Food and Agriculture Organization of the United Nations

Zambia

Cropping systems diversification to enhance productivity and adaptation to climate change in Zambia

BRINGING TOGETHER EVIDENCE AND POLICY INSIGHTS

KEY MESSAGES

- **Spatial disconnect between cropping system diversification and climate risk.** In Zambia, farmers residing in areas with low and medium rainfall risk are more likely to adopt diversified systems than farmers in areas with lower rainfall and greater rainfall variability. Lack of diversification in high risk regions poses a significant threat to livelihood resilience in those regions.
- **Diverse cropping systems improve productivity and resilience.** Increased level of diversification is associated to more stable crop income, when compared to maize monocropping. However, farmers facing land fragmentation, weakness of private input and output markets and uncertainty from the public policies are less likely to adopt these systems.
- **Strengthen investment in the private input and output markets.** Competitive input and output markets is an important driver of diversification in Zambia. Identifying policy options to improve private market conditions, such as improved predictability of agricultural trade policy and promoting stable macro-economic conditions, can help support Zambia's diversification objectives.
- **Secure land tenure and land access.** Farmers adopting cropping systems of three or more crops hold, on average, 2 hectares of land more than farmers adopting two-crop or monocropping systems in the same areas. Land policies that support farmers' access to land, now and in the future, is a critical element of crop diversification.

ECONOMIC AND POLICY ANALYSIS OF CLIMATE CHANGE ◀ EPIC

Introduction

The National Agriculture Investment Plan for Zambia (NAIP) 2014–2018 has the objective of developing a sustainable, dynamic and diversified agricultural sector to ensure households' food security and maximize agricultural sector's contribution to gross domestic product (GDP). Cropping system diversification has the potential to enhance agricultural productivity and sustain the agricultural production resilience to weather and market fluctuations. However, cropping system diversification is not uniformly beneficial. The impact of a particular cropping system on farmers' welfare and farm productivity depends on the agronomic and market attributes of the crops that comprise the system and on their interactive effect. For example, some alternative staple crops, such as cassava, are particularly drought-tolerant and thus support the resilience of the cropping system, but often are poorly commercialized and mostly consumed within the household. Other crops, such as legumes, can fix atmospheric nitrogen and confer agronomic benefits to the soil, thus bringing benefits to other crops in the systems. Alternatively, cash crop production can produce higher returns, especially when farmers access to competitive output markets with favorable prices. However, their prices can be highly volatile due to fluctuations in international markets or to uncertainty associated to national policies. Under certain circumstances, diversification into these crops can expose households to considerable risk and lead to a potential deterioration of household's welfare.

Understanding the impact of different cropping systems on household welfare and productivity and the key socio-economic drivers of adopting different systems is necessary to Identifying policies and cost-effective investment options to support beneficial crop diversification that can contribute to the development objectives articulated in the NAIP. To this end, this brief provides empirically-based insights to help identify and prioritize policies and investments that can increase the benefits from cropping system diversification in terms of profitability and resilience of the agricultural production at a local level. Specifically, the brief focuses on a set of smallholder maize producers and identifies appropriate policies options based on the analysis of: a) the factors that influence the adoption of relatively more profitable and resilient cropping systems conditional on the local agro-ecological conditions; and b) the effects of adopting different cropping systems on maize productivity and crop income volatility.

Defining and analysing cropping systems in Zambia

The brief focuses on seven different cropping systems, which are based on combinations of four categories of crops: 1) dominate staple (maize); 2) alternative staple (e.g. cassava, millet, sorghum, rice, sweet and Irish potato); 3) legumes (e.g. groundnuts, soya beans, mixed beans, cowpeas), and 4) cash-crops (e.g. cotton, tobacco, sunflower, coffee, paprika, sugarcane, sesame). The analysis uses the Rural Agricultural Livelihood Survey (RALS), which gathered information on a set of individual-, field-, and community-level characteristics from more than 5 000 households observed during the agricultural seasons 2011/2012 and 2013/2014. Drawing on these data, a multinomial endogenous treatment effect econometric model is used to estimate the effects of each of these seven systems on household maize productivity and crop income volatility (relative to maize monocropping), as well as the key socio-economic, institutional, and biophysical factors that push or pull a farm to adopt a particular cropping system.

