HEALTHY HARVESTS: THE BENEFITS OF SUSTAINABLE AGRICULTURE IN AFRICA AND ASIA

POVERTY

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EXECUTIVE SUMMARY

This report argues that smallholder farmers in Africa and Asia can improve agricultural productivity, food security and livelihoods by adopting sustainable [1] approaches that utilise resource-conserving technologies and that draw upon their own knowledge. Many thousands of communities in countries such as India, Cambodia, the Philippines, Burkina Faso, Zimbabwe and Kenya are already benefiting from sustainable farming but they need more support and, above all, these approaches need to be scaled up.

Seventy per cent of the world's nearly 1 billion hungry people are smallholder farmers and the rural landless. Marginalised smallholder farmers have long been locked in a cycle of low productivity, lack of assets and services and weak market power. In addition, they face a number of newer challenges. Many crop and livestock producers are deeply vulnerable to the effects of climate change. Land degradation and groundwater depletion are increasingly posing a threat to food security and the livelihoods of rural people. Meanwhile, scope to expand agricultural production into new lands is increasingly limited, and competition for existing farmland is increasing too: from foreign investors, industry and urban developers. Rising food prices since the onset of the global food crisis of 2007 to 2008 have posed a further challenge to smallholder farmers who tend to be net food buyers and who also have to meet the costs of rising fertiliser prices.

This report asks the question: what kind of agriculture can address poverty and hunger in a world in which the climate is changing, food demand is growing and land, soil and water resources are increasingly under pressure; and in a way that preserves the natural resource base for future generations?

In recognition of the challenges facing agriculture, donors and governments have in recent years made welcome new political and financial commitments to smallholder farming, especially in Africa. However, as this report outlines, the solutions for Africa advocated by donors, governments and the initiatives of private foundations have tended to centre around the promotion of synthetic fertilisers and pesticides, which are costly for farmers and very often resource-depleting. This drive for a new 'Green Revolution' for Africa has tended to sideline more sustainable, farmer-led approaches. For example, recent input-subsidy programmes in Africa

'States can and must achieve a reorientation of their agricultural systems towards modes of production that are highly productive, highly sustainable and that contribute to the progressive realisation of the human right to adequate food.'

Olivier De Schutter, UN special rapporteur on the right to food

have brought significant short-term benefits in certain cases, but they are looking increasingly unsustainable and risk sidelining investment in greener alternatives. And our research identifies concerns that the agro-dealer networks funded by the Alliance for a Green Revolution in Africa (AGRA) are selling ever more quantities of agro-chemicals to farmers, thus marginalising the space for alternative approaches that are more sustainable.

The experience of Asia's Green Revolution holds some very important lessons for policy-makers globally. There is no denying its achievement in lifting yields and reducing hunger, especially from the 1960s to 1980s. But this process of change began to stall in the 1990s and this is posing major challenges for Asian governments today. One cause is the heavy burden on the natural resource base of the widely-adopted, intensive mono-cropping system. Soil degradation has meant farmers have had to increase the quantity of fertiliser used in order to maintain their yields. This has in turn affected their profit margins and is one factor behind increasing levels of farmer debt. There have been a range of other serious consequences of the Asian Green Revolution (for example, the loss of on-farm biodiversity, social inequalities, and the dangerous effects of pesticides on the health of farmworkers), which should give governments more than a pause for thought.

We define sustainable agriculture as a way of producing food that balances the economic, social and environmental aspects of farming. It is an approach that minimises or avoids chemical inputs, uses resource-conserving technologies and materials available on the farm, and draws and builds upon the capacity of farmers and community organisations. These principles are already being successfully adopted by farming communities in Asia and Africa, including with the support of Christian Aid partners.

A growing body of evidence – both academic and data and analysis available from development programmes – demonstrates that such sustainable approaches can be highly effective in boosting production, incomes and food security; supporting soil and water conservation, on-farm biodiversity and crop health; improving resilience to natural disasters and climate change; lowering greenhouse gas emissions; and empowering communities. For example, in

'[With proper support for agro-ecological approaches] we can see a doubling of food production within 5 to 10 years in some regions where the hungry live.'

Olivier De Schutter, UN special rapporteur on the right to food

Cambodia, the adoption of new growing techniques for rice, which minimise the use of agro-chemicals and water (known as the 'system of rice intensification') has helped increase yields for farmers from an average of 2.5 tonnes per hectare to 3.7 tonnes per hectare.[2] In Zimbabwe, Christian Aid partners ZimPro and the Dabane Trust have assisted over 3,000 households to adopt conservation agriculture. This enabled farmers to increase significantly their yields of sorghum, millet and maize – helping to improve household food security. And in other countries, farmers have been able to cut back on pesticide use by adopting natural methods of tackling pests. This has delivered both income and health benefits.

However, these approaches remain severely under-supported. To scale them up governments and donors need to significantly re-balance their current focus on quick-fix, external-input intensive 'solutions', towards a much greater support for sustainable, agro-ecological approaches. This should come through a re-balancing of government subsidies towards resource-conserving technologies and by building these approaches into revived public research and extension programmes that place smallholder farmers, their associations and networks at the centre of decision-making. National seed laws should primarily focus on promoting farmers' rights and access to seeds of their own choosing, be they modern or local seed varieties. They should also enshrine the right of farmers to freely breed, conserve and exchange traditional varieties. Governments will also need to increase poor people's access to land and smallholders' security of tenure – both are important pre-requisites for rural food security and the adoption of sustainable agriculture. Governments need to encourage and harness the potential of the private sector to play a role in supporting sustainable farming, while also putting in place appropriate regulations, for example to ensure that private agro-dealers do not replace government extension service as a source of advice on inputs for farmers. This must also be accompanied by initiatives that enable the creation of, and access to, markets that return fair prices for small-scale producers, and global trade policies that safeguard the position of domestic producers in national food systems.

Recommendations:

DFID, the EU and other donors should:

- Meet and increase funding commitments for agriculture, with priority given to supporting sustainable, smallholder farming:
  - DFID should honour its commitment to spend £1.1bn on food security and agriculture over three years (2009/10 to 2011/12) and budget for further increases as overseas development assistance rises. But, above all, it should outline a strategy for spending this money that enables the scaling up of proven, sustainable approaches (see below)
  - in their budgeting for food security and agriculture in developing countries, the EU and member states should ensure the prioritisation of sustainable agriculture and support to small farmers and their organisations. Future EC country programme support in this area should be in line with the priorities of the new Food Security Policy Framework
  - all donors should set out plans to allocate a minimum of 10 per cent of ODA to agriculture and food security to match the 10 per cent commitment made by African governments in the Maputo Declaration of 2003.
- Within research budgets, place a greater emphasis on low-cost, sustainable and farmer-led technologies, such as the promotion of indigenous and local varieties of crops that do not require agro-chemicals; participatory seed breeding; organic methods of soil fertilisation (for example cover crops, composting, crop rotation, agro-forestry, low/zero tillage); polycultures; mixed livestock-arable-aquaculture systems; soil/water conservation measures (for example bunding, zai pits, mulching, the system of rice intensification); cheap, labour-saving tools; and natural pest-control techniques.
- Support more research partnerships involving collaboration among poor farming communities, extension services and agricultural scientists.
- Ensure research programmes examine what kinds of sustainable agriculture techniques, equipment and crops can most benefit women.
- Significantly boost funding for extension services, in particular for training and dissemination of the sustainable approaches in this report: support countries' efforts to reinvigorate these services in the most marginal (and hunger-prone) agricultural zones.
- Integrate a nutritional dimension into agricultural programmes: this could involve increasing the diversification of smallholder agriculture, promoting micronutrient-rich food, especially local varieties, monitoring nutrition-related outcomes, and supporting agricultural research that is conducted from a nutrition perspective.
- Refrain from pushing developing countries, in particular in EU trade agreements, to align their domestic seed legislation with international accords such as UPOV and TRIPS because these limit farmers' ability to save and exchange seeds and sell them locally.
- Ensure that trade agreements do not restrain governments from protecting their agricultural sectors from subsidised imports and import surges that undercut domestic producers and are a disincentive for them to invest in sustainable production.
- Given its proven adaptation and mitigation benefits, ensure that smallholder, sustainable agriculture is one of the sectors that receives public funding under new North-South 'climate finance' initiatives.

