Food and Agriculture Organization
of the United Nations

Supporting climate adaptation in smallholder agriculture

SUMMARIZING LESSONS LEARNT

KEY MESSAGES

- Adoption of climate adaptive practices and technologies in smallholder systems is typically hindered by their costs, small and uncertain benefits under normal weather conditions, and a lack of household resources.
- Investments towards the development and dissemination of appropriate technologies and practices are critical for smallholders, but insufficient to achieve widespread adoption.
- Holistic and multi-sectoral approaches that enable farmers to manage the costs and risks of adopting new practices and technologies are required.

IDENTIFYING STRATEGIES AND POLICIES FOR EFFECTIVE CLIMATE CHANGE ADAPTATION IN SMALLHOLDER FARM HOUSEHOLDS

Supporting smallholder farmers to adapt to climate change is essential for achieving Sustainable Development Goals 1 (No poverty) and 2 (Zero hunger). This will require policies and programmes that enable farmers with few resources to adopt farm practices and technologies that reduce sensitivity to rising temperatures, the spread of new pests and diseases, and increasingly erratic rainfall. This brief consolidates evidence and stylized facts to guide policy discussions on climate adaptation in smallholder agriculture, based on work carried out by the Economic and Policy Analysis of Climate Change team (EPIC) of the Food and Agricultural Organization of the United Nations.

Human activities are profoundly altering the global climate, leading to rising temperatures and increasing likelihood of severe weather. While dramatic reductions in emissions can help to mitigate the severity of climate change, the persistence of greenhouse gases (GHG) in the atmosphere ensures that warming above pre-industrialized levels will continue for centuries to come. Adapting to a changing climate is critical.

Nowhere are the needs for climate adaptation more pressing than in the agriculture sector. Not only does the production of agriculture rely directly on weather and associated biological processes, but the people who are directly involved in agriculture are also some of the most economically vulnerable in the world. Of the 736 million people in the world who live in extreme poverty, it is estimated that 80 percent live in rural areas, relying on agricultural production and related activities for their livelihoods (FAO, IFAD, UNICEF, WFP and WHO, 2019). As a result, many agriculture-dependent people lack the economic resources, and associated access to markets and services, needed to cope with and manage the risks posed by climate change.

Why are investments in climate change adaptation difficult for smallholders?

Despite significant efforts to develop farm management practices and technologies to support greater climate adaptation among smallholder farmers, in much of the world they are not widely adopted by farmers and, when they are, adoption tends to be partial and dis-adoption frequent. Understanding the factors driving this phenomenon is critical to develop more effective climate adaptation policies and programmes.

There are three key constraints that hinder the adoption and sustained adoption of climate adaptive practices and technologies (CAPTs) in the context of smallholder farming systems: i) adoption related costs; ii) low and uncertain benefits of CAPTs; and iii) a lack of household resources.

Costs associated with adoptions of CAPTs may be prohibitive

The adoption of any new practice or technology entails various costs. Those can be **direct costs**, such as new equipment purchases or investments in new plant or animal genetics, and **opportunity costs** associated with changes in how land, labour and capital are used. For resource-poor smallholder farmers, these costs can be both financially prohibitive and highly risky to take on. For example, in Malawi, a cost–benefit analysis of different CAPT scenarios shows that the direct upfront costs of adopting these scenarios are 38 to 84 percent higher than conventional farming practices (Ignaciuk, Maggio and Sitko, forthcoming). In the latter case, the adoption costs are roughly equivalent to the average annual income of a farm household in Malawi.

In Sri Lanka, adoption of CAPTs in the rice sector involves high opportunity costs, particularly related to household labour (Bandara *et al*., 2020). Many CAPTs are labour intensive. In Sri Lanka, where off-farm income makes up a large share of farmers income, allocating more labour to the adoption of CAPTs can contribute to a reduction in off-farm income earnings. Thus, while the adoption of CAPTs can help to reduce the risks to agricultural production posed by climate change, this benefit may not translate into improved household income. Indeed, based on an analysis of 11 CAPTs in Sri Lanka, results show that only one practice (improved crop residue management) is associated with an increase in total household income.

