IFAD OCCASIONAL PAPER 3

Climate-smart smallholder agriculture: What's different?

IFAD
Enabling poor rural people to overcome poverty

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Abstract

There is a growing consensus that climate change is transforming the context for rural development, changing physical and socio-economic landscapes and making smallholder development more expensive. But there is less consensus on how smallholder agriculture practices should change as a result. The question is often asked: what really is different about 'climate-smart' smallholder agriculture that goes beyond regular best practice in development? This article suggests three major changes:

- **First**, project and policy preparation need to reflect higher risks, where vulnerability assessments and greater use of climate scenario modelling are combined with a better understanding of interconnections between smallholder farming and wider landscapes.
- **Second**, this deeper appreciation of interconnected risks should drive a major scaling up of successful 'multiple-benefit' approaches to sustainable agricultural intensification by smallholder farmers. These approaches can build climate resilience through managing competing land-use systems at the landscape level, while at the same time reducing poverty, enhancing biodiversity, increasing yields and lowering greenhouse gas emissions.
- **Third**, climate change and fiscal austerity are reshaping the architecture of public (and potentially private) international development finance. This calls for: (i) new efforts to enable smallholder farmers to become significant beneficiaries of climate finance in order to reward multiple-benefit activities and help offset the transition costs and risks of changing agricultural practices; and (ii) better ways to achieve and then measure a wider range of multiple benefits beyond traditional poverty and yield impacts.

IFAD is actively helping developing countries make these changes according to their differing needs and circumstances. These changes underpin IFAD's various new policy and institutional frameworks, such as the Environment and Natural Resource Management Policy, the Climate Change Strategy, the initiative on climate finance for smallholder farmers (Adaptation for Smallholder Agriculture Programme) and the IFAD Strategic Framework 2011-2015.[1]

1 See links: IFAD Environment and Natural Resource Management Policy (2011); IFAD Climate Change Strategy (2010); Adaptation for Smallholder Agriculture Programme; IFAD Strategic Framework 2011-2015.

Climate-smart smallholder agriculture: What's different?

The context

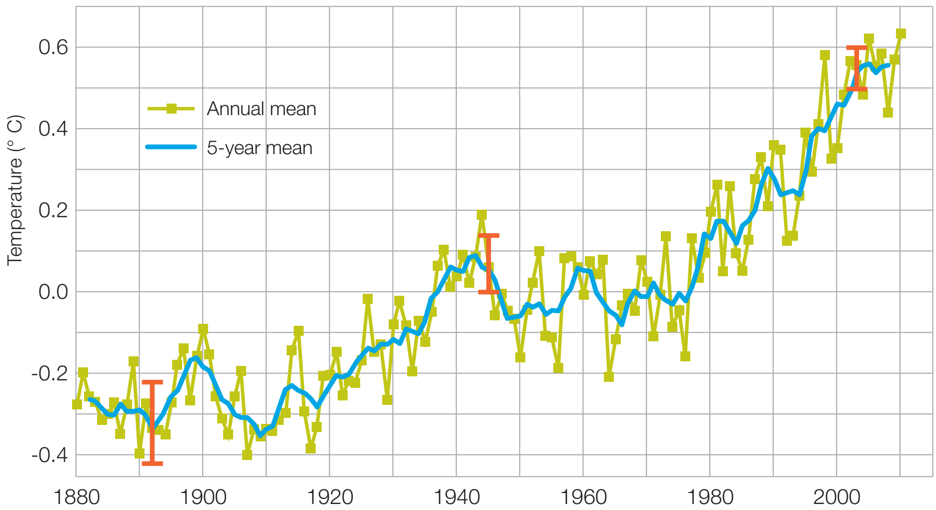
The need for climate-smart agriculture for the world's 500 million smallholder farms cannot be overlooked: they provide up to 80 per cent of food in developing countries, manage vast areas of land (farming some 80 per cent of farmland in sub-Saharan Africa and Asia) and make up the largest share of the developing world's undernourished. As the most vulnerable and marginalized people in rural societies – many of them are women heads of household or indigenous peoples – smallholder farmers are especially exposed to climate change. They inhabit some of the most vulnerable and marginal landscapes, such as hillsides, deserts and floodplains. They often lack secure tenure and resource rights. They rely directly on climate-affected natural resources for their livelihoods.

The need for climate-smart agriculture for the world's 500 million smallholder farms cannot be overlooked

There is growing acknowledgement that agriculture and food systems need to change, irrespective of climate change.[2] The last time the world faced such pressure to find a permanent solution to world food insecurity was in the 1960s and 1970s, when food production and distribution could not keep pace with the growing population (primarily in Asia). The response was the Green Revolution: high-yielding, pest/disease resistant varieties of mainly rice and wheat were introduced and their cultivation was supported through subsidies for inputs such as seed, fertilizer and irrigation.[3]

Agriculture and food systems need to change, irrespective of climate change

Graph 1
Global land/ocean temperature index[4]



Source: NASA

2 See IFAD/FAO/WFP/Bioversity submission on Rio+20, www.uncsd2012.org/rio20/index.php?page=view&type=510&nr=618&menu=20.

3 FAO data.

4 Source: NASA Goddard Institute for Space Studies, www.nasa.gov/topics/earth/features/temp-analysis-2009.html.

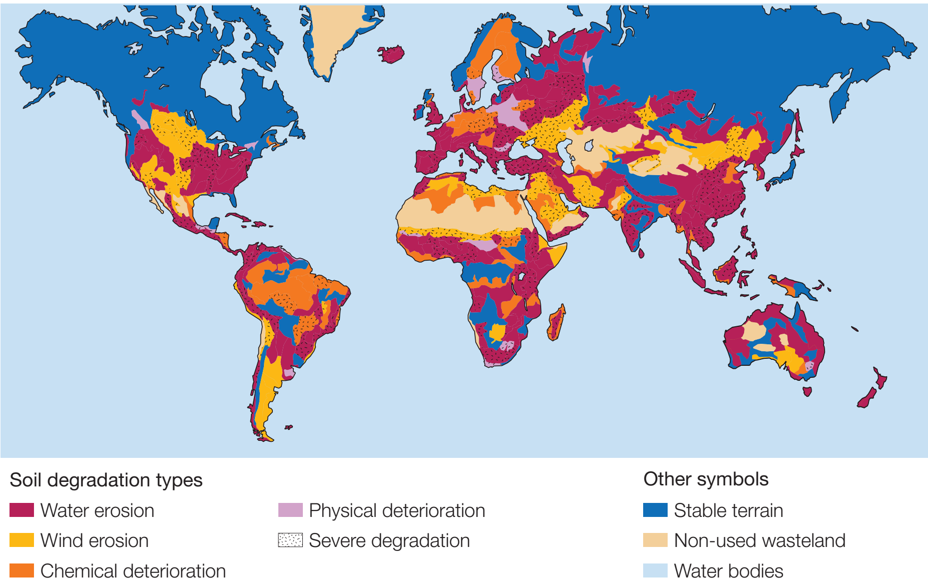
The Green Revolution resulted in spectacular achievements, but its longer-term limitations are driving a rethinking of agriculture

The Green Revolution resulted in spectacular achievements,[5] but its longer-term limitations are driving a rethinking of agricultural best practice.[6] Its focus on monocropping and often-excessive use of agricultural inputs such as pesticides and fertilizers has resulted in poor soil quality, reduction of biodiversity, pest resistance, pesticide and fertilizer pollution in the environment (soil and groundwater) and human health risks. Overuse of irrigation water has resulted in salinization and/or a withdrawal of groundwater beyond its replenishment capacity. These practices were all supported by policies of input subsidies and have led to diminishing returns on further intensification and an excessive burden of subsidies on governments. Besides the stagnation of crop yields, landscapes have been compromised through the overuse of groundwater, the spreading of nutrients and pesticides and encroachment of agriculture into ecologically fragile zones such as mountainous areas, forests and marginal lands.

Land degradation remains an urgent priority

About 1.2 billion hectares (ha) (almost 11 per cent of the Earth's vegetated surface) has been degraded by human activity over the past 45 years. An estimated 5 million to 12 million ha are lost annually to severe degradation in developing countries.[7] The causes include deforestation, biomass burning and agricultural practices such as repetitive tillage and inadequate application of nutrients. The worst affected is sub-Saharan Africa, where per capita food production continues to decline and hunger affects about a third of the region's population. Continued cultivation of marginal areas without adequate management is a major driver of widespread land degradation through deforestation, wind and water erosion, and overgrazing. Map 1 illustrates global land degradation.

Map 1:
Fragility of soil[8]



Source: FAO

5 According to FAO, between 1970 and 2008 India increased its rice production from 63 million to 148 million tons and its wheat production nearly quadrupled from 20 million to 78 million tons. China saw its wheat production rise from 30 million to 112 million tons over the same period, while its rice production increased from 113 million to 193 million tons and its maize production quintupled from 33 million to 166 million tons.

6 See 'best-practice statements' in Annex I of the IFAD Environment and Natural Resource Management Policy (2011).

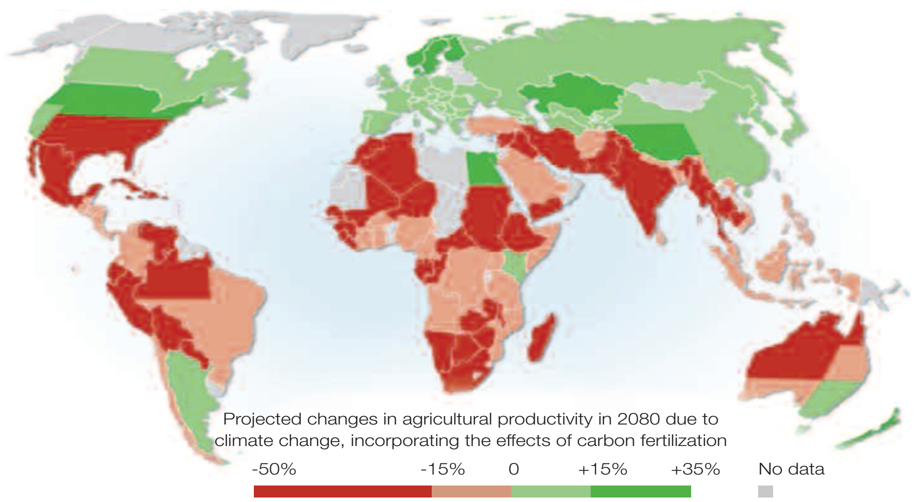
7 IFPRI, *Soil Degradation: A Threat to Developing-Country Food Security by 2020?*, Food, Agriculture and the Environment Discussion Paper 27 (Washington, D.C.: International Food Policy Research Institute, 1999).

8 Source: www.fao.org/docrep/004/y3557e/y3557e08.htm.

Climate change is adding pressure to the already stressed ecosystems in which smallholder farming takes place. Over the centuries, smallholders have developed the capacity to adapt to environmental change and climate variability, but the speed and intensity of climate change is outpacing their ability to respond. Many of IFAD's smallholder partners are already reporting climate change impacts on the key ecosystems and biodiversity that sustain agriculture. In the absence of a profound step change in local and global action on emissions, it is increasingly likely that poor rural people will need to contend with an average global warming of 4° C above pre-industrial levels by 2100, if not sooner.[9] Such substantial climate change will further increase uncertainty and exacerbate weather-related disasters, drought, biodiversity loss, and land and water scarcity. The major cereal crops (such as wheat, rice and maize) are already at their heat tolerance threshold and with an increase in temperature of between 1.5° C and 2° C could collapse.[10] Livestock productivity will be impacted by increased temperature with higher-yielding breeds more likely to be negatively affected than more-robust local breeds. The rise in temperature will, of course, have an impact not only on crops and livestock but also on the pests and diseases they are exposed to. Some farming systems will not remain viable because of climate change, requiring farming system shifts.[11] These 'first-round' effects will be compounded by a second round of socio-economic impacts in terms of economic opportunities and political stability. Map 2 illustrates projected changes in agriculture.

Climate change is adding pressure to the already stressed ecosystems for smallholder farming

Map 2:
Projected changes in agriculture in 2080 due to climate change[12]



Source: Hugo Ahlenius, UNEP/GRID-Arendal.

9 Betts, R.A. et al. When could global warming reach 4°C? in *Four Degrees and Beyond: the Potential for a Global Temperature Increase of Four Degrees and its Implications*, eds. M. New et al. (London: The Royal Society A: Mathematical, Physical & Engineering Sciences, 2011), http://rsta.royalsocietypublishing.org/content/369/1934/67.full.

10 Intergovernmental Panel on Climate Change, 4th Assessment Report; Lobell, D.B. et al. *Prioritizing Climate Change Adaptation Needs for Food Security in 2030* (2008); and presentation by D.B. Lobell, *Towards Food Security in a Warmer World: Understanding Crop Responses to Climate* (2010).

11 For example, where cropping areas are no longer viable for crops and need to shift to livestock, where orchard systems need to shift to some other kind of cropping system or where coffee production is no longer commercially viable for quality coffee.

