POLICY POINTERS

Farming's climate-smart FUTURE

PLACING AGRICULTURE AT THE HEART OF CLIMATE-CHANGE POLICY

“Placing a greater emphasis on agriculture in negotiations on climate change, as in the development of national policies, will ensure that agriculture fully contributes to efforts to adapt and mitigate without undermining food production and the fight against poverty.”

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Recognising the importance of agriculture

Global warming will change the face of farming, and is already doing so in some parts of the world. Increases in temperature, changing patterns of rainfall, more extreme droughts and floods, the shifting distribution of pests and diseases: all can be attributed in part to the increase in emissions of greenhouse gases resulting from human activities. All will have an impact on food production in the future.

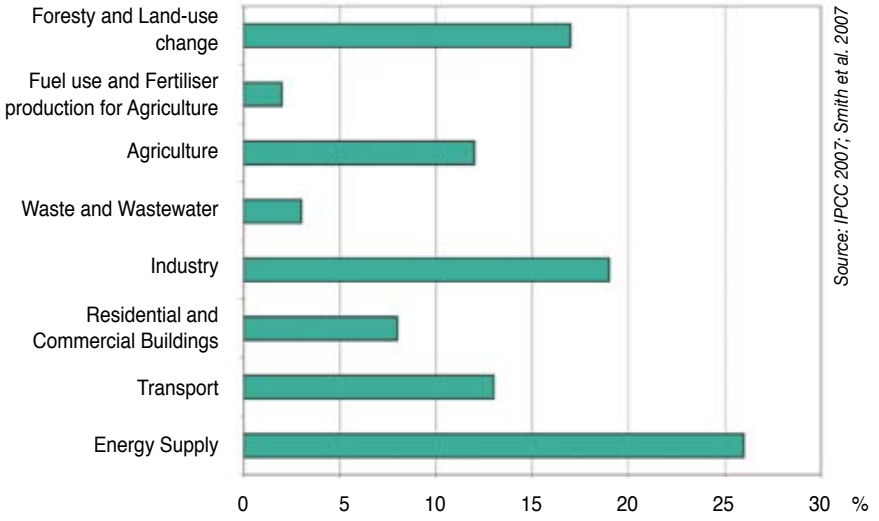
Moreover, the impact of climate change on agriculture has repercussions that extend far beyond the supply of food. Agriculture accounts for 29% of the gross domestic product (GDP) in developing countries and provides jobs for 65% of their populations. In many countries, economic health is closely linked to the fortunes, or misfortunes, of farming communities.

Maize yields in sub-Saharan Africa could be adversely affected by climate change.

Agriculture is not just a victim of climate change; it is also a significant cause of climate change. Agricultural activities are directly responsible for 10–12% of human-generated greenhouse gas emissions, excluding emissions resulting from fuel use and fertiliser production. However, agriculture is responsible for a much greater share of global emissions if the clearance of forests to make way for crops and livestock is included.

FEEDING THE WORLD

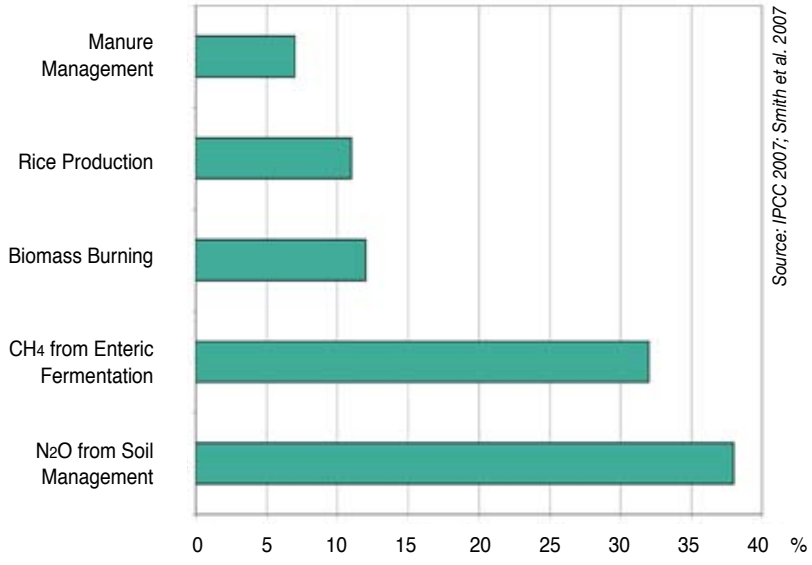
Although the proportion of the world's population suffering from hunger has declined from 24% to 13% since 1970, largely as a result of dramatic increases in crop and livestock productivity, around 1 billion people still go hungry every day. During the next four decades, food



Greenhouse Gas Emissions by Sector

Emissions by sector as a percentage of total Greenhouse Gas Emissions

Women in Chad protesting against drought, and their lack of resources, by displaying their empty water vessels.



Source: IPCC 2007; Smith et al. 2007

Emissions in the Agriculture Sector

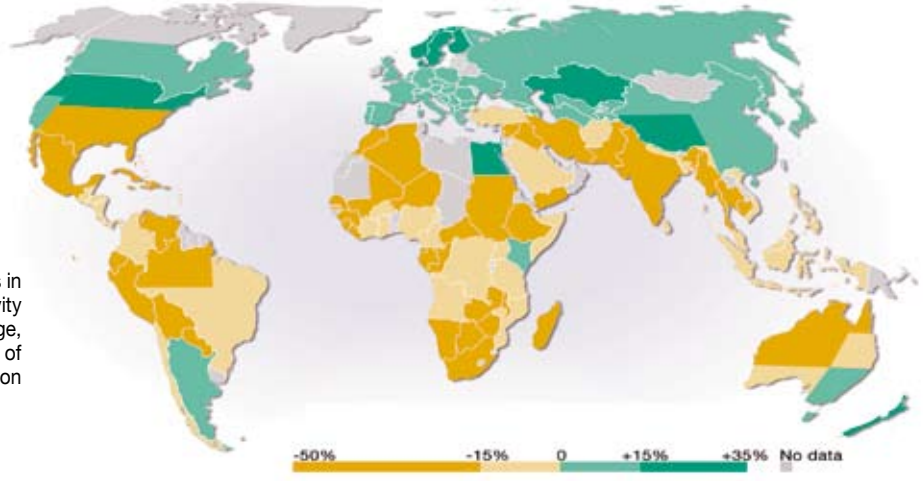
Emissions by agricultural activity as a percentage of total emissions in the sector

production must rise by 70% if we are to satisfy a population which is forecast to increase from 7 to 9 billion people. This is a very tall order. To increase food production without further increasing greenhouse gas emissions from agricultural activities makes this challenge all the greater. At the same time, many food producers will need to adapt to climate change by changing the way they farm and fish.

