Planning and costing agriculture's adaptation to climate change

Policy Perspectives

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October, 2011

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Citation:
Downing, T. and Chambwera, M., Cabot Venton, C., Dyszynski, J., Crawford, V., 2011. *Planning and costing agriculture's adaptation to climate change: Policy Perspectives.* International Institute for Environment and Development (IIED), London, UK.

This Policy Perspectives paper was prepared by the project on Planning and Costing Agriculture's Adaptation to Climate Change, led by the International Institute for Environment and Development (www.iied.org). The Stockholm Environment Institute (www.sei-international.org/oxford) and the Global Climate Adaptation Partnership (www.ClimateAdaptation.cc) were core partners, along with teams in five developing countries. The five country study reports and the Synthesis Report are available from www.iied.org. The project was funded by the UK's Department for International Development (DFID) under the Climate Change, Agriculture and Food Security Policy Research Programme.

Acknowledgements:
The authors would like to thank the following for their contributions to the overall project on "Planning and costing agricultural adaptation" from which these policy perspectives were derived: Tom Birch, Ruth Butterfield, Nanki Kaur, Mintewab Bezabih, Simon Anderson, George Matiya, Rodney Lunduka, Margaret Sikwese, Siza Tumbo, K. Mutabazi, A. Kimambo and F. Rwehumbiza , Bikash Paudel, B.B. Tamang, Krishna Lamsal, Pratima Paudel, Jean Chrysostome Ngabitsinze, Adrie Mukashema, Mireille Ikirezi, Fidèle Niyitanga, Nazria Islam, Khandaker Mainuddin and Saad Quasem

Introduction

Agriculture has a crucial role to play in meeting development goals – from demand for food as populations grow and become wealthier to maintaining essential ecosystem services, diverse livelihoods, and economic development. Underinvestment over the past 20 years has resulted in a sector that is not adequately prepared for the challenges of climate change. Yet for most developing countries, agriculture has been one of the earliest sectors to be affected by climate change, with negative impacts already apparent and more serious consequences projected for the future.

There is increasing recognition by both the climate change and agricultural development communities that agriculture needs to be part of a new global climate change deal. 'No agriculture, no deal' is a clear signal from concerned stakeholders that agriculture will be a key feature of climate change negotiations, both for reducing greenhouse gas emissions and protecting vulnerable populations and economies. There has been a long history of assessments of the impact of climate change on agriculture, and recent international movements to press toward effective action are noteworthy.

This Policy Perspectives paper summarises the results from a recent study led by the International Institute for Environment and Development, the Stockholm Environment Institute and the Global Climate Adaptation Partnership, with national teams in five developing countries (see Box 1). The principal conclusions inform policy and planning by addressing the following issues:

- Framing and methodological development in the assessment of climate adaptation.
- Assessment of current vulnerabilities, and potential future impacts and costs of adaptation.
- Identification of strategies and measures considered priorities across regions and types of agriculture in 'pathways of adaptation'.

Box 1. About this study

The study sought to inform climate change policy by analysing agricultural adaptation in developing countries. Country case studies following a common methodology in Bangladesh, Malawi, Nepal, Rwanda and Tanzania, provided fresh evidence of the possible costs of agricultural adaptation to climate change. A global review of the literature on agricultural impacts of climate change, adaptation strategies and measures, and economic valuation informed a perspective based on understanding adaptation pathways in developing countries. This generalised framework places climate change adaptation at the heart of development planning.

Each case study focused on a different agricultural system, documented local adaptation pathways (called 'signatures' in the general framework), and evaluated possible costs.

The roles of stakeholders at different levels, from local to national, provided a picture on the different entry points for adaptation investments and deployment of adaptation funds. Project teams learned from workshops with national stakeholders and experts who reviewed emerging findings. A synthesis workshop with all of the national teams developed key messages and lessons learned from using the analytical approach.

1. Framing adaptation in complex farming systems

Understanding climate change, and current and future vulnerabilities; assessing potential impacts on diverse agricultural systems; evaluating plausible and cost-effective responses; and valuing those adaptation options invokes a huge breadth of terms, relationships and processes (see Figure 1 for a iconic view). This real-world complexity has implications for robust, purposeful approaches to identifying and valuing adaptation.

Figure 1: Keywords relating to climate adaptation and agriculture.

Common terms (tags) from the 'Key Messages' section of the study Synthesis Report indicate the breadth of relevant topics, from local levels to sectoral and national development. The size of a word in Figure 1 correlates to its prevalence in the text.

The ability to predict future climate change impacts is limited, with diverse causal chains linking climate change to substantial effects in local and global agricultural systems.

The diversity and breadth of variables, states and processes in developing countries, and their interactions with global conditions, limits the ability to predict the future of agriculture and the potential impacts of climate change in terms that provide robust targets for adaptation. Examples of the challenge of planning climate change adaptation include:

1. While climate change scenarios show that almost all areas will be warmer in the future, predictions for agro-ecological zones are quite uncertain, especially as a result of rainfall and storm-related conditions (see Figure 2). Additional uncertainty about future states of environmental services, especially soil quality, makes it difficult to predict the impacts of weather-related conditions.

2. Agricultural systems are complex, with linkages across scales, conflicting objectives among stakeholders, and strong path-dependencies. For instance, the impact of a drought can be seen in the lack of rainfall that reduces yields on a dryland plot, the failure to deliver water to marginal farmers in a small irrigation scheme, and adjustments to national food availability and prices mediated by the political economy. Differentiating climate change impacts and adaptation from this dynamic complexity over the course of the next few decades is impossible in most situations.

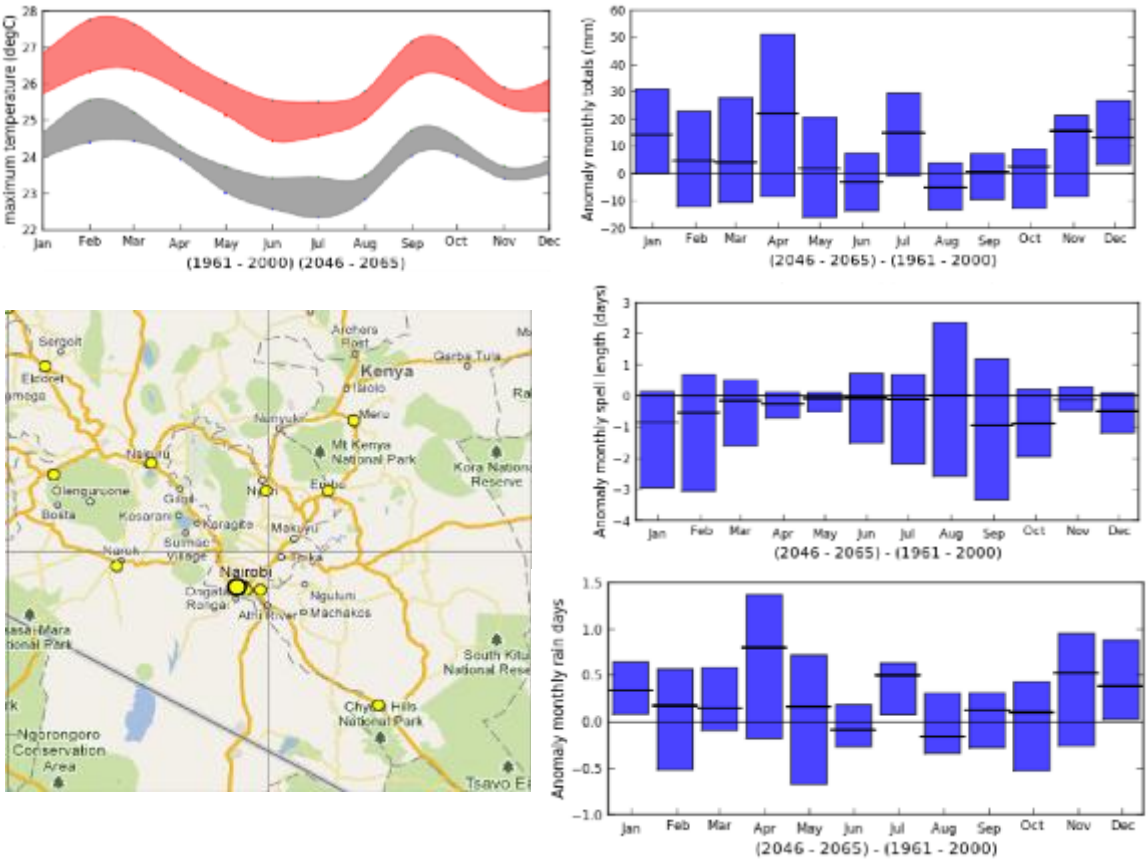
Stakeholders have diverse views as to what constitutes climate change adaptation and there is no single approach or framing that covers all of the issues.

Climate change can be classified as a 'wicked' environmental problem (in the political science literature, a problem that is complex, contradictory, intractable and apparently insoluble). Consequently, the value of climate models for specific, long-term planning at the local level is limited, with adaptation options being shaped by climate, development and environmental considerations.

Box 2. Key features of a wicked problem:

1. The definition of the problem depends on the framing – where to draw the boundaries of actors and processes. For climate change adaptation in agriculture, the 'problem' might be seen as a global challenge to Western diets or, more narrowly, as tuning some decisions to incorporate a wider range of risks.
2. Stakeholders bring to the problem different framings: there is no universal solution. For instance, IFPRI's review tends to focus on research while UNCTAD highlights issues in global trade; and most development agencies make a strong case for sustainable development, poverty reduction and social protection.
3. The future counts (low discount rates are implied in policy processes) and time is running out. Clearly, climates are changing so there is only a limited window for action to ensure a robust agricultural system that is prepared for a variety of possible futures.

Figure 2: Envelopes of climate change for a selected station.



Envelopes for Nairobi/Dagoretti for the 2050s are: (top left) monthly average temperature (red) compared to present range (grey) and (right, top to bottom) change in monthly rainfall, length of dry spells, and rain days over 10mm. These profiles are typical of East Africa: significant warming is virtually certain, while it might be wetter or drier with climate change. However, the length of dry spells is likely to increase. The number of days with intense rainfall (over 10 mm) may increase as well. (Source: Climate Information Portal, CSAG/UCT).

Identifying effective strategies and measures requires multiple lines of evidence, from global-aggregated approaches to local studies in the context of development processes.

Estimating a single global adaptation price-tag for the present and the future covering all agricultural systems is not realistic, whether one is working from the top or from the bottom. Neither is there a single approach for planning adaptation that suits every community or country. As such, a universal costing and planning methodology does not exist.

Global estimates of the cost of climate change impacts and adaptation do not accurately reflect, and often underestimate, the cost of adaptation give the diversity of agro-ecological systems. However local, bottom-up approaches are highly sensitive to key assumptions and cannot be aggregated to provide reliable global estimates. For instance, the framing of adaptation as a development issue, or limited to the additional costs to adapt to uncertain futures, may produce a range of estimates of at least an order of magnitude.

However, there is considerable insight into the sensitivity of agricultural systems to climate variations, and a well-documented set of agricultural strategies for managing climate-related risks. Uncertainty about medium-term futures is not a reason for inaction at present – quite the reverse.

A generalised framework that presents adaptation as a 'pathway' of social, economic and institutional change enables actors to adjust to known climatic and developmental stresses while learning how to adapt to future, uncertain climates as better information becomes available.

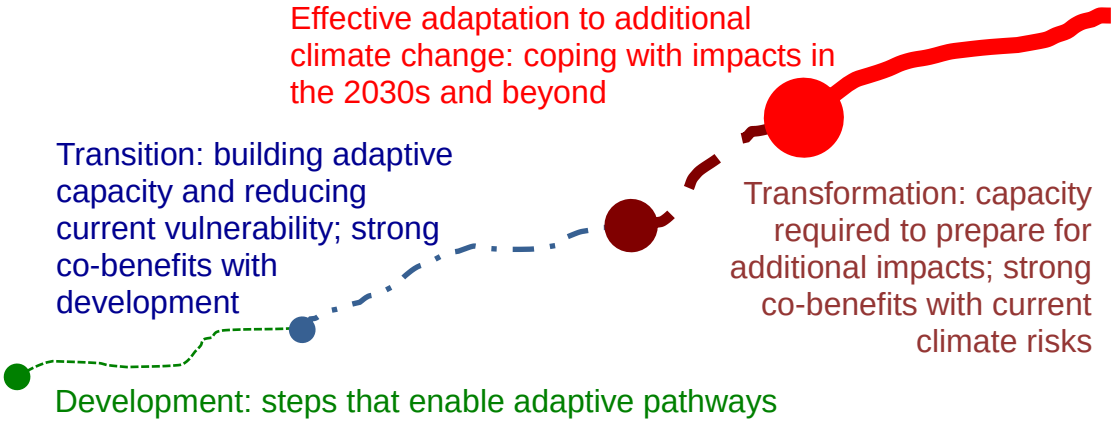
A simple metaphor is of adaptation as a journey: decision makers follow various pathways to navigate across the adaptation landscape. Of course there are many such paths, all local in some respect but sharing common features as well. The adaptation pathway can be viewed as a sequence of decision nodes. Decision making at each node is bounded by the stakeholder framing – including the choice of criteria, consideration for future conditions, and decision nodes. Each node consists of a combination of decisions and actions undertaken by several actors and influenced by several external factors.

In the case of adaptation pathways, several types of future nodes are worth noting:

- Social learning would continue, even though future nodes look much like the present. This is implied in the figure below.
- Current decisions might be designed to significantly expand the decision space for future decisions. This might involve gathering new kinds of information, entraining new actors, or changing decision criteria; all are substantial changes to the adaptation space. Mandatory reporting requirements are a topical example in the UK.
- More options might be available in the future – often considered desirable, but only if certain decisions are taken in previous nodes. For instance, weather insurance requires a dense network of weather stations, and at least 10 years' of data to establish the baseline risk.
- Pathways may 'lock-in' some choices, or lead to 'dead ends'. Without knowing whether these are justified by present costs and benefits, many adaptation plans assume that flexibility is a key attribute of climate resilience. For instance, major water reservoirs are a long-term commitment that precludes other adaptive options.

This generalised framework – called the 'adaptation signature approach' – was successfully applied in the different agricultural systems of the study and stakeholders involved could more easily connect with the study than they were able to with other costing approaches. Near-term adaptation strategies and costs were better arrived at than those for the long-term future. For the long term, research, capacity building and institutional strengthening were the main adaptation options identified. Anything more specific, such as permanent migration, was more speculative and based on the notion that future climates could be worse than now, in any direction.

Figure 3: Adaptation as a pathway from development to climate protection.



2. Assessment of vulnerability, impacts, adaptation and costs

The implications of climate change for agriculture span a huge range of issues. The study focuses on the costs of adaptation within the context of selected agricultural systems in developing countries.

Agriculture will be affected by climate change through an array of processes: adaptation in production systems needs to be complemented with investment in supply chains, sectoral policies and consumption, nutrition and health.

Climate change will affect agriculture in a variety of ways; each is an impact pathway where adaptation strategies and measures are required:

- Direct weather impacts on crop yields, the most common focus (including the so-called indirect effects of CO_2 enrichment).
- Shift in production regions, linking direct weather effects and comparative advantage and trade.
- Reduced labour productivity due to extreme working conditions, especially heat waves, and loss of facilities from disasters.
- Changes in environmental services such as soil quality and water resources.
- Supply chains disrupted by climate events, or opened up as Arctic sea ice is reduced.
- Increased energy prices and costs of producing food (including fertilizers) as well as shipping produce.
- Changes in the quality of foods and nutrition, linked to changes in consumer preferences.
- Policy-led shifts, e.g., organic farming and local production (e.g., 'Eat British').

This assessment focuses primarily on adaptation pathways for direct effects; these are the starting point for adaptation in most developing countries. However, the scope for research and development, policies on imports and exports, and other global interventions are significant and should be explored further.

Global, sectoral estimates of the cost of climate change adaptation in agriculture are limited, but indicate annual costs in a wide range, from US$5 billion to over US$100 billion by the 2030s.

Global estimates have focused attention on agriculture; however their coverage, assumptions, methodologies and validity are problematic (see Figure 4). A key issue is the inclusion of investment that would otherwise be considered 'development' as a broad and necessary foundation for adaptive capacity. None of the global studies have been well validated against either local to national studies or detailed models of sectoral production, trade and consumption.

Despite the limited studies and problematic methodologies, there is ample evidence that current investment in agriculture is insufficient for building resilience to the range of climate impacts that are already being experienced and might be further challenges in the next decade or two.

Figure 4: Key gaps in assessing the economics of adaptation in agriculture.

	Institutional capacity	Humanitarian crises
Market infrastructure	Social protection	Migration
Private investment	Extension	Trade dislocations
Fixed capital formation	Community resource management	Research and development

A range of known economic processes are not adequately reflected in existing estimates of the cost of climate change adaptation in developing countries, depicted as progressing from local-household issues to global-sectoral factors.

Much of the cost of adaptation will be borne by individuals, households and organisations: opportunities for private sector involvement in adaptation are vast.

Estimates of the cost of adaptation are not the same as requirements for public finance to support agriculture. Private sector involvement is already evident at the global level. Private sector opportunities at the country level need to be evaluated and quantified.

The benefits of adaptation are primarily in furthering development goals, although reduced climate change impacts are significant.

The wealth of global studies of climate change impacts on agriculture suggests costs up to about five per cent of GDP beyond the 2050s in the absence of adaptation. Some studies indicate a global benefit for relatively mild climate scenarios; all studies show strong differences between crops and regions.

Relatively few global studies have included climate change adaptation costs, and all use either top-down, global assumptions or are limited to a narrow set of adaptation actions (generally reflecting an orientation toward crop-climate impacts modelling). It appears that purposeful adaptation actions could reduce future climate change impacts by half or more, although this conclusion needs more widespread testing to be considered robust.

In the near term, investment in agriculture should produce more adaptive systems that enhance economic development and livelihood security. For instance, many analyses suggest that stronger market infrastructure, primarily rural roads to get produce to export and urban markets, would greatly reduce future climate change impacts. Such infrastructure investment would support many other goals as well. Case study research also suggests that several adaptation actions are primarily aimed at addressing existing agricultural inefficiencies, such as in the coffee washing stations of Rwanda.

Adaptation in national case studies is possible given current plans, and effective against a range of climate futures.

The study undertook case studies of specific agricultural systems, including estimates of the cost of adaptation. The local and national assessments are indicative, and are pioneering estimates in developing countries. However, much further work is necessary to produce the evidence base that is required for sound investment decisions, including the incentives for stakeholders such as the private sector to invest in adaptation.

Bangladesh: modifying food production in marginal areas prone to salinity:

- Coordinated national action against salinity would cost US$10 million initially (about US$0.06 per person), possibly rising three-fold in the future.

Nepal: increasing food production in maize-based systems with mixed cropping:

- Costs for a small village are in the order of US$20,000 (about US$70 per target household), with support from district and national services.

