Info Note

The economic advantage: assessing the value of climate change actions in agriculture

Economic evidence from research by IFAD, CGIAR and partners

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Key messages

- The majority of nationally determined contributions (NDCs) to the Paris Agreement express intentions for actions on climate in the agriculture sector, but economic assessment is weakly developed to date.
- Credible economic and financial proposals are needed to unleash large-scale public and private investment in agriculture under climate change.
- Globally there is a strong economic case to invest in agriculture for future food security and rural livelihoods under climate change.
- At the farm level, positive economic returns can be demonstrated for practices that build adaptive capacity and reduce emissions intensity across several of the priority sub-sectors highlighted in the NDCs.
- Policy development, capacity-building, institutional strengthening, services to provide finance, information, extension and research, and programme management are important investments that support climate actions in agriculture, but are difficult to quantify and value.
- The ingredients of a strong economic assessment for NDCs and other climate change plans for agriculture include: policy mainstreaming, iterative planning, a balance of project-level and farm-level assessment of costs and benefits, understanding of how costs and benefits are distributed, and appraisal of drivers of behavioural change, economic incentives and the enabling environment for farmers and other private-sector actors.

Download the full report:
bit.ly/EconomicAdvantage

This brief summarizes an International Fund for Agricultural Development (IFAD) report: *The Economic Advantage: assessing the value of climate-change actions in agriculture*. The report informs readers who seek to build economic evidence in support of the inclusion of actions on agriculture in climate change plans and programs, particularly at the national level, for example the nationally determined contributions (NDCs) to the December 2015 Paris Climate Agreement, National Adaptation Plans (NAPs) and related policy instruments.

Agriculture and economics in the Nationally Determined Contributions

Agriculture is a sector especially sensitive to climate change. It also accounts for significant emissions and is, therefore, a priority for both adaptation and mitigation plans and actions at global, national and local levels. The majority of NDCs, which are voluntary national submissions for post-2020 action under the Paris Agreement, express national-level intentions for action on adaptation and mitigation in agriculture: 84% of intended NDCs propose mitigation actions in agriculture and land-use sectors and 92% of intended NDC adaptation plans prioritize agriculture (Richards et al. 2016).

However, economic assessment and financial analysis of agriculture in NDCs, and in related plans, like national adaptation plans (NAPs), are weakly developed to date. A small number of countries have proposed overall costs for implementation, but have not provided detailed assessment, particularly not of the expected distribution of returns at farm level or national level over time. More credible economic and financial proposals with a high likelihood of delivering meaningful returns are needed to unleash large-scale public and private investment in agriculture under climate change.

The global economic case for investing in agriculture under climate change

Globally, there is a strong economic case to invest in agriculture for future food security and rural livelihoods under climate change. For example, the world's largest programme for smallholder farmers' adaptation, IFAD's Adaptation for Smallholder Agriculture Programme (ASAP), will deliver globally positive returns to investment across a range of climatic futures if adoption rates are high. Ex-ante economic analysis shows that the 32 country-level ASAP investments approved since 2010 will generate and redistribute net worth US$0.44-1.63 per dollar invested over a timeframe of 20 years to smallholder farmers and other project beneficiaries, generating a mean net present value of US$6.8 million over the period (Figure 1).