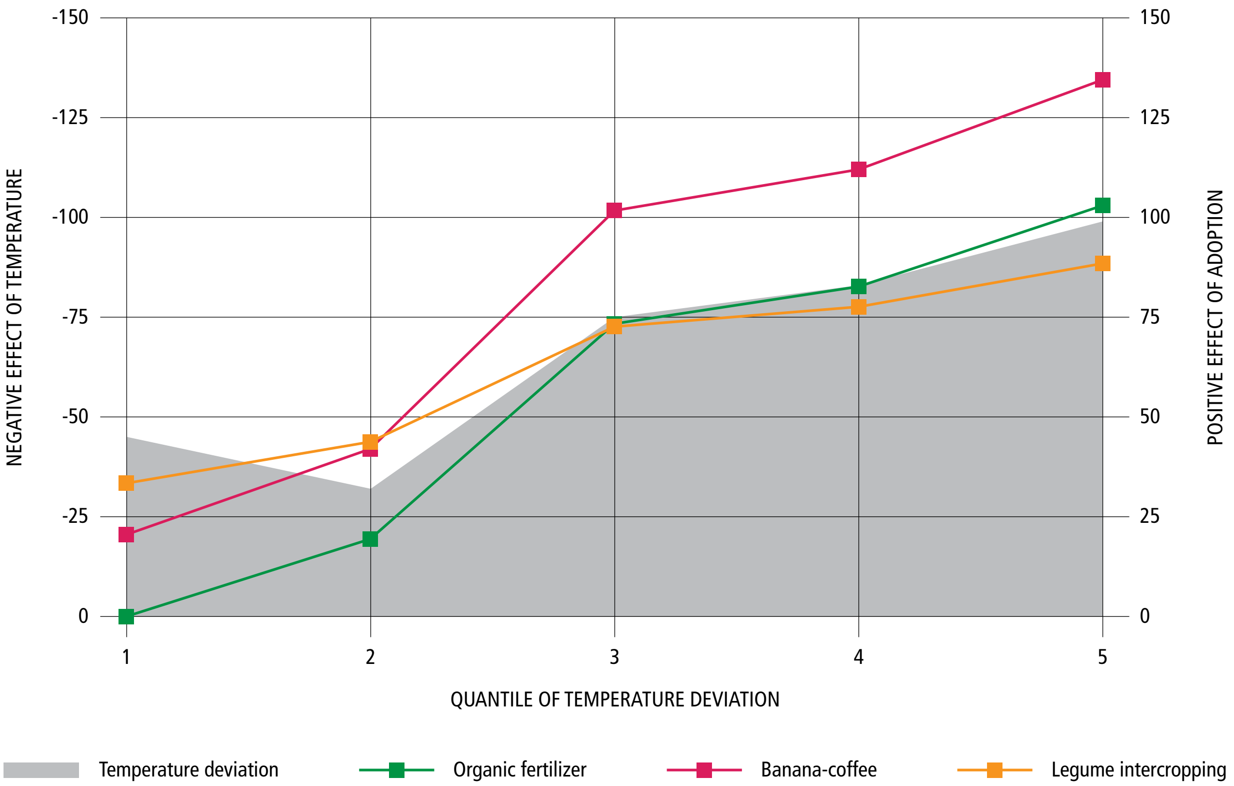
Food insecure farmers have myopic preferences

The benefits of adopting many CAPTs may be relatively **low in monetary terms**. In addition, they **may be only apparent after multiple years of adoption or under weather shock conditions**. For example, in Malawi the adoption of CAPT scenarios in maize and mixed crop systems generates greater net present values (NPV) over a 15-year time period than conventional farming practices. However, in monetary terms, this amounts to only an additional USD 68, discounted over 15 years. Given the costs and risks of changing farm practices, these positive returns are likely insufficient to prompt large segments of the population to adopt them.

