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Costing agriculture's adaptation to climate change

Climate change poses a major challenge to agriculture. Rising temperatures will change crop growing seasons. And changing rainfall patterns will affect yield potentials. Underinvestment over the past 20 years has left the agricultural sector in many developing countries ill-prepared for the changes ahead. Policymakers and researchers alike acknowledge the need for adaptation within agriculture. But what action should be taken? And, more importantly, how much will it cost? Five case studies — of specific agricultural systems in Bangladesh, Malawi, Nepal, Rwanda and Tanzania — provide fresh insights into the options available and likely costs, which are at least US$20,000 for an integrated cropping system in a village, and may well be more than US$100 million for a whole sector such as livestock in a country.

Policy pointers

- **Effective adaptation in** agriculture follows a pathway that begins with development, combines a range of strategies and actions, and ends in climate protection; research, extension and institutional capacity building cut across all agricultural systems and timescales.
- **There is no universal** approach to planning adaptation to climate change: effective strategies vary across agricultural systems, and over space and time; so do the costs.
- **Adapting agriculture in** developing countries to climate change will require far more investment than is likely to emerge from global adaptation funds.
- **Effective adaptation requires** investments at local, district and national levels.

A wicked problem

Political scientists call problems 'wicked' if they are complex, contradictory, intractable and apparently insoluble. By these criteria, climate change is undoubtedly a wicked environmental problem. Its definition depends on how it is framed and by whom. Its impacts are hard to predict and vary enormously over time and space. And despite years of UN negotiations, world leaders remain unable to strike a global deal for tackling it.

Adapting agriculture to climate change is equally problematic. The one thing that is clear is that time is running out. Across the world, agriculture is already suffering adverse impacts from climate change. There is a limited window for action to ensure a robust agricultural system that can withstand the more serious consequences projected for the future. But different stakeholders see adaptation in different ways. So while the International Food Policy Research Institute advocates more research, the UN Conference on Trade and Development highlights issues in global trade; and most development agencies concentrate on boosting sustainable development, poverty reduction and social protection.

A large part of the problem is the diversity of variables, states and processes that exist in developing countries; and the different ways in which these interact with global conditions. This makes it very difficult to predict how agriculture will develop and be affected by climate change in terms that provide robust targets for adaptation.

For example, while climate models generally predict a warming in almost all areas, they vary significantly in predictions for agro-ecological zones particularly with regards to rainfall. Additional uncertainty about the future of environmental services, especially soil quality, adds to the difficulty in making predictions that can inform adaptation planning for specific adaptation actions now.

Agricultural systems are also complex, with links across scales and sectors. This means that the impacts of climatic events have multiple dimensions. 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 next few decades is impossible in most situations.

Adaptation pathways

The truth is that climate models have limited value for specific, long-term planning at the local level. But uncertainty about medium- and long-term futures is no reason for complacency or inaction now. Global predictions may be uncertain but there is still much knowledge about the sensitivity of individual agricultural systems to climate change, and a well-documented set of agricultural strategies for managing climate-related risks.

Today's decisions can shape tomorrow's adaptation options

Adaptation options in agriculture are shaped by a combination of climate, development and environmental considerations and there is no single planning approach that suits every community or country.

But thinking of adaptation as a 'pathway' of social, economic and institutional change can help actors to adjust to known climatic and developmental stresses while learning how to adapt to future climates as better information becomes available.

From this perspective, adaptation is a bit like a journey: decision makers follow various pathways through the adaptation landscape. Of course there are many such paths, all local in some respect but sharing common features as well. Each pathway is made up of a sequence of 'decision nodes' — crossroads where the decisions and actions taken by several actors define future directions. The choices available are influenced by external factors such as input and output prices, technology and weather information. And the decisions made depend on who's making them, current priorities and a consideration of future conditions. For example, over the coming ten years, agriculture could be shaped by growing demand from China, which is already leading to acquisition of large farms in developing countries.

