CHAPTER 11

Food Value Chains
Increasing Productivity, Sustainability, and Resilience to Climate Change

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KEY MESSAGES

- Key nodes along food value chains, from crop production patterns to consumption, will have to adapt in response to climate change.
- Higher temperatures and humidity resulting from climate change will lower on-farm productivity and increase food spoilage and contamination along food value chains, with implications for food prices and nutrition.
- Consumer demand for sustainably produced products can create incentives for upstream change in value chains, but can also jeopardize livelihoods of poor farmers.
- Climate change is a threat multiplier. Resource scarcity and food insecurity can trigger grievances and conflict, and further disrupt value chains, especially amid widespread inequality.

Three action-ready solutions can begin to address climate change impacts in food value chains:

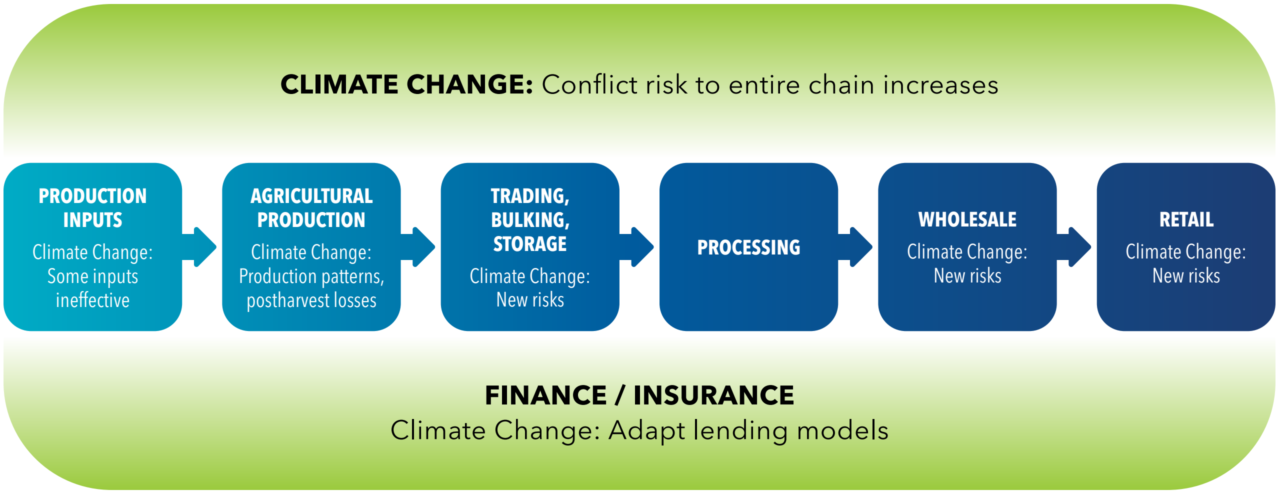
- Monitor the impacts of climate change, especially for vulnerable populations. Governments must monitor consumption, with particular attention to ensuring poverty does not increase and diets do not deteriorate.
- Create an enabling environment for cold chain development. In the value chain midstream, cold chains can reduce food loss and waste. However, growth of private sector investment will depend on government provision of adequate infrastructure.
- Support simple, low-cost options to reduce aflatoxins. At the local level, appropriate technologies to reduce aflatoxin contamination are available for all farmers and aggregators. Farmers will need government or NGO assistance to understand their options for reducing aflatoxin risks.

Climate change will drive responses and adaptations throughout agrifood systems. Changes in growing conditions for many crops will alter agricultural production patterns. Along with these shifts in crop production, rising temperatures, changes in humidity levels, and increased extreme weather will also affect the value chains through which agricultural products are traded, aggregated, processed, and sold to consumers. This chapter illustrates how incentives for producers and other value chain actors will change as climate change reduces the effectiveness of inputs, such as herbicides and pesticides, increases the risks of spoilage faced by middlemen and retailers, and potentially leads to increases in transaction costs. Whole value chains may be affected from farmer to consumer; for example, if international shipping costs rise with increasing fuel costs, export-oriented chains for select products in some countries may become unprofitable and even disappear. Although research has largely neglected the impacts of climate change on value chains beyond the farm, one thing is clear — many value chain actors along with farmers will need to adapt to new realities, as they showed they were capable of in the face of disruptions from the COVID-19 pandemic.[1]