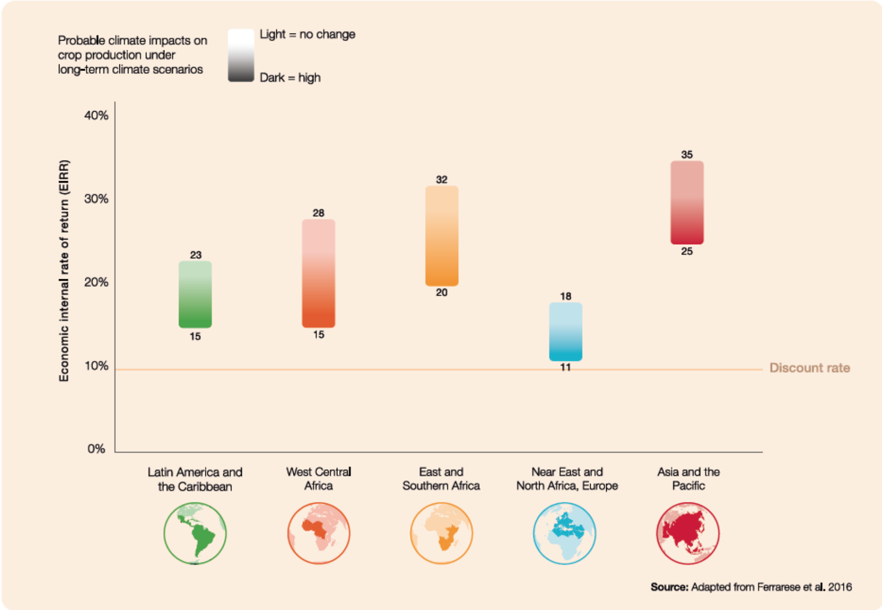

Figure 2. Rate of return of ASAP investments across lower and higher climate impact in five regions

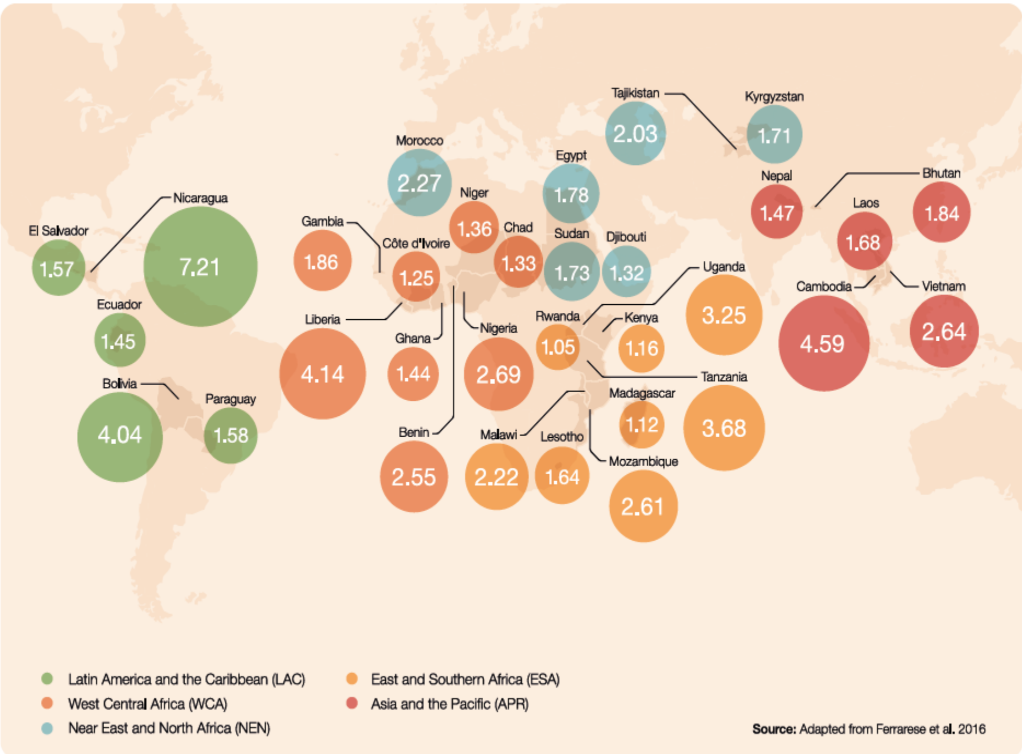

Figure 1. Benefit-to-cost ratios of ASAP investments in 32 countries

A similar ex ante rationale for investing in agriculture under climate change is also apparent from a commodity perspective instead of a country perspective. For example, simulation of two of the most promising climate-related technologies in rice cultivation, alternate wetting-and-drying and urea deep placement, show benefits to global production of around 5%, which in turn translate into commodity market price reductions of 16-17% (De Pinto et al. in process). The inclusion of the global trade model shows that there are net benefits to both nutrition and emissions reductions globally, leading to a global reduction in the risk of hunger of 12-13 million people and reducing net global greenhouse gas emissions from rice by 7-9%. Two caveats are that adoption is assumed as 100% and impacts on farmer incomes are not considered.

The analysis also shows that returns from ASAP are robust across a set of climatic futures (Figure 2). At the higher end of climate change impact, losses to crop yields are estimated at 27-40% below expected mean values without climate change (at the lower end), but the economic returns to project investment remain greater than the opportunity costs of capital, at a discount rate of 10%.

Country programmes like ASAP and technologies like urea deep placement are not silver bullets – the economic assessments show these to be part of the toolbox for meeting the challenge of climate change, rather than blanket solutions for future food security and farmer livelihoods.

Economic evidence on farm-level practices

Priority sub-sectors highlighted in the NDCs include (in order of number of inclusions across mitigation and adaptation actions) soil and land, water crops, livestock, fisheries and trees. Positive economic returns can be demonstrated for multiple practices that build adaptive capacity and reduce emission intensity across each of these sectors. The full Economic Advantage report provides a full overview and links to further resources. Some examples are:

- *Soils and land*: In a review of tillage practices in the Indo-Gangetic Plain, net returns from zero-tillage were US$97 higher than conventional tillage (Erenstein and Laxmi 2008). By contrast, a six-year study in Zimbabwe found negative net present value for switching from conventional tillage to conservation agriculture, which includes zero tillage (Mafongoya et al. 2016).
- *Livestock*: Studies from Uganda and Kenya showed net returns of US$62-US$122 per year for supplementary feeding with nitrogen-fixing *Calliandra* species (Dawson et al. 2014). More generally, in dairy systems, increases in milk yield have been shown to correlate with decreases in emissions intensity (Gerber et al. 2013) and increases in gross margins.
- *Crops*: Optimization of N fertilization rate (e.g. using optical sensors that allow field-specific application of fertilizer) has been shown to increase net returns on a per hectare basis in India and Mexico. Other practices that reduce greenhouse gas emissions from fertilizer, such as shifting from urea to ammonium sulphate or nitrate, use of controlled-release fertilizers, nitrification inhibitors and fertilizer deep placement are at present not generally financially viable at the farm level (Basak 2016).
- *Water*: A study of water harvesting, with supplemental irrigation, of sorghum and maize estimated a net profit (per hectare per year) of US$151-US$626 in Burkina Faso and US$109-US$477 in Kenya, compared with profits from existing farm practices of US$-83 for the Burkina Faso case and US$40-US$130 for the Kenya case (Fox et al. 2005). Positive net returns are dependent on nutrient inputs to obtain high crop productivity, or else the initial costs outweigh the economic benefits (Biazin et al. 2012).
- *Fisheries*: Genetic improvement of aquaculture species has shown positive returns at farm and at programme level for Nile tilapia (Ponzoni et al. 2007).
- *Trees*: In a large-scale study, the majority of 56 agroforestry systems had positive net present value using a 20% discount rate (Mercer 2004; Current et al. 1995). More specifically, the marginal rate of return for adding banana to mono-cropped coffee in Uganda was 911% in *arabica* and 200% in *robusta*-growing regions (van Asten et al. 2011).

Importantly, the economic performance of agricultural practices is highly context-specific and may take several years to deliver positive returns. This is illustrated by the two contrasting examples on zero tillage above. Evidence is emerging too that portfolios of actions may deliver better outcomes than single interventions. In the livestock sector, for example, combining pasture management with improved breeds, watering systems and supplementary feeding can double gross margins while conferring adaptation and mitigation benefits.