12 UNEP/GRID-Arendal, Projected agriculture in 2080 due to climate change (UNEP/GRID-Arendal Maps and Graphics Library), http://maps.grida.no/go/graphic/projected-agriculture-in-2080-due-to-climate-change (accessed 20 December 2011).

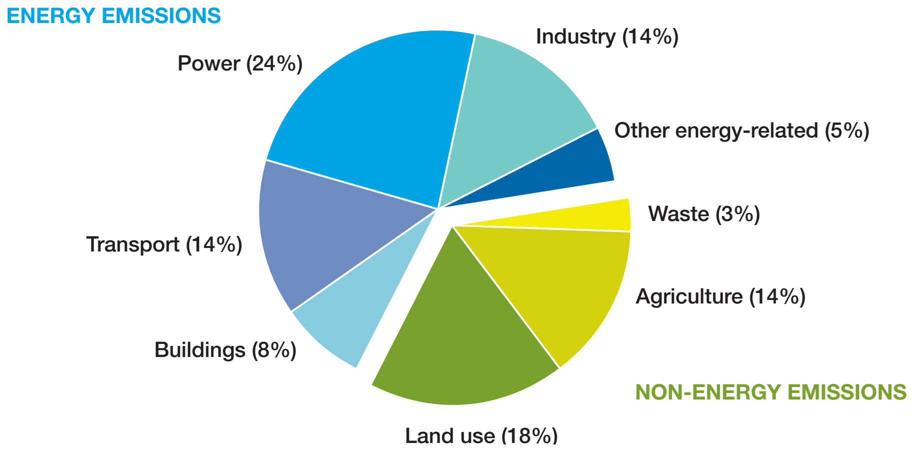
Climate change is making the development of smallholder agriculture more expensive

Climate change is making the development of smallholder agriculture more expensive. At the *project level*, climate-resilient programmes typically have higher upfront design and implementation costs for governments, donors and private investors – for example, the costs of infrastructure, increased upkeep, capacity-building, knowledge generation and the strengthening of institutions, in addition to higher project development costs (downscaled data generation and community-based approaches) and the increased costs in enhancing cross-sectoral and stakeholder collaboration. At the *global level*, the United Nations Framework Convention on Climate Change (UNFCCC) and the World Bank have estimated costs of adaptation that range from US$41 billion to US$170 billion per year by 2030. The annual costs of the climate change adaptation required in developing world agriculture are estimated by the International Food Policy Research Institute (IFPRI) to be in the region of US$7 billion to US$8 billion per year, while the UNFCCC estimates the costs of adapting agriculture to climate change to be from US$11.3 billion to US$12.6 billion per year in 2030. While estimates vary considerably, recent studies suggest costs two or three times higher than earlier estimates[13] and highlight the fact that most earlier studies consider a highly ambitious 2° C stabilization scenario, often without factoring in associated costs such as ecosystem degradation and consequent loss of goods and services critical to agricultural production.

Agriculture is also a contributor to emissions

Agriculture is also a significant source of greenhouse gas emissions. Overall, agriculture accounts for 14 per cent of global emissions, and land-use change for 18 per cent (see Graph 2).[14] While information on the overall share of agricultural emissions by smallholders is not available; it is likely to be significant given the number of smallholder farmers, the amount of land covered and the prevalence of smallholders

Graph 2:
Greenhouse gas emissions in 2000 by source[15]



Source: Stern Review
Total emissions in 2000: 42 $GtCO_2e$.
Energy emissions are mostly CO_2 (some non-CO_2 in industry and other energy related).
Non-energy emissions are CO_2 (land use) and non-CO_2 (agriculture and waste).

13 Parry, M. et al. *Assessing the Costs of Adaptation to Climate Change: A critique of the UNFCCC estimates* (London: International Institute for Environment and Development, 2009).

14 See also www.fao.org/docrep/012/i1315e/i1315e00.htm.

15 Stern, N. *The Economics of Climate Change: The Stern Review* (Cambridge University Press, 2007).

on fragile landscapes. Smallholder farming is the main driver of forest loss in sub-Saharan Africa, largely as a result of the breakdown in traditional shifting cultivation systems (itself attributable in part to population increase) and the lack of alternatives to agricultural extensification. Where soils are naturally poor, unsustainable practices in smallholder agriculture also often drive land degradation, with implications for emissions because of the reduced ground cover.[16]

Three key implications of climate change for rural development programmes

Climate change does not mean throwing out or reinventing everything that has been learned

As a starting point, it is important to recognize that responding to climate change does not mean throwing out or reinventing everything that has been learned about agriculture and rural development. Instead, it requires a renewed effort to tackle wider and well-known challenges. Many of IFAD's programmes are implicitly or explicitly designed to increase the resilience of smallholders and poor communities to shocks, which are often weather-related. A coherent response to climate change requires continued emphasis on, for example, country-led development, community-based natural resource management, gender awareness, targeting of poor rural people, dealing with land tenure issues, improving access to financial services and markets, increasing sustainable productivity, and institutional and human capacity-building. It remains essential to promote good governance and to both empower farmers and recognize the relevance of their traditional and indigenous knowledge in addressing issues such as climate variability, and the differences between women's and men's knowledge and roles in responding to climate change. As set out in Toulmin (2011):[17]

> The root of smallholder vulnerability lies in the marginalisation of farmers, pastoralists and other rural groups in power and decision-making. This is a fundamental problem for smallholders everywhere, and a consequence of their large numbers, weak and costly organisation and consequent very limited political power.

So what's really different?

But beyond regular development best practice, what really is different about climate-smart smallholder agriculture? This paper sets out three major changes, responding to climate change, in how government and donor support to rural development – and smallholder agriculture in particular – is practised. In summary, project designs need to reflect a different context, in which vulnerability assessments, opportunities for payment for environmental services (such as emissions reductions) and greater use of climate scenario modelling are likely to alter the balance of activities and the way these are implemented. In many cases, this will lead to more-rapid scaling up of successful approaches that have already been piloted in various ecosystems, such as agroforestry, sustainable land management and conservation watershed management, but in a way that is fully cognisant of potential climate impact scenarios.

16 See United Nations Environment Programme, Green Economy Report, www.unep.org/greeneconomy/GreenEconomyReport/tabid/29846/Default.aspx.

17 *Toulmin, C. Prospering Despite Climate Change*. Paper presented at the IFAD Conference on New Directions for Smallholder Agriculture, 24-25 January 2011.