Rwanda: improved smallholder cash cropping, especially coffee:

- US$2.4 million for coffee sector improvement at local level and national level, including coffee research, and US$14.2 million for a national agricultural comprehensive climate change strategy, including R&D, institutional capacity and marketing (less than US$2 per person).

Tanzania: pastoral and livestock systems:

- Protecting the entire country would cost in excess of US$280 million at present (about US$6 per person), and possibly rising to $2.7 billion in the future.

Malawi: maize-based subsistence farming systems:

- Almost two-thirds of the US$55 million cost of adapting one district to climate change could be met from private sources, mostly through market linkages, credit facilities, and private sector-provided goods and services. However, benefits from national-level investments in research and capacity building could spread to other regions of the country.

Anticipated adaptation funding does not appear to be sufficient compared to the potential cost of adaptation in agriculture identified the country studies.

Global commitments to fund adaptation are in the order of US$50 billion per year by the 2020s. Agriculture could only expect to receive a fraction of this amount, perhaps US$10 billion per year. The costs in just five of the countries could account for nearly half of this amount. Both the promised funding and costs estimates are highly uncertain. What is clear is that fully adapting agriculture in developing countries to the challenges ahead will require far more investment than is likely to be forthcoming from global 'adaptation' funds.

Identification of actions and actors to adapt to climate change

The study identified a range of actions that would be effective starting points for adapting to climate change. The objective of the study focused on costing action, and did not attempt a complete catalogue and screening of options.

1. Current vulnerabilities, resource management and adaptive strategies in agriculture reflect actors at different levels and roles.

No single actor will solve adaptation in the agricultural sector. Clear assignment of institutional responsibility for coordinating climate change adaptation in a country will enhance effective action at all scales. Strengthening the integration of 'agents of change' at the local to district level into national processes and plans is essential.

Similarly, funding for agricultural development and climate change adaptation must be invested at all scales – national, district and local – to achieve the best impact in the short and long term. Funding should target actors who bridge scales and play several roles in order to enhance overall effectiveness. Only through inclusive planning will these actors be identified and involved.

2. Agricultural institutions should drive mainstreaming adaptation into existing strategies, plans and processes.

A promising start has been made in many countries, notably with the climate change units in agricultural research institutes in Africa that are taking shape. Building capacity at this operational level is a sound investment: training partnerships, knowledge management and pilot projects are enduring strategies.

Institutional change at national level is required to ensure that climate change is integrated in all agricultural development activities, policies and development plans. Lessons learned in developing effective agricultural strategies should support adaptation in other sectors. Operational ministries should mobilise effective coordination, access to funding, and knowledge-led capacity. This does not necessarily imply creation of new institutions, but optimising or streamlining the way in which existing institutions function.

3. The urgency of investing in agricultural adaptation, as part of a broad development strategy, is further supported; however, the complexity of future agricultural systems means there is low confidence in projections of the cost of adaptation over the next 30 years and beyond.

Sufficient evidence is widely available to promote a range of effective adaptation pathways, from early warning to better use of existing climate information, natural resource management to disaster risk reduction, and scaling up from pilot actions to sectoral resilience. This is well illustrated in the Malawi case study, where a wide range of activities is already being implemented on the ground. Though they are not termed 'climate change adaptation activities', they essentially address climate-related stresses one way or the other, and several could be implemented at the same time in one community.

Further assessments will be instrumental in scaling up lessons learned; developing innovative technical, financial and institutional instruments; and preparing to adapt to the more challenging scenarios of climate change beyond the 2030s.

However, capacity to undertake economic assessments of agricultural adaptation is limited. A real-world focus on decision making is essential, linked to participatory approaches for understanding local choices as well as formal methods to identify costs and benefits. Institutional assessment and transformation are part of the adaptation landscape.

Figure 5: An ensemble of adaptation strategies is required, urgently.