Economic evidence on national-level and project-level investments

Adaptation and mitigation in agriculture involves far more than new technologies and infrastructure. Equally critical will be investments in institution-building and capacity-building, in services to provide finance, information, extension and research, in policy and legal frameworks and in programme management, particularly for monitoring and evaluation. These categories overlap considerably in real programmes, so it is impossible to derive completely accurate analyses or guidance for how best to allocate funds or to understand resulting benefits. Nonetheless, a superficial assessment of spending

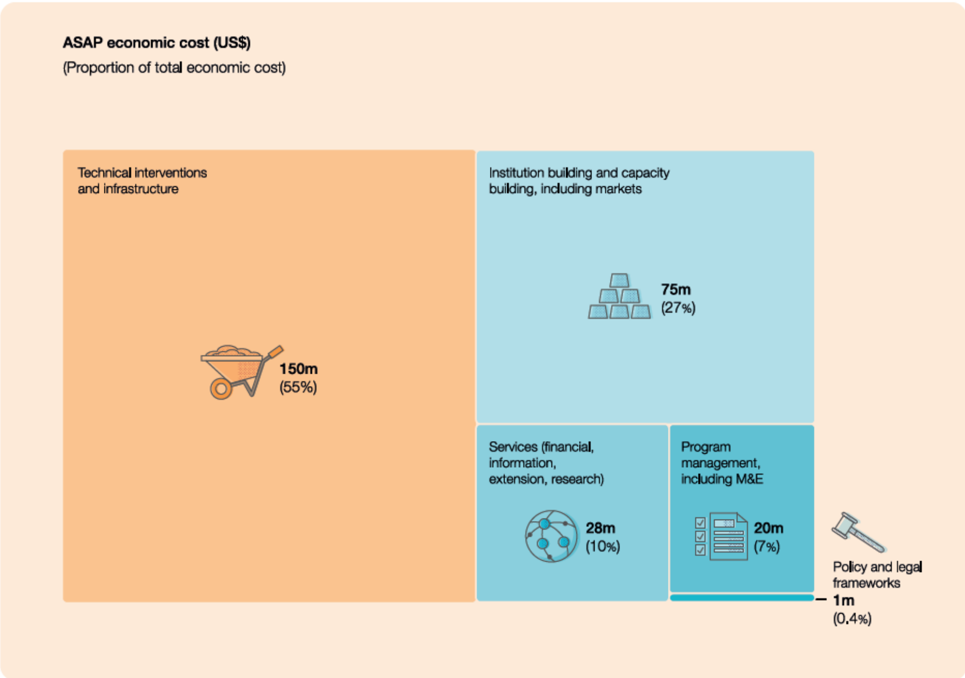

Figure 3. Globally aggregated distribution of spending across ASAP-supported activities

categories of IFAD's ASAP shows a very substantial level of investment in non-technical, non-infrastructure activities (Figure 3).

All of these types of options – institution-building and capacity-building, services, policy and legal frameworks and programme management – will be important within NDCs, NAPs and other climate change plans at the national level, but are challenging to assess through quantitative economic appraisal. Financial, information and knowledge services are perhaps the best understood in terms of economic analysis, as the following examples show.

- *Weather and climate-information services* have generated a reasonable literature to inform economic assessment. Analysis by the World Meteorological Organization shows that benefit-to-cost ratios for national hydro-meteorological services are positive in all reviewed cases globally (WMO 2015). Improvements in climate-information services to reduce disaster losses at the national level have benefit-to-cost ratios of 4:1 to 36:1. Household-level benefit-to-cost ratios are also positive.
- *Index-based weather insurance* is increasingly promoted as it overcomes challenges of moral hazard and high transaction costs, which made traditional loss-based crop insurance unfeasible for smallholder farmers. Empirical studies show that insurance can improve farm livelihoods, by reducing loss of productive assets and enhancing adoption of agricultural innovations. Low demand for, and trust in, insurance products among farmers may limit benefits at scale, but evidence suggests that better design can rapidly improve uptake of insurance (Greatrex et al. 2015).
- *Knowledge services, research and development* are widely understood as critical to climate-change actions in agriculture. For example, empirical evidence shows that access to knowledge increases women farmers' propensity to adopt climate-change innovations (Twyman et al. 2014). Over a third of submitted INDCs outlining intentions on adaptation specifically refer to knowledge systems, knowledge transfer and indigenous knowledge (Richards et al. 2016). Several economic appraisals show positive returns from research to climate-sensitive agricultural livelihoods.