Nevertheless, there are reasons to be optimistic. A range of practices which come under the heading of 'climate-smart agriculture' could increase food production, help farmers to become more resilient to climate change and reduce emissions of greenhouse gases. How widespread these practices become will depend to a significant degree on the importance given to agriculture in international climate-change negotiations and national policymaking.

Until now, agriculture has failed to receive the attention it deserves in the climate-change policy arena. For example, there is no 'work programme' for agriculture, as there is for various other issues, under the United Nations Framework Convention on Climate Change (UNFCCC).

A mechanism known as Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD+) has become a major focus of recent negotiations, with the aim



Projected changes in agricultural productivity 2080 due to climate change, incorporating the effects of carbon fertilization

Source: Hugo Ahlenius, UNEP/GRID-Arendal.

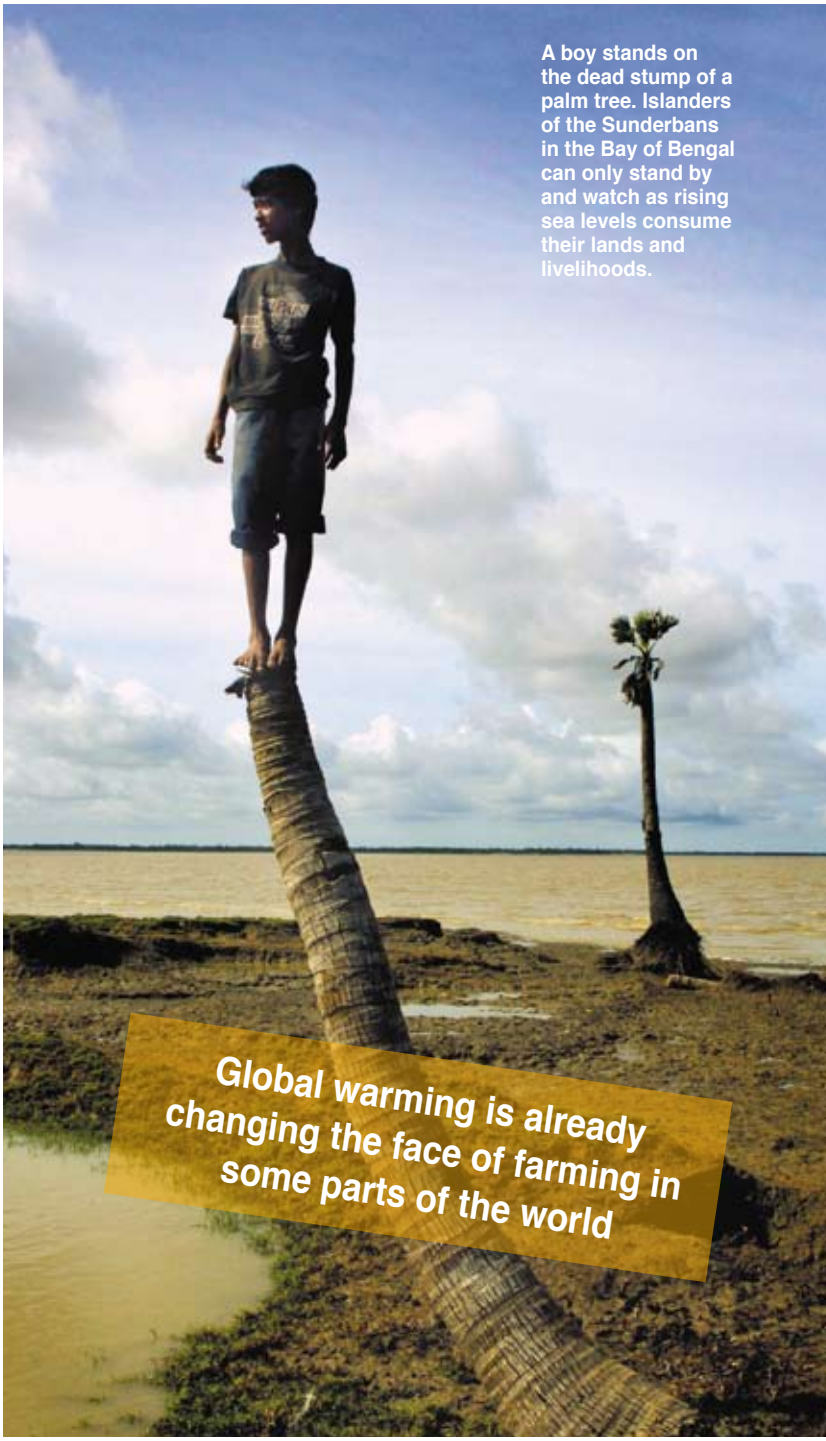
Projected changes in agricultural productivity

of promoting policies and incentives which will reduce emissions and encourage sustainable forest management. Yet little attention has been paid to how REDD+ will deal specifically with agriculture, despite the fact that REDD+ will only achieve its objectives if it acknowledges the importance of agriculture as a driver of deforestation, and recognises the implications of reducing deforestation for food security.

No government – democratic or otherwise – will adopt measures to reduce greenhouse gas emissions if they threaten a nation's ability to feed its population. However, a failure to reduce agricultural greenhouse gas emissions and make the shift to climate-smart agriculture would put future food security at risk. This is one of the compelling reasons why agriculture should be at the heart of the international climate-change negotiations.

Climate-smart agriculture helps farmers to increase food production, become more resilient to climate change and reduce greenhouse gas emissions

At national levels, greater attention is being paid to climate issues and agriculture, but even here there is significant room for further elaboration and action. For example, a recent analysis of country REDD+ readiness proposals revealed that although many countries acknowledge the importance of agriculture as a cause of deforestation, the strategies they propose are not robust enough to meet the challenges we face. There is an urgent need for more detailed and tangible measures. ■



A boy stands on the dead stump of a palm tree. Islanders of the Sunderbans in the Bay of Bengal can only stand by and watch as rising sea levels consume their lands and livelihoods.

Global warming is already changing the face of farming in some parts of the world

A woman harvests rice at her farm in Ghana's Upper West Region, which has suffered from failed rains and rising temperatures.

Cause and effect

Agriculture is directly responsible for the release of 5100–6100 megatonnes (Mt) carbon dioxide equivalents (CO_2e) a year[1] – roughly the same as the world's transport sector – and it contributes a disproportionate amount of two high-impact gases, nitrous oxide (N_2O) and methane (CH_4). Agricultural practices are responsible for approximately 47% of human-generated methane emissions and 58% of nitrous oxide emissions.

The release of nitrous oxide from the soil, largely derived from the breakdown of nitrogen fertilisers, accounts for 38% of agricultural emissions. Enteric fermentation in livestock produces large quantities of methane, comprising 32% of agricultural emissions. Irrigated rice production adds a further 11% of methane emissions. Finally, the burning of crop residues and poor manure management constitute 19% of agricultural emissions, mostly in the form of nitrous oxide and methane.

Agricultural clearance is thought to be responsible for three-quarters of all tropical deforestation

Carbon dioxide, the most significant greenhouse gas in terms of its impact on the climate, accounts for only a small proportion of the emissions caused by activities directly related to the production of food, fibre and vegetable oils. Agricultural soils both emit and absorb large quantities of carbon dioxide, resulting in relatively small net emissions of 40 Mt CO_2e a year.

In contrast, the clearance of forests and scrubland to make way for crops and livestock releases an estimated 5900 Mt CO_2e a year. Small-scale agriculture is a significant cause of forest loss, especially in sub-Saharan Africa. The drainage and conversion of peatlands in Southeast Asia, largely for oil palm production, contributes 20% of global land-use change emissions. Large areas are also cleared each year to make way for cattle

47%

Agriculture's share of human-generated methane emissions

[1] This measure takes into account the different warming effects of greenhouse gases over a specific time period. Over 100 years, the global warming potential of nitrous oxide and methane is approximately 300 and 25 times greater, respectively, than that of carbon dioxide, although human activities are producing the latter in much greater quantities.

ranching and commercial crops, driven primarily by urban demand and export markets. Agricultural clearance is thought to be responsible for three-quarters of all tropical deforestation.

AN UNCERTAIN FUTURE

There is compelling evidence that the increase in greenhouse gases caused by human activities is responsible for global warming. However, there is considerable uncertainty about its extent and scale. Natural variations in the climate, the difficulty of modelling the atmosphere's and the oceans' response to emissions, uncertainty about how much greenhouse gas will be added in future and the lack of good data, especially in developing countries, mean that projections about climate change and its impact on farming systems are inevitably imprecise. None of this is to deny that decision-makers have plenty of solid scientific evidence on which to base climate-smart policies.

In 2007, the Intergovernmental Panel on Climate Change (IPCC) forecast that global average temperatures could rise by 1.1˚C to 6.4˚C by the end of the century. If the rise is at the lower end of the scale, the impact on agricultural systems may be modest; if it is at the higher

One of the severest droughts in recent memory has led to the drying up of much of Lake Banzena in Mali.

end, it will almost certainly be disastrous. Even a 2°C rise by the end of the 21st century – and this is an optimistic scenario – will lead to dramatic changes in patterns of land use.

In some parts of the northern hemisphere farmers may benefit from warming, with a longer growing season leading to higher cereal yields in Northern Europe, Russia and China. However, there are likely to be many more losers than winners. Unless strong adaptation measures are taken, higher temperatures and changes in rainfall are projected to cause significant declines in crop yields in semi-arid, tropical and sub-tropical regions. Sub-Saharan Africa is likely to be one of the worst affected areas. Recent projections based on African population growth suggest that in order to maintain today's already insufficient food consumption level on the continent, yields of all food crops would have to increase by 230% by 2050 – this in a region where climate change is expected to

Even a 2°C rise by the end of the 21st century will lead to dramatic changes in patterns of land use

Indonesia, Kuala Cenaku, Riau Province. An area which has recently been deforested in preparation to expand a palm oil plantation.

In the Volta River Basin, flooding is the most common form of irrigation practice. Changes in the region's climate have led to an increase in the amount of evapotranspiration, a reduction of river flows and in some cases to water scarcity.

This coral reef in Sri Lanka died in 1998. Marine biologists believe that a rise in water temperature, associated with global warming, was to blame.

Island nations are particularly vulnerable to climate change. In the Caribbean, the number of hot days in the year has been rising and the number of cool days declining

reduce yields by 10–20% and where a third of the population already suffer from hunger.

An increase in climatic variability will also have a profound impact on agricultural production. Extreme events, such as floods and droughts, are likely to become more frequent and more severe, with serious implications for both crop and livestock production. Indeed, more erratic patterns of rainfall are already affecting farming systems and food security in some areas. A survey of farmers in 11 African countries found that many were already planting different crop varieties and changing their planting dates in order to cope with change.

Scientists working under the umbrella of the Consultative Group on International Agricultural Research (CGIAR) have modelled the impact of climate change on a range of crops. One study projects that smallholder rain-fed maize yields could decline by 10% in Central and South America and sub-Saharan Africa by 2055. Another predicts that more than half of the Indo-Gangetic Plain in South Asia could be too 'heat-stressed' to grow wheat by 2050. Another predicts potato yield reductions of 20–30% in the tropics and sub-tropics.

Island nations, such as those in the Caribbean and the Pacific, are particularly vulnerable to climate change. In the Caribbean, the number of hot days in the year has been rising and the number of cool days declining. Climate models suggest that there will be drier wet seasons and longer dry seasons in future. Rising sea levels are expected to increase the saltwater intrusion of coastal freshwater aquifers. Rising temperatures have already led to coral bleaching and declines in marine biodiversity in many parts of the tropics.

Climate change will have a significant impact on fisheries and aquaculture, which currently provide a living for around 500 million people and are the main source of animal protein for many of the world's poorest countries. Climate change is expected to result, among other things, in an increase in sea-surface temperature, decreases in sea-ice cover and changes in salinity and acidity, all of which could affect productivity. The precise impact will vary from fishery to fishery, depending on the regional nature of climate change and the species involved. Some may benefit from longer growing seasons and faster growth rates. Others may be adversely affected, with significant implications for commercial and subsistence fisheries. ■

230%

One study suggests that crop yields in sub-Saharan Africa will have to increase by this much by 2050 just to maintain today's already insufficient food consumption

In search of solutions

Farmers and fishers need to adapt to climate change and at the same time maintain or increase food production. They also need to adopt practices which reduce agriculture's climate footprint.

Adapting to climate change must be the first priority; indeed, it is already a priority for many people. This may involve the use of varieties and species which have the ability to cope with higher temperatures, drier conditions and emerging pests and diseases. Harvesting water during the rainy season for use in the dry season will become increasingly important in sub-Saharan Africa and elsewhere. Livestock farmers will need to consider changing feeding regimes and improving pasture management. In some regions, such as the Caribbean, protected agriculture – growing crops under glass – could prove to be one of the best ways to adapt to climate change and climate variability. Adaptation to short-term climatic variability and long-term climate change also involves better risk management, for example through insurance schemes and by providing farmers with access to better weather forecasts.

In an ideal world agriculture would aim to meet future food requirements without further increases in emissions

There will be times when incremental changes are insufficient. Farmers may need to make major changes, such as shifting from one farming system to another. In Australia, this sort of 'transformative adaptation' is already being considered seriously, for example by the wine industry. Such bold moves are not yet commonplace, but would appear inevitable if global warming occurs at the top end of current projections.

In an ideal world, agriculture would be 'carbon neutral': farming activities would take out of the atmosphere a quantity of greenhouse gas equal to or greater than the amount they emit. At the very least, these activities should aim to meet future food requirements without further increases in emissions. However, there is also significant potential to reduce emissions. The IPCC has estimated that emissions from agricultural activities (not

Planning for the future. Scientists at the International Rice Research Institute taking measurements from varieties of hybrid rice which are undergoing simulation of drought conditions.

Comparison of good and bad millet yields, in Ghana's Upper West Region, which experienced failed rains and rising temperatures.

500 million hectares

Area of agricultural land classified as a moderately or severely degraded in sub-Saharan Africa

including the clearance of forests to make way for farmland) could be reduced by up to 6000 Mt CO_2e by 2050. This is roughly equivalent to the current emissions of 5100–6100 Mt CO_2e a year.

The reductions could be achieved by improving the efficiency of food production and reducing post-harvest losses, which would lead to fewer emissions per unit of food produced and used, and by adopting a range of practices which reduce emissions. These include many proven techniques, such as crop rotation, mulching, the use of nitrogen-fixing legumes, the targeted use of mineral fertilisers and efficient water and waste management. It also makes sense for new agricultural development to take place on degraded land or land which is not rich in carbon, rather than on carbon-rich habitats, such as peatlands and wetlands.

All these activities – whether for adaptation or mitigation – come under the heading of climate-smart agriculture, whose aim is to increase food production, help farmers to become more resilient to climate change and reduce greenhouse gas emissions. The examples below provide a brief overview of the transformative powers of climate-smart agriculture. However, it is important to point out that isolated success stories are not enough. Countries need to take a holistic approach to tackling climate change and ensuring food security by devising the appropriate policies and providing the right incentives for farmers.

CONSERVATION AGRICULTURE

The organic matter in the top 30 cm of the Earth's soil contains almost as much carbon as there is in the entire atmosphere. When poorly managed,

New agricultural development should take place on degraded land or land which is not rich in carbon

Man checks seedlings in a greenhouse, Arusha, Tanzania.

soils not only provide meagre crop yields, they release significant quantities of carbon. This is precisely what is happening in many parts of the world. In sub-Saharan Africa, for example, 500 million ha of agricultural land is moderately or severely degraded: this is a disaster for both food security – maize yields have scarcely risen over the last 30 years – and the climate.

However, farming also has the potential to sequester huge quantities of carbon through practices such as conservation agriculture, which improves the nutrient- and water-holding capacity of the soil. There are three main practices involved in conservation agriculture. First, farmers prepare their land using minimum or zero tillage, disturbing the soil as little as possible. Second, they keep the soil covered throughout the year with organic matter, in the form of crops, crop residues and trees. Third, they rotate crops, making use of nitrogen-fixing legumes such as beans, as well as trees which provide additional soil fertility and improve soil structure.

In Zambia, the Conservation Farming Unit has been working with smallholders since the mid-1990s. By the end of 2010, over 180,000 farmers were practising conservation agriculture, and their number was expected to rise significantly over the coming years. Conservation agriculture has enabled many farmers to more than double their maize yields

According the United Nations Food and Agriculture Organization (FAO), conservation agriculture reduces water needs of crops by 30%, lowers

energy needs by 70%, and sequesters significant amounts of carbon. It also helps farmers adapt to climate change as the perennial cover of organic matter protects the soil from high temperatures, desiccation and erosion. Worldwide, around 120 million ha of arable land are under some form of conservation agriculture, and this figure is said to be rising by around 6 million ha per year.

AGROFORESTRY

Over 40% of the world's farmland has at least 10% tree cover, and every year the area devoted to agroforestry increases as more and more farmers recognise the benefits of planting trees. By yielding a broad range of products, including fruits, fuelwood, timber and resins, agroforestry helps farmers to diversify their incomes, providing them with greater protection against market failures and fluctuations. The use of nitrogen-fixing trees and shrubs increases soil fertility and crop yields. Trees sequester much greater quantities of carbon than annual crops, and in some instances provide farmers with access to the carbon market. Trees also help farmers adapt to climate change, as perennial crops are better able to cope with droughts and floods than annual crops.

A story from the Sahelian region of sub-Saharan Africa provides a graphic demonstration of how swiftly agroforestry can transform landscapes and livelihoods. In the early 1990s, Niger, a country frequently afflicted by droughts, revised its forestry regulations, giving farmers the right to decide how to manage trees on their land. They immediately responded by encouraging the natural regeneration of *Faidherbia albida*, a tree which improves soil fertility by shedding its nitrogen-rich leaves during the rainy season, and other species which provide a free source of soil fertility, as well as fruit, fuelwood and livestock fodder.

Conservation agriculture reduces water needs of crops by 30%, lowers energy needs by 70% and sequesters significant amounts of carbon

Today, around 5 million ha of land have a good covering of *Faidherbia* and other indigenous species, and farmers are growing their annual crops in these agroforestry systems. Yields of sorghum and millet have increased significantly, together with farmers' incomes. At the same time, this form of 'evergreen agriculture' is sequestering significant quantities of carbon and protecting farmers from the vagaries of climate change.

SMART SOLUTIONS FOR LIVESTOCK

Between 1980 and 2005, meat consumption in China quadrupled and the consumption of milk increased tenfold. There was nothing unusual about this: as nations lift themselves out of poverty an increase in wealth leads to an increase in the consumption of livestock products. By 2010, 33% of the world's cropland was devoted to growing animal feed and 26% of ice-free land was used for grazing.

In many areas, livestock farming is responsible for overgrazing, land degradation and the loss of forests, releasing large quantities of greenhouse gases. Livestock are also the largest major source of global methane emissions. Furthermore, a significant portion of the annual soya bean harvest – much of which is grown on land in Latin America that has been cleared of tropical forests – is used in animal feed. Even without any further expansion of the livestock industry, reducing its

Watering plants in the Ten Souelim tree nursery (Mauritania).

Livestock farmers will need to consider changing feeding regimes and improving pasture management.

impact on the climate would be a major challenge. As it is, meat consumption is forecast to rise dramatically over the coming decades.

A wide range of measures are required to reduce the livestock sectors' climate-change footprint. These include improving production and feed systems, developing new breeds of ruminant which produce less methane, introducing methods of manure management which reduce emissions, and integrating livestock with crops in order to reduce waste and improve soil fertility. Better grazing management could also do much to improve animal nutrition and reduce greenhouse gas emissions.

33%

Share of the world's cropland devoted to growing animal feed

It could also be argued that eating habits in the developed world need to change. Reducing the amount of meat we eat would be beneficial for a variety of reasons. It would help to lessen the ecological footprint of the livestock industry and reduce the industry's greenhouse gas emissions. It would also mean that more land could be devoted to growing food for humans, rather than feed for domestic animals. It might also be good for our health.

A fisherman shows his catch of tilapia fish on Lake Kapolowe. The fish are small due to overfishing (Lubumbashi, Haut Katanga, RDC)

Here are two examples of climate-smart livestock farming. The first, an adaptation story, describes an insurance programme designed to help pastoralists cope with climate-related risk. The second focuses on mitigation activities.

In 2010, the International Livestock Research Institute (ILRI), working with partners in local government and the private sector, launched an index-based livestock insurance scheme for pastoralists in Northern Kenya. The project insures over 2500 farmers in drought-prone Marsabit District against livestock losses resulting from a lack of forage. Payments are triggered when forage becomes scarce over a long period of time and it can be predicted that over 15% of the livestock will have died of starvation. The scheme, which uses satellite data to assess the state of vegetation, helps to reduce the risks associated with pastoralism in an area which frequently suffers from drought. In 2012, the scheme will be extended to southern Ethiopia, targeting 2700 pastoralists.

In China's Guangxi Province, a project supported by the International Fund for Agricultural Development (IFAD) is turning a greenhouse gas into energy. The farmers involved in the project now channel their waste, mostly from pigs, into sealed tanks, where it is converted into a gas used for cooking. In addition to reducing methane emissions, the project has also taken pressure off local forests, as families have reduced their consumption of firewood. Instead of burning their straw, as they did in the past, farmers now incorporate it in their biogas tanks, where it is transformed, along with the pig manure, into fertile compost. The result: higher incomes, less pollution, lower greenhouse gas emissions and better soil management.

AND MUCH MORE...

There is no blueprint for climate-smart agriculture, and its precise nature will vary from place to place, influenced by a whole host of local factors, including the climate, the crops grown, the livestock reared, available technologies and the knowledge and skills of individual farmers.

In some cases, climate-smart strategies will be crop-specific. Take, for example, the challenge of reducing methane from rice paddies. Anaerobic decomposition in irrigated rice systems is responsible for around 11% of agriculture's greenhouse gas emissions, and the crop is therefore a major target for mitigation activities. One of these uses a water-saving technology, Alternate Wetting and Drying (AWD), devised by the International Rice Research Institute (IRRI) and its national partners in the Philippines. By optimising the use of irrigation water, AWD has helped farmers on Bohol Island to maintain crop yields and, at the same time, reduce methane emissions by an estimated 48% compared to those of continuously flooded rice fields. AWD is also helping farmers adapt to possible shortages of water caused by climate change.

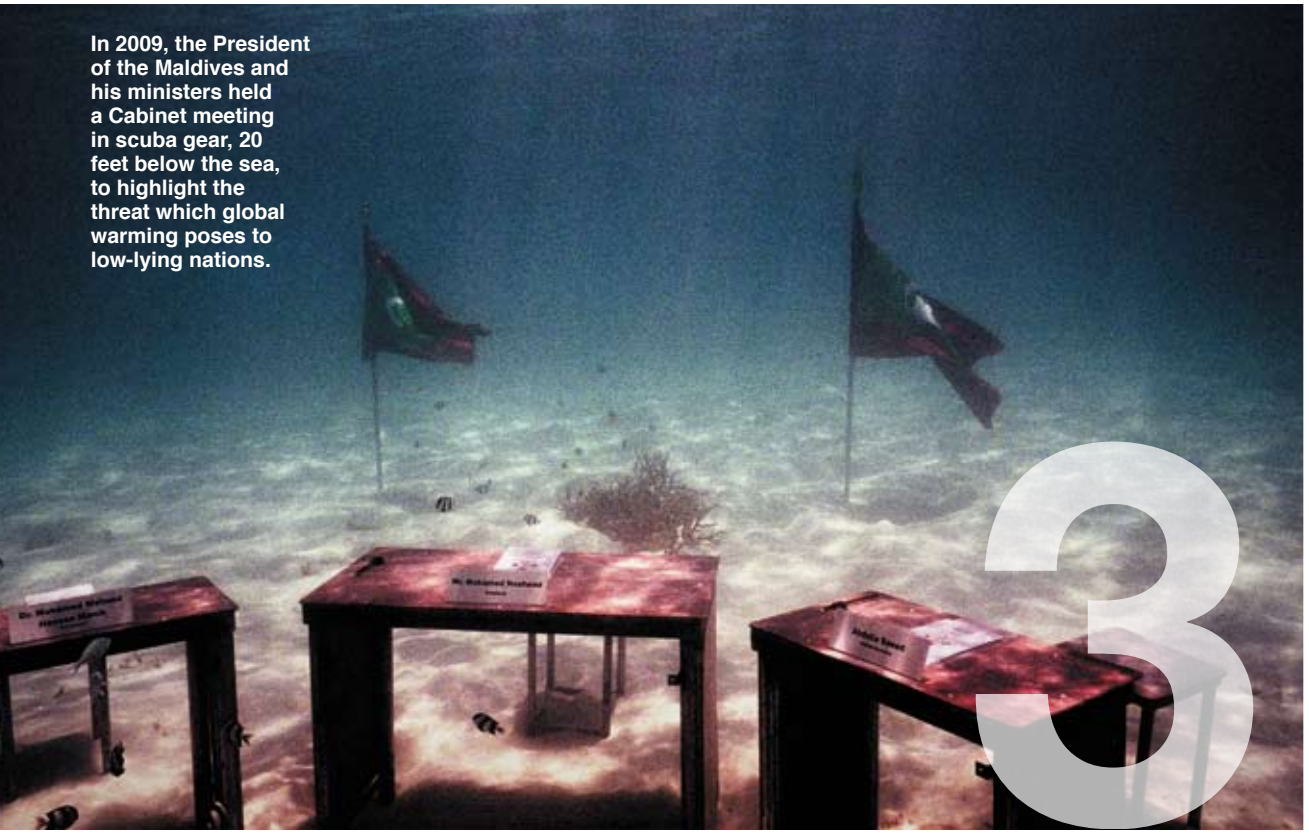
Overfishing and poor management have already had a dramatic impact on the sustainability of marine and freshwater fisheries, and climate change poses a further threat. Helping fishing communities adapt to climate change and lower their greenhouse gas emissions will require a broad range of measures. These could include reducing overcapacity of fishing fleets, improving the energy efficiency of fishing vessels, protecting and restoring fragile coastal ecosystems such as mangrove swamps and coral reefs, and introducing more efficient feeding regimes on fish farms. Once again, climate-smart measures will often be specific to particular locations and production systems. ■

Climate-smart measures will often be specific to particular locations and production systems

In China, many communities are transforming waste from pigs into biogas, which they use for cooking. Not only does this reduce methane emissions, it takes pressure off local forests.

Shifting agriculture to centre stage

United Nations climate-change negotiators first began to discuss mechanisms to Reduce Emissions from Deforestation and Forest Degradation (REDD+) in 2006. Forestry now has its own work programme and considerable financial resources have been devoted to promoting REDD+ activities in developing countries. Agricultural mitigation, in contrast, has failed to attract similar levels of support.



In 2009, the President of the Maldives and his ministers held a Cabinet meeting in scuba gear, 20 feet below the sea, to highlight the threat which global warming poses to low-lying nations.

At the 2009 Conference of Parties to the UNFCCC, held in Cancun, Mexico, efforts to establish an agricultural work programme failed. Those who opposed the idea argued, among other things, that emissions of agricultural greenhouse gases and their sequestration are difficult to measure, that agriculture does not have the same mitigation potential as forestry, and that food security and trade policy make agricultural mitigation highly controversial.

However, a broad range of research institutes, development agencies and farmers' organisations have continued to make the case for establishing a work programme. For one thing, they say, agriculture differs from most other sectors in that it is important for both adaptation and mitigation. These need to be tackled together and a work programme would ensure that this happens. It is also vitally important that mitigation activities do not threaten food security. This is another reason why agriculture needs to be considered in a single forum.

Catching them young. Teaching primary school children the rudiments of agroforestry in Fort Portal, Uganda

The creation of a work programme would put agriculture at the heart of climate-change negotiations and policy-making, ensuring that it makes a full contribution to both adaptation and mitigation without prejudicing food production and poverty alleviation. A work programme would also ensure that agriculture has full access to climate-change finance.

PLANNING FOR THE FUTURE

The UNFCCC is responsible for establishing the international policy framework governing the way in which agriculture is incorporated in future climate agreements. However, much of the policy development must take place at national levels. In Africa, the Comprehensive Africa Agriculture Development Programme (CAADP), coordinated by the New Partnership for Africa's Development (NEPAD), is seeking to ensure that national agricultural development plans take climate change into consideration.

Since the Cancun conference, over 40 developing countries have submitted Nationally Appropriate Mitigation Plans (NAMAs) to the UNFCCC, and over half of these include agricultural mitigation policies or activities. NAMAs, which will benefit from technology transfer and financial support from developed countries, are expected to lead to large-scale emission reductions in developing countries. Unlike the Kyoto Protocol's Clean Development Mechanism (CDM), NAMAs can include mitigation activities which involve soil carbon sequestration. A recent analysis, however, suggests that many of the strategies and activities proposed for agriculture are very general in nature, so more detailed and nuanced plans will be required in future.

A recent survey of NAMAs submitted to the UNFCCC revealed a wide range of different activities related to the production of food, fibre and vegetable oils. For example, the Republic of Congo proposed a number of measures to enhance the carbon stocks of agricultural soils. Ghana plans to promote the recycling, rather than burning, of crop residues to reduce greenhouse gas emissions. Jordan plans to capture methane from livestock, chicken farming and slaughterhouses. Ethiopia proposes to reduce greenhouse gas emissions and sequester carbon by promoting agroforestry.

Least developed countries have also been encouraged to submit National Adaptation Programmes of Action (NAPAs) to the UNFCCC, and these can include agricultural policy reforms and agricultural activities. Among those proposed by 10 countries belonging to the Association for Strengthening Agricultural Research in Eastern and Central Africa are the following: the promotion of drought-tolerant and early-maturing crops, rainwater harvesting, the restoration of degraded land, and a shift to smaller livestock, such as sheep and goats.

Various organisations, including the Technical Centre for Agricultural and Rural Co-operation (CTA) and the Indigenous Peoples of

6000 Mt CO_2e

The IPCC estimates that direct emissions from agriculture could be reduced by this amount by 2050. This is roughly equivalent to current emissions

Local communities should be involved in the design of national adaptation programmes and policies

Africa Coordinating Committee (IPACC), have made a strong argument in favour of involving local communities in the design of national adaptation programmes and policies. Experience in Africa and the Pacific has shown that the use of geo-spatial information technologies, such as participatory modelling, can reveal how local communities are coping with climate instability and help farmers and policymakers assess the best ways of adapting to climate change.

To give just one example, Partners with Melanesians and The Nature Conservancy helped villagers in Boe Boe, in the Solomon Islands, to develop three-dimensional models to explore the impact of climate variability. The models also encouraged discussions about the costs and benefits of different adaptation strategies, such as the restoration of abandoned gardens in the hills as a 'safe haven' for crop production when coastal areas suffer rising sea levels.

LINKING FORESTS AND FOOD

Deforestation and land clearance are responsible for around one-fifth of the world's greenhouse gas emissions. Reducing the rate of deforestation will not only be beneficial for the climate, it will conserve biodiversity and protect the livelihoods of forest-dwelling communities. The policy approaches and incentives designed to reduce emissions and promote conservation and sustainable forest management are now described as REDD+.

REDD+ will only achieve its goals if it takes into consideration the role of agriculture as a driver of deforestation. Increasing agricultural yields is

Protected agriculture could prove one of the best ways of adapting to climate change and climate variability.

The creation of three-dimensional models enabled villagers in the Solomon Islands to explore the impact of climate variability.

one way to meet future food supply needs without clearing forests. However, increasing yields typically makes agriculture more profitable, encouraging farmers and governments to clear more forested land. This means that large-scale investment in agricultural R&D, the development of efficient markets and improvements in agricultural extension must be complimented by strategies to protect forests and identify areas for future agricultural expansion, such as already degraded lands. The agricultural sector, in short, must play as much of a role in developing REDD+ policies and approaches as the forestry sector. At the same time, forest governance needs to improve.

WHY WE MUST ACT NOW

The development of REDD+ and its earlier incarnations provides a number of lessons for agriculture. It exemplifies, among other things, the power of coalitions, which played a key role in launching and gathering support for the REDD+ process. A broad coalition of agricultural interest groups – many have been involved in the Agriculture and Rural Development Days in recent UN negotiations – is making a strong case for putting agriculture at the heart of climate-change policymaking. Not that all developing countries have the same interests. Some have agricultural sectors which are major greenhouse gas emitters; others make an almost negligible contribution to climate change, but suffer its impacts disproportionately. This will inevitably influence the way coalitions form.

The strong support which REDD+ receives now owes much to a range of activities and projects, or 'early actions', which tested different approaches to reducing emissions from deforestation and degradation. These received considerable financial support from bilateral donors – for example, in 2007 the Norwegian government pledged up to US$500 million a year for REDD activities in developing countries – and from multilateral institutions like the World Bank. The early actions helped to convince international and national policymakers that forestry-based projects could play a significant, cost-effective role in the reduction of greenhouse gas emissions. This explains the full head of steam behind REDD+ at recent climate-change negotiations.

There is an urgent need for agriculture to follow a similar path by establishing a range of pilot projects which provide solid proof of the virtues of climate-smart agriculture. This will involve the development of national plans for agricultural adaptation and mitigation, conducting trials of market-based mechanisms to reduce emissions, working out how to reduce the transaction costs of involving millions of smallholders in mitigation activities, and testing new approaches for getting information to farmers about the technologies and practices which can help them adapt to climate change. Although targeting smallholders is important, this should not obscure the fact that industrial-scale food production is responsible for the bulk of emissions and should be a key focus of climate-smart reforms. ■

There is an urgent need for pilot projects which illustrate the virtues of climate-smart agriculture

These Acacia saplings will be used to create windbreaks to prevent wind erosion and stabilise the land.

In Kiribati, mangroves have been planted to protect the coastline from erosion caused by the rise in sea level and storm surges.

Children playing with an interactive globe at the Bright Green Conference, part of the 2009 UN summit on climate change in Copenhagen.

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Money matters

One recent study estimates that the annual global cost of adapting to climate change in the agricultural sector could amount to US$7 billion a year. The UNFCCC has come up with a figure of double that. It has also calculated that the additional investment and financial flows needed in developing countries for mitigation activities in the agricultural sector will amount to US$12.25–14 billion a year by 2030. This does not appear to include the cost of soil carbon sequestration.

There are two main sources of finance for adaptation and mitigation activities. The first involves public sector funding processes. The second involves carbon markets using formal arrangements such as the Kyoto Protocol's Clean Development Mechanism (CDM) and voluntary schemes like the World Bank's BioCarbon Fund.

The Cancun Agreement, a significant outcome of the 16th Conference of Parties of the UNFCCC, included a commitment by developed countries to provide US$30 billion of new finance to developing countries during the period of 2010 to 2012, to be divided between adaptation and mitigation activities. The agreement also included a long-term commitment of US$100 billion by 2020. It is worth pointing out that past pledges to provide climate-change funding have frequently not been honoured.