IMPLICATIONS OF CLIMATE CHANGE FOR AGRIFOOD VALUE CHAINS

The potential impacts of climate change on key elements of agrifood value chains are illustrated in Figure 1. Climate change can be expected to reshape these value chains in three ways: through gradual changes; through increased likelihood of shocks; and through increased potential for conflict. While crop production is most obviously affected by climate change, risks of postharvest losses will increase and incentives for finance and insurance providers will also change. Threats to livelihoods and food security increase the risk of civil strife and conflict, which can disrupt whole value chains.[2] Consumers may add to the pressures for change across entire value chains not only through changes in diets but also through demand for sustainably produced products. All these changes have implications for value chain actors from smallholders to urban consumers.

FIGURE 1 Potential impacts of climate change on an agrifood value chains



Source: Authors' illustration.

PRODUCTION CHANGES

Gradual changes in precipitation patterns, temperatures, and humidity levels in low- and middle-income countries (LMICs) are expected to increase stress on agricultural production systems.[3] New climate patterns will also affect weed growth, disease prevalence, and pest populations and potentially reduce the efficacy of herbicides, pesticides, and integrated pest management. In addition to changes in rainfall and humidity, the risk of extreme weather events increases with climate change. These events can have even larger effects, as they can affect production in future years.[4] Together, these factors can reduce the maximum potential yields for crops, affecting their economic viability. Depending upon resulting yields, market conditions, and transaction costs within value chains, crop production patterns may change dramatically.[5] As a result, the downstream value chains that follow crops, whether for domestic use or exports, will need to adapt. For example, if it becomes too dry to grow peanuts in Senegal's "peanut basin," farmers may switch completely to growing millet and sorghum, meaning peanut traders would need to adapt their purchases and find buyers for these grains.

FOOD WASTE AND LOSS AND RELATED NUTRITION IMPACTS

Higher temperatures and humidity levels will increase the risk of postharvest losses. For grains, greater humidity could lengthen drying times, increasing the likelihood that they will be stored before properly dry and thus raising their susceptibility to pests and contamination with aflatoxins or other molds. Fruits, vegetables, and animal-source foods are usually stored for shorter periods of time, but these perishable products begin to spoil more rapidly, and higher temperatures will accelerate that process. Increased loss of perishable products is particularly concerning because these foods are the source of critical micronutrients that are already insufficient in the diets of many LMIC populations (see Chapter 8).[6] The effects of climate change on food spoilage could make perishables and their associated micronutrients even scarcer.[7] While perishables can be dried or otherwise processed to slow or stop spoilage, these techniques can also lead to nutrient loss. In addition to increasing scarcity of these foods, foodborne pathogens, like salmonella in animal-source products, will likely become more prevalent.[8]

Recent work suggests that postharvest losses already average around 14 percent of total potential harvests, but vary substantially by both crop and region.[9] As most of these estimates are for nonperishable crops, among perishable crops these losses may be higher; few estimates are either survey-based or account for reduced food quality.[10] While spoilage can occur in any of the value chain nodes beyond the farm, risks are highest for traders and aggregators who deliver crops in bulk to processors. For fresh foods, evidence suggests that losses are concentrated on the farm and at the retail level.[11] At the retail level, climate change could increase losses as informal markets often lack infrastructure to cool perishables.[12]

FINANCE, INSURANCE, AND SERVICES

Financial service providers in agrifood systems can be expected to change their behavior gradually in response to changes in perceived risks both on the farm and further along the value chain. While finance and insurance companies may be able to adapt to growing risks by simply adjusting their lending or insurance terms, both aggregate investment funding and insurance available locally could decline. Other firms along value chains may also change their investment strategies, whether or not they depend on availability of finance, which could likewise cause cascading changes.[13] For example, storage can be affected; in Nigeria and other humid climates, maize is susceptible to mold when stored before it is dry, and with increasing humidity, traders are becoming more averse to storing maize at all.[14] In turn, financial instruments dependent upon storage (that is, warrantage) become riskier, potentially reducing farmers' access to finance. And in value chains in which farmers depend on finance for inputs, such as sugarcane or coffee chains, reduced inputs would reduce yields and total harvests in a region, thus reducing the returns to trading and processing those crops as well, which can lead value chain actors to exit the market.

SMALLHOLDERS AND VULNERABLE POPULATIONS

Smallholders are likely to bear the brunt of climate change impacts on value chains. Because it is inherently more complex to help a hundred small farms adapt than one large farm, it will be more difficult and costly to help smallholders adapt to gradual changes. Even if governments are willing to help, remote smallholders are hard to reach and may be resistant to adopting new practices, if these are perceived as risky. In addition, smallholder access to credit or formal sources of insurance will be the first to be reduced as uncertainty increases. This is particularly true for female and minority value chain actors, whose access to finance is already more constrained.[15] Moreover, if the risks of storing grain or other food products increase, traders may also reduce the amount they are willing to pay farmers.

CIVIL STRIFE AND CONFLICT

In places where the climate crisis sparks civil unrest and conflict, further cascading effects on the functioning of value chains are likely. Evidence suggests that natural resource scarcity and food insecurity can lead to violence when exacerbated by climate impacts and associated with other insecurities, such as poverty, inequality, and overall sociopolitical fragility.[16] Lower agricultural productivity and natural resource scarcity due to climate extremes and variability could reduce food supply and quality, and lead to higher food prices that would compound food and nutrition insecurities among the poor and vulnerable, potentially sparking protests, riots, or armed conflict in already fragile contexts.

In addition, economic shocks resulting from climate change may lead to an increase in criminal activity or other disruptive behavior that escalates challenges for agrifood value chain actors, for example, by increasing risks of theft when transporting foods to, through, or from conflict-affected areas.[17] Climate-induced tensions and conflicts may be most frequent where there are large structural inequalities, characterized by social and political marginalization and existing vulnerability.[18] Such conflict risks can affect whole agrifood value chains, not just individual nodes. Conflict can thus intensify the damage to value chains. In response, value chains must both adapt to climate change and do so in a conflict-sensitive manner.

CONSUMER DEMAND

Consumer demand may shift as a result of climate change concerns, as some well-informed consumers will likely increase their demand for more sustainably produced foods. If these shifts are large enough and drive an increase in prices for these products, consumer demand can create incentives for producers and processors to shift toward more environmentally sustainable crops and technologies; however, there are several challenges. First, consumers will want assurance that the products they purchase are sustainably produced, thus increasing demand for traceability and "process standards." Process standards certify the way that foods were produced; existing standards include certification for organically grown products and other measures of environmental and social sustainability. At present, the products most commonly certified under such standards are coffee and cocoa.[19] If demand increases substantially, organizations that provide certification, such as the Rainforest Alliance, will need to increase capacity. Second, increased demand for foods with sustainability certification can lead to increased inequality by reducing market options for poorer farmers who lack the resources to meet the new standards.[20] And if farmers expand their production of certified products too quickly, it is likely that they will need to sell a portion of the certified food into uncertified markets at lower prices, affecting their incentive to participate.[21]

ADAPTING AGRIFOOD VALUE CHAINS

Clearly, agrifood value chains must *adapt* to climate change. Value chains offer less potential to help *mitigate* climate change, however. Despite the growing complexity of some value chains, evidence on greenhouse gas emissions suggests that the value chain steps between production and consumption — including processing and transporting agricultural products to end markets — only account for 18–29 percent of total emissions from agrifood systems, even for products traded over long distances.[22] Since this range represents a total over a wide range of products and levels of value chain complexity, there are no easy fixes for reducing those emissions. For example, research suggests that "buy local" movements will not materially reduce emissions, and instead might increase them, as there are returns to scale in moving bulky agricultural products.[23] Even effective interventions to reduce emissions between farms and retailers may have little overall effect.

Though reorganizing downstream value chains to reduce emissions may not be a cost-effective way to mitigate climate change, other interventions could help avoid deterioration of other important outcomes, such as nutrition-related outcomes. Solutions are clearly needed to assist smallholders, and particularly women, in adapting to climate change and to changes in the value chains into which they sell their crops.

In this section, we consider two potential solutions that can be initiated now, both of which require government intervention. First, we consider how governments and other stakeholders can act to prevent climate-related food waste and loss that reduce food security and nutrition. We focus on storage technologies that can reduce both postharvest losses and greenhouse gas emissions, even if those reductions cannot be measured at the macro level. Second, we suggest how better monitoring can be used to help government and the private sector identify problems along value chains, adapt value chains to climate change, and ensure stability.