Development of policy-based actions may not comprise a major cost component in NDCs or related instruments, but it can provide major leverage for behaviour change among farmers and other value-chain participants. An ex-ante economic analysis of the costs and benefits of climate-adaptation policy in four countries (Malawi, Tanzania, Bangladesh and India) examines returns to public policies and programs in climate-related research and extension, input quality and availability, water availability, market access and infrastructure and improving value chains (Cacho et al. 2016). The study shows positive economic returns to policy and associated investment in these programmatic areas, including significant improvements in a composite resilience indicator, particularly in South Asia. Notably, a key finding is that meeting the size of the climate-change challenge will require a package of integrated policies, rather than a selection of single best-bet policy interventions.

To justify increasing investment in policy interventions – for example, increasing the US$1 million in global ASAP policy and legal framework interventions (Figure 3) – there are ways to track the benefits of policy outcomes that go beyond economic and financial modelling. IFAD is currently developing methods to measure the impact of policy engagement across its project and grant portfolio.

Understanding incentives for, and drivers of, behavior change

Demonstration of positive economic net benefits or financial returns at farm level, such as benefit-cost ratios, net present value or internal rate of return, does not necessarily mean that farmers will adopt the new practices. Some practices take several years or particular farming conditions to generate positive returns, while others may be slow to gain popularity for reasons of regulations, culture, trust, information, finance or other barriers.

Economic assessments therefore need to include not only cost-benefit analyses but also adoption behaviour analyses, to understand the drivers of adoption of new practices, and the incentives that are likely to work to promote farmers and firms to deliver public goods. Some drivers, incentives and enablers of adoption of new agricultural practices under climate change may be generic across many regions of the world. For example, analysis of adaptation behaviours in CCAFS-CGIAR research sites finds that two drivers – membership of farmers' organizations and access to climate information – are somewhat universal across countries and continents (Figure 4). Other drivers, such as physical assets, are important at only a minority of sites (Chen et al. in process). We can also understand better the reasons that people give for changes in behavior. At the CCAFS-CGIAR research sites, farmers across all sites say that they make changes in response to both markets and to climate variation, although markets are a more widely shared reason than climate (Figure 4).

This data analysis across multiple sites (Figure 4) also points to the importance of understanding farmers' behaviours and preferences within the context of different scales of time and space. Farmers across Asia, Africa and Latin America widely report that markets are a key driver of their on-farm practices and choices; markets provide a link between actions at the farm level and actions at the national and international levels. Due to causal links across scales, farm-level costs and benefits at best only part of the story. Improved practices that increase yields at scale will shift the supply-demand equilibrium and in most cases reduce producer prices, which in turn will have a damping effect on uptake of the new practices. This may explain low adoption rates of innovations, such as drought-resistant seed in sub-Saharan Africa, for example. Thus, iterative analyses at different scales are needed, covering both private and public good outcomes. Ideally economic assessments need to be situated in a wider "theory of change" – a plausible storyline about how innovations in policy and investment will lead to outcomes for adaptation, mitigation, farm livelihoods and food security.

Understanding the distribution of benefits and costs

While investments can be shown to generate strong economic and livelihood benefits at the project level, there is no guarantee that all farmers and intended beneficiaries will take a fair share of this value. Information on heterogeneity within farming communities, such as demographic information, income, education, farm size, household labour and current climate risks, all help to target investments and assure higher adoption of practices and scaling for greater impact.

For example, an economic study in Tra Vinh and Ben Tre provinces in Vietnam where the IFAD program is being implemented (Lan et al. 2016) shows how the attractiveness of practices differs among social classes. For example, ASAP promotes planting of coconut and sugarcane in areas no longer suitable for rice cultivation (due to rising salinity or reduced water availability) and farmers concur that this is a high priority action. Higher-income farmers may be better able to make this shift, as the initial cost is a relatively small proportion of their annual income, but may have less interest given that their income dependency on rice is only around 10%. For lower-income farmers, shifting rice to coconut and sugarcane requires significant initial investment, equivalent to 67% of income – but would be attractive under extreme climate conditions for rice if financial support were available.

Integrating climate plans and agricultural plans

There is an increasing emphasis on mainstreaming adaptation and mitigation into current policy and development, rather than implementing measures as stand-alone activities. The challenge for the NDCs and other climate policy instruments is to shift underlying growth and development pathways towards low-carbon pathways and climate-resilient growth. Several tools are available to help integrate consideration of climate change into the agriculture policy cycle (see recommended resources below), and economic assessment can play a role at several stages, including situation analysis, targeting and prioritization, program support and monitoring, and evaluation and learning.

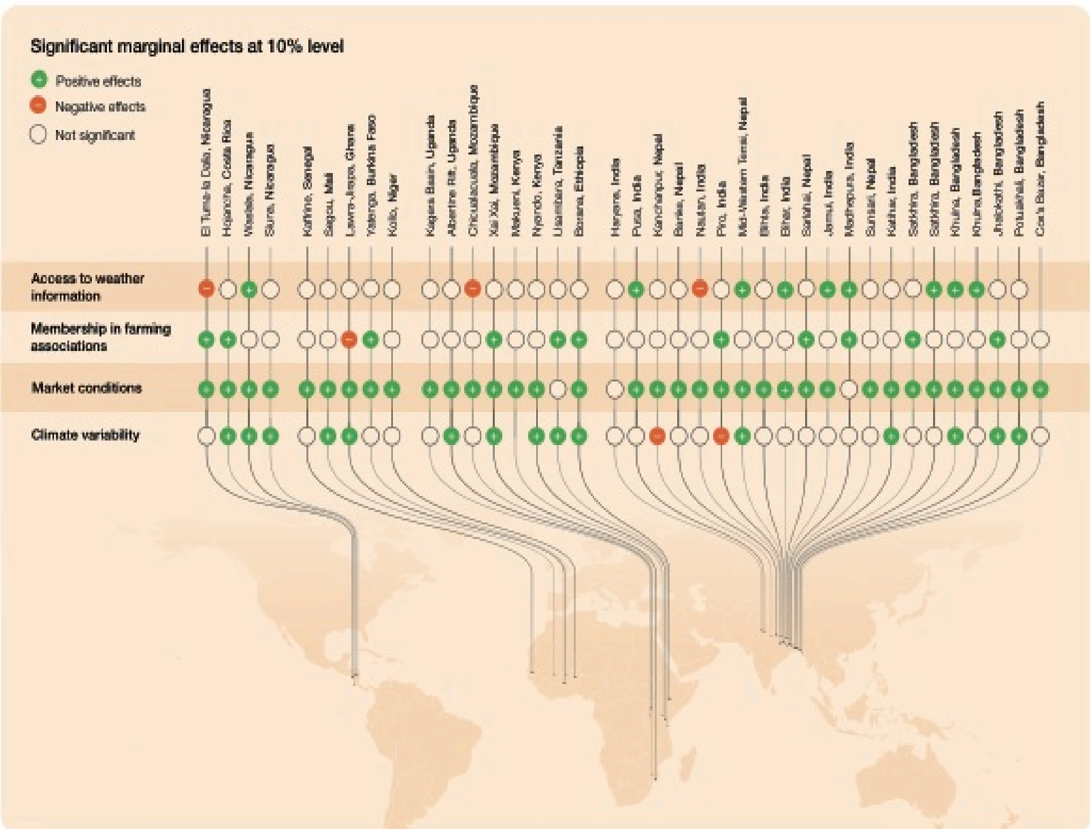

Figure 4. Map showing importance of four key factors – weather information, farmer organizations, markets and climate variation – correlated with adaptation at CCAFS-CGIAR research sites

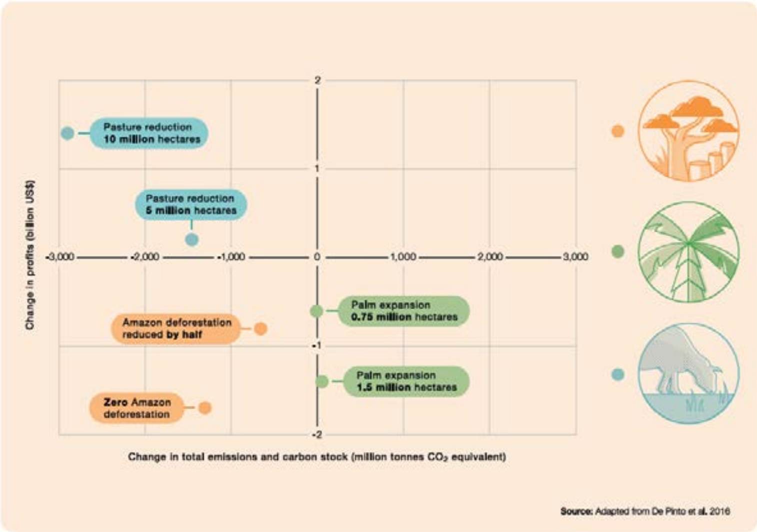

Figure 5. Synergies and trade-offs between profits and emissions reductions in Colombia

One critical role for economic assessment is to assess potential trade-offs in the agriculture sector, particularly between mitigation and economic growth. In developing the NDC in Colombia, the government assessed how different agricultural development options deliver on both emissions reductions and private profits (Figure 5). The results strengthened the case for government programs to support pasture reduction, which delivers both higher profits and emissions reductions (De Pinto et al. 2016).

The impacts of climate change, and thus of adaptation benefits, primarily arise in the future. This creates a particular challenge in terms of economics. Early action to address longer-term risks will incur costs in the short-term, but these are difficult to justify as benefits arise much later on, while individuals and society generally prefer to pay for goods and services received now rather than later. This is compounded by the fact that climate change involves high uncertainty. These challenges can be overcome with the use of iterative climate risk management, as recommended in the IPCC Fifth Assessment Report (Chambwera et al. 2014).

Pragmatic iterative climate-risk management can address the specific challenges of climate change in agriculture by proposing sets of actions in three different timeframes: (1) immediate actions to address current climatic risks and variability, (2) integration of adaptation into current investments with long lifetimes, and (3) early monitoring, research and learning to prepare for the future impact of climate change (Figure 6).

Conclusion: Ingredients of a robust economic assessment for climate actions in agriculture

More robust economic assessment will help to release greater finance for climate action in agriculture, and to ensure higher likelihood of positive outcomes for food security and emissions reductions. Climate change plans for the agricultural sector need to be based on solid economic assessment that includes:

- *Mainstreaming with development policy* of climate actions into agricultural sectoral development plans, rural development plans, green growth strategies, and nutrition and health, gender equality and environmental protection policies
- *Iterative planning* that specifies actions and economic assessments at three different timeframes to address current near future and longer term climate risks
- *A balance of national-level, project-level and farm-level assessments of costs and benefits*, drawing on the growing body of economic evidence in the agriculture sector
- *Analysis of distribution of costs and benefits*, over time and among different social groups
- *Appraisal of adoption behaviours, economic incentives and the enabling environment* for farmers and other private-sector actors, within an overall theory of change

To be successful, NDCs and related climate policies such as National Adaptation Plans will need to deal create tangible economic returns within five years, not twenty. At the same time they will need a vision for a future in which food security and rural development are likely to be vastly different from today, with much uncertainty around climate, demography and geopolitics. Thus plans for