FIRST, project and policy preparation need to be based on better risk assessment

First, project and policy preparation need to be based on deeper risk assessment, with a better understanding of interconnections between smallholder farming and wider landscapes. Climate change is now changing the context quickly enough for us to have to think about it in project design. It is a 'threat multiplier' for smallholders, increasing existing livelihood threats and vulnerabilities, rather than an isolated specific risk:

- **Climate change will magnify traditional risks**. Historical averages can no longer be relied on since climate change is increasing variability, the range of extremes and the scale of volatility and risk. For example, historical drought or flooding frequency is no longer a straightforward guide to the future.
- **There will be new sources of risk beyond the traditional ones**, such as sea-level rise and glacier-melt impact on water supply. Smallholder farms will need to increase their general resilience to withstand currently unidentified direct and indirect shocks. New opportunities for greenhouse gas emissions reduction rewards and carbon financing schemes can bring their own risks – for example, if poor people were to remain without access to emissions reduction rewards as a consequence of social exclusion and limitations on land-use rights.
- **The impact of a changing climate on long-term trends needs to be better understood over time**. Although predictive capability will increase with new data and enhanced decision-support tools, climate uncertainty will continue to be a challenge. While impacts are already being felt, they will worsen increasingly in the years to come. Many project investments are expected to have a lifespan of 20 or more years, well within the time frame for further significant climate impacts. This is especially important in agriculture, where most of the main staple crops are already being grown at their temperature threshold.[18] For many regions, despite the fact that science is yielding clearer projections (e.g. drought in North Africa), traditional project appraisal has often discounted such future project risks. Of foremost concern is the need to avoid 'maladaptation' – project design that exacerbates vulnerability – for example, facilitating habitation in a flood plain or low-lying coastal area.

This means recognizing the complexity of people's interaction with landscapes

These risks need to be understood in the context of the complexity of people's interaction within their communities and with landscapes and ecosystems. Embracing such complexity certainly adds to the effort involved in policy and project design, but can lead to better (and often simpler) solutions. The range of tools and approaches available to map risk and vulnerability at the community and landscape level is increasing rapidly. For example, better spatial analysis supported by geographic information systems can identify how investments or management practices in some parts of a landscape or watershed can produce benefits or reduce negative impacts in other parts, to provide 'connectivity' of hydrological systems or wildlife habitat.

Uncertainty regarding climate impacts is no reason for inaction

Uncertainty regarding climate impacts is no reason for inaction. New downscaled climate models provide opportunities to reduce uncertainty in local vulnerability assessments, particularly where there is concurrence among global climate models in

18 See National Research Council, www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=12877.

some regions.[19] Information can be gathered, for example, on day- and night-time temperature increases, water availability, shifts in vegetative cover and soil fertility. Where uncertainty remains, there are many 'no regrets'[20] actions that can have significant development benefits under a range of climate scenarios. A key immediate priority is to help communities build resilience to withstand a range of potential shocks while also adjusting to longer-term climatic trends where these are clearer. Most of the examples presented in this paper (see the Table on page 17) are useful in maintaining agricultural production with or without climate change – for example, diversifying household food production, enhancing agricultural extension services, promoting better crop diversity and biodiversity, integrating farming and agroforestry systems, and improving post-harvest management to reduce losses in terms of quantity and nutrient content.[21]

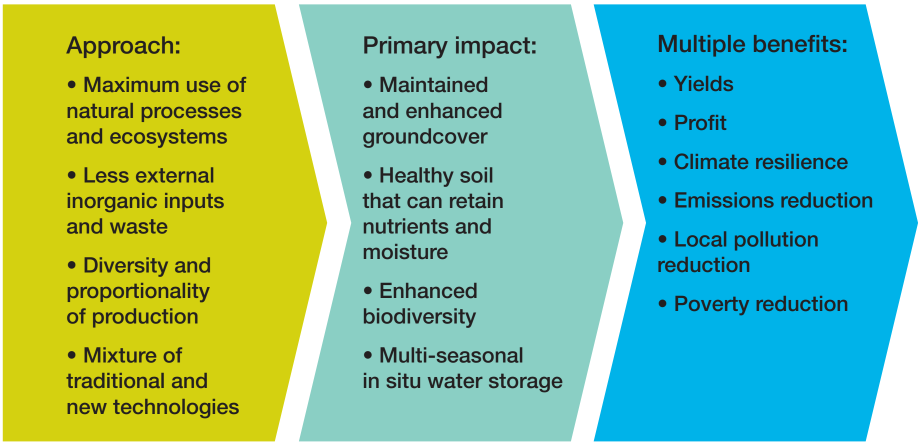
SECOND, there should be a major scaling up of sustainable agricultural intensification

Second, this deeper appreciation of interconnected risks should drive a major scaling up of successful 'multiple-benefit' approaches for sustainable agricultural intensification. Over the last few decades, a wide range of approaches has been developed that typically maximize the use of natural processes and ecosystems, reduce excessive use of external inorganic inputs, enhance the diversity of production and tailor production intensity to the capacity of the landscape, and use a mix of traditional and new technologies (see Figure 1).

The technical foundations of climate-smart agriculture already exist

The technical foundations of climate-smart agriculture already exist. There are many examples to choose from. *Terracing* or *bunding* prevents soil loss through erosion and water flooding, and thereby loss of soluble nutrients, while allowing water retention. *Minimum or zero tillage, coupled with crop rotation and the application of manure,*

Figure 1
Approach, primary impacts and multiple benefits



19 See Wilby, R.L., and H.J. Fowler. Regional climate downscaling, in *Modelling the Impact of Climate Change on Water Resources*, ed. C.F. Fung, A. Lopez and M. New (Oxford: Blackwell Publishing, 2010).

20 The 'no regrets' aspect of adaptation means taking climate-related decisions or actions that make sense in development terms, whether or not a specific climate threat actually materializes in the future.

21 United Nations System Standing Committee on Nutrition, *Climate Change and Nutrition Security: Message to the UNFCCC negotiators* (2010), www.unscn.org/files/Statements/Bdef_NutCC_2311_final.pdf.

compost or mulching, and the fallow system can improve soil structure and fertility and build up organic matter in the soil and its water-holding capacity. Adding manure to the soil supports a mixed system of livestock/crop production that diversifies risks across different products. This also implies a system of crop rotation – production of both food crops and fodder crops – which reduces risk at the farm level and often improves family nutrition. *Agroforestry* is another integrated system that combines trees with agricultural crops and/or livestock. The trees can in themselves be a source of income depending on the species. They can also serve to improve soil quality through nitrogen fixation (if they are legumes) and capture nutrients from deep in the soil (making them available through leaf litter), in addition to creating a more favourable microclimate. Better management of *grazing land or pasture* can also increase soil carbon content and productivity. *Rotational grazing or a combination of stall feeding and grazing*, based on fodder crops and limiting the dependence on grazing, can result in increased productivity in the livestock sector, combined with a build-up of carbon stock in the rangelands.

They are 'multiple-benefit' because they typically build climate resilience alongside other benefits

These approaches are described as 'multiple-benefit' because they typically build climate resilience alongside other benefits. They manage competing land-use systems at the landscape level, while at the same time reducing poverty, enhancing biodiversity, increasing yields and lowering greenhouse gas emissions. In many cases they are implemented as packages at the farm level. Taken together, they are examples of what is referred to as sustainable land management, sustainable land and water management, landscape approaches and watershed management, conservation agriculture, and rangeland management. Often, they also embrace the technique of integrated pest management and by design they are integrated systems of plant nutrient management. These approaches are knowledge-intensive and heterogeneous. They need to be adapted to local circumstances, requiring significant knowledge support at a time when extension services are often lacking the resources required to support smallholder farmers and farmers in marginal areas. They are already being successfully scaled up. In Brazil, for example, minimum tillage is currently practised on about 60 per cent of its cultivable area. Since the end of the 1980s, new agroforestry systems have been built by farmers on 5 million ha in the Niger's Maradi and Zinder regions – helping to produce more than 500,000 additional tons of food per year.[22] IFAD's *Rural Poverty Report 2011*[23] states:

> The broadest assessment of sustainable agricultural approaches in developing countries to date is based on a study of 286 initiatives in 57 poor countries, covering 12.6 million farms on 37 million hectares.[24] According to this study, virtually all these initiatives have increased productivity, while improving the supply of critical environmental services. Out of 198 sampled yield comparisons, the mean yield increase over four years was 79 per cent; all crops showed water-use efficiency gains; the practices sequestered carbon; and most of those projects with data substantially reduced pesticide use while increasing yields.

22 Reij, C., G. Tappan, and M. Smale. *Agroenvironmental Transformation in the Sahel: Another kind of 'Green Revolution'*, IFPRI Discussion Paper (Washington, D.C., 2009).

23 IFAD, Rural Poverty Report 2011 (Rome, 2010), p. 160. See also chapter 5, p.144, www.ifad.org/rpr2011/report/e/rpr2011.pdf.

24 Pretty, J. et al. Resource-conserving agriculture increases yields in developing countries. *Environmental Science and Technology* 40 (2006) (4): 1114-1119.

New and existing technologies will both play a vital role. In the face of the long-term climate challenges, we know that today's knowledge and technologies will not be enough. There is a need to support promising technologies that are new to the market, but still require promotion and piloting; smallholder farmers need training in how and why to use them, and incentives to adopt them, together with government support in formulating policies that provide those incentives either directly or through markets. There are many technologies ready to be scaled up, such as those relating to improved seed and crop varieties that can tolerate or are resistant to drought, heat, salt, insects or pests. New technology is important, but one weakness of the first Green Revolution was that it overlooked the value of local innovations and the knowledge and seed varieties already possessed by farmers. Promoting, revitalizing and scaling up existing local and traditional knowledge of crop management and ecosystem services can effectively support adaptation to climate change by marginal rural and indigenous communities and strengthen the deployment of new technologies.

New and existing technologies will both play a vital role

Addressing inappropriate policies will accelerate the scaling up of these approaches.[25] All these techniques and approaches require a socio-economic and governance context that makes them economically viable. Distorting trade policies and fossil fuel and other subsidies, together with a lack of effective land management policies, are key constraints, restricting the access of poor rural people to secure, varied markets and diversification of the non-farm rural economy. In addition, smallholder farmers are not rewarded for their current and potential impact on reducing or containing emissions. In particular, a lack of clear land access and tenure rights removes incentives to make the typically long-run investments that maintain land in such a way that it is resilient to climate change. A root cause of such failures is often the segmentation of issues at local, national and international levels. Ministries are tasked with maximizing agricultural production and other organizations with protecting the environment, often based on institutional structures that compete around trade-offs rather than seeking multiple benefits. According to the IFAD 2011 Environment and Natural Resource Management Policy:

Addressing inappropriate policies will accelerate their scaling up

> A perception of a universal trade-off between food production and the environment has for too long dominated policy thinking. A juxtaposition of reducing poverty, tackling climate change, feeding the world and protecting the environment as any one singular option is a false choice. Some trade-offs do exist in the short run and these should be properly costed and reduced. In the long run, though, these are often false trade-offs, as continued agricultural production cannot be sustained if it is at the cost of undermining natural assets.

These technical approaches are being updated to include climate change more explicitly in their use. For example,[26] in Senegal there has been a rapid southwards movement of the isohyet line (the 800 millimetre/year line moved south by almost

These technical approaches are being updated to include climate change more explicitly

25 For further analysis, see World Bank, *World Development Report 2008* (Washington, D.C., 2007), chapter 4, http://siteresources.worldbank.org/INTWDR2008/Resources/2795087-1192112387976/WDR08_08_ch04.pdf.

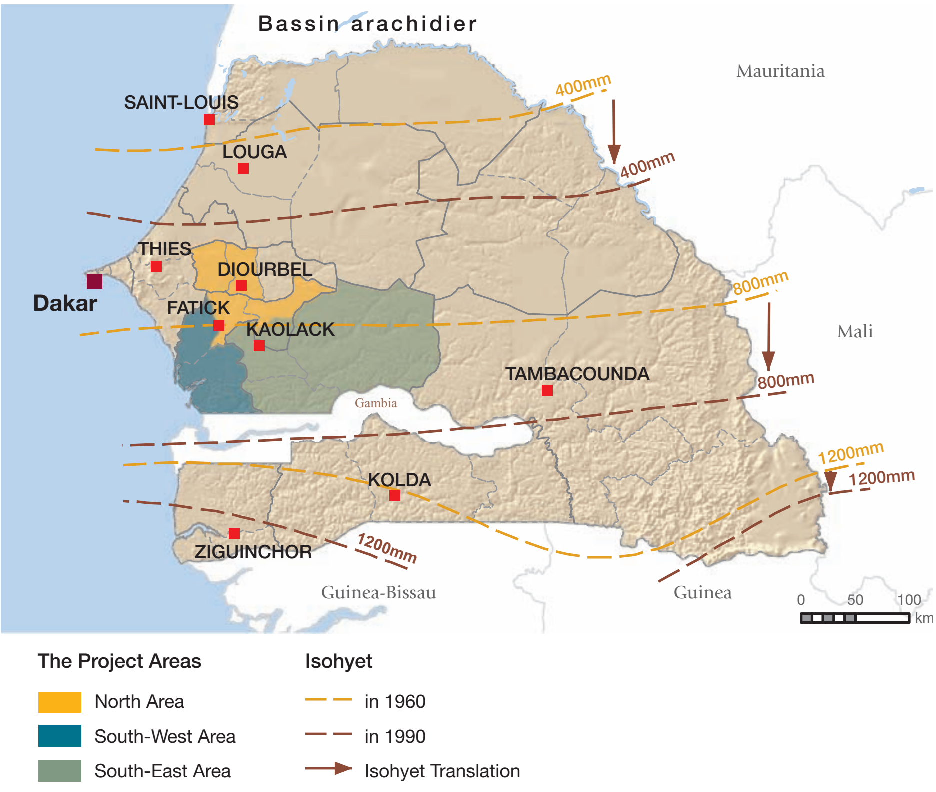
26 Another example is integrated pest management, which will need to factor in the anticipated impacts of temperature change on crops, pests and their natural enemies. This is particularly challenging because such impacts are sometimes difficult to predict.

120 kilometres over the 30 years from 1960 to 1990[27] – Map 3). This is changing the land management practices and cropping patterns required in the 'groundnut basin' (*bassin arachidier*), an area where IFAD is active in supporting communities through government partners. To make things worse, the area is exposed to greater salinity, driven by sea-water intrusion as a result of the sea-level rise in the Atlantic Ocean. Without such direct climate change impacts, farmers would have increased or maintained their production systems and yields using the conventional practices of sustainable land management (soil fertility and water management in this case). But as a result of new climate risks, farmers are being supported in the operation of dykes and engineering methods to collect freshwater in microwatersheds and use it to 'wash' the soil and 'push' the salt back towards the ocean while restoring the hydrological equilibrium (surface and aquifer water). The land is then reclaimed for cultivation and the dykes are gradually moved further out towards the ocean.

Climate mitigation is a major 'co-benefit'

The global public good of climate mitigation is a major 'co-benefit' of these multiple-benefit approaches. In the immediate future, formal or voluntary carbon markets are unlikely to be a major source of funding for smallholders, hence a poverty and yield-driven approach with strong mitigation 'co-benefits' may be the most

Map 3
Southward movement of the isohyet in Senegal[28]



27 IFAD President's report – see www.ifad.org/gbdocs/eb/94/e/EB-2008-94-R-13-Rev-1.pdf. For further information, see also Leborgne, J. 1980 – or most likely Le Borgne, J. (1988) – *La pluviométrie au Sénégal et en Gambie*, document multigraphié, ORSTOM (Dakar: Coopération française), http://horizon.documentation.ird.fr/exl-doc/pleins_textes/num-dakar-02/26481.pdf.

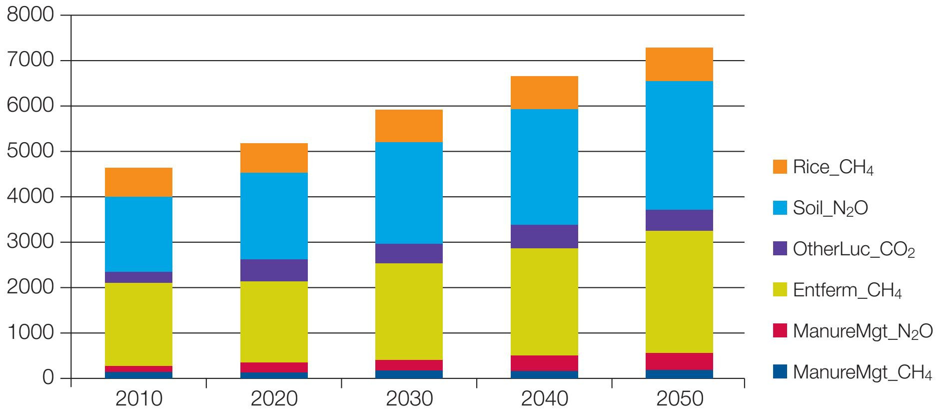
28 IFAD. President's report. Proposed loan and grant to the Republic of Senegal for the Agricultural Value Chains Support Project. (Rome: IFAD, 10-11 September 2008).

effective way to achieve reductions in emissions from smallholder farming. Increased soil carbon content is an important factor in raising the productivity of many agricultural systems, particularly in marginal areas and in (typically low-input) smallholder agriculture.[29] Soil carbon sequestration and crop residue management could help increase productivity in many poorly managed agricultural systems by up to 30 per cent in marginal areas.[30]

There are many ways in which these approaches reduce emissions

The examples of multiple-benefit approaches included in this paper have a wide range of emissions-reducing properties. They typically enhance soil fertility and improve soil carbon retention; increase vegetation, especially through more tree cover; reduce nitrous oxide (N_2O) and methane (CH_4) emissions through improved nutrient, livestock and manure management; and reduce carbon dioxide (CO_2) emissions by proposing alternatives to unsustainable slash and burn practices and elimination of burning crop residues. The common practice of burning organic debris such as crop residues and weeds can be reversed to provide mulch or compost for later application to the soil. Adding organic matter through green manure, i.e. growing a crop for the sole purpose of incorporating it into the soil, is an efficient way of increasing soil organic matter and, if the crop is a leguminous one, it has the added value of adding nitrogen to the soil.[31] Graph 3 illustrates developing countries' emissions from agriculture.

Graph 3
Developing country emissions from agriculture by category (MtCO$_2$eq p.a.)[32]



Legend: Rice methane (CH_4) from paddy production; soil nitrogen (N_2O) from fertilizer applications and soil disturbance; other land-use change carbon dioxide (CO_2) from natural biome encroachment; livestock enteric fermentation (CH_4); livestock manure management (N_2O and CH_4).

29 An example of this is the crucial role soil carbon content plays in drought-prone areas. Limited access to water and nutrients significantly restricts productivity in such areas. By increasing the organic matter in the soil, its water-holding capacity increases, which helps in 'gluing together' particles of soil to produce a crumb structure that leads to better aeration and percolation and allows the root system to access a larger area of soil water. Together, these factors enhance the early vigour of seedlings, making them more competitive with weeds and leading to earlier maturation, reducing the risk of total crop loss due to water stress. Organic matter also reduces the erosion propensity of the soil, which is important in limiting any loss of nutrients. In addition, the organic matter itself contains many micronutrients that would be lacking even with the use of chemical fertilizers, which typically contain only the main nutrients.

30 Lal, R. Enhancing crop yields in the developing countries through restoration of the soil organic carbon pool in agricultural lands, *Land Degrad. Develop.* (2006) 17: 197-209; and Lal, R., Carbon sequestration, *Phil. Trans. R. Soc. B.* (2008) 363: 815-830.

31 Leguminous crops have nitrogen-fixing properties.

32 Climate Focus North America Inc., IIASA and UNIQUE GmbH. *Climate Focus, Carbon Market and Climate Finance for Agriculture in Developing Countries* (25 April 2011).

Smallholder agriculture is a significant source of untapped emissions reductions

Smallholder agriculture has a rich and untapped potential for emissions reductions that are in the interests of farmers themselves. Take the example of agroforestry: planting acacia trees in maize fields in Africa has led to yields even doubling, while the resilience of the soil to land degradation has been increased by improving its organic and nitrogen content, water retention capacity and microclimate moderation. At the same time, this is reducing soil carbon emissions by maintaining greenery and promoting tree growth and biodiversity, which provides a diversified habitat and a source of food for both wild and domesticated animals.[33] Helping pastoralists manage land better can have a substantial impact on their livelihoods, but also on the reduction of greenhouse gas emissions. Considering the importance of rangelands in land use (about 40 per cent of the total land surface in Africa), herders and pastoralists could play a crucial role in soil carbon sequestration. Across the world there are some 100 million to 200 million pastoralist households covering 5,000 million ha of rangelands that store 30 per cent of the world's carbon stocks.[34]

THIRD, climate change is reshaping international development finance, with new opportunities for smallholder farmers

Third, climate change is reshaping the architecture of public (and potentially private) international development finance, generating new opportunities for smallholder farmers. The increasing share of public development finance earmarked for climate change represents a major opportunity for smallholder farmers in their capacity as managers of a large part of the world's land and water resources. The fast-start commitments undertaken in the Copenhagen Accord provide ambitious spending plans. Various global funds, such as the Climate Investment Funds, have been set up to deploy public finance addressing climate change. But more can be done to enable smallholder farmers to benefit from both climate finance and regular development finance.[35]

Equitable access by smallholder farmers to future carbon markets must be ensured

Foundations should be laid to enable smallholder farming to benefit equitably from future carbon markets. Smallholder farmers can benefit from limited opportunities in the voluntary carbon market and through the Clean Development Mechanism. But, aside from the pace of development of the carbon markets, the technical challenges entailed in including soil carbon are a constraint on progress. For example, there is a need to secure permanence in the increase in soil carbon content – it can be lost very quickly if soil management practices are changed. There is also a need to establish procedures for regularly estimating the increase in carbon content, which varies from season to season as a result of management practices. In addition, a further challenge is posed by the need to ensure that carbon credits are typically paid on the basis of verification of increased carbon levels. This is particularly important given that smallholders tend to require upfront financial support to make the needed investments in new management practices. Without secure land tenure, smallholders also risk expropriation of their land if carbon revenue streams increase profits. All these issues are being assessed and solutions must be developed – including a landscape approach rather than a plot (or field-level) approach to measuring carbon, which reduces the

33 See http://worldagroforestry.org/.

34 See IFAD, Livestock and Climate Change (Rome, 2009), www.ifad.org/lrkm/events/cops/papers/climate.pdf.

35 For example, IFAD is launching a new initiative in 2012 to channel climate finance to poor smallholder farmers. The Adaptation for Smallholder Agriculture Programme will use earmarked climate finance to cofinance and thus reshape agricultural investments made by IFAD and other partners. See www.ifad.org/climate/asap/index.htm.

season-to-season variation – and credits provided to farmers for upfront investments, to be repaid with future carbon credits. For both public and private finance, better evidence-based measurement is needed of the emissions impacts of diverse approaches in different agroecological zones.

There is growing recognition of the catalytic potential of investing in sustainable smallholder agriculture

There is growing recognition of the catalytic potential of international climate, environmental and development finance in scaling up multiple-benefit approaches. A little finance can go a long way in changing approaches, especially for smallholder farmers, who are unable or reluctant to wait a long time for returns on investments and yield increases, or to take on transition costs and risks – investments in agroforestry, for example, can take about five years to reach their full potential.[36] These approaches typically involve initial costs related to higher capital and knowledge inputs. An IFAD blog entry[37] about the Hague Conference on Agriculture, Food Security and Climate Change offers the following example:

> Imagine that you have been farming a piece of land for generations. Yields have been going down steadily for years, but you still have just enough to feed your family. Then you hear from an agricultural extension worker that if you plant acacia trees in your maize field you will be able to double or triple yields. You don't have the small upfront savings to do this, plus you worry that any change in approach may fail, leaving your family hungry. This is where a small amount of development assistance can make a huge difference by buffering the risk and helping governments support farmers.

International public finance will increasingly seek 'multiple-benefit' interventions

International public finance – for either projects or policy reforms – is likely to increasingly seek 'multiple-benefit' interventions. As set out below, such approaches to smallholder agriculture generate returns across a number of public policy priorities (typically poverty reduction, yield increases, emissions reduction,[38] adaptation and biodiversity enhancement). With increasing budget austerity, there is a growing incentive to maximize returns in this way. The compartmentalization of many environmental issues into separate boxes and conventions has in the past created pressures for 'single-issue' financing windows without reference to other benefits. Subject-specific global funds risk concentrating on only one element of the picture, although some have introduced positive incentives for multiple benefits – for example, the Global Environment Facility recently introduced incentives for multiple-focal-area projects. The design of the Copenhagen Green Climate Fund could ideally emulate such approaches by rewarding rather than ignoring multiple benefits from any single investment. The reality in IFAD's experience is that issues converge on the ground and must be treated holistically if climate finance is to be successfully deployed.

36 World Agroforestry Centre (ICRAF), verbal communication.

37 See www.thebrokeronline.eu/en/Online-discussions/Blogs/A-new-agriculture-for-food-security/An-evergeen-revolution-in-agriculture.

38 While no marginal abatement cost curve has yet been developed that generalizes the (narrow) climate emissions versus costs equation of smallholder agricultural approaches, it is likely to have an unusually high level of multiple-benefit investment potential. For multiple-benefit investments in smallholder farming, the main costs are often associated with upfront investment and know-how and are paid back over time. Unlike forestry, for example, with smallholder farming there is no need to factor in compensation for lost revenues.

This will create new demands for evidence, metrics and monitoring

Greater demand for multiple benefits from policies and investment in rural areas is likely to create new demands for evidence, metrics and monitoring. The yield impacts of the sustainable agriculture approaches discussed above have been well documented. Less well documented, although scientifically intuitive, are the impacts on emissions, soil health, biodiversity and climate resilience. Many case studies have been developed, although there is scope for greater synthesis to document the multiple benefits of such approaches. This may be required if smallholders are to successfully make the case for a greater share of current and future environment (and climate) finance; for instance, further technical groundwork will be needed on the measurement and metrics of emissions impacts of diverse approaches.

Some technical examples

The following Table provides a brief menu of some of the interventions being implemented or likely to be implemented in IFAD-supported programmes. These are described according to key areas for smallholder adaptation to climate change, but all activities typically generate multiple benefits. It is important to note that they are provided solely as examples, since communities are the principal drivers of investment options. The list does not include the potentially larger set of actions at the policy level to support and stimulate the uptake of these ground-level activities.

Examples of multiple-benefit responses to adaptation challenges

Adaptation challenges	Potential ground-level multiple-benefit investments
1. Reduce yield losses associated with climate impacts through improved **land management** and climate-resilient agricultural practices	• Monitoring current climate change impacts and predicting future trends in downscaling and communicating weather and climate information to local communities for agricultural planning purposes, and in changing crop varieties and/or crop calendars to empower smallholder farmers to better contend with variability in rainfall and temperature • Identifying and promoting crop varieties that are heat, drought and salt tolerant, including wild varieties with high nutritional value • Optimizing land-use systems (e.g. shift to 'crop-for-drop' from yield-per-hectare systems) to maximize sustainable yield under increasing climatic variability • Scaling up sustainable land management practices to the landscape level to improve hydrogeologic functions, soil nutrient replenishment, habitat heterogeneity, floral and faunal diversity, moderation of microclimate, and reduction in pest infestations and soil salinity as a means of improving the overall agricultural production context • Rehabilitating natural systems to protect agriculture in coastal areas against climate risks such as storm surges, e.g. mangrove, coastal wetland and sand dune rehabilitation, coral reef restoration • Recovering, documenting, disseminating and replicating traditional knowledge based on natural resource management and farmer-generated innovations suitable for promoting adaptation and healthier ecosystems
2. Increase availability and efficiency of **water use** for smallholder agriculture production and processing	• Undertaking analyses of water use and distribution at the landscape level in light of changing trends in rainfall patterns to inform the design of sustainable agricultural production and processing systems • Using integrated water-resource management to maintain and improve the healthy functioning of watersheds and to build resilience to climate change by combining watershed management with resilience-oriented land-use planning, climate-proof infrastructure, water users associations, water recycling and grey water use • Adopting a range of water-harvesting techniques such as low-cost groundwater recharge methods, water-use-efficient irrigation systems and climate-proofed medium-sized reservoirs • Implementing flood management through catchment source control to reduce peak discharges, using mini-dams and levees that are designed to contend with rainfall of a higher intensity and longer duration

Adaptation challenges	Potential ground-level multiple-benefit investments
3. Increase **institutional capacity** for adaptation at local and national levels	• Building the capacity of local institutions to adapt to climate change and adopt agroecological farming models, including the capacity to identify and address agricultural systems that are simply not viable under conditions of climate change and will require farming system shifts • Building expertise in agricultural research that is climate-change-oriented and in the provision of advisory and extension services • Undertaking gender-differentiated vulnerability and risk assessments, assessing current livelihood systems and understanding smallholder farmers' own adaptation responses in order to formulate scaled-up adaptation management options • Developing user-friendly data management systems and intersectoral coordination mechanisms (at national and local levels) for synergistic programme and project development and implementation in which responses to climate impacts have been harmonized across a range of sectors • Increasing the capacity to develop policy frameworks that are resilient to climate change and equipped with climate change triggers to activate adaptation response mechanisms • Strengthening health, food security and agriculture linkages in light of climate impacts, e.g. through a focus on nutrition • Improving regulatory systems to provide incentives for the uptake of adaptation responses and climate-smart sustainable land management • Improving the clarity of governance structures dealing with climate-change-related matters that have an impact on the rural sector and establishing linkages between relevant local and national government institutions • Improving access to 'green markets' and creating incentives for climate-resilient products (e.g. rooibos tea) • Promoting South-South cooperation in exchanging knowledge on responses to climate change and, where relevant, developing transboundary initiatives that foster uptake of adaptation measures
4. Strengthen **disaster risk reduction** at the community level	• Establishing early warning systems and disaster mitigation plans • Strengthening community-based disaster preparedness (social networks and safety nets) and response and rehabilitation mechanisms • Establishing climate-proof storage for community seed, food and forage • Turning disasters into opportunities to undertake climate-smart land-use zoning, and formulating and rolling out ecosystem restoration plans for post-disaster scenarios • Developing a climate risk-management strategy based on financial assets (such as savings, mutualization, insurance), promoting in particular the development of climate risk insurance

Adaptation challenges	Potential ground-level multiple-benefit investments
5. Promote **technologies** that reduce vulnerability of rural livelihoods and increase efficiency along agricultural value chains	• Developing downscaled data-gathering and management systems to improve decision-making and project design • Using geographic information systems to better understand and monitor landscape use • Exploring the use of improved seed varieties that can withstand flooding, drought and salinity, and developing in situ conservation of genetic resources (e.g. through seed banks) • Enhancing the use of information communication technologies in disseminating best practice in adaptation (short videos of sustainable land management and adaptation techniques) and mobile phone early warning systems • Testing prototype agricultural production systems that can withstand a range of climate-change-induced stresses in diverse agroecological zones, combined with a shift from extensive low-nutrition agricultural productive systems to intensive high-nutrition production systems
6. Ensure that rural **infrastructure** is climate-resilient	• Assessing climate change impacts on existing key agricultural infrastructure in order to refine design and engineering specifications to keep pace with future impacts • Raising crop stores and livestock housing above new flood levels • Building/retrofitting rural infrastructure to cope with climate-related risks such as water shortages and extreme weather events, e.g. dykes, breakwaters, submersible roads • Strengthening food security systems by improving storage and marketing facilities • Preventing the pollution of water supplies

Want to read more by IFAD on climate and environment? Click below:

- IFAD Policy on Environment and Natural Resource Management (2011)
- IFAD Climate Change Strategy (2010)
- An Evergreen Revolution: Climate Action publication
- IFAD Rural Poverty Report 2011 – Chapter 3 on risk, Chapter 5 on sustainable intensification (2010)
- IFAD President, Keynote speech to Hague Conference on Agriculture, Food Security and Climate Change
- UK Guardian Blog - Smallholder agriculture can be good for poor people and for the planet

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