Key findings

In Zambia, about 27 percent of the farmers adopt a three-crop system comprised of maize, with a legume, typically groundnuts, and an alternative staple food, such as cassava (see Table 1). This system is primarily concentrated in the northern and northwestern parts of Zambia, and is associated with relatively high levels of productivity and input use. In total, 27 percent of maize producers grow cash crops under three different cropping systems (maize-cash crop, maize-cash crop-legume, and maize-cash crop-legume-alternative staple). Farmers in these systems have high levels of access to credit, but do not necessarily have adoption rates for fertilizer or higher average maize yield. One interesting pattern in Zambia is that cropping systems that include legumes have higher average maize yields than systems without, suggesting legume cultivation can confer yield benefits for maize producers in Zambia.

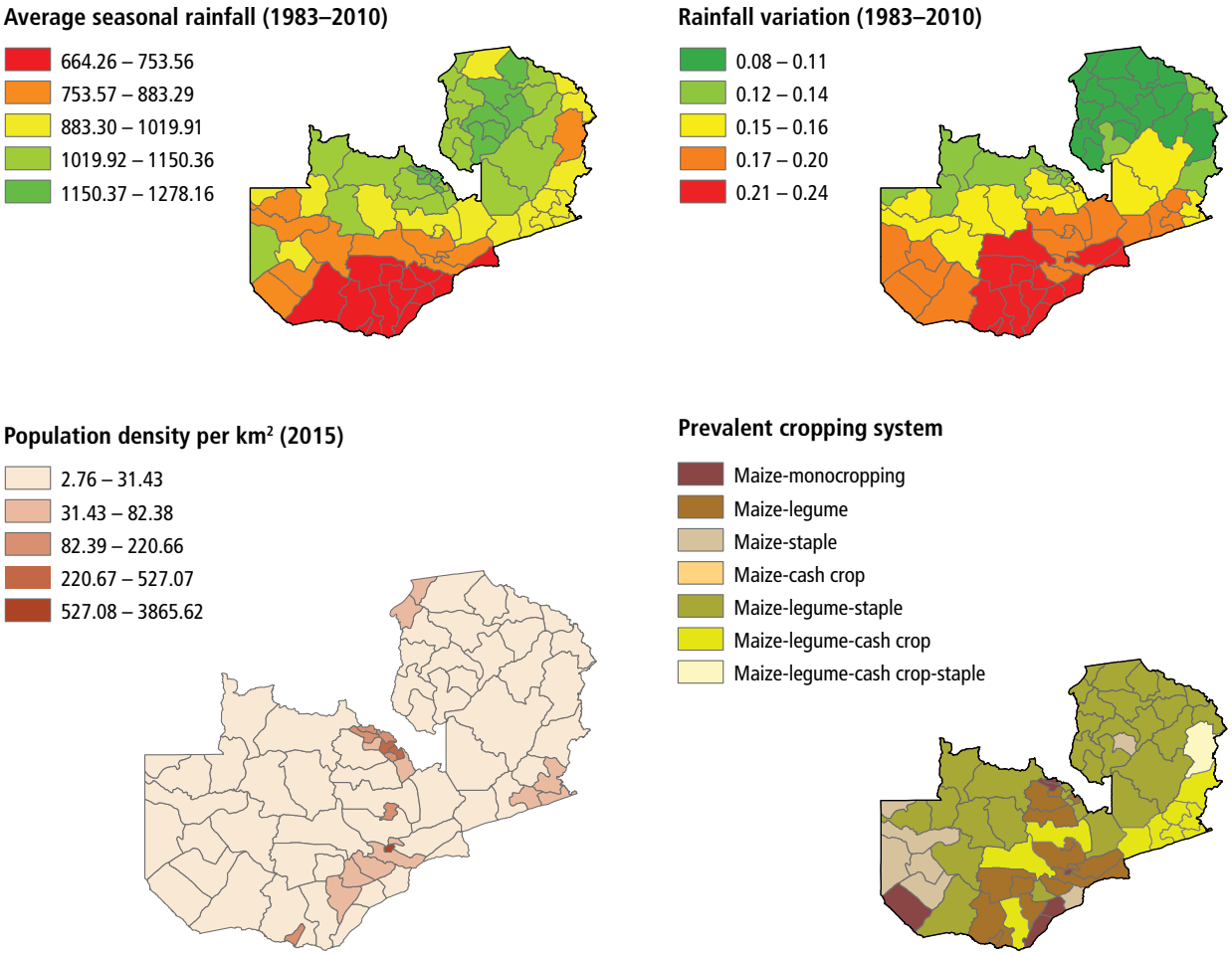
In Zambia there is a worrisome spatial disconnection between the dominant cropping systems and the level of weather-related risk. As shown in Figure 1, in the north and north-western of the country, the prevalent system is a three-crop system comprising maize with legume, typically groundnuts, and an alternative staple food, frequently cassava. These areas observe consistent rainfalls and have lower population densities compared to the rest of the country. The southern provinces observes higher land fragmentation, due to high population density, and more rainfall volatility. Yet, despite the potential benefits of diversification on

reducing climate risk exposure, farmers in these zones frequently adopt maize mono-cropping or two-crop systems based on a combination of maize and legume or maize and an alternative staple crop.

TABLE 1 **CROPPING SYSTEMS: ADOPTION RATES, CREDIT AND INPUT ACCESS, AND MAIZE YIELD**

Cropping system	Adopters	Credit recipients	Inorganic fertilizer adopters	Maize yield
Maize monocropping	14.3%	6%	64%	2 096
Maize-legume	19.3%	7%	72%	2 309
Maize-staple	12.3%	4%	45%	1 769
Maize-cash crop	5.8%	57%	59%	2 086
Maize-legume-staple	26.9%	6%	75%	2 595
Maize-legume-cash crop	17.3%	56%	75%	2 482
Maize-legume-cash crop-staple	4%	37%	77%	2 638

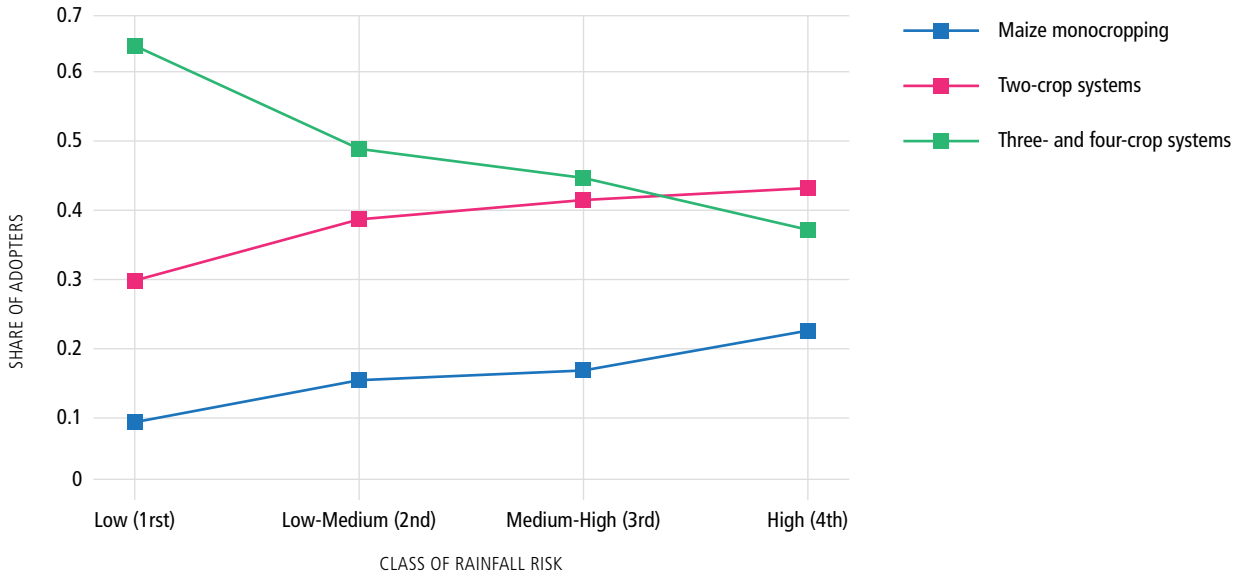
FIGURE 1 **CROPPING SYSTEMS ARE SPATIALLY DISCONNECTED TO THE AGRO-ECOLOGICAL AND SOCIO-ECONOMIC SOURCES OF RISK**



Source: FAO, Economic and Policy Analysis of Climate Change (EPIC) team.

Indeed, in Zambia higher rainfall risk is strongly associated with lower level of diversification (see Figure 2). The share of farmers adopting three- and four-crop systems is higher in areas with low and medium rainfall risk than in other areas. On average, 63 percent of farmers in areas with low and medium rainfall volatility adopt highly diversified systems, but this value decreases to just 26 percent in the highest risk areas. In contrast, the percentage of farmers growing maize in monocrop increases from 7 percent in low rainfall risk regions to 21 percent high risk areas. Similarly, while only 28 percent of households adopt two-crop systems in low and medium-risk zones, this percentage increase to 42 percent for the highest level of rainfall risk.