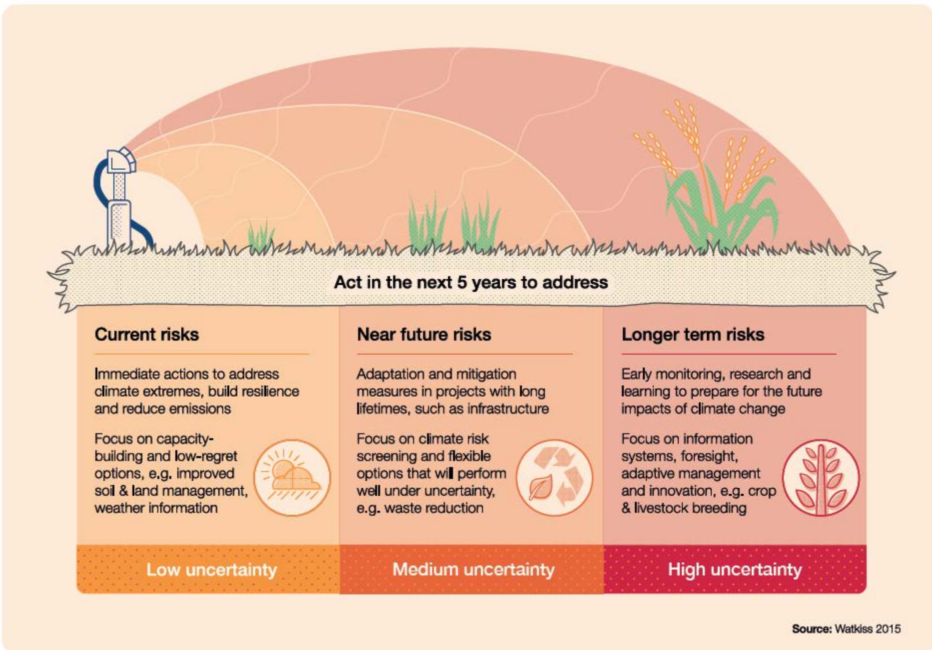

Figure 6. Action on climate change at three timeframes

near-term economic returns to farm profitability, jobs, emissions reductions and other benefits need to be complemented with mechanisms for more transformative change, which address the root causes of climate vulnerability, long-term sustainability and social equity. While NDCs do not yet collectively deliver on the global target to keep mean surface temperature rise below 2C, the more ambitious NDCs signal transformative actions to meet the global challenge of climate change.

Recommended resources

Analysis of agriculture in INDCs: Database and maps on inclusion of agricultural mitigation and adaptation in INDCs, including analysis of inclusion of specific measures and finance requirements. http://hdl.handle.net/10568/69115

CSA Country Profiles: Give an overview of the climate change challenges and solutions in selected countries in Latin America and the Caribbean, Africa, Asia and Europe. https://ccafs.cgiar.org/publications/csa-country-profiles

CSA Guide: Guidance for practitioners, decision makers, and researchers for implementing Climate-Smart Agriculture projects and programmes. Includes guidance on entry points for interventions, planning, financing, and monitoring and evaluation. https://csa.guide/

EconAdapt: Supports climate change adaptation planning by providing user-oriented methodologies and evidence relating to economic appraisal criteria.Decision areas covered include extreme weather events, long term adaptation, financial instruments including overseas development assistance for adaptation. http://econadapt.eu/

EPIC: Economics and Policy Innovations for Climate-Smart Agriculture (EPIC) programme, supports formulation of investment proposals, provides advice on the formulation and implementation of policies, and conducts research on impacts, effects, costs and benefits as well as incentives and barriers to the adoption of practices. http://www.fao.org/climatechange/epic

FAO Investment Centre: Supports increased and more effective public and private investment in agriculture and rural development, working directly with governments and other investors, and providing practical online resources including guidelines, reviews of good practices, country case studies. http://www.fao.org/investment/ourwork/en/

NAMA Facility: Support to preparation of NAMAs http://www.nama-facility.org/start.html

NAP Support Portal: Guidance on preparation of NAPs, including data & analysis https://unfccc.int/adaptation/workstreams/national_adaptation_programmes_of_action/items/7279.php

UNDP Designing and Preparing NDCs: Guidance on preparation of NDCs, including data & analysis http://www.undp.org/content/undp/en/home/librarypage/climate-and-disaster-resilience-/designing-and-preparing-intended-nationally-determined-contribut.html

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IFAD Investing in rural people

This brief summarizes the report "The Economic Advantage: assessing the value of climate-change actions in agriculture" published by IFAD.

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