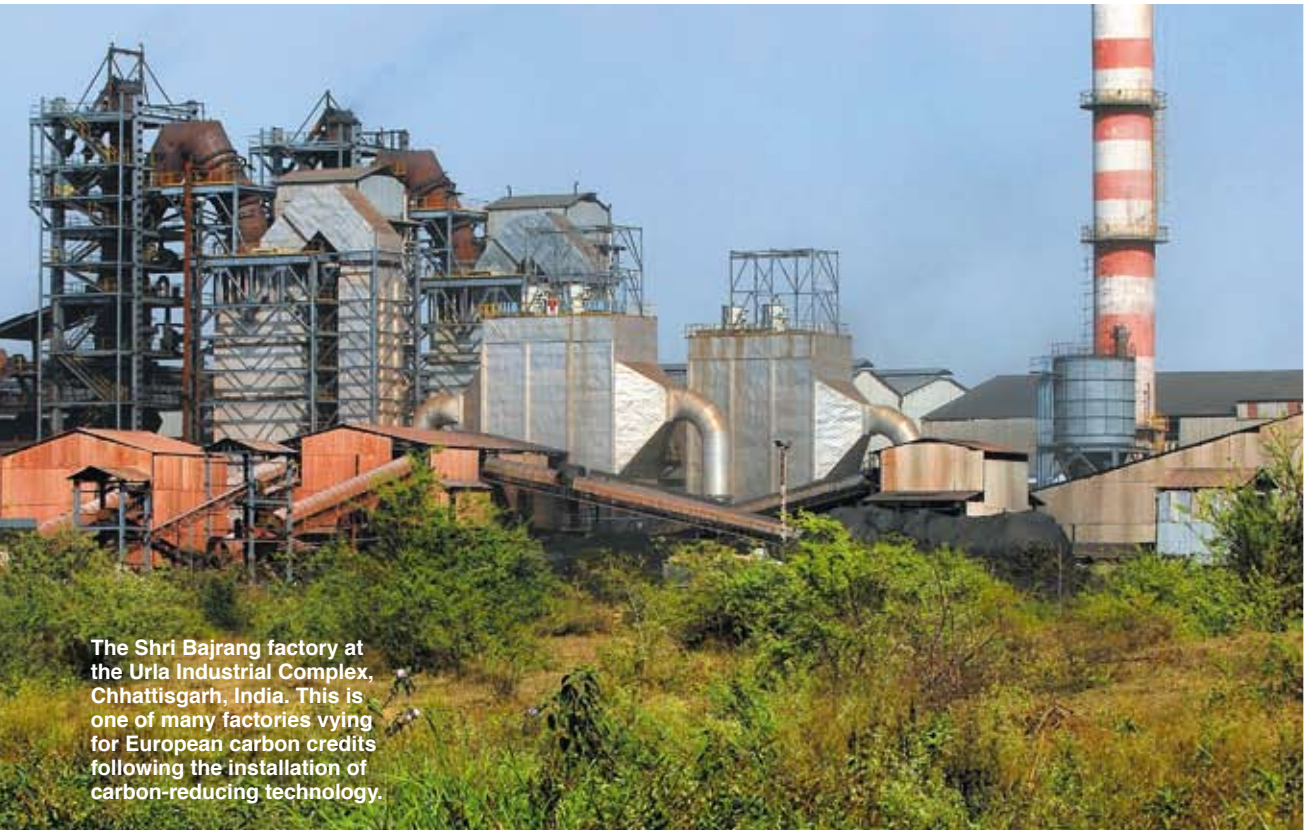
The financial mechanism of the UNFCCC is serviced by the Global Environment Facility (GEF), whose Trust Fund supports climate-change mitigation and adaptation activities, including those related to agriculture, such as National Adaptation Programmes of Action. A new fund, the Green Climate Fund, was launched at Cancun, and is likely to manage a large proportion of the US$100 billion committed at the conference. However, priority may be given to energy, industry and REDD+ projects and it is unclear to what extent agricultural activities will benefit.

MARKET SOLUTIONS

Market-based mechanisms to reduce emissions have led to the creation of a thriving carbon market, described by the *Economist* as the fastest-growing commodity market in the world, worth US$120 billion by 2010.

US$ 120 billion

This was the value of the carbon market, the fastest growing commodity market in the world, in 2010



The Shri Bajrang factory at the Urla Industrial Complex, Chhattisgarh, India. This is one of many factories vying for European carbon credits following the installation of carbon-reducing technology.

The Clean Development Mechanism (CDM) enables businesses and organisations in developed countries to meet their emission quotas by financing mitigation activities in developing countries. By mid-2011, over 3380 project had been registered under the CDM, with the majority in China and India. Of these, just 4.5% related to agriculture, most being energy projects designed to process crops and manure into biofuels. The CDM excludes activities such as soil carbon sequestration, which has the greatest potential for agricultural mitigation. A wide range of interests and organisations have argued that a reformed Kyoto Protocol – it is currently been renegotiated – should make a broad range of agricultural activities eligible for inclusion under the CDM.

The voluntary carbon market, in contrast, is supporting a wide range of projects that provide clear evidence of agriculture's potential to reduce its greenhouse gas emissions. To give just one example, the World Bank's BioCarbon Fund is now purchasing carbon credits from an agricultural project in Western Kenya which is reducing emissions over an area of 45,000 ha. It is doing this by providing technical support to some 60,000 farmers who are adopting climates-smart practices, such as reduced tillage, the use of cover crops, mulching, the tar-

A sign of the times. The government of Kiribati has been forced to raise the sea wall to protect the international airport from rising sea levels.

geted application of fertilisers and agroforestry. It is estimated that these practices could sequester 60,000 tonnes CO2e a year, and at the same time increase crop yields and reduce the vulnerability of small farmers to climate change. This is just one of an increasingly large portfolio of climate-smart agricultural projects that are benefiting from the voluntary carbon market.

MORE REQUIRED

If agriculture is to be part of the solution to climate change, and at the same time continue to contribute to food security and poverty alleviation, there will need to be a significant increase in investment in climate-smart agricultural policies and practices. Agriculture should be eligible for support from existing and future climate-change financing mechanisms. Among other things, these mechanisms could reward farmers for adopting practices that generate multiple benefits for food security, development and climate change. Measures should be also taken to ensure that smallholders can benefit from carbon markets and the CDM. ■

Farmers could be rewarded for adopting practices that generate multiple benefits

Cattle head home along a dry riverbed in Tete Province, Mozambique.

Further reading

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The Technical Centre for Agricultural and Rural Cooperation (CTA) is a joint international institution of the African, Caribbean and Pacific (ACP) Group of States and the European Union (EU). Its mission is to advance food and nutritional security, increase prosperity and encourage sound natural resource management in ACP countries. It provides access to information and knowledge, facilitates policy dialogue and strengthens the capacity of agricultural and rural development institutions and communities. CTA operates under the framework of the Cotonou Agreement and is funded by the EU.
For more information on CTA, visit www.cta.int

The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) is a strategic partnership of the CGIAR and the Earth System Science Partnership (ESSP). CCAFS brings together the world's best researchers in agricultural science, development research, climate science and Earth System science, to identify and address the most important interactions, synergies and tradeoffs between climate change, agriculture and food security. The CGIAR Lead Center of the program is the International Center for Tropical Agriculture (CIAT) in Cali, Colombia.
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Climate-smart agriculture helps to reduce greenhouse gas emissions while offering solutions to ensure food security

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