FIGURE 2 **FARMERS ARE ADOPTING MORE VULNERABLE SYSTEMS FOR HIGHER CLASSES OF RAINFALL RISK**

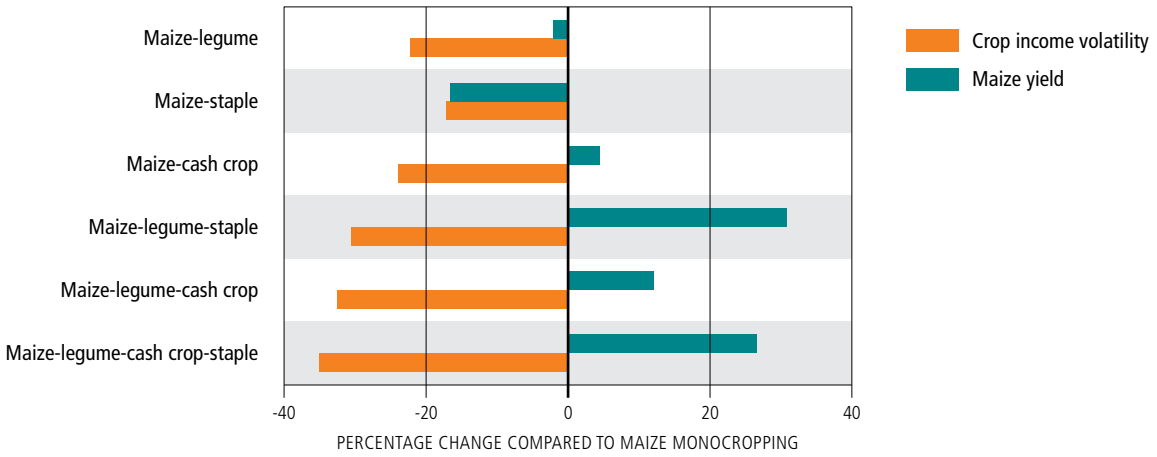


Source: FAO, Economic and Policy Analysis of Climate Change (EPIC) team.

Since farmers more exposed to climatic and socio-economic risk are also likely to diversify less, the main policy challenge in Zambia is to understand how to incentivize these constrained and risk-exposed farmers to shift to more diversified cropping systems by reducing their barriers to adoption. The empirical analysis shows that a combination of low levels of household resources, weakness of private input and output markets and uncertainty from the public policies, limit farmers ability to diversify. In terms of household resources, larger land holdings strongly affect diversification out of maize monocropping. For example, in high rainfall risk regions farmers adopting cropping systems of three and four crops hold on average 2 hectares of land more than farmers adopting two-crop or monocropping systems. This suggests that addressing household constraints in land access to is critical to achieve adoption of diversified cropping systems.

Functional and competitive private input and output markets represent two other important determinants for diversification. Farmers observing higher prices for maize seeds, for example, are less likely to adopt systems based two, three and four crops. This finding suggests that farmers prioritize maize over other staples: as real budgets decrease due to higher maize prices, smallholders reduce their investment into alternative staple crops. Also, the presence of more private grain buyers, a proxy of output market competitiveness, pull farmers towards the adoption of more diversified systems. Conversely, proximity to parastatal marketing boards, which acquire maize from individual farmers and cooperatives at a pan-territorial indicative prices, discourages cropping system diversification. For example, as the distance from a Food Reserve Agency (FRA) depot increases, the probability of adopting three- and four-crop systems increases significantly, all else equal. These systems are associated with a significant increase in maize productivity and with a reduction of crop income volatility (Figure 3). It is important, therefore, that policy-makers consider the impact of public marketing boards in the light of the local effects on farmers' diversification. In terms of income resilience, increased level of diversification is associated to more stable crop income, when compared to maize monocropping.

FIGURE 3 **ASSESSING THE IMPACT OF CROPPING SYSTEMS ON MAIZE PRODUCTIVITY AND CROP INCOME VOLATILITY**



Notes: The figure reports the result from the empirical analysis, and * denotes significant statistical impact.
Source: FAO, Economic and Policy Analysis of Climate Change (EPIC) team.

Policy options for consideration

What are the steps that policy-makers can take to increase the level of cropping system diversification in regions where this can effectively contribute to productivity and income stabilization? The above findings support the following three recommendations:

- Strengthen investment in the private input and output markets.
- Expand land access and secure land tenure in urban areas.
- Encourage seed market intensification.