Asian and African governments should:

- Increase the percentage of budgets directed towards agriculture, with a greater focus on sustainable agriculture. In the case of African governments this would include meeting the 2003 Maputo commitments to allocate 10 per cent of budgets to agriculture. In Asia, governments should reverse the recent decline in support to the sector and return to 1990 funding levels (8.5 per cent of state spending).
- Progressively re-orientate subsidies and funds towards sustainable, resource-enhancing and affordable farming approaches that work well for small-scale farmers with limited assets and incomes – see examples above.
- Support more research – led by farmers – on sustainable agriculture, in the same areas mentioned above.
- Revamp extension services with a greater focus on farmer-to-farmer knowledge transfer and group-learning processes. These services should support the adoption of the agro-ecological practices outlined in this report; they should also target women farmers, who have been particularly neglected in existing extension services. Coverage should be increased in the most marginal, hunger-prone regions.

- Ensure that land and other natural-resource policies create incentives for the adoption of agro-ecological approaches: for example, smallholder farmers need guaranteed security of tenure and landless people access to land; and rural communities as a whole should play a stronger role in the sustainable management of natural resources, including land, water, fisheries and forests.
- Recognise the central role that women farmers can play in scaling up sustainable approaches by increasing:
  - their participation in agricultural research (see above)
  - their involvement in and influence over extension services and local decision-making bodies.
- Strengthen local and regional markets in staple foodstuffs, by supporting farmers' organisations such as cooperatives; investing in roads, processing and crop storage facilities, and providing targeted price information and weather/climate forecasting services.
- Ensure that national seed laws give maximum scope to farmers to save, re-use, exchange and sell locally seeds of their choosing – including both local varieties and modern varieties (MVs) developed by seed companies.
- Put in place incentives to harness the potential of the private sector to contribute to sustainable farming; as well as regulatory frameworks to ensure that a small number of transnational corporations (TNCs) or other companies do not dominate markets; and that their promotion of fertilisers, pesticides and MV seeds do not sideline sustainable approaches.
- Prioritise sustainable agriculture in national plans on climate change adaptation, and food security and nutrition.
- Limit the amount of pesticides used in farming by investing in natural methods of pest control; phase out highly hazardous pesticides;[3] and in order to protect the health of small-scale users in tropical climates, and in line with section 3.5 of the FAO *Code of Conduct on the Distribution and Use of Pesticides*, avoid using pesticides 'whose handling and application require the use of personal protective equipment that is uncomfortable, expensive or not readily available'.

Endnotes

1 The terms sustainable agriculture and agro-ecology are used interchangeably in this report – see Section 3.

2 Figures recorded by the Cambodian Ministry of Agriculture.

3 See this list of highly hazardous pesticides drawn up by the Pesticides Action Network (PAN) International in 2011, pan-germany.org/download/PAN_HHP-List_1101.pdf

INTRODUCTION AND CONTEXT

Locals dig boreholes into the river bed to find water in eastern Kenya. The IPPC warns that by 2020 climate change could leave up to 250 million people in sub-Saharan Africa exposed to increased water stress.

This report argues that smallholder farmers in Africa and Asia can raise agricultural productivity and meet food security, livelihood needs and environmental objectives by adopting sustainable agriculture approaches. We define sustainable agriculture as a way of producing food that balances the economic, social and environmental aspects of farming. It is an approach that minimises or avoids chemical inputs, uses resource-conserving technologies and draws and builds upon the capacity of farmers and their organisations.

In a context of persistent hunger, rural poverty, rising demand for food, climate change and increased pressure on natural resources, focusing investment on approaches to food production that rely upon intensive use of costly and environmentally-damaging chemical fertilisers and pesticides, to the exclusion of agro-ecological alternatives, will not pave the way for sustainable futures.

Of course, adoption of sustainable approaches towards agricultural production will not provide smallholder farmers with all that is needed to escape poverty and hunger. A number of fundamental reforms will be needed in addition. These include increased control over assets for smallholder farmers, such as land for rural communities, access to credit and price information, revival of state-sponsored research, and extension and support to link with markets. These reforms need to be combined with trade rules that give domestic producers the breathing space to grow and an increase in jobs outside the farming sector in rural areas. But, as this report demonstrates, the promotion of sustainable agriculture is a critical part of the picture and is likely to become more and more necessary in an increasingly resource-constrained world.

The global context

Across the world today nearly one billion people go hungry.[1] Seventy per cent of them are smallholders and the rural landless.[2] Too many smallholder farmers in Africa and Asia do not grow enough food to feed themselves and their families throughout the year. These marginalised farmers have long been locked in a cycle of low productivity, lack of assets and services and weak market power, as has been well documented.

In addition, they face a number of newer challenges. Many crop and livestock producers are deeply vulnerable to the effects of climate change, which, in addition to increasing temperatures, also appears to be affecting now the reliability, frequency and volume of the rains on which most African and Asian smallholders depend. The Intergovernmental Panel on Climate Change predicts that some African countries could see yields from rain-fed agriculture decline by up to 50 per cent by 2020,[3] with other estimates suggesting that 29 African countries could face a loss of around 35 million tonnes in potential cereal production.[4] In south Asia, cereal yields could fall by up to 30 per cent by the middle of the century.[5]

At the same time, land degradation and groundwater depletion are increasingly posing a threat to food security and the livelihoods of rural people, who often live on marginal lands with very low levels of fertility. Land degradation is affecting 38 per cent of the world's cropland: 1.9 billion hectares in all.[6] Meanwhile, scope to expand agricultural production into new lands is increasingly limited,[7] especially in the context of population growth. And there is new competition for land: from investors seeking to produce food and biofuels for export; and from industry and urban developers. In addition, water tables are plummeting, as usage for irrigation and other purposes is greater than the rates of replenishment.

Smallholder farmers have also been victims rather than beneficiaries of rising food prices. Most smallholders are net food buyers,[8] partly the result of governments and donors cutting funding to food production in recent decades and encouraging farmers to produce cash crops for export instead. In only a small number of developing countries, including Vietnam and Madagascar, are the poor primarily net sellers of food. Thus food price rises are tending to make most poor farmers poorer.

Moreover, it is not easy for small producers who are selling crops to respond to the opportunity of higher prices by increasing production. They face a range of constraints to production, they often have limited access to markets and the benefits of higher prices are in any case too often captured by those higher up the market chain. Meanwhile, input prices have risen sharply in the past decade. For example, in the early part of 2008 the price of some fertilisers was 160 per cent higher than for the same period in 2007.[9] These price rises, caused by increased global demand and the rising cost of oil, were quickly passed on to farmers in many countries. So the steep rise in input costs often simply cancelled out any gains from higher output prices, for farmers selling in markets.[10]

Despite these challenges, smallholder farmers in developing countries have huge potential to meet not only their own food needs, but the growing requirements of increasingly urbanised and expanding populations. Already, smallholder farmers – commonly defined as those producing food on

holdings of less than two hectares – produce more than 50 per cent [11] of the world's food. With the appropriate support they can not only support their own livelihoods and household food needs, but also make a major contribution to the overall enhanced levels of food production that will be necessary. For this, a number of significant changes are required.

First, a massive reinvestment in agriculture is needed and key commitments to this effect have been made in recent years. In 2009, the G8 countries pledged US$22bn over three years as part of the L'Aquila Global Food Security Initiative and the European Commission has committed to support agriculture in developing countries through its 'Food Facility', to which it has donated €1bn. It is welcome that donors and governments are recognising this need and putting in place measures to turn around the previous disinvestment in agriculture in developing countries. African governments have also committed, under the Maputo Declaration of 2003, to increase spending to 10 per cent to address previous neglect of the sector.[12]

Second, more important even than the level of support for agriculture, is what kind of agriculture is supported. The need for a rethink was highlighted in the 2008 IAASTD report.[13] This World Bank- and UN-led report, endorsed by 58 governments including the UK, was highly critical of the way in which the post-war path of input-intensive food production had insufficiently internalised its social and environmental costs. It said that a fundamental shift in policy was required if farming was to successfully meet development and environmental goals, and that these changes should be directed primarily at those who have been served least by previous approaches.

Olivier de Schutter, the UN special rapporteur on the right to food, recently noted that 'In a context of ecological, food and energy crises, the most pressing issue regarding reinvestment is not how much, but how.' [14] It is this 'how' that is the focus of this report. We ask the question: what kind of agriculture can address poverty and hunger in a world in which the climate is changing, food demand is growing and land and water resources are increasingly under pressure; and in a way that preserves the natural resource base for future generations? A first step in this analysis is to examine how small farmers fared under the Green Revolution in Asia and draw lessons from this for the African context, where a similar 'revolution' is being proposed.

We will argue that there needs to be a rebalancing away from the existing focus of governments and donors on farming that places too great an emphasis upon costly chemical inputs and seed technologies, and towards increased support for sustainable agriculture.

Report outline

The next section looks at the approaches to agriculture that are currently being prioritised by governments and other actors for Africa, which we argue are partly based on an overly optimistic view of the positive effects of the Green Revolution in Asia. Section 2 examines the social, economic and environmental legacy of that process of change in Asia and the lessons for policy-makers globally. Section 3 outlines an alternative model – low-external input, farmer-led sustainable agriculture. Section 4 examines the evidence regarding the benefits of this model. We draw on both academic literature and data available from Christian Aid and other non-governmental organisations (NGO) projects and surveys to make our case. Section 5 assesses what is needed to scale up these approaches. The final section presents our conclusions and a short set of recommendations for policy-makers.

This report focuses on smallholder farming in Asia and Africa. There are also many examples of sustainable agriculture to be found in Latin America and although these fall beyond what it has been possible to cover in this report, some of the global studies examined in Section 4 do include data from projects in that region.

Endnotes

1 Food and Agriculture Organisation (FAO) of the UN, *State of Food Insecurity in the World*, 2010.

2 World Bank, *World Development Report 2008: Agriculture for Development*, Washington: World Bank, 2007.

3 IPCC Fourth Assessment Report, *Climate Change 2007, Synthesis Report: Summary for Policymakers*, Table SPM.2, 2007.

4 Gunther Fischer, Mahendra Shah, Harrij van Velthuizen and Freddy Nachtergaele. *Global Agroecological Assessment for Agriculture in the 21st Century*, FAO and IIASA, 2001.

5 IPCC, Fourth Assessment Report, *Climate Change 2007: Working Group II: Impacts, Adaptation and Vulnerability*, 10.4.1.1, 2007.

6 International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD), *Agriculture at a Crossroads*: Synthesis Report, 2008, p59.

7 Some estimates suggest that only 12 per cent of new land is available to expand into – see International Fund for Agriculture Development (IFAD) *Rural Poverty Report, 2011*, p148; or *Economist*, 'A special report on feeding the world', 24 February 2011.

8 Alberto Zezza et al, *The Impact of Rising Food Prices on the Poor*, ESA Working Paper 08-07, FAO, August 2008; 'Rising food prices: the opposition's opening statement', *Economist*, 29 July 2008; Daniel Gustafson, 'Biofuels and Food Security', FAO, 2008.

9 FAO, *The State of Agricultural Commodity Markets 2009*, p35. The percentage relates to the price rise in US dollars for triple superphosphate and muriate of potash.

10 FAO, *The State of Agricultural Commodity Markets 2009*, p31-7.

11 Miguel A Altieri, *Small Farms as a Planetary Ecological Asset: Five Key Reasons Why we Should Support the Revitalisation of Small Farms in the Global South*, Penang: Third World Network, 2009, agroeco.org/wp-content/uploads/2010/11/smallfarmes-ecolasset.pdf

12 Average spending on agriculture for 31 African countries in 2003 stood at only 5.6 per cent of total budgets. Even in Asia – where the Green Revolution was underpinned by strong state investment – average spending fell from 8.5 per cent of total budgets in 1990 to around 4 per cent in 2008.

13 IAASTD, *Agriculture at a Crossroads*: Synthesis Report, 2008, p59.

14 Olivier De Schutter, UN special rapporteur on the right to food, *Agroecology and the Right to Food*, 2011, p1.

SECTION 1. A GREEN REVOLUTION FOR AFRICA?

For a number of years now several key actors – notably the World Bank, Department for International Development (DFID), USAID, the Rockefeller and Gates Foundations and African governments themselves – have promoted the idea that Africa needs a Green Revolution (see box *'What was the Green Revolution?'* below). In sub-Saharan Africa the average yield for cereals has been stagnant since the 1960s, at around 1 tonne per hectare.[1] Average annual growth in per capita food production was -0.01 per cent in Africa compared to 2.3 per cent in Asia between 1980 and 2000.[2] Looking to the benefits of the Asian Green Revolution – which in its early years increased food production and reduced hunger – proponents of the African Green Revolution seek to replicate these successes while, they claim, appreciating the need to avoid any negative impacts. This would be a 'uniquely African' approach.

There are a number of supporters of this approach. One major initiative is the Alliance for a Green Revolution in Africa (AGRA), which was founded in 2006 by the Rockefeller and Bill and Melinda Gates Foundations, with DFID joining as a funding partner in 2008 and with further support from the African Development Bank and, recently, Sweden.[3] AGRA works in 12 African countries, mainly supporting research institutes, private sector entities and farmers' groups. It funds projects promoting improved seeds, soil health, market access, finance and policy work.[4] AGRA identifies declining soil fertility as a key challenge faced by small-scale farmers. It also aims to improve productivity by improving farmers' access to mainly hybrid seeds that can be higher yielding and inputs such as chemical fertilisers. AGRA's key activities in this regard include funding the training of African agricultural scientists to develop hybrid seeds and improved crop varieties and networks of rural agro-dealers to expand small farmers' access to inputs.[5]

Christian Aid is concerned that the agro-dealer networks funded by AGRA (in eight countries) are selling ever more quantities of chemicals to farmers, and increasing their reliance on such inputs. Sustainable agriculture alternatives are being marginalised as a consequence. Added to this, these agro-dealer networks are becoming an increasingly important source of extension advice to farmers.

In Malawi, for example – where AGRA provided a US$4.3m grant for an Agro-dealer Strengthening Program between 2007 and 2010 – Christian Aid research found that the project literature referred to the task of 'creating demand' for inputs such as hybrid seed, fertiliser and pesticides among farmers.[6] 'Agro-dealers… act as vessels for promoting input suppliers' products', one internal evaluation notes.[7] The principal beneficiaries of these efforts are the key suppliers of the inputs, mainly Monsanto.[8] These agro-dealers are selling only those hybrids supplied by the seed companies and in the majority of cases these require more fertiliser and pesticides than other seeds.[9] At the same time, training of agro-dealers on product knowledge – a key part of the AGRA programme – has partly been undertaken by the same transnational company (TNC) suppliers. Christian Aid is concerned about the independence of the training given by TNCs, who will be interested in promoting their own products.

Christian Aid is concerned that there is no space in this agro-dealer programme to promote sustainable agriculture; the agro-dealers are not trained in this and are primarily tasked with selling chemicals. Yet these same agro-dealers are becoming an increasingly important source of extension advice for farmers, in effect displacing the government service. A World Bank report on the AGRA-funded agrodealer networks in Kenya, Uganda and Malawi notes that 'the agro-dealers have… become the most important extension nodes for the rural poor'. It also states that 'a new form of private sector-driven extension system

What was the Green Revolution?

The Green Revolution refers to the process of intensification of developing world agriculture that began in the mid-1960s and delivered sharp rises in countries' cereal yields in the two-and-a-half decades that followed. The positive impact of the revolution was felt most in Asia and Latin America; its effects in Africa were much more limited.

One of the key triggers for this change was the development in the early 1960s of new short-straw, fast-growing, 'fertiliser-responsive' modern varieties of wheat, maize and rice – see box *'Seeds and sustainability', page 26*. These varieties were introduced in developing countries and, to optimise yields, they were grown as monocultures with chemical fertilisers, pesticides and irrigation. The new system involved the planting of two or even three crops of wheat and rice in the same year. In Asia, governments also invested heavily in the sector, funding irrigation projects, subsidising the input 'package', regulating output prices and paying for new agricultural research.

is emerging in these countries as the major agricultural input supply companies are increasingly conducting commercial demonstrations of new technologies in rural areas with rural stockists'.[10] (See box *Renewing Africa's extension services*, below.)

In Malawi, AGRA does fund the training of students and research on soil health and intends to scale up the dissemination of soil fertility technologies. It has also provided a grant for seed multiplication, which plays an important role in enabling small farmers to access open pollinated variety (OPV) seeds. These initiatives are positive. However, such projects appear to be small in scale compared to the agro-dealer network discussed above. Of the 12 projects supported by AGRA in the country – which, in addition to soil health and seed multiplication, have also included grants for market access projects and for research into hybrid seeds – by far the biggest has been the agro-dealer network, which ended in 2010. According to our research the latter was funded to the tune of US$4.3 million, while grants to all the other projects combined added up to little more than half of this.

Another case researched by Christian Aid is that of AGRA's role in promoting pesticide usage in Ghana. In Ghana AGRA is funding a US$2.5m project to train over 2,000 agro-dealers in business skills and safe handling of inputs to make agro-inputs 'more available and affordable in remote rural areas'.[11] However, our research finds that although the training in safe handling of pesticides is welcome, there does not appear to be any training in alternative approaches, such as integrated pest management (IPM), which helps to minimise pesticide use, or organic pest control methods. According to the AGRA website, the agro-dealer shop owners will be trained in providing field demonstrations and soil testing 'thereby transforming them into providers of basic extension services and creating an invaluable source of knowledge and advice to farmers'.[12] This is worrying in light of the limited access of Ghanaian farmers to government extension services. A recent study notes that only 12 per cent of men-headed households and a minuscule 2 per cent of women-headed households have access to extension services.[13] AGRA's promotion of pesticides should be viewed in the context of only limited regulation of pesticide use in Ghana. Farmer deaths linked to inadequate pesticide storage have recently been reported, while there are numerous academic studies finding the presence of dangerous levels of pesticide residues in fish, water, fruit, vegetables and meat, as well as in people's bodies and breast milk.[14]

It is not just AGRA and other donors but also African governments and continental initiatives such as the Comprehensive Africa Agriculture Development Programme (CAADP), that have been advocating for an African Green Revolution. In June 2006, at the African Fertilizer Summit African ministers issued the *Abuja Declaration on Fertilizer for an African Green Revolution*. This stated that Africa was 'trapped in a fertilizer crisis' due to its under-use, and resolved that African states would 'accelerate the timely access of farmers to fertilizers' by increasing their use from

Renewing Africa's extension services

In the past two decades in most African countries, public investment in extension services has collapsed under pressure from donors seeking reduced state involvement in agriculture. At the same time, many states have encouraged a much greater role for the private sector and NGOs in delivering extension services. In Kenya, for example, around one-fifth of the 10,000 or so extension service providers are now private companies, and around 16 per cent are NGOs; the government service accounts for around 40 per cent.[15] These services are supposed to be 'demand-driven' – where farmers articulate their needs for training and advice – and payment (cost recovery) is usually required for those services provided by the private sector.

Christian Aid believes that there are various ways that extension services can be provided effectively and that the private sector can have an important role to play.[16] In the past, many state-run services were too 'top-down' and not sufficiently adapted to farmers' needs. However, there is still a major need for the government to invest adequately – much more than presently, in most countries – in ensuring an efficient government extension service, and there is also a need for free services to be provided to poor small farmers. The requirement for some farmers to pay for services can exclude many from access to them altogether, with women being particularly marginalised from these services.[17] It must also be recognised that many of the poorest farmers are not able to 'demand' services adequately since they are not organised in farmer groups; again, government support is often required to facilitate the establishment of these groups to make the system work.

the average of 8kg per hectare to at least 50kg per hectare by 2015. Targeted input subsidies programmes were to be promoted and agro-dealer networks in rural areas scaled up.[18] The summit had been funded by a number of key donors, including the Rockefeller Foundation and DFID. A few months later AGRA was born.

Many African governments have in recent years re-introduced fertiliser subsidy programmes (after seeing them removed at donor insistence in the 1990s). Countries including Tanzania, Kenya, Ghana, Zambia and Malawi now have substantial government programmes seeking to expand the use of fertiliser by farmers in order to boost

Malawi's fertiliser subsidy programme

Malawi – with a population of 13 million, 40 per cent of whom live in poverty – has faced drought and famine over many years, notably in 2004 when it confronted the worst food crisis in a decade and the World Food Programme requested food aid for a third of the population. In 2005, however, the government introduced a new input subsidy scheme intended to increase the production of the country's food staple, maize, on a massive scale. The scheme provided 1.5 million farmers with two vouchers to purchase two 50kg bags of fertiliser and a small bag of hybrid seed at a fraction of the market price. Implemented every year since, the subsidy programme has significantly increased maize production. Malawi has registered surplus maize production since 2006, producing over 14 million tonnes of maize during the first five years of the subsidy scheme, compared to just over 8 million in the five years before its introduction.[19] The number of people requiring food aid has fallen from several million to a few hundred thousand.[20]

Malawi's increased food production has been widely trumpeted. But despite this success, there is reason to be cautious about the extent to which Malawi's strategy is a model for other countries to follow.

First, the subsidy programme accounts for a massive 60 per cent of the Ministry of Agriculture's budget, which means that Malawi is spending very little on other support services to farmers such as extension services (just 7 per cent of its budget) and agricultural research (2 per cent), while the provision of credit to farmers is virtually non-existent.[21] Yet these services are critical in enabling farmers to improve their productivity over the long term. Instead, the danger is that they are becoming dependent on subsidised fertiliser and seeds when there are no guarantees that this programme will remain in place over the long term and continue to remain affordable and cost-effective.

Second, impacts upon the environment and upon the quality of soils that need to be preserved for future production are not accounted for when measuring the success of the scheme. For example, insufficient attention has been paid to impacts upon drinking water quality and the productivity of Lake Malawi's fishery resources as a result of fertiliser run off; or to the damaging effects of the fertilisers on soil structure, which is leading to lack of water and nutrient retention. A related danger is that Malawi's farmers are being encouraged by the programme to stay in maize farming – 'monocropping' instead of diversifying into new crops that might be more nutritious for families and offer better market opportunities in the future.

Third, there is a danger that the strategy of prioritising fertiliser is undermining Malawi's adoption of more sustainable agriculture approaches. The government recognises the importance of sustainable agriculture and is promoting this to some extent.[22] For example, agroforestry systems are being promoted, using nitrogen-fixing trees, to ensure sustained growth in maize production in preparation for the medium-term situation when fertiliser subsidies may have to be scaled back or withdrawn. By mid-2009, over 120,000 Malawian farmers had received training and tree materials from the programme.[23] The government (with funding from donors) is also supporting conservation agriculture. Although these programmes are important, the expenditure levelled at them is far less than that given to fertilisers, and this is reflected in the number of farmers practising different approaches. For example, a 2009 report for the FAO notes that Malawi has just 47,000 hectares under 'some form' of conservation farming involving 5,000 groups of farmers but with only 1,000 hectares that can 'truly' be said to be practising conservation farming.[24]

The input subsidy scheme raises the question of whether it is a better use of resources over the long term than an equally big political commitment to develop sustainable agriculture.

These issues are complex and there are many different views on the subject, but they raise questions, at least, about the appropriateness of fertiliser subsidy programmes in the context of encouraging sustainable agriculture.

food production, especially of staples. Malawi's Farm Inputs Subsidy programme has received the most attention, since it has substantially boosted maize production after years of deficits and food aid. Christian Aid, along with other NGOs, has applauded the success of Malawi's scheme, though we also believe it contains several flaws (see *'Malawi's fertiliser subsidy programme'* on previous page).

Christian Aid believes that governments of developing countries must have the right (and policy space) to promote input subsidies. Such programmes can be especially important for the poorest farmers in more remote areas where there are few market suppliers of key inputs, or where those that are available are unaffordable.

However, governments also need to weigh up carefully what is in the best long-term interests of farmers, as well as considering the impact on the environment. Fertiliser subsidy programmes can certainly provide a quick fix of increased farm production. But their financial costs and environmental impacts can be large and, as noted in the box on Malawi (page 13), they can reinforce a dependence by farmers on such inputs and do little to improve their prospects over the long term.

Even worse is where subsidies undermine farming strategies that are better adapted to an area's climate. For example, in southern and eastern Africa, subsidies for maize inputs (hybrid seeds and fertilisers) have to a certain extent marginalised indigenous crops that are better adapted to the region's climate. This in turn has led to a reduction in crop diversity on farms and increased the vulnerability of resource-poor small farmers to erratic rainfall and crop pests and diseases (see box *'Africa's first experiments with a Green Revolution'*, page 15). As in Malawi, one danger is that such subsidies – if focused narrowly on one staple crop – discourage farmers from diversifying.

The problem currently is that there is a big imbalance – an overwhelming focus by governments on high external input agriculture (hybrids seeds together with chemical fertilisers and pesticides) as the solution to low food production, and too little investment in sustainable agriculture alternatives.

It is hard to pin down precise figures on how much governments are investing in agro-chemical-based farming as compared to sustainable agriculture, but the evidence indicates that the former considerably outweighs the latter. The Ugandan Government, for example, recognises the importance of sustainable land management but its *Development Strategy and Investment Plan for Agriculture* (DSIP) – the roadmap for agricultural strategy – proposes allocating only 3.8 per cent of the 'ideal' DSIP budget to this area, while only 0.8 per cent of the Medium Term Expenditure Framework budget is allocated to the same.[25] Moreover, while many developing countries are devoting sizeable proportions of their agriculture budgets to fertiliser-subsidy programmes, very few have comprehensive sustainable agriculture strategies in place. Similarly, most developing countries spend very little agricultural research money on organic farming, with most funds supporting conventional farming.[26]

To take another country example, in Ghana, where the government introduced a fertiliser-subsidy programme in 2008, the 350-page agriculture strategy – the *Medium Term Agriculture Sector Investment Plan* – makes only one brief mention of the promotion of organic farming ('… encourage organic production of yams for export market).[27] Ghana's previous agriculture strategy – the *Food and Agriculture Development Policy* (FASDEP II), drawn up in 2007 – makes no mention at all of organic farming. Small units exist in the Ministry of Food and Agriculture and Environmental Protection Agency, and there are some donor-funded projects training some farmers on the use of integrated pest management (IPM) and alternatives to pesticides, including organic approaches. But these activities appear to be low level and underfunded, reaching few farmers.[28] A study for IFPRI found that only 5 to 10 per cent of Ghanaian farmers use organic fertilisers.[29]

The African Green Revolution approach is at risk of undermining the more successful examples across Africa of sustainable soil management and yield increases that do not involve a focus on chemical inputs and hybrid seeds – examples that are documented in Section 4 of this report. With more government and donor support, these could be significantly scaled up.

Before moving on to outline the benefits of alternative, sustainable approaches, as we do in Section 4, Section 2 provides a reminder of the problems that arose in parts of Asia that followed the Green Revolution route, as well as drawing out some lessons for Africa and Asia today.

Africa's first experiments with a Green Revolution

While less well documented than the Asian Green Revolution, it is important to acknowledge that Africa has also had its own experiences with Green Revolution approaches, which largely failed.

As part of the same network of research institutes that promoted the Green Revolution in Asia and elsewhere (known as the Consultative Group on International Agricultural Research or CGIAR), research institutes such as the International Institute for Tropical Agriculture (established in Nigeria in 1967) were set up to develop modern seed varieties for some of Africa's food crops and promote the use of fertilisers and pesticides as part of the input package. But too often the outputs from these institutes did not take into account the realities of diverse African farming systems and climates, and thus the technologies failed to take hold across the continent to the same extent as elsewhere. And where the technologies did get adopted, problems appeared later on.

For example, in **Zimbabwe** the Green Revolution technologies, principally fertilisers and hybrid seeds, were adopted by commercial farmers as early as the 1940s and by smallholder farmers in the 1960s. Smallholder farmers increasingly adopted new, primarily hybrid maize varieties often in monocultures, which rapidly replaced mixed systems where maize was intercropped with traditional small grains such as sorghum and millet. The latter crops were an important part of farmers' food-security strategies, as they are more nutritious than maize and have greater resistance to drought. As a legacy, maize continues to dominate even in areas previously considered too dry for maize cultivation. The increase in (mostly hybrid) maize cultivation was a result of government promotion of the new seeds, along with fertilisers in free production packs, as well as the use of maize in food aid schemes.

However, the provision of free or subsidised fertiliser or credit by the government was not sustained and subsequently smallholder farmers could not afford to buy the fertiliser. They ended up planting the hybrid maize without significant use of fertiliser, leaving them without the promised yield improvements but with the loss of traditional grains and farm biodiversity that had been critical to food security. Arguably, this shift in cropping patterns has made smallholders more susceptible to drought [30] as maize is also highly vulnerable to moisture stress and temperature changes and therefore severely affected by climate change.

In cases where fertilisers were widely used, soil often became degraded. In **Zambia**, for example, a 1999 study by the Institute of Economic and Social Research at the University of Zambia documented the impacts of maize monocropping from the 1960s into the 1990s. It showed how the heavy application of chemical fertiliser produced acidification and a reduction in soil organic matter,[31] impacts that were also widespread in Asia. A similar legacy is found in a number of other southern African countries, where largely hybrid maize was supported through government subsidy programmes in the post-independence period.

In other cases, new Green Revolution varieties developed by research institutes and promoted by governments were simply not taken up because the process did not involve farmers, did not take into account their socio-economic circumstances and were not adapted to local conditions. One example is **Uganda**, which received 200 clones of sweet potato in the 1990s. These had been evaluated in different agro-ecologies and it was found that nearly 100 per cent of the varieties were not adapted to the local growing conditions or suitable for domestic consumption.[32]

Endnotes

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6 University of Malawi, Centre for Agricultural Research and Development (CARD), *Malawi Agro-Dealer Strengthening Program, Interim Evaluation Phase 1 Report*, December 2009, pviii.

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8 Ibid, p19.

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15 Republic of Kenya, Ministry of Planning, National Development and Vision 2030, *Public Expenditure Review: Policy for Prosperity 2010*, p143.

16 See IFAD, FAO and World Bank, *Gender in Agriculture* sourcebook, 2009, p268, for seven types of extension service in use today.

17 The World Bank-sponsored *Gender in Agriculture* sourcebook states that: 'It is hard to see… how the rural poor, including women, could pay for extension services, no matter how cost effective they are' (p269) and: 'It will be impossible' for less-advantaged groups such as women farmers and indigenous people to pay for extension services, 'which makes it imperative to rethink the trend toward privatizing or outsourcing extension, or both, which until recently has been considered a public good'. IFAD, FAO and World Bank, *Gender in Agriculture* sourcebook, 2009, p258.

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SECTION 2. LESSONS OF THE ASIAN GREEN REVOLUTION

What conclusions can be drawn about the effects of the Green Revolution in Asia? And what lessons can be drawn for today's policy-makers in Africa and elsewhere? These questions are the focus of this section. On the plus side, the Green Revolution in Asia led to a doubling of cereal output in the space of two-and-a-half decades (between 1965 and 1990). This meant that countries were able to feed most of their citizens at a time when populations were growing. Per capita food intake rose during this period: from 2,045 calories per person per day in 1970, to 2,537 in 1995.[1] This was clearly a major achievement. There were also income gains for many farming households, who benefitted from increased yields, subsidised inputs and also state regulation of agricultural trade and markets. In many regions, the increased productivity of the farming sector had major benefits for overall levels of development and the wider economy.

But, as we document below, the limits of this expansion phase in Asian agriculture appear to have been reached. One of the reasons, we argue, is that too little attention was paid to the ecological and social consequences of this process of change. Here we set out seven major legacies of the Green Revolution model in Asia.

i) Monocropping, combined with a heavy reliance on chemical inputs and irrigation, has caused widespread soil degradation and increased pest problems. This is now affecting yields

The growth in cereal yields has been slowing down in Asia since the early 1990s. And in some intensively farmed Green Revolution areas, such as Punjab state in India, yields have even started declining.

Rice is the single most important cereal crop in Asia. The table below shows the change in the average annual growth rate for rice yields in the 1990 to 2004 period compared to 1970 to 1990. The growth rate fell in all three of the sub-regions.

Table 1: Rice yield growth in three sub-regions of Asia, 1970 to 2004 (average annual yield shown as a per cent)[2]

	East Asia	Southeast Asia	South Asia
1970-1990	2.5	2.5	2.2
1990-2004	0.5	1.5	1.3

What explains this slowdown – and in some cases stagnation? There are a number of causes, including lower public investment in agriculture in recent years and the fact that yield increases from a higher starting point (the case in Green Revolution agricultural areas) are often harder to achieve. But a major cause – one largely ignored by governments – is the cumulative impact of Green Revolution farming practices. Intensive and continuous monocropping of rice and wheat relies on irrigation and chemical inputs for adding nutrients to the soil. Over time this system has caused widespread and severe soil degradation.[3] This can happen in many different ways, for example:[4]

- Repeated planting of the same crop with no fallow period or crop rotation reduces soil fertility and increases the crop's vulnerability to pests and disease.
- Using nitrogen fertilisers over a long period reduces soil organic matter, which in turn impairs the soil's natural capacity to store and supply its own nitrogen.[5]
- Macro-nutrient imbalances occur when nitrogen is applied in greater quantities than phosphorus and potassium (the other two macro-nutrients supplied in fertilisers).
- The practice of flooding rice fields for long periods affects long-term soil health and causes iron toxicity and a loss of micro-nutrients.
- Sub-standard drainage systems on irrigated land have caused widespread salination and waterlogging.

How extensive are these problems? According to the United Nations Environment Programme, 140 million hectares or 43 per cent of farmland in India, Bangladesh, Nepal, Sri Lanka and Bhutan is affected by soil degradation.[6] In its latest five-year plan, the Indian Government admitted that 'two-thirds of our farmlands are in some way either degraded or sick'. Not all of this degradation is the result of arable farming: other causes include deforestation, overgrazing and the over-cutting of vegetation. However, intensive, farming practices are the dominant cause of several types of land degradation in south Asia, including soil fertility decline, waterlogging and the lowering of the water table; and they are also a factor in salination.[7]

The steady erosion of soil health is having a dramatic economic impact because it has put some land completely out of use, reduces yields and pushes up the cost of food production. Farmers are having to constantly increase the amount of fertiliser used in order to maintain yields on increasingly degraded soils: hence the year-on-year rises in fertiliser consumption seen across Asia.

Some examples of how soil degradation is affecting productivity and input costs are summarised here:

Rice and wheat, India
There was a decline in the ratio of grain produced to fertiliser used from 60:1 in 1966 to less than 10:1 in 1992. For wheat the ratio similarly fell across the same period: from 15:1 to 5:1.[8]

Cereals, China
A 13 million tonne increase in chemical fertilisers brought a production gain of 160 million tonnes of grain crops between 1965 and 1982 (the initial phase of the Green Revolution); but from 1991 to 2008 a 24 million tonne rise in fertilisers was needed for a lower production gain of 94 million tonnes. (NB: the figures for fertilisers relate to all crops, not just grain crops: no breakdowns were available for separate crops.) In this last period pesticide use in China also rose from 0.76 million tonnes to 1.67 million tonnes.[9]

Punjab, India
Punjab is the leading 'breadbasket' and 'rice bowl' of India: in the early 2000s it was contributing one-third of rice and over half of the wheat procured by the Food Corporation of India. But in recent years, wheat yields have been falling: from 4.7 tonnes per hectare in 1999 to 2000 to 4.2 tonnes per hectare in 2005 to 2006. And rice yields have grown only very slowly.[10] A recent report on the problem stated that this trend 'can be directly linked to the ecological consequences of intensive monoculture systems'.[11] The state government has now responded with a programme to support greater crop diversification.

South Asia
In the 1990s a trio of UN agencies assessed the economic costs of land degradation for eight south Asian countries. The study calculated economic costs by combining yield loss with the extra input costs that farmers faced when they sought to maintain yields on degraded soils. This study showed that the annual cost to south Asia's farmers of three types of degradation directly linked to Green Revolution practices (waterlogging, soil fertility decline and salination) was nearly US$3bn.[12]

Intensive, agro-chemical-based monocropping also increases the risk of crops being damaged by pests and disease: natural enemies of pests are reduced in the field owing to indiscriminate pesticide spraying. Crops growing on degraded soils are more vulnerable to pests and diseases, and monocropping places a higher share of the farmer's overall output at risk of attack. (The improved resilience of sustainable, diversified farming systems is discussed further in Section 4.)

ii) Farmers' dependence on purchased, external inputs is a risky strategy in an era of market liberalisation

The Green Revolution pushed up production costs for small-scale farmers by increasing their reliance on purchased inputs (fertiliser, seeds, pesticides and irrigation). While this approach gave a good economic return and as long as inputs were subsidised, these costs were not such a problem. But in the past two decades smallholders' profit margins have been increasingly squeezed. Public investment in agriculture began to fall from the early 1990s, which meant, among other things, a slowing down in the development of new irrigation projects. Market liberalisation has led to a reduced role for marketing boards, a decline in levels of state procurement of crops, the deregulation of agricultural trade (both internal and external) and reduced coverage by formal credit institutions.[13] There has also been a long-term decline in the farmgate price of cereals – a trend only partially reversed by the recent food crisis. But, most relevant for our debate on Green Revolution technologies, input costs have also risen. This is due to:

- the loss of soil fertility, which means that more fertilisers are required than before to achieve adequate yields
- rising world fertiliser prices – though this has been offset to some extent by ongoing state subsidies for fertilisers
- declining levels of access to formal credit.

So what is clear is that the economic viability of the input-dependent model has to a large extent been undermined by changes occurring in the external market environment since the 1990s. The changes have driven farmers increasingly into debt, since they resort to borrowing from money-lenders or offering up a share of the harvest in order to purchase inputs, without the guarantee of a good income from their crops. The scale of farmer debt in Asia is illustrated by the recent announcements by the Indian and Thai Governments of farm debt cancellation packages worth £8.39bn and £860m respectively.[14] Forty-nine per cent of Indian farmers are indebted according to a report by the country's Ministry of Agriculture.[15]

As debt levels spiral, many farmers are being forced to sell their land. Others have taken the tragic step of committing suicide: In India, the number of suicides by farmers has risen in recent years: 183,000 suicides were recorded between 1997 and 2007 (equivalent to 17,500 per year).[16] An estimated two-thirds of the suicides are concentrated in just five states.[17]

A 2004 study of farmer suicides conducted in Andhra Pradesh concluded that there was a strong link between farmers adopting the monocropping of cash crops, such as groundnut and cotton – crops that are usually grown with agro-chemicals – and the higher rate of suicides. These farmers had become more exposed to major income loss and debt in times of drought.[18]

iii) The Green Revolution increased farmers' dependence on external technologies and led to a decline in traditional farming knowledge

The changes reduced the scope for farmers to innovate at a local level and use or adopt farming practices that are most suited to their own circumstances – both environmental and socio-economic. It was a one-size-fits-all and top-down approach to farming and food production using broadly the same package of inputs for all cases. Extension services and public sector research efforts became exclusively focused on promoting this single model.[19] For example, up until 1981 the Philippine Government only gave loans to farmers who agreed to plant government-backed modern varieties. This had the effect of sidelining traditional farming practices, such as farmers saving and re-using seeds.

iv) Hunger stills persists on a large scale in Asia

Despite the productivity gains of the Green Revolution, there are still 578 million hungry people in Asia. These numbers have actually been rising again since the mid-1990s. And in south Asia, where the hunger problem is worst, more than one in five people are malnourished.[20] A recent report by the World Food Programme found that hunger levels in rural India had remained static between 1993 to 1994 and 2004 to 2005, despite the strong economic growth in the country during this time.[21] In rural areas, *half* of all children below the age of three are underweight.[22] One explanation of this is that the Green Revolution was mainly concerned with technological change and did not directly address questions of inequitable land ownership and the limited purchasing power of the poor. These important drivers of hunger need to be dealt with via broader strategies than simply new agricultural technologies.

Monocropping has also played a role in reducing household food security: for example, the money small farmers get from selling one or two crops of rice, wheat or cotton is rarely enough to pay for food for the family throughout the year. And by focusing on one crop, farmers are limiting the variety of food available for direct consumption.

Micro-nutrient deficiencies in people's diets are also a growing problem in Asia, particularly in levels of vitamin A, iron, iodine and zinc. Monocropping may have exacerbated this problem because it has concentrated production on wheat and rice, which do not supply the full range of nutritional needs (see Section 4 for a discussion of how sustainable agriculture has the potential to address this).

v) It often increased levels of income inequality – both between producers and regions

The spread of the new technology occurred initially in agricultural zones of high-production potential – areas close to large urban centres, with existing irrigation systems and favourable soils and climates for growing cereals. Public investment was concentrated in these areas. This targeted growth strategy was of course successful in many respects, as shown by the yield boom in these regions. But small farmers operating on marginal, predominantly rain-fed land were largely cut off from the productivity leap. This problem was only partially alleviated by a strategy in later decades of expanding Green Revolution technologies to these less favourable agricultural regions. Moreover, research efforts tended to focus on rice and wheat: there was less investigation of how to improve the yield of other crops that can perform better in these marginal environments – for example, millet in semi-arid and arid regions.

There is also a considerable body of evidence to suggest that the changes increased levels of inequalities within rural communities.[23] The IAASTD sub-regional report for east and south Asia and the Pacific, citing evidence from India, states that: 'In many areas, the Green Revolution failed to raise incomes of the rural poor appreciably or contribute substantially to their effective purchasing power. Also, larger-scale farmers had greater access to subsidies for irrigation and credit from the government.'[24]

Lipton and Longhurst, in their seminal analysis of the social impacts of the Green Revolution, found that initial employment gains linked to the adoption of the new technologies 'fell off' in later years as better-off farmers adopted labour-saving methods of weeding and threshing.[25] This lends weight to the view that the income and employment gains from the Green Revolution for the poorest segments of rural society – for example for landless agricultural workers – were in fact fairly modest.

vi) Impacts of pesticides on people's health, especially that of farmworkers

Pesticides are a common feature of the Green Revolution approach but their use carries a high social and environmental cost. One aspect of this debate relates to the traces of pesticides that are commonly found in Asia's food and drinking water supply and the long-term health impacts of this.[26] However, arguably the most direct effect of pesticides concerns the impact on farmworkers. In developing countries, farmworker poisoning from pesticides is worse for a number of reasons. First, many of the pesticides used are already banned in developed countries because of their high toxicity. Second, farmworkers often do not wear protective clothing when spraying; a recent study by Christian Aid partner PANAP conducted in 12 communities and spanning eight Asian countries showed an 'inadequate or complete lack of personal protective equipment' among an alarmingly high number of respondents.[27] Third, farmworkers commonly lack the necessary training on the safe use, storage and disposal of pesticides: this causes an untold number of accidents on farms. In addition, when farmworkers are illiterate they will be unable to read safety labels. And, finally, farmworkers who experience pesticide poisoning may not know that it is vital to seek immediate medical help, or they may live a long way from a hospital.

The overall result is large numbers of poisonings of farmworkers every year: the effects range from relatively mild and short-term symptoms, such as dizziness, itchy eyes, coughing and rashes, to more serious problems, such as eye damage or blindness, and respiratory and skin diseases. In cases involving a major exposure, death can also result. In the most reliable study on the issue, by the World Health Organisation, it was estimated that globally 20,000 people die from unintentional pesticide poisoning each year and a minimum of 1 million people are poisoned each year as a result of single, short-term exposures.[28] The exact number of poisonings occurring in Asia is not known but it is likely to be a high proportion of these global figures.

vii) Broader environmental impacts

Besides soil degradation, the Green Revolution in Asia brought about a range of other environmental problems or 'negative externalities' whose impacts have been felt beyond the farm. Some of the most important ones are described briefly below.

Depletion of water resources

The extraction of groundwater and river water for irrigation is occurring in Asia at rates that are unsustainable. Over-extraction is a major problem in south Asia, where irrigation accounts for 80 per cent of total water consumption. For example, in some parts of northern India, where intensive rice and wheat monocropping is practised, the water table has fallen by 20 metres or more in recent years. As a result, the cost of drilling down to reach the water is becoming prohibitively expensive, especially for poorer farmers.[29]

Pollution caused by run-off of nitrates from farms

Nitrogen fertilisers and intensive livestock farming are a major source of nitrate pollution in water bodies. One example is that of Laguna de Bay, a large lake near the Philippine capital Manila. Intensive farming practices relying on chemical fertilisers were introduced in the surrounding areas in the 1970s. A decade later excessive run off of nitrates had caused severe eutrophication and algal blooms in the lake. The marine life of the lake was being steadily suffocated. The Philippine Government has taken steps in recent years to tackle the pollution, which is also caused by effluent from factories and the release of untreated sewage from adjacent residential areas, but the problem still persists. The situation is a major concern for the lake's aquaculture industry, which supplies the nearby capital with fish. A recent survey conducted in China looked at the level of nitrates in groundwater at 600 sites in 20 counties where the level of fertiliser use in agriculture was high. It found that at nearly half of the sites nitrate levels were above 50mg/l, which is the maximum safe level in developed countries. High levels of nitrates and nitrites in drinking water can cause 'blue-baby' syndrome.[30]

Pollution in a river that flows into Laguna de Bay, near Manila.

Biodiversity loss[31]

The trend towards more uniform cropping systems that was characteristic of the Green Revolution has had major effects on biodiversity. For example, monocropping has displaced many traditional varieties, resulting in genetic erosion. According to the IAASTD report, 1,500 rice varieties were lost in Indonesia between 1975 and 1990. There has also been a large decline in the number of traditional breeds of cattle, pigs and poultry. These changes could have a major effect on future plant and animal breeding efforts, as breeders rely on the existence of a high degree of genetic diversity.

Climate change

Green Revolution farming practices in Asia have contributed in recent decades to rising greenhouse gas emissions from this sector, although per capita emissions in developing countries of Asia still remain well below those found in the North. In south and east Asia the largest sources of emissions are methane from intensive rice production and livestock-rearing, and nitrous oxide from soils and fertilisers.[32] There are two types of emission resulting from nitrogen fertiliser: nitrous oxide (N_2O) emissions that occur when fertilisers are applied to the soil and CO_2 emissions that occur in the manufacturing process (because natural gas or coal is burnt). According to a recent Greenpeace study, in China, 100 million tonnes of coal is being burnt every year to produce nitrogen fertilisers; and these fertilisers are responsible for 8 per cent of the country's greenhouse gas emissions.[33]

Lessons of the Asian Green Revolution for policy-makers today

Different conditions exist today than in Asia during its Green Revolution, meaning that it is doubtful whether the benefits of the latter can be replicated (in Africa) or repeated (in Asia) using the same approaches.

First, in Asia various supportive government policies and investments enabled smallholders to adopt modern seed varieties and fertilisers and to intensify their farming. Asian countries were spending an average of over 15 per cent of their national budgets on agriculture by 1972, and the real value of that expenditure doubled by 1985.[34] Governments developed infrastructure by making major investments in roads, power and irrigation, with the latter particularly critical in yield increases. They also provided subsidised credit and inputs, along with considerable extension services, and intervened in markets to stabilise prices for farmers. Now, governments in Africa are spending an average of only 5 to 6 per cent of their national budgets on agriculture; only seven are spending more than 10 per cent.[35] Moreover, in the post-structural adjustment era, few African or Asian governments have the policy space or the political commitment to support agricultural production to the same extent (although several countries have now returned to promoting input subsidy schemes, for example). Thus most smallholders cannot depend upon access to extension services, credit, markets and stable prices in their farming since these are presently woefully unsupported and underfunded by governments.

Another difference with the Asian Green Revolution is in the extent of corporate control over seeds and agrochemicals, including the greater enforcement of intellectual property rights over hybrid and GM seeds. The original modern varieties were developed by government-funded international research institutes and were open-pollinated varieties. This gave farmers the option to multiply and further develop these varieties themselves, as they had always done with traditional varieties. Commercial companies, however, have introduced hybrid varieties, which need to be bought each year to maintain the higher yields and are increasingly protected by plant breeders' rights (PBR). Three decades ago there were thousands of seed companies and public breeding institutions, while now 10 companies control over two-thirds of global proprietary seed sales, which account for 82 per cent of the commercial seed market worldwide.[36]

A third major difference is the heightened global awareness of the impacts of chemical-based farming on the natural resource base and its implications for climate change. The negative environmental effects of the Asian Green Revolution, which we highlight above, cannot afford to be repeated in Africa. Modern seed varieties (MVs) that farmers are now being encouraged to use – developed to resist droughts or pests – often require increased use of chemical fertiliser and pesticides to obtain maximum yields. Yet if the only choice on offer for farmers is to buy MV seeds requiring more chemical inputs, this shifts modes of farming even further away from promoting sustainable alternatives.

The following section presents an alternative to the Green Revolution model: sustainable agriculture that relies on low-cost and readily available technologies and practices.

Endnotes

1 Cereal production rose from 313 million tonnes in 1965 to 615 million tonnes in 1990. The calorie intake figure relates only to developing countries of Asia. Source: G Conway, *The Doubly Green Revolution: Food for All in the Twenty-First Century*, Cornstock Publishing, 1997.

2 *Dynamic of Rice Economy in India: Emerging Scenario and Policy Options*, Occasional Paper 47, Department of Economic Analysis and Research, National Bank for Agriculture and Rural Development, 2005.

3 PL Pingali *et al, Asian Rice Bowls: The Returning Crisis*, 1997, CAB International and IRRI, pp79-87.

4 Most of these examples are drawn from PL Pingali *et al, Asian Rice Bowls: The Returning Crisis*, CAB International & IRRI, 1997.

5 RL Mulvaney, SA Khan, TR Ellsworth, 'Synthetic nitrogen fertilizers deplete soil nitrogen: a global dilemma for sustainable cereal production', *Journal of Environmental Quality*, 2009, 38(6), pp2295-314.

6 IAASTD, *Sub-global report, Volume II: East and South Asia and the Pacific*, 2.4.3.1, 2008.

7 FAO, UNDP, UNEP, *Land Degradation in South Asia: Its Severity, Causes and Effects upon the People*, 1994, fao.org/docrep/V4360E/V4360E00.HTM

8 M Santikarn Kaosa-ard and B Rerkasem, *The Growth and Sustainability of Agriculture in Asia*, Asian Development Bank, 2000, p72.

9 National Bureau of Statistics: Rural Social and Economy Research Division, China Statistics Press. *China Compendium of Statistics, New China 60 Years Statistics Compilation*, Chemical fertiliser used (total for all crops, in million tonnes: 1965: 2; 1982: 15; 1991: 28; 2008: 52. Grain produced (all cereals, million tonnes): 1965: 195; 1982: 355; 1991: 435; 2008: 529. Data supplied by Third World Network.

10 These statistics are drawn from VP Sharma, *India's Agrarian Crisis and Smallholder Producers' Participation in New Farm Supply Chain Initiatives: A Case Study of Contract Farming*, Indian Institute of Management, Ahmedabad, 2007.

11 Ibid, p20 and p22. The effects mentioned were the build-up of soil salinity, waterlogging, declining soil fertility, increased soil toxicity and increased pest populations. The over-use of canal irrigation water and poor drainage systems were causing water-logging and salination. This had resulted in 'valuable agricultural land going out of use'. The report also cited the level of fertiliser use – the highest in India at 222kg per hectare in 2005 to 2006 – and imbalances between nitrogen, phosphorus and potassium applications as a further cause of productivity decline.

12 See note 7. The value of yield losses were calculated on the basis of US$150 per tonne for cereals and additional input costs on the basis of US$300 per tonne of fertilisers (1992 prices). The respective annual costs for each (GR-related) degradation type were: salination: US$1.5bn; lowering of the water table: not assessed; soil fertility decline: US$0.6-1.2bn; waterlogging: US$0.5bn. This gives a total of US$2.6bn to US$3.1bn. Source: Table 21 of UN report.

13 fao.org/docrep/005/y4671e/y4671e0j.htm#bm19

14 Source for Indian figure (600bn rupees): *Union Budget 2008/09, Budget Highlights*, p6, Government of India, accessed at: indiabudget.nic.in/ub2008-09/high.htm Source for Thai figure: 'Thailand to cancel $1.3bn of farmers' debt', *Financial Times*, 31 March 2010.

15 Ministry of Agriculture, Government of India, *Agricultural Statistics at a Glance 2010*, This figure is based on a survey conducted of farm households in 2003. A study in Andhra Pradesh, *Ecologically Sound, Economically Viable*, found that after input costs had been subtracted, farmers with one to two hectares of land were earning only US$154 from farming *during a whole year*, siteresources.worldbank.org/EXTSOCIALDEVELOPMENT/Resources/244362-1278965574032/CMSA-Final.pdf

16 P Sainath, 'The largest wave of suicides in history', www.counterpunch.org/sainath02122009.html The average number of farmer suicides in the 1997-2001 period was 15,747 per annum. Data on the profession of suicide victims has only been gathered in India since the 1990s, which makes comparisons over a longer timescale difficult. Suicide figures are recorded by the Indian Government's National Crime Records Bureau.

17 Ibid. The five states were Andhra Pradesh, Maharashtra, Karnataka, Madhya Pradesh and Chattisgarh.

18 RM Vidyasagar, K Suman Chandra, *Farmers' Suicides in Andhra Pradesh and Karnataka*, Centre for Social Development, National Institute of Rural Development, 2004.

19 H Paul *et al, Hungry Corporations*, Zed Books, 2003, p5.

20 FAO, *The State of Food Insecurity in the World 2010: Addressing Food Insecurity in Protracted Crises*, 2010, p10 and p50.

21 World Food Programme and MS Swaminathan Research Foundation, *Report on the State of Food Insecurity in Rural India*, 2008, p32.

22 Ibid, p 50. Forty-nine per cent of children living in rural areas and between the ages of six months and three years are underweight (2005-2006).

23 DK Freebairn 'Did the Green Revolution concentrate incomes? A quantitative study of research reports', *World Development*, 23(2) 1995, pp 265-279, Freebairn reviewed all of the academic literature which had assessed the impacts of the Green Revolution in Asian countries, published between 1970 and 1989. He found that of the studies that contained conclusions on the effects of Green Revolution technologies on the distribution of income benefits at an inter-farm and inter-regional level, *over 80 per cent concluded that greater inequality had resulted*. M Lipton and R Longhurst in *New Seeds and Poor People* (1989) point out that the inequalities caused by the introduction of Green Revolution technologies were usually more pronounced in villages where pre-existing power structures had been unequal.

24 See note 6.

25 M Lipton R Longhurst, *New Seeds and Poor People*, 1989, Unwin Hyman, p401.

26 Long-term exposure to endocrine-disrupting chemicals, which exist in many pesticides, is believed to be a cause of certain types of cancers, as well as respiratory, reproductive, neurological and immune system diseases and disorders. Concerns in India about a possible link between a recent rise in birth defects affecting children in rural areas and the use of endosulfan have led to a number of states issuing bans on this pesticide.

27 Pesticides Action Network Asia and Pacific, 'Executive summary', *Communities in Peril: Asian Regional Report on Community Monitoring of Highly Hazardous Pesticide Use*, 2010, p1.

28 *Public Health Impacts of Pesticides Used in Agriculture*, World Health Organisation, 1990.

29 Sometimes these problems have been exacerbated by government policy. For example, