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agriculture

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mainstreaming environment and climate change

Image: E. Rasmussen

Environment matters

- The environment provides the basis for food and agriculture systems.
- Agriculture can sustain the environment (for example, through ecosystem management) or harm it (for example, through pollution or soil degradation).
- Agriculture must cope with three key environmental challenges: declining diversity, water scarcity and climate change.
- Integrating environment into food and farming policies can help deliver sustainable agriculture.

Nearly one billion people worldwide suffer from hunger. Improving food security over the coming decades will ultimately rely on our ability to make agriculture both more productive and more resilient to shocks, such as floods, droughts, market fluctuations and pest outbreaks. Achieving this means using our environment, on which agriculture depends, more sustainably. In particular, we will need to tackle three key environmental issues — declining diversity, water scarcity and climate change — in a way that does not compromise development goals. Delivering pro-poor, sustainable and more productive agriculture requires policymakers to integrate environment into food and farming policies, programmes, activities and funding decisions, in a process known as 'mainstreaming'.

The UN Food and Agriculture Organization (FAO) estimates that, disregarding rising demand for fuel and fibre, feeding the world population in 2050 will require total agricultural production to increase by 70 per cent — and in developing countries, by 97 per cent.[1]

Achieving this growth ultimately relies on sustainable use of our environmental resources and more equitable access to land and other resources. Agriculture and nature are intrinsically linked. Agriculture uses about a third of the world's land surface and depends directly on the wider environment for its existence and sustainability — sunlight, water, nutrients and a diversity of plants, animals, insects and microbes all play fundamental roles in agricultural production. Agriculture is also inherently linked to development — three out of four people in developing countries live in rural areas and most depend on agriculture for their livelihoods.

Farmers, herders and fishermen can often make the best use of their environment through special, locally adapted agricultural systems that dictate their choices of crops and livestock, land and water

management practices, production systems and local institutional arrangements.

This local knowledge about the environment is crucial. Farmers in Nigeria, for example, know that the variegated grasshopper severely damages their cassava crops after all their other crops have been harvested. To limit the damage, these farmers replant maize and sorghum on their cassava plots until harvest time to provide an alternative food supply for the grasshopper and protect their cassava. This conscious manipulation of crop diversity is an important indigenous method of pest control.[2]

Agriculture and nature are intrinsically linked

Agriculture's impacts

Agriculture can either sustain or degrade the environment. It degrades the environment through:

- conversion of forests, grasslands and other habitats for agricultural use;
- degradation of soil quality, for example through excessive grazing;
- pollution of soil and water through excessive or inappropriate use of pesticides and fertilisers;
- climate change — according to the Intergovernmental Panel on Climate Change (IPCC), agriculture accounts for 10–15 per cent of global emissions; and
- loss of crop and livestock genetic diversity through the spread of monocultures — for example, Mexico has lost more than 80 per cent of its maize varieties since 1930, while Ankole cattle in Africa face extinction within 50 years.[3]

Image: Marlene Gunther

Thousands of crop species are traditionally used in agriculture in developing countries.

These negative impacts are particularly associated with intensive agriculture, which affects the environment through high-energy consumption and the polluting effects of chemical inputs such as pesticides and fertilisers.

Each impact can decrease yields — climate change alone could halve yields from rain-fed agriculture in some African countries.[4] Combined, the negative impacts of agriculture on the environment threaten to create a downward cycle of agricultural productivity that could compromise future global food security.

But if agriculture can harm the environment, it can also sustain it. Agricultural systems, both modern and traditional, that rely on ecosystem management can conserve biodiversity, enhance ecosystem functions and help cope with the impacts of climate change (see Sustainable agriculture). For example, polyculture systems in West Africa — which grow many different crops on the same piece of land — are often highly biodiverse, conserving valuable crop and livestock diversity as well as effectively suppressing pests and boosting nutritional values.[5]

Key challenges

In 2010, the FAO estimated that there were nearly one billion hungry people in the world, including almost 16 per cent of the population in developing countries.[7] Preserving and enhancing food security in the decades to come will require agriculture to become both more productive and more resilient to shocks, such as floods, droughts, market fluctuations and pest outbreaks.