The benefits of adopting many CAPTs frequently take time to accrue, as many CAPTs seek to improve climate resilience through enhancements in biological processes, such as building up soil organic matter or integrating trees into farm systems. New practices also take time to learn and perfect. In both cases, **there is a short-term risk of yield losses during the transition period and considerable uncertainty about longer term benefits**. For food insecure households, the risk of yield loss, even a modest one, is a significant barrier to adopting CAPTs.

Uncertainty over the benefits of adopting CAPTs is also a major barrier for smallholders. For example, in Uganda, positive impacts from adopting CAPTs on farmers' income are highest when temperatures during the farming season deviated substantially from their long-term averages (Figure 1) (Ignaciuk *et al*., forthcoming a). Under relatively normal conditions (i.e. temperatures close to their 30-year averages), the impacts of adopting the practices are modest and, in some cases, not significantly different from conventional approaches. While it is reassuring to know that these practices are effective at managing climate risks, a lack of substantial gains from adoption under normal conditions, combined with their direct and indirect costs, limits farmers' willingness to adopt.

FIGURE 1 **RETURNS FROM ADOPTION INCREASES MONOTONICALLY UNDER HIGH TEMPERATURE SCENARIOS AND COMPENSATE THE NEGATIVE EFFECTS OF TEMPERATURE SHOCKS**



Source: Authors' own elaboration.

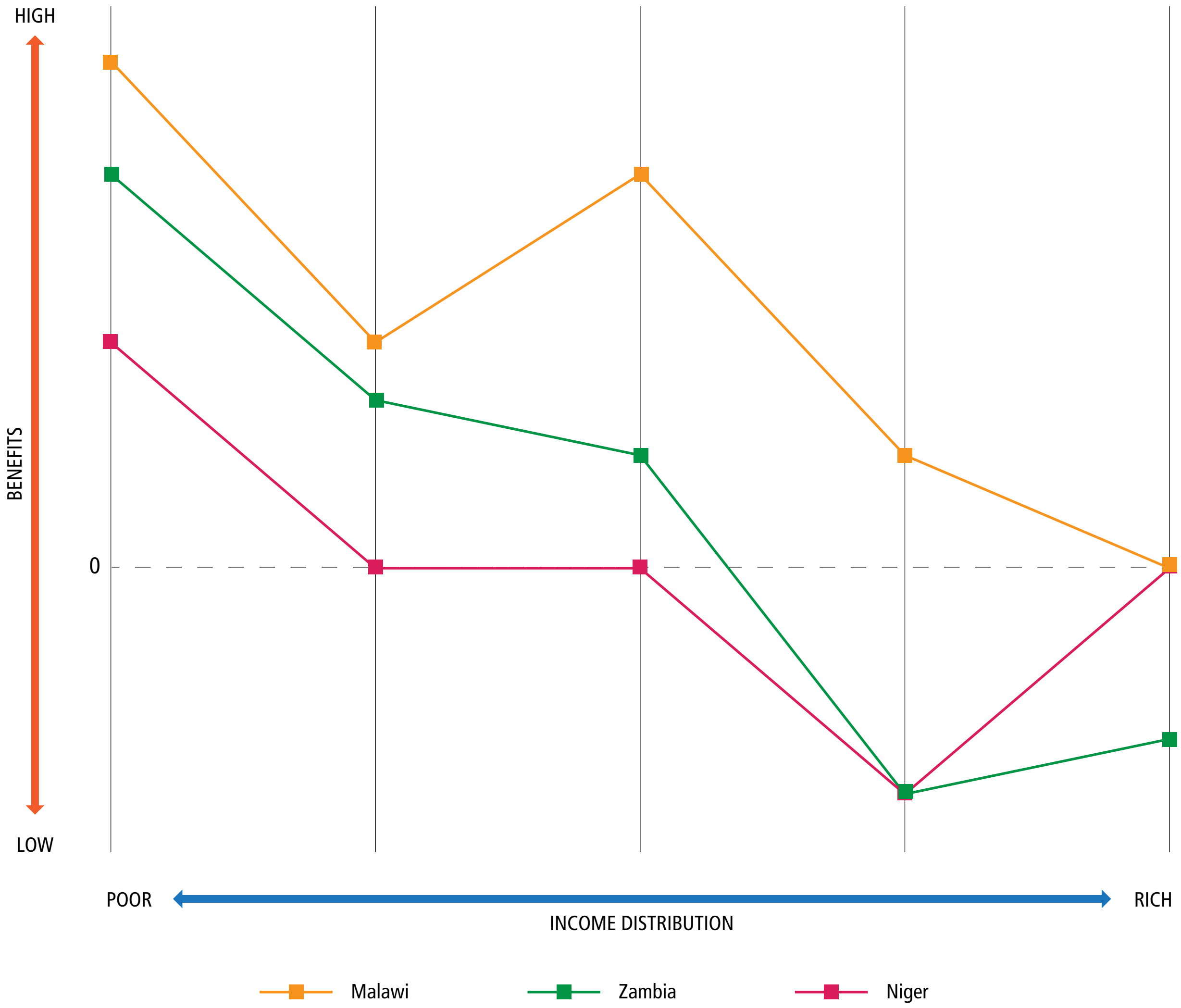
In Malawi, the adoption of soil water conservation structures actually has a negative effect on maize yields in the first year of adoption. However, after two years of adoption, positive impacts are found under average and below average rainfall conditions. Similarly, in Uganda, the benefits of adopting different CAPTs are low in the initial years but increase by 35 to 56 percent for each additional year a farmer adopts. Without long programmatic timelines and specific modalities to support farmers to adopt and sustain adoption of CAPTs over multiple years, farmers will be unlikely to sustain adoption of CAPTs long enough to realize their benefits.

Lack of resources for initial investments impedes adoption

Managing the costs and risks associated with adopting CAPTs requires resources. This is particularly the case in many smallholder contexts, where formal markets for credit and insurance are missing or incomplete.

Analysis consistently shows that proxies for wealth, such as land size and agricultural assets, are associated with the adoption of CAPTs. Households with the fewest resources, therefore, face the greatest constraints to adopting CAPTs, leaving them trapped in a vicious cycle of climate vulnerability that is difficult to escape. That said, those with the fewest resources also benefit the most from adopting CAPTs, because they are often the most reliant on agriculture for their incomes and have fewer formal and informal tools to manage climate risks outside of agriculture. In Niger, Malawi and Zambia, for example, a 1 percent increase in the level of crop diversification among the lowest income group increases total income by nearly a percent (Figure 2) (Asfaw *et al.*, 2019)). For wealthier segments of the population, crop diversification has no effect on, or in the case of Zambia actually leads to a reduction of, total income. **Developing specific strategies to address the resource and financial constraints of poor households is critical to achieve widespread adoption of CAPTs and to generate substantial welfare benefits for farmers**.

FIGURE 2 **POOR FARMERS BENEFIT THE MOST FROM CROP DIVERSIFICATION**



Source: Authors' own elaboration.

Enabling adoption of climate adaptive agriculture through holistic and multi-sectoral approaches

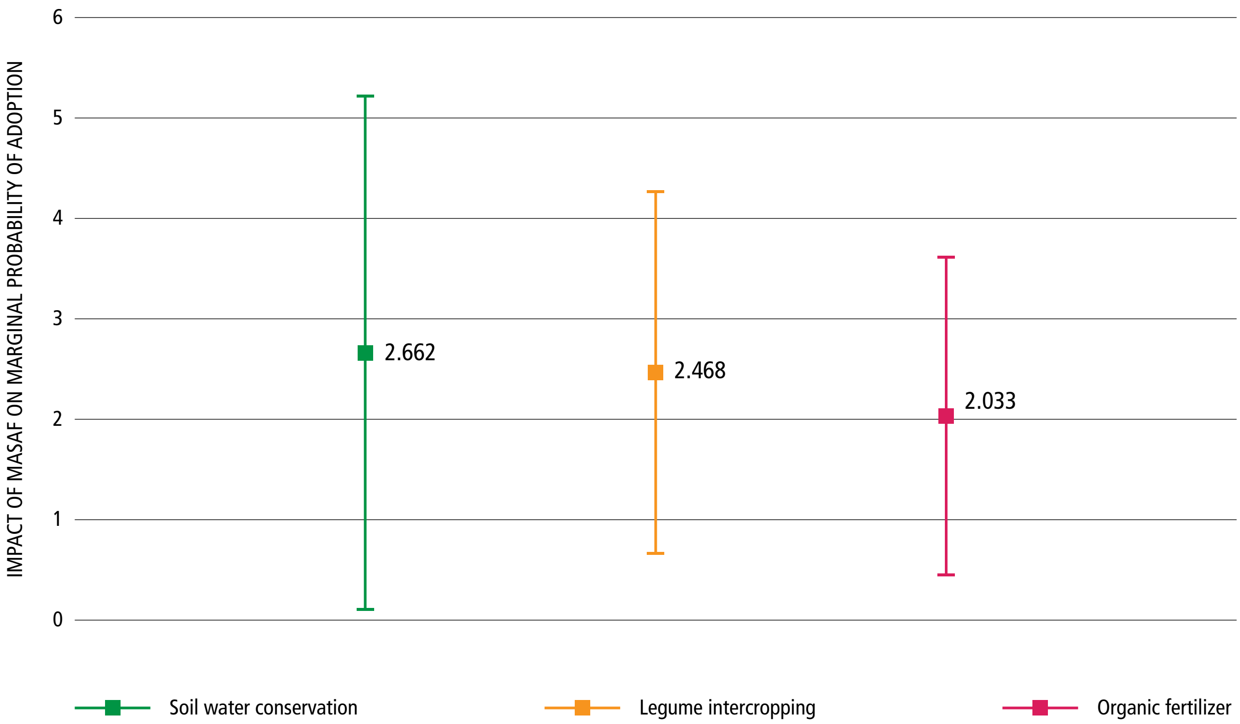
Developing context appropriate CAPTs and disseminating them to farmers through information campaigns is necessary but insufficient to achieve sustained and widespread adoption. A holistic policy and programmatic approach, which integrates information dissemination on CAPTs with other policy mechanisms designed to address the liquidity, resource and risk constraints faced by farmers, is critical.

One particularly promising means of supporting greater adoption of CAPTs is through the integration of social protection programmes with campaigns to promote their adoption. Social protection programmes, including cash transfers, food aid, and public works programmes, offer obvious benefits in terms of reducing consumption risks and enabling households to retain and build up assets, even when a weather disaster strikes. In addition to these benefits, social protection instruments can positively influence farmers' capacity to adopt CAPTs. For example, in Ethiopia and Malawi, households that receive food aid are respectively 6.9 and 6 percentage points more likely to invest in soil conservation structures than similar non-beneficiary households (Ignaciuk *et al*., forthcoming b). Moreover, in Tanzania receiving a transfer of food increases the probability of adopting legume intercropping by 5.7 percentage points, while also increasing the probability of adopting organic fertilizer in Malawi by 3.1 percentage points.

Similar results are found for Malawi's largest public works programme, the Malawi Social Action Fund (MASAF) (Scognamillo and Sitko, forthcoming). MASAF provides cash payment for public works. Farmers who are MASAF beneficiaries are more likely to adopt soil water conservation structures (SWC), legume intercropping (LI), and organic fertilizer (OF), all of which are considered critical climate adaptation practices in Malawi (Figure 3).

The size of the social protection transfer has important effects on the types of investments farmers make. Food aid transfers have an income effect on smallholders by off-setting food expenditures. Results show that larger food aid transfers are associated with investments in livestock accumulation in Eastern Africa. An increase of 1 percent in the value of the food aid transfer a household receives increases the number of animals owned by 5.6 percent in Ethiopia, 3.6 percent in Malawi, and 9.1 percent in Tanzania. This is an important insight because **livestock are often effective at reducing households' risks associated with weather shocks, yet are quite capital-intensive investments**, making them inaccessible for many resource-poor farmers.

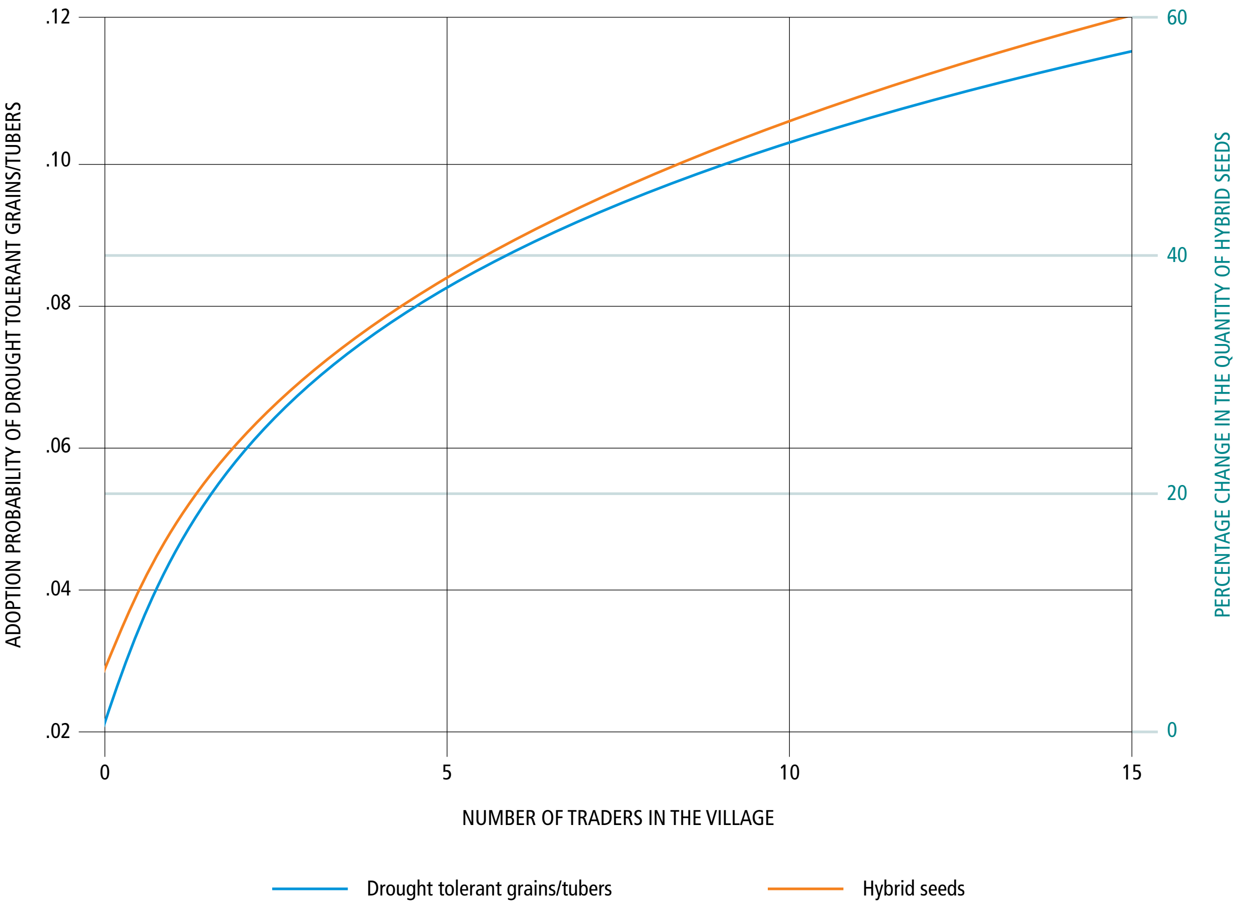
FIGURE 3 PARTICIPATING IN MASAF ENABLES FARMERS TO ADOPT CLIMATE ADAPTIVE PRACTICES IN MALAWI



Source: Authors' own elaboration.

Social protection transfers aren't the only effective tool for facilitating effect climate adaption by smallholders. In Zambia, for example, evidence shows that receiving **seasonal forecast information** prior to the El Nino-induced drought in 2015 led to a shift in household cropping systems (Maggio and Sitko, 2019). In particular, households that received the drought forecast were between 11.3 and 12.2 percent more likely to adopt drought tolerant combinations of crops than those that did not receive the information, and more likely to invest in short duration hybrid maize seeds. Yet this average impact masks an important point of heterogeneity. The results show that **the probability of responding to seasonal forecasts is strongly influenced by the market access conditions of farmers**. In areas where output markets are fairly competitive, defined as 5 or more private grain buyers operating in a village, farmers' adaptive response to seasonal forecasts is robust and significant. When markets are limited or uncompetitive, seasonal forecasts have no measurable effect on farmers' response to seasonal forecast (Figure 4).

FIGURE 4 **PRIVATE MARKETS ENABLE FARMERS TO ADAPT STRATEGIES TO SEASONAL WEATHER FORECASTS**



Source: Authors' own elaboration.

Finally, it is critical to account for the broader agricultural policy context. Existing public support policies for agriculture, such as input and output support, shape farmers' incentives to make investments. **Harnessing supportive public policies and modifying those that work against the adoption of CAPTs is critical for achieving effective results**. In Malawi and Zambia, input subsidies and output market support for maize profoundly influence farmers' willingness to diversify their cropping systems (Maggio and Sitko, 2020). In Malawi, for example, farmers that live in close proximity to government maize buying depots are less likely to adopt more diversified cropping systems. In Zambia, the results are similar, with negative impacts found particularly for cropping systems involving drought tolerant alternative staple crops, such as cassava, millet and sorghum. Alternatively, recent modification to input subsidy programmes, which include legume seeds in addition to maize, are associated with increased adoption of maize-legume diversification pathways.

Integration and harmonization: steps toward an effective climate adaptation strategy

Achieving national adaptation objectives for agriculture will require new approaches and new ways of thinking about the problem. The evidence makes clear that to enable millions of smallholder farmers to change their farming practices and adopt the new technologies needed to adapt to climate change, effective policies and support will be needed.

Given scarce public resources in many developing countries, what are effective strategies for supporting smallholders? First, **governments must enhance coordination within the agricultural sector and between sectors to maximize synergistic benefits from current programmes**. This may include, for example, integrating existing social protection programmes with agricultural extensions advice and seasonal forecast information. By so doing, these existing programmes can provide complimentary benefits that help farmers adopt appropriate CAPTs, and thereby reduce their risk exposure to climate change over time.

It is essential to critically assess current government support to agriculture to ensure that it does not hinder effective adaptation investments, and ideally helps to incentivize farmers and other private sector actors to make appropriate investments. In many ways, this entails creating opportunities and choices for farmers. For example, replacing traditional subsidy programmes with voucher-based input systems that build on private sector distribution channels and public procurement systems that crowd-in private investment in agricultural output markets should be explored.

Second, it must be recognized that national public resources alone may not be sufficient to cope with the magnitude of the challenge. **While the private costs to farmers of adopting many CAPTs are high, and the benefits are often uncertain, the public benefits can be substantial**. In particular, many CAPTs generate considerable benefits in terms of GHG reduction and removals. The Ex-Ante Carbon Balance tool can be used to help governments and other partners to quantify these benefits. This information is critical for making the case for global climate financing support to help farmers make investments in CAPTs.

Through this approach, the resources required to unlock substantial farm level investment in climate adaptation can be effectively spent in ways that ensure that the poor are not left behind.

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