practices on GHG emissions and emission per unit of product



Source: FAO-Global Livestock Environmental Assessment Model (GLEAM), ESA-Copernicus Global Land service.

ECONOMICS AND POLICY INNOVATIONS FOR CLIMATE-SMART AGRICULTURE [EPIC]

The Economic and Policy Innovation for Climate-Smart Agriculture Change (EPIC) programme works with governments, research centres, universities and other institutional partners, and applies sound economic and policy analysis techniques, to support the transition to a more productive and resilient food system in the context of climate change.

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