Strengthening investment in the private input and output markets

Strengthening private output and input markets is critical for promoting crop diversification in Zambia. Policy-makers can support agricultural market development in several ways. First, improving the predictability of agricultural trade policy and promoting stable macro-economic conditions is considered a priority for stimulating greater private investment in agricultural markets. Actions to restrict agricultural trade, when necessary, should be implemented in an orderly and predicable fashion, based on predetermined consumer and farm gate price thresholds.

Second, the government should carefully consider any intervention that could indirectly distort farmers' incentive to diversify. In particular, the dual functions of the government's Food Reserve Agency (FRA), which manages the country's national grain reserve and supports maize market development, induces households to reduce diversification, and thus has a regressive effect on welfare. Restricting the role of the FRA to its food reserve function, while exploring options to lessen the need to hold large physical stocks of maize should be considered as part of a crop diversification agenda in Zambia.

Finally, the objective of crop diversification should be more explicitly integrated in the on-going reforms to the Farm Input Subsidy Programme (FISP). Reforms of the current e-voucher system are already supporting diversification by crowding-in more private-sector participation in the input distribution, allowing farmers to choose inputs of their choice, and to track input demand at local level. However, these vouchers can be enhanced by improving coordination with agro suppliers, to ensure that a greater diversity of seeds and other inputs are available in private markets, and providing pre-planting extension advice to voucher recipients on recommended varieties and crop choices based on forecasted seasonal weather conditions and available market intelligence.

Improve land administration to enhance tenure security

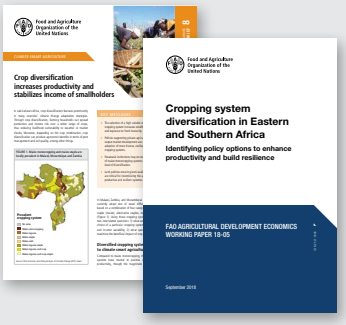
Adoption of diversified cropping systems is fundamentally associated to large land-holdings in Zambia. Land policy, and its effects on land access and land fragmentation, must, therefore, be considered part of any crop diversification agenda. The dual land administration systems in Zambia enables the conversion of customary land to statutory leasehold land. While the majority of smallholder farmers access land under customary tenure, there is significant pressure from local and foreign investors to grant individual leaseholds on customary land. This pressure is particularly acute in areas in close proximity to urban settlements. Partially as a result of the conversion of customary land to statutory leasehold, land scarcity is an increasing

concern in parts of Zambia. Recent estimates suggest that 54 percent of smallholders in Zambia claim that customary authorities no longer have land to allocate to local residents and only 51–54 percent of arable land remains under customary control. Improving the ability of smallholders to secure their current landholdings and to limit conversion of customary land to statutory tenure where land access is currently constrained should be considered in order to support a long-term diversification agenda among smallholders.

Encourage seed market intensification

Access to a diverse range of seeds at favorable prices remains a necessary condition for cropping system diversification. In Zambia, markets for certified seeds are well advanced compared to the rest of the region. The industry observes the participation of private sector actors and other public stakeholders organized around the Zambia Agriculture Research Institute (ZARI). Many seed companies control the entire chain of their production, from the breeding to commercialization, thus developing their own foundation seeds used to produce the marketed certified seeds. Yet, these investments are particularly concentrated in maize and soy seed varieties developed for the commercial farming sector. Policy support is needed to improve incentives for companies to invest in suitable varieties for smallholder production systems, including improved legume seed varieties and short duration or open pollinating maize varieties. Policy-makers may envisage modification to the FISP that improve companies' ability to forecast demand for a diverse range of non-maize seeds and short duration or drought tolerant maize varieties. This should be combined with conditional lending or other financial mechanism to encourage more investment supply chains for these seeds, in order to improve the diversity of seeds on the private market and their suitability for smallholder rain-fed production systems.

This brief is prepared by Nicholas Sitko (Programme Coordinator of the Economic and Policy Analysis of Climate Change (EPIC) team, FAO) and Giuseppe Maggio (EPIC Consultant, FAO). It builds on the FAO Agricultural Development Economics Working Paper 18-05 *Cropping system diversification in Eastern and Southern Africa: Identifying policy options to enhance productivity and build resilience* (available at www.fao.org/3/ca1562en/CA1562EN.pdf) and the related FAO Agricultural Development Economics Policy Brief 8 *Crop diversification increases productivity and stabilizes income of smallholders* (available at www.fao.org/3/i9458en/I9458EN.pdf).



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