PREVENTING FOOD WASTE AND LOSS

Possible solutions to the problem of food spoilage differ by crop type. For perishable, micronutrient-rich foods, greater availability of cold storage and cold chains can maintain or even improve access to these fresh foods by reducing spoilage. For a cold chain to work properly, cold storage must be available at or near the farm soon after harvest, refrigerated trucks must be available to transport produce to larger cold storage facilities or to retailers, and people who handle the food must be trained in proper handling procedures. Cold chains are dependent on complementary infrastructure, particularly good roads and reliable sources of electricity (see Chapter 9). Some emerging cold chain technologies adaptable to settings with little existing infrastructure include solar-powered or electrically efficient cold rooms that can be used in villages.[27] However, prices for these technologies will remain high so long as demand is low, and demand is likely to remain low as long as producers do not perceive large income effects from using such technologies.

Further along the chain, there is a need for companies that are able to invest in refrigerated trucks, which in turn depends on adequate road infrastructure to ensure sufficient returns on private investment. Without public investments in this necessary supporting infrastructure, private sector entrepreneurs will not find investment in cold chain technologies attractive. However, given that the social benefits of such investments extend well beyond the food system and are likely to be quite high, government has an important role to play in providing the infrastructure to foster cold chain development. The benefits of these investments are evident in the growing economies of

Southeast Asia, where strong road networks and rural electrification preceded cold chain development that has expanded the availability of perishable food products in markets.[28]

For grains and legumes, the major concern from a health perspective is the growth of aflatoxins. More widespread use of aflatoxin-reduction technologies could reduce losses and prevent an increase in contamination. Several technologies, from simple to complex, can reduce aflatoxins; the key is to use those that are context appropriate, cost-effective, and sustainable. For example, simple technologies, like spreading tarps underneath crops that are drying in fields, have been shown to cost effectively reduce aflatoxin levels.[24] Hermetic bags are a second solution, though trials have shown that while farmers are willing to use the bags if free, value chains for bags are not well developed, so farmers have difficulty obtaining them post-trial, and therefore tend to stop using them.[25] Improved sales outlets for bags could help, but it is not clear whether farmers would be willing to pay for them. Solutions such as Aflasafe, a biocontrol product developed by the International Institute for Tropical Agriculture, are also effective at reducing aflatoxins but are expensive, and would likely require specialized value chains to ensure the existence of buyers for aflatoxin-safe grains before they could be cost-effective.[26] For smallholders, then, promoting the use of tarps spread underneath drying crops would seem to be a cost-effective and already available solution.

ADDRESSING INSTABILITY AND CONFLICT

For these solutions to work, as well as many other efforts to address climate change throughout the food system, agrifood value chains and the wider economy require stability and security. An integrated approach to maintaining stability in the face of gradual change and shocks requires both technical solutions to challenges, like those proposed above, and "restorative" and "sustainable" solutions.[29] Restorative solutions enable stability by creating a common platform for dialogue. These collaborative dialogues aim to understand the main causes of discontent arising from climate impacts and to facilitate cooperation by building trust and legitimacy.[30] Sustainable solutions address root causes of conflict and grievances through collective-action approaches for institutionalizing joint management systems. Such systems link local communities on an equal footing with public and private decision-makers and work across multiple levels and sectors (see Chapter 7 on landscape management).

The effectiveness of such solutions will depend heavily on the context, on the structural drivers of grievances, and on how effective monitoring systems are in detecting disruptions occurring at different levels of the value chain. To help meet these needs, CGIAR is developing a "Climate Security Observatory" — a decision-support tool that will provide real-time or almost real-time scientific evidence on how climate exacerbates existing social, economic, and political risks and insecurities, including the potential for conflict.

CONCLUSION

As our climate changes, agrifood value chains must adapt to new cropping patterns and changes in investment and input needs. Governments must safeguard against the risk of increasing food and nutrition insecurity, and agrifood value chains must be transformed to address climate security concerns. In the short term, policymakers can focus on ways to reduce food loss and waste in value chains, particularly for perishables, to yield more food from their agrifood systems and potentially to alleviate the local environmental stress associated with food systems development. In the medium term, investments in climate-smart infrastructure, including new roads and electrification to support development of cold chains, will be important to safeguard food and nutrition security. To ensure that civil strife and conflict are not fostered by climate change, investments will be needed not only in monitoring but also in ensuring that smallholders and other vulnerable value chain actors can adapt, and that both diets and livelihoods are protected and improved.