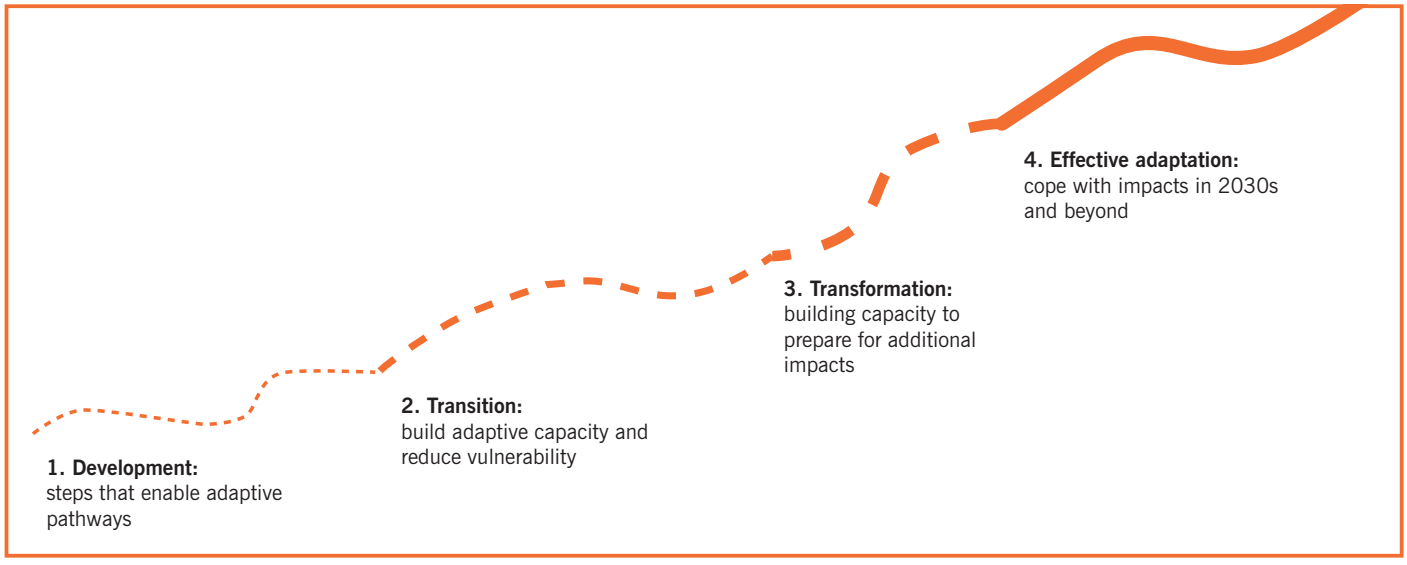
In many cases, the first steps on an adaptation pathway will have little to do with climate change per se. Rather, they will address inefficiencies in agricultural systems — such as the lack of rural roads to get produce to export and urban markets — and pressing local development needs. This type of initial investment lays the foundations for more adaptive systems that enhance economic development and livelihood security and enable actions to cope with new impacts (see Figure).

The shape of adaptation pathways over time is influenced by several factors. In many cases, today's decisions can shape tomorrow's options. The decision to gather new information or train new actors now could significantly expand choices later. For example, establishing a network of weather stations now opens up the future option of weather insurance, which requires at least ten years' of data to establish baseline risk. Conversely, investing in major water reservoirs now precludes other adaptive options later.

Deciding on action is not simple. Despite imprecise predictions, we know that climate change will affect agriculture in many ways. It will, for example, lead to:

- direct weather impacts on crop yields (including the so-called indirect effects of carbon dioxide enrichment);
- shifts in production regions, through both direct weather effects and comparative advantage and trade issues;
- reduced labour productivity due to extreme working conditions, especially heat waves;
- loss of facilities from extreme events;
- changes in environmental services such as soil quality and water resources;

Figure. Adaptation as a pathway from development to climate protection



- disruptions to supply chains by climate events (or new supply chains as Arctic sea ice melts);
- increased energy prices and food production and shipping costs;
- changes in the quality of foods and nutrition, linked to changes in consumer preferences; and
- policy-led shifts, such as the push for organic farming or local production.

Each one of these potential impacts will require its own set of adaptation strategies and measures. To achieve full climate resilience, adaptation in production will have to be complemented with investment in supply chains, sectoral policies and consumption, nutrition and health.

But there are broad actions — from inclusive planning to effective cross-sector coordination — that can provide effective starting points for adapting to climate change (see Laying the ground for agricultural adaptation).

Costing adaptation

The big question for policymakers is how much will all this adaptation cost? There's a wealth of global studies to suggest that the cost of not adapting agriculture to climate change will equal roughly five per cent of GDP beyond the 2050s.

But these studies often shy away from calculating how much it will cost to adapt agriculture to climate change. The few attempts that have been made offer a wide range of estimates, from US$5 billion to more than US$100 billion each year by the 2030s.

Such estimates are far from accurate. They do not reflect many economic processes — from social protection to trade dislocations — that are known to affect adaptation costs. They have not been well-validated against either local to national studies, or detailed models of sectoral production, trade and consumption. And very few include investment that would otherwise be considered 'development' as a broad and necessary foundation for adaptive capacity.

Putting a single price-tag on adaptation across all the world's agricultural systems is difficult. Top-down approaches to estimating global costs cannot accurately reflect the full diversity of agro-ecological systems, local contexts and the myriad ways in which both are affected by climate change.

But bottom-up approaches cannot easily be aggregated into reliable global estimates because small-scale estimates of adaptation costs are highly sensitive to local contexts, pathways and assumptions. For example, whether you include development activities within adaptation or not can result in a range of estimates of at least an order of magnitude. Excluding them could make actions ineffective.

Nevertheless, local and national assessments that consider specific agricultural systems and reflect realities on the ground can help inform donors, and local and national decision makers of potential adaptation costs.

A series of recent case studies in Bangladesh, Malawi, Nepal, Rwanda and Tanzania aim to do just that. Each study focused on a different agricultural system, documenting local adaptation pathways and evaluating possible costs.

Each included an estimate of how much adaptation would cost — at the scale for which adequate data and assessment were available (see Table on back page).