In particular, it will require us to find strategies for tackling three key environmental issues posed by the way we farm today: declining diversity, water scarcity and climate change. If we are not to compromise development goals along the way, these strategies must also help reduce poverty.

Declining diversity

Agricultural biodiversity refers to the diversity of genetic resources — species, varieties and breeds — used in agriculture, either directly or indirectly. By applying their knowledge and skills, farmers, herders and fisherfolk have developed agricultural biodiversity over 10,000 years. Only 150 crop species are grown commercially on a global scale, but several thousand more species are traditionally used — particularly by the rural poor in developing countries — as important sources of food, fibre and fodder.

Agricultural biodiversity not only includes all of these species, but also the diversity of species that support

production, such as soil organisms and pollinators, as well as that of the broader pastoral, forest and aquatic ecosystems within which agriculture takes place. This broader biodiversity can often directly enhance agricultural productivity. For example, a 2004 study[8] of coffee farms in the forest margins of Costa Rica showed that the closer coffee bushes were planted to patches of forest, the more and better quality harvest they produced. The effect was shown to be due to greater pollination by wild bees living in the forest.

Agricultural biodiversity plays key roles in: decomposition of organic matter and nutrient cycling; natural pest control; soil conservation; pollination and seed dispersal; local and global climate; the water cycle; and biomass production. It represents a vital source of existing and as yet undiscovered food, and is particularly valuable in ensuring that agriculture can cope with shocks such as temperature extremes or pests and diseases.

Yet agricultural biodiversity is under threat. Agricultural practices that damage biodiversity include:

- intensification and specialisation, particularly the abandonment of mixed cropping systems;
- conversion of natural ecosystems to agriculture;
- unsustainable use of fertilisers and pesticides, which can kill wild species;
- replacement of traditional varieties with modern cultivars and monocultures in crop and livestock systems — for example, an over-reliance on a small number of livestock breeds is resulting in the loss of around one breed every month;[9] and
- mechanisation of traditional practices.

Declining agricultural biodiversity has important implications for development. It erodes wild food resources (seeds, leaves, roots, wild animals) that provide nutritionally and economically important food reserves for vulnerable groups.[10] It can also lead to the loss of indigenous knowledge on the use of wild foods and agricultural practices important for preserving biodiversity.

Such indigenous knowledge is often extensive: the agropastoral Tswana of Botswana, for example, can easily respond to shifts in local food supplies because of their vast knowledge of local plants and animals — they consume 126 plant and 100 animal species.[11]

Strategies for preserving agricultural biodiversity include:

Seed banks. The Global Crop Diversity Trust aims to conserve and make available as many crop varieties as it can by supporting 'seed banks', particularly in the developing world. The Trust co-manages the Svalbard Global Seed Vault in Norway — "the ultimate safety net for seeds samples". More recently, the International Livestock Research Institute (ILRI) in Kenya has led calls for similar genebanks to conserve livestock genetic diversity.[3]

On farm conservation. Much crop genetic diversity exists in the form of traditional varieties conserved 'on farm', often by poor, small-scale farmers. Such *in situ* conservation — of both domesticated crops and wild

Sustainable agriculture

Agriculture can be designed to enhance ecosystem services and human wellbeing. Such sustainable agriculture can raise poor farmers' incomes and more than double their yields.[6] It can be achieved by conserving resources, maintaining healthy soils, reducing water pollution, increasing on-farm biodiversity and being energy efficient.

In particular, sustainable agriculture includes:

- rotating crops to improve soil fertility;
- using grass in rotations to improve soil structure;
- growing 'cover' crops to reduce water runoff;
- integrated pest management favouring ecological pest control over pesticide spraying;
- using livestock manure to increase soil organic matter;
- planting legumes, which boost nitrogen levels in the soil;
- using windbreaks and contour farming to conserve soils and water; and
- using minimum-tillage farming — breaking the soil only where seeds are to be planted — to prevent erosion.

Image: IRRI

Seed banks in the developing world that conserve crop species are a key strategy for preserving agricultural biodiversity.

relatives — is important to ensure ongoing genetic diversity by allowing species to continue to adapt and evolve with changing natural surroundings.

Low external input farming. This is particularly appropriate for small farmers because it minimises purchased inputs and makes the fullest possible use of indigenous knowledge. It includes minimum tillage techniques, the use of nitrogen-fixing plants and 'green' manures, biological pest control, crop rotations, mixed farming and the productive use of plant and animal residues.[12]

Lack of water is a constraint to producing food for hundreds of millions of people

Promoting traditional breeds. Mechanisms that encourage the marketing and use of local, traditional breeds and varieties of crops and livestock can help maintain the diversity of farming systems and boost resistance to pests and diseases. Seed fairs in Kenya and Zimbabwe motivate farmers to diversify their crops by offering an annual forum for obtaining rare crop varieties, identifying seed sources and exchanging seeds.[13]

Water scarcity

An estimated 70 per cent of freshwater withdrawals from rivers and groundwater is used to produce food and other agricultural products.[14] But rising demand, inefficient irrigation, overexploitation and pollution are making water a scarce resource. Demand for water has increased sixfold over the past century and nearly three billion people (about 40 per cent of the global population) now live in areas where demand outstrips supply. Climate change poses an additional threat to water security. The area of land classified by the IPCC as 'very dry' has more than doubled since the 1970s.[15] In addition, there is greater flooding in the mid- to high-latitudes, longer and more frequent droughts in parts of Asia and Africa and more intense and frequent El Niño events, all of which affect the balance of supply and demand for water.

Lack of water is a constraint to producing food for hundreds of millions of people. The rural poor often suffer most. For example, policies that support the spread of deep, motorised bore wells for irrigated cash crops such as sugarcane have sucked dry the underground aquifers in many parts of dryland India, creating water scarcity for the poor. A similar situation exists in parts of dryland Africa, where land is used for growing vegetables and other export crops that rely on irrigation for their production.

Boosting agricultural productivity, particularly for the poor, in the face of water scarcity essentially relies on better water management. Indeed, unless water management in agriculture improves, we will not be able to meet the Millennium Development Goals for poverty, hunger and a sustainable environment.

There are many technological strategies available for improving water management.

Traditional water conservation. Traditional methods of capturing and conserving rainwater can help regulate water supplies and mitigate water scarcity. These include contour bundling, gully plugs, dykes, rooftop tanks, surface ponds and fog harvesting. From 1984 to 2000, some 3,000 'johads' — small earthern check dams — have been revived across more than 650 villages in Rajasthan, India. Together, the johads have increased groundwater levels by nearly six metres.[16]

Soil water conservation. Practices such as minimum tillage and crop residue management, and using green manures and clays can reduce the need for irrigation. Cover crops grown between widely spaced crops such as coffee can protect the soil from erosion. Often they are combined with mulches — cut grass, crop residues or other plant material — to limit evaporation and conserve soil water.

Efficient irrigation. Improving the efficiency of irrigation — by changing the timing of irrigation or using technologies such as drip irrigation — can help reduce both water demands and poverty. For example, the installation of seven efficient irrigation systems in a pilot project in Pintadas, Brazil, has boosted farmers' incomes by up to US$80 per month.[17]

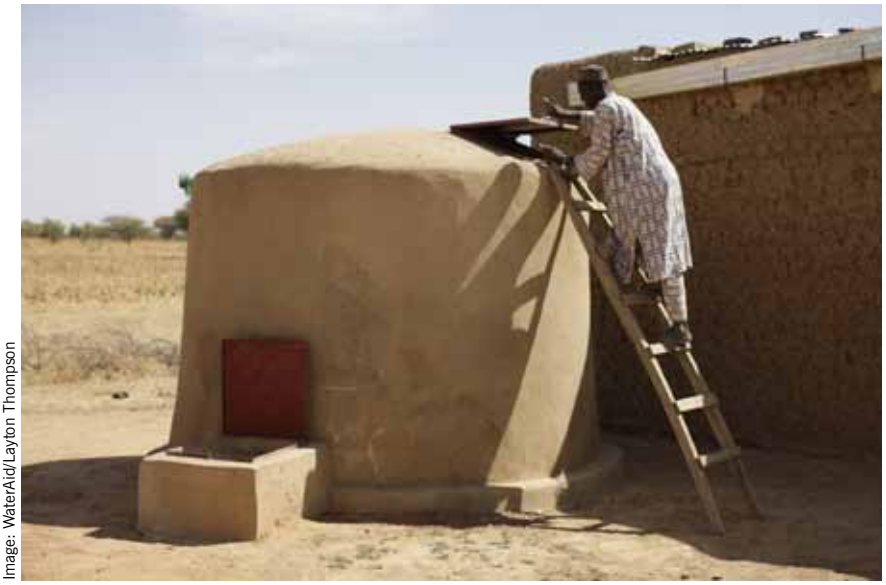

Image: WaterAid/Layton Thompson

Traditional ways of capturing and storing rainwater can help regulate water supplies and mitigate water scarcity.

Table 1 Mitigation routes to climate-smart agriculture

Strategy	Description	Example
Conservation agriculture	Zero-tillage and direct seeding; crop residues and mulches; crop rotations including trees and nitrogen-fixing legumes.	In Lesotho, a form of conservation agriculture known as likoti has enhanced soil fertility and boosted agricultural yields. It has helped rural communities build resilience against widespread poverty and increasing vulnerability to climate change.
Livestock management	Improved feeding and nutrition, genetics and reproduction, and animal health control; enhanced processing techniques; efficient manure treatment (for example, composting manure or using manure instead of inorganic fertilisers).	In Cajamarca, Peru, FONCREAGRO has spearheaded several pro-poor livestock initiatives focused on breeding programmes, improved pasture and manure management, fewer inorganic fertilisers and better veterinary services. The programmes have increased milk production per cow by 25 per cent, boosted incomes by about 60 per cent, and reduced emissions from the system.
Agroforestry practices	Use of trees and shrubs in agricultural crop or animal production systems. Includes improved fallows, 'taungyas', home gardens, boundary planting, farm woodlots, shelterbelts, fodder banks.	The Nhambita community carbon project, set up in 2003, shows that agroforestry can promote sustainable rural livelihoods and also reduce emissions. The project pays 1,000 smallholder farmers on the fringes of a national park in Mozambique to sequester carbon by adopting agroforestry practices. Farmers received US$433–808 per hectare over seven years.
Improved rice cultivation	Techniques to reduce methane emissions: periodic draining, intermittent irrigation, shallow flooding.	An International Rice Research Institute project in Bohol, Philippines has used 'alternate wetting and drying' to conserve water use in rice production, boost yields and reduce methane emissions.

Adapted from information in 2010 FAO report, "Climate-smart" agriculture[18]

Farming practices. A wide range of farming practices — from changing cropping patterns and soil management techniques to adopting new varieties — can improve water use in agriculture. The International Crops Research Institute for the Semi-Arid Tropics in India is encouraging the uptake of more drought-tolerant varieties of sorghum, pearl millet, chickpea, pigeonpea and groundnut, which could all help boost agricultural productivity in water-scarce areas.

Policymakers can also improve water efficiency through legal, economic and communication strategies. Economic incentives such as water metering and pricing can help encourage people to conserve water, while educational projects can improve awareness of sustainable water management and enable better planning and use of resources. Similarly, seasonal forecasting can help promote more efficient planning for water use. Establishing clear water rights offers another way of improving water efficiency by clarifying people's legal entitlement to access water resources.

