How does climate change alter agricultural strategies to support food security?

Executive summary

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The purpose of this paper is to identify how climate change affects how we should approach the process of transforming agricultural systems (including crops, livestock, fisheries and forestry) to support global food security and poverty reduction in a sustainable way, focusing on implications for FAO and CGIAR priorities.

Threats of climate change to agricultural production systems

Climate change affects agricultural production through its effects on the timing, intensity and variability of rainfall and shifts in temperatures and carbon dioxide concentrations, which can all have direct consequences on plant and animal growth, as well as indirect effects on production through potential changes in pest and disease patterns. There is still considerable uncertainty about the immediate and long term effects of climate change. Although in a few locations the effects of climate change on agriculture may raise yields, in most developing countries the net effect is expected to be negative. This raises considerable concern as the negative effects of climate change are predicted to affect the populations with least capacity to adjust, but with the greatest need for improved agricultural performance to achieve food security and reduce poverty.

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1. Responses to climate change

We identify five major categories of responses within agricultural transitions that can be taken to respond to climate change: 1) increase the resilience of production systems, 2) diversification, 3) expand the use of "no regrets" technologies and planning, 4) better use of information for risk management, and 5) utilize the co-benefits from mitigation.

Increasing resilience of agricultural production systems involves actions that improve the capacity of agricultural ecosystems to withstand physical shocks to the system (such as drought, floods, pest attack) and maintain productive capacity. Such capability is increasingly valuable given the projected increases in intensity and frequency of extreme events under climate change. Measures to increase resilience generally involve greater attention to maintaining ecosystem services that regulate stability in agricultural ecosystems, such as soil and water quality, genetic diversity and landscape level management and protection. Restoring degraded ecosystems (e.g. fisheries, grasslands, croplands) and increasing the use of integrated management techniques are key actions required to improve resilience.

Diversification is frequently called for as a solution to the risks climate change imposes on agriculture. To achieve risk management goals, it is key to consider the covariance of risks associated with diverse activities as well as the tradeoffs implied: if risk-averse diversification strongly decreases average income, it can lead to a vicious cycle of decreasing household assets, eventually leading to exposure to greater risk. Little systematic information exists to guide farmers and farming communities on how to best manage diversification options.

One of the most important impacts of climate change is through its effect on increasing uncertainty and essentially "destroying information" on the expected probabilities of rainfall and temperature distributions that humans, and particularly agricultural producers, have built up over generations. We are now operating in a world with much greater uncertainty, and this has important implications for technology development and planning, as well as risk management strategies. Uncertainty increases the value of developing "no regrets" technologies and planning systems that build in flexibility and the need for incremental and even transformative changes into planning systems. Incremental changes to existing systems that build upon existing infrastructure, practice, technologies and knowledge are an important aspect of climate change adaptation, but more transformative changes may be needed where climate change impacts are projected to be most severe. Framing transformational adaptation as not a single step but rather a continuing process which may reverse, or undergo incremental change increases the likelihood of achieving a "no regrets" process.

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Mitigation of climate change must be a fundamental response in agricultural transitions, in both developing and developing countries. Agriculture is a major source of GHG emissions, and developing country agriculture is projected to be an important source of emissions growth. Early action for mitigation- beyond the initial commitments defined under the Kyoto Protocol – is needed to limit the dangers of climate change, and such action is considerably less expensive than delaying action to the future. Integrating mitigation into agricultural transition strategies involves increasing efficiencies and restoring ecosystem services – which in many cases are synergistic with development and adaptation objectives. However it is important to recognize that mitigation may involve trade-offs, particularly in the form of higher costs in initial transition phases.

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2. Making Transitions Happen

The urgency of reducing food insecurity together with the need for immediate responses to climate change impels us to define mechanisms, actions and approaches to stimulate desired transitions. The paper identifies four categories for priority actions FAO and CGIAR can take to incite actions amongst stakeholders from farm to national and international level. These include: 1) developing and promoting agricultural technologies and innovations; 2) strengthening local institutions; 3) achieving coordinated and informed policies; and 4) increasing access to financing.

Agricultural technologies - their development, assessment, promotion and dissemination - are an important area of work for both CGIAR and FAO. One of the main effects of climate change on agricultural technology development is to add urgency to new breeding activities and the use of new technologies directly linked to factors such as increased drought, more extreme temperatures, more widespread flooding, higher levels of salinity and shifting patterns of pest and disease occurrence. There may be genetic differences in plant response to such changes, and these could be exploited in future breeding programs.

Building adaptive capacity through supporting, building and extending formal and informal networks is a key priority for supporting agricultural transitions under climate change.

In terms of technology assessment and promotion, climate change accentuates the importance of considering multiple objectives, since both adaptation and mitigation are important to explicitly include. However, it is not simply a matter of identifying the "best" technology for a given situation. Climate change increases uncertainty and the need for flexible responses, which in turn requires capacity for innovation. Building networks to support social, institutional and technological innovation builds adaptive capacity is thus a key priority for supporting agricultural transitions under climate change.

Greater emphasis on building local institutions to support information dissemination, risk management and collective action is also an essential element for providing the enabling conditions for agricultural transformation to support food security under climate change. Local institutions (both formal and informal) are the primary information interface between agricultural producers and information sources, and thus it is essential to ensure that they have access to reliable and relevant information that can be interpreted to meet the needs of local populations in terms of decision-making and planning. Likewise, local institutions are key to risk management, through a variety of mechanisms including migration, storage, diversification, risk pooling and market exchanges. Support to local institutional development for risk management thus involves developing tools and guidance for assessing appropriate options as well as direct technical and financial support. Climate change increases the need for collective action since many of the activities required to increase resilience in agricultural systems requires group participation. In addition, collective action can create more effective networks of innovation and exchange to support adaptation.

Supporting local institutional capacity for information dissemination, risk management and collective action is an essential enabling action for needed transformations under climate change

Given the cross-cutting nature of the response needed to achieve rapid transformation of developing country agriculture, institutional and policy innovations that favor greater

integration and coordination will be essential. Coordination mechanisms to overcome institutional fragmentation are needed and these should be embedded in the existing institutional architecture and be nationally owned in order to be sustainable. Greater interaction, consultation and dialogue among Ministries of Agriculture, Environment and Finance, as well as other key stakeholders are needed in order to better enable more coherent policies, planning and investment. Climate change increases the importance and value of establishing mechanisms to allow for better dialogue between researchers and policy-makers. For issues related to complex systems change, there is a need for policy to engage future uncertainty together with research to avoid planning blindly or badly. One tool to bridge this gap is participatory scenario development which both CGIAR and FAO are working with.

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Financing at adequate levels and delivered with accessible and appropriate mechanisms is a final enabling action needed to support agricultural transitions under climate change. FAO and CGIAR have important roles to play in meeting this challenge, through advocacy, policy and investment support and the development of appropriate financing mechanisms.

3. How to monitor and evaluate?

Both FAO and CGIAR are undergoing reform processes to improve the effectiveness of their respective work programs. A fundamental aspect of this reform is moving to the use of results-based frameworks which require the development of indicators for tracking progress towards stated objectives. Climate change affects the nature of the indicators we need to monitor effective progress towards meeting the two organizations objectives. We have identified four areas that capture essential elements of the way climate change impacts our work in attaining agricultural transitions to support food security and sustainability under climate change:

- Risk-adjusted returns to agricultural systems

  Moving from an agenda based on mean yields and income towards a more relevant one based on the variance of yields and income and threshold probabilities has clear implications for measurement, monitoring and analysis: there is a major research agenda here, touching particularly on data collection methods, climate modeling and downscaling, and decision analytics and modeling.

- Changes in transitory food insecurity in the wake of climate shocks

  Considerable improvements are needed so that we can better identify food-insecure people and their targetable characteristics. This is particularly true if the nature of climate shocks will change with increased variability or long-term temperature increases. This is an area where the use of qualitative surveys of household behavior and perceptions can add a lot, and enrich our knowledge and monitoring capacity beyond what can be understood with standardized quantitative indicators.

- GHG emission intensity per unit agricultural output

  Standardized methodologies and life-cycle assessment methods are key, otherwise results can be dependent on (e.g.) where the system boundary is drawn. Some mitigation activities,

while providing additional income, may involve a trade-off in income from other agricultural activities, highlighting the importance of analyses using robust tools that are capable of evaluating the synergies and trade-offs that may result at different scales

- Indicators that can identify potential maladaptation well in advance

If adaptation is framed as a continuing process, this has considerable implications for monitoring, in attempts to identify divergences from desired outcomes as soon as possible. For large-scale, costly or heavily time-lagged alternatives, it may be far better to pre-screen them before embarking on such adaptations.

4. Conclusions: Priority areas for CGIAR and FAO

We identify three main priority areas of action for the CGIAR and FAO in order to better meet the objectives of achieving sustainable agriculture and food security under the conditions climate change imposes:

a. Enhance our understanding of how climate change impacts agriculture

The impacts of climate change and increases in climate variability on agricultural systems and natural-resource-dependent households, as well as on food security and the future vulnerability of already hungry people in the tropics and subtropics, are largely unknown. The agricultural research-for-development community will need to strengthen considerably links with the global change community if global climate model-based uncertainties are to be addressed adequately in impact studies. The inputs of CGIAR and FAO, along with many other partners, will be crucial if light is to be thrown on these issues.

b. Developing tools and assessments for evaluating options

The provision of guidelines for risk management under climate change, and practical advice on how these can be implemented, is a critical area of ongoing research. There are several ways in which FAO and CGIAR might develop this work in the future. These include increased understanding the role of assets (physical, human and social capital) and collective action in managing climate risks, how risk aversion affects farmers' decision-making in response to climate change, and increased engagement of civil society to bring about more participatory approaches to risk management and communication.

Another area that has been highlighted is the need to assess technologies and policies in relation to multiple objectives and multiple temporal and spatial scales. Understanding the limits to adaptation of different types, and the existence of thresholds, beyond which transformation of livelihood systems may be required, are all areas in which CGIAR and FAO can contribute.

c. Promoting innovation and linking knowledge with action

The engine that will drive sustained adaptation and transformation of agricultural systems is innovation: social, institutional and technological. CGIAR and FAO are themselves in the process of transformation that offers increased potential for partnerships, inter-centre collaboration, and trans-disciplinary research. One example is scenario approaches, which have considerable power to engage governments, the private sector, researchers, civil society and the media. Multi-stakeholder processes can explore key socio-economic uncertainties, and can be combined

directly with climate scenarios to explore how these human and biophysical future stressors interact to affect future food security, environments and livelihoods. The combination of stakeholder perspectives with quantitative modeling can provide a linked science-policy interface.