The adaptation goals varied across the studies, as did actions required to support those goals. So while priorities in Bangladesh were to breed and distribute salt-tolerant varieties of rice throughout the whole country to help farmers adapt to increasing salinity, in Malawi, the priorities focused on strengthening market infrastructure within an individual district.

In most of the cases studied, decision makers remain in early stages of the adaptation pathway and adaptation actions sit squarely within the realm of 'development'. In Rwanda, for example, many actions to improve smallholder coffee production are aimed at addressing inefficiencies in coffee farms and washing stations in the short term. But there was also evidence of strategies such as research and development to build adaptive capacity whose benefits accrue in the longer term. And while some of the studies focused on individual villages or districts, study participants recognised that the benefits could be further-reaching. For example, in Malawi, it was thought that the benefits from investing in research and capacity within the district studied could spread to other regions of the country.

Laying the ground for agricultural adaptation

Studies in Bangladesh, Malawi, Nepal, Rwanda and Tanzania identify a range of actions that could help lay the ground for adapting agriculture to climate change.

First is the need to assign institutional responsibility for coordinating adaptation within countries. Adapting agriculture to climate change cannot be done by any single person or organisation alone. Integrating local and district 'agents of change' into national processes and plans will help ensure effective action on the ground. Such inclusive planning can also help ensure the necessary funding for agricultural development and adaptation at all scales.

Second is the need to integrate adaptation into agricultural institutions. The emergence of climate change units in agricultural research institutes across Africa is a promising start for building capacity. But institutional change at national level is also required. Lessons learnt in how to develop effective agricultural strategies should support adaptation in this sector. And operational ministries should mobilise effective coordination, access to funding and knowledge-led capacity.

Third is the need to enable continuous assessment along the adaptation pathway, which is essential to apply lessons learnt, scale up successes, develop innovative technical, financial and institutional instruments and prepare to adapt to the more challenging scenarios of climate change beyond 2030.

Table. Estimates of adaptation costs emerging from five case studies

Country	Adaptation goal	Adaptation actions	Scale	Annual adaptation cost
Nepal	Increasing food production in integrated hill farming systems with mixed cropping	Soil and water management, new seed varieties, local awareness and capacity building	Village	On the order of US$20,000 (about US$70 per target household), excluding the costs of district and national services
Malawi	Strengthening maize-based subsistence farming systems	Market linkages, credit facilities, goods and services provided by the private sector	District	US$55 million
Bangladesh	Modifying food production in marginal areas prone to salinity	Breeding and disseminating salt-tolerant varieties of rice	National	US$10 million initially, possibly rising three-fold by 2030
Rwanda	Improving smallholder cash cropping, especially coffee	Research and development, institutional capacity and marketing	National	US$2.4 million for coffee sector improvement; US$14.2 million for a national agricultural comprehensive climate change strategy (less than US$2 per person).
Tanzania	Protecting pastoral and livestock systems	Early warning, land use planning, research, water provision, migration	National	More than US$280 million (about US$6 per person), possibly rising to US$2.7 billion by 2030

The funding challenge

The local and national assessments made through these five case studies offer pioneering estimates of adaptation costs in developing countries — although much more work is needed before they can provide the evidence required for sound investment decisions.

The assessments are also indicative of the scale of funding needed to effectively adapt agriculture to climate change. While they cannot simply be aggregated into a robust global estimate, they do suggest that adaptation costs rise significantly as you scale up from village to district to national levels.

As indicative estimates, these studies also suggest that anticipated adaptation funding will fall short of what is needed to secure agriculture against changing climates.

Global commitments to fund adaptation add up to around US$50 billion each year by the 2020s. Agriculture can only expect to receive a fraction of this amount, perhaps US$10 billion each year. The costs in just the five countries studied would account for nearly half of this amount. 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.

Of course, estimates of adaptation costs are not the same as requirements for public finance. Private sector involvement is already evident at the global and national level. In the Malawi study, it was suggested that almost two-thirds of the US$55 million cost of adapting one district to climate change could be met from private sources (households, small and large businesses). Any assessment of adaptation options and costs must include evaluating and quantifying private sector opportunities. The emerging investment by global agricultural private companies in climate-related research and development must be taken into account not only for its contribution to adaptation but also to ensure compatibility with local priorities and sustainability criteria.

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Further reading

■ Tumbo, S. *et al*. 2011.*Costing and planning of adaptation to climate change in animal agriculture in Tanzania*. IIED, London. ■ Mainuddin, K. *et al*. 2011. *Planning and costing agriculture's adaptation to climate change in the salinity-prone cropping system of Bangladesh*. IIED, London. ■ Matiya G. *et al*. 2011. *Planning and costing agricultural adaptation to climate change in the small-scale maize production system of Malawi*. IIED, London. ■ Paudel, B. *et al*. 2011. *Planning and costing of agricultural adaptation with reference to integrated hill farming systems in Nepal*. IIED, London. ■ Ngabitsinze, J.C. *et al*. 2011. *Planning and costing adaptation of perennial crop farming systems to climate change: Coffee and banana in Rwanda.* IIED, London. ■ Downing, T. *et al*. 2011. *Planning and costing agriculture's adaptation to climate change: Policy Perspectives.* IIED, London.

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