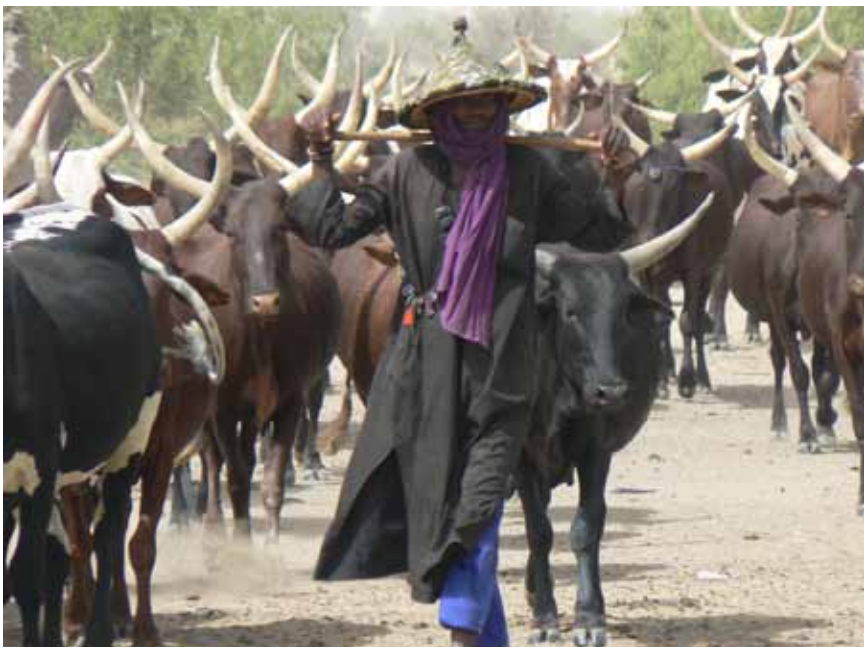

Image: Steve Anderson

Better livestock management offers one route to climate-smart agriculture.

Climate change

Agriculture is both a driver and a victim of climate change. On the one hand, the carbon emissions of each link in the food chain from seed to plate — including the production of inputs such as fertilisers and pesticides — all contribute to climate change. On the other hand, the impacts of climate change — increasing frequency and intensity of rainfall, saltwater intrusion, shorter growing seasons, higher

Agriculture is both a driver and a victim of climate change

temperatures, changing patterns of pests and diseases and more frequent extreme events such as floods and droughts — all serve to damage crops, degrade land and reduce food production. These can have devastating economic impacts: the flooding in East Africa associated with the 1997–98 El Niño caused catastrophic loss of livestock to Rift Valley disease and led to a billion-dollar ban by the Gulf states on trade from the area.[19]

There is a growing recognition that ensuring food security over the next four decades requires 'climate-smart' agriculture — agriculture that is sustainably intensified, resilient and low-carbon emitting.

There are two principal approaches to climate-smart agriculture: mitigation strategies that reduce agricultural emissions; and adaptation strategies that help agriculture cope with changing climates. In both cases, the most successful approaches will also help reduce poverty and improve livelihoods.

It is increasingly clear that effective climate-smart practices already exist. Mitigation strategies include conservation agriculture, organic farming, grazing land management and agroforestry. Adaptation can be reactive, for example changing planting dates or controlling erosion. Or it can be proactive, anticipating impacts before they happen — for example developing new drought- or salt-tolerant crops and animal breeds, or diversifying crops and improving soil management (see Tables).

Complicating factors

Ensuring that agriculture meets both environment and development goals requires more than simply changing agricultural practices. It also requires redressing inequitable political and economic forces.

Hunger and environmental degradation often occur when local people lose access rights to natural resources such as land, water and trees. Lack of control severely reduces their incentive to conserve these resources and undermines local food and livelihood security. In most developing countries, the poor have no secure tenure over their 'own' land and this, along with colonial 'land grabs' and the displacement of farming communities from fertile to marginal lands with poor soils or inadequate rainfall, has degraded the environment. In some countries, the progressive incorporation of these people into poorly paid seasonal workforces for export agriculture means the landless and near-landless remain hungry and poor.

Market forces can also promote environmental degradation and poverty (see Global markets).

Table 2 Adaptation routes to climate-smart agriculture

Strategy	Description	Example
Crop and animal breeding	Modern and traditional breeding techniques.	Researchers from the Consultative Group on International Agricultural Research (CGIAR) have used many different breeding techniques to develop and disseminate 'climate-smart' crops, including drought-tolerant maize and beans in Africa and 'waterproof' rice in Bangladesh.[20]
Traditional varieties	Repatriating seeds of traditional crop varieties to indigenous communities.	The Potato Park near Cusco, Peru was created in 2005 to protect the genetic diversity of the region's many potato varieties. Under a unique agreement, the International Potato Centre has repatriated seeds of traditional potato varieties to be grown and conserved within the park.
Soil-water management	Minimum tillage, crop residue management, green manures and clays, mulches, cover crops.	In Lesotho, the adoption of minimum tillage, crop residues and rotations has significantly increased maize yields and profits for poor farmers.[21]
Change farming practices	Changing planting or harvesting times, fertiliser use, cropping patterns.	Studies by the International Food Policy Research Institute (IFPRI) show that small-scale farmers in Ethiopia are already changing crop varieties and planting dates to cope with changing climates.[22]
Early warning	Seasonal forecasts, yield predictions, drought warning, climate modelling, traditional indicators.	Forecasting can help avert food crises but only if systems are in place to use it and policymakers are willing to act on it. Forecasts in Zimbabwe in 1992 and Ethiopia in 2000 made little difference. But Ethiopia learnt from the experience and used forecasting in 2002–3 to successfully limit a food crisis.[23]

The path to mainstreaming

Perhaps most importantly, ensuring the uptake of sustainable, climate-smart agriculture requires integrating, or 'mainstreaming', environment into food and farming policies, programmes, activities and funding decisions. This means getting better coherence and coordination between agriculture, climate change and development policies and establishing the institutional support to implement those. A range of approaches can be used to achieve this.

Aligning plans. A first step perhaps lies in aligning national plans for environment and development — ensuring that National Adaptation Plans of Action, Nationally Appropriate Mitigation Actions and Poverty Reduction Strategy Papers speak to each other and present a coherent strategy fuelled by common domestic objectives.

Using evidence. Major investments are needed to improve our knowledge of the links between environment, climate change and agriculture and the results must be used to devise evidence-based policies. This knowledge can partly come from modern scientific research. The CGIAR, for example, works with a range of modern technologies and methods — from crop genetic improvement to natural resource management — to promote sustainable agriculture and reduce the poor's vulnerability to climate change and environmental degradation. But traditional and local knowledge of poor farmers and resource users will also prove vital in building our understanding of agriculture and environment. 'Extended peer communities'[24] in Ethiopia, for example, that provide farmer-led operational research, have already proved a valuable source of practical solutions to the challenges faced by farmers. Here, farmers, nongovernmental organisations, universities, agricultural research centres and government departments have worked together, through consortia, to identify new plant breeds and innovative farming techniques, and to improve soil and water conservation and strengthen land tenure.

Strengthening local organisations. Official and nongovernmental support agencies need to shift from implementing projects to promoting local people's development. This process should strengthen local organisations and institutions,[25] and enhance local people's capacity to take part in planning, management, governance and evaluation (see Strengthening local organisations).

Securing local rights. Sustainable agriculture requires agrarian reform and a fair redistribution of rights to access resources such as land, water, forests and seeds. Such reforms need to distinguish between territory and land, and consider the rights of indigenous peoples to autonomy in their territories.

Providing financial support. Microcredit and micro-insurance schemes, social safety nets and payments

Global markets

Globally traded food is increasingly processed and sold by transnational corporations to meet the desires of relatively wealthy, urban consumers. This often forces farmers worldwide to comply with demands for standardised environmental management regimes and uniform food production (such as European Regulation 2257/94 that stipulates shape, minimum length and diameter for bananas).

The lack of markets for most traditional crops means they cannot remain part of agricultural landscapes, leading to biodiversity loss.

Market prices for both commodity crops such as coffee and vanilla and basic staples such as millets and sorghum do not reward farmers for sustainable agriculture. As a result, environment and agricultural livelihoods are being undermined on an unprecedented scale as market prices fail to cover production costs.

Strengthening local organisations

Local groups and organisations are important in facilitating collective action, coordinating food systems and sharing labour and costs. As such, they must be strengthened and empowered.

Local organisations are well-placed to monitor and adapt to environmental change. They can also help provide the flexible responses, mobility and adaptive strategies needed to cope with the complexity of agricultural environments and climate change impacts. The International Institute for Environment and Development works with pastoralists in East Africa to build their capacity to engage with the policy processes that affect their lives. Its project trains community leaders and other advocates in effectively arguing for pastoralism as a livelihood and an integral part of policy design and implementation.

Federated organisations are also important in influencing policy by representing the concerns of small-scale food producers. They need higher capacity to frame and advocate policies and strengthen the communication and alliances between each other.

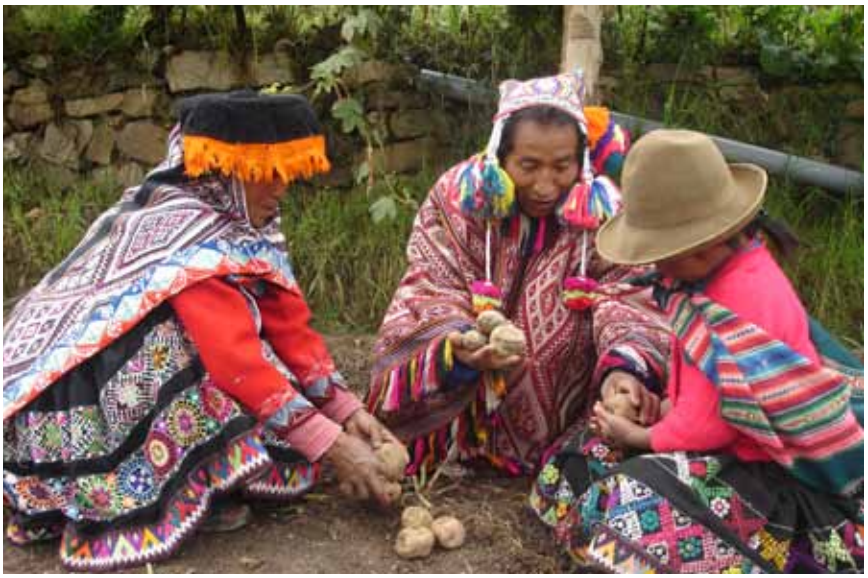

Image: ANDES

The Potato Park near Cusco, Peru, protects the genetic diversity of the region's many potato varieties.

for environmental services may all have a role to play in supporting sustainable agriculture for the poor. More than 9,500 Kenyan smallholders, for example, have begun buying 'pay-as-you-plant' insurance through a scheme known as Kilimo Salama, so that if they lose their harvest, they can still afford to farm the next season.[26]

Reforming trade and markets. Integrating environmental sustainability into food and agriculture will require systemic reforms of trade policies, markets, taxation, subsidies and economic incentives. These should support 'food sovereignty' — the idea that farmers should be in control of what they farm and how they farm it.[27] In particular, trade and market reforms should: prioritise the feeding of people locally; encourage the buying of inputs and selling of produce at local markets; restrict the overproduction of commodity crops; curb the power of transnational corporations; and better regulate international trade to prevent 'food dumping'.

Disseminating information. Effectively disseminating information about sustainable agriculture and climate change can help increase farmers' capacity to make short- and long-term planning decisions and technology choices. Agricultural extension services offer one way of achieving this and deserve stronger support. The FAO has long promoted Farmer Field Schools as a participatory approach to farmer education and a first step to farmer organisation. Climate Field Schools in Indonesia are an extension of these and have been used to help integrate climate information within the farm decision-making process.[18]

Notes

[1] Bruinsma, J. 2009. The resource outlook to 2050. In: *Expert Meeting on How to Feed the World in 2050*. FAO, Rome. See: ftp://ftp.fao.org/docrep/fao/012/ak971e/ak971e00.pdf [2] Altieri, M.A. 1998. *Agroecology: The science of sustainable agriculture*. Intermediate Technology Publications, London. [3] ILRI. 2007. A 'livestock meltdown' is occurring as hardy African, Asian, and Latin American farm animals face extinction. See: http://www.ilri.org/ilrinews/index.php/archives/550 [4] IPCC. 2007. Climate Change 2007: Synthesis Report. In: *IPCC Fourth Assessment Report: Climate change 2007*. See www.ipcc.ch/publications_and_data/ar4/syr/en/mains3-3-2.html [5] FAO. 1999. The multifunctional character of agriculture and land. Main Issues Paper. Conference on the Multifunctional Character of Agriculture and Land, The Netherlands. [6] Pretty, J. *et al.* 2006. Resource-conserving agriculture increases yields in developing countries. *Environmental Science & Technology* 40(4), 1114–1119. [7] FAO. 2010. *The State of Food Insecurity in the World.* FAO, Rome [8] Ricketts, T.H. *et al.* 2004. Economic value of tropical forest to coffee production. *Proceedings of the National Academy of Sciences* 101(34), 12579–12582 [9] FAO. 2007. *The State of the World's Animal Genetic Resources for Food and Agriculture.* FAO, Rome. [10] Scoones, I., Melnyk, M., Pretty, J.N. 1992. *The Hidden Harvest: Wild foods and agricultural systems*. IIED, London. [11] Grivetti, L.E. 1976. Dietary resources and social aspects of food use in a Tswana tribe. PhD thesis. University of California at Davis. [12] Natural Resources Institute. 2003. *Small Producers in Export Horticulture: a guide to best practice.* NRI, University of Greenwich. See www.nri.org/projects/NRET/SPCDR/index.htm [13] Practical Action. 2002. Preserving the web of life. World Summit on Sustainable Development. Johannesburg, South Africa. [14] Molden, D. (ed). 2007. *Water for Food, Water for Life: A comprehensive assessment of water management in agriculture.* Earthscan, London; International Water Management Institute, Colombo. [15] Parry. M. L. *et al.* (eds) 2007. *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge University Press, Cambridge and New York. See www.ipcc.ch/publications_and_data/ar4/wg2/en/contents.html [16] For more information on johads and other traditional Indian rainwater harvesting techniques, see www.rainwaterharvesting.org [17] Obermaier, M. *et al.* 2009. Adaptation to climate change in Brazil: The Pintadas pilot project and multiplication of best practice examples through dissemination and communication networks. In: *Proceedings of RIO 9 World Climate & Energy Event, Rio de Janeiro, Brazil, 17–19 March 2009, 185–190*. [18] FAO. 2010. "Climate-smart" agriculture: policies, practices and financing for food security, adaptation and mitigation. FAO, Rome. [19] DFID. 2004. *The Impact of Climate Change on the Health of the Poor.* DFID Key Sheet. DFID, London. [20] CGIAR. 2009. *Global Climate Change: Can agriculture cope?* Briefing dossier. CGIAR, Washington DC. See www.cgiar.org/impact/global/climate.html [21] Silici, L. 2010. *Conservation Agriculture and Sustainable Crop Intensification in Lesotho.* Integrated Crop Management. Vol. 10. FAO, Rome. [22] Deressa, T.T. 2008. *Analysis of the Determinants of Farmers' Choice of Adaptation Methods and Perceptions of Climate Change in the Nile Basin of Ethiopia.* IFPRI Research Brief 15–9. IFPRI, Washington DC. [23] Patt. A., Winkler, J. 2007. *Applying Climate Information in Africa.* NOAA, Washington DC. [24] Funtowicz, S.O., Ravetz, J. 1993. Science for the post-normal age. *Futures* 25(7), 739–755 [25] Pimbert, M. 2008. Local organisations at the heart of food sovereignty. In: Pimbert, M. *Towards Food Sovereignty: Reclaiming autonomous food systems.* IIED, London [26] Ogodo, O. 2010. Kenyan farmers get micro-insurance. SciDev.Net news article. [27] Pimbert, M. 2009. *Towards Food Sovereignty*. Gatekeeper Series 141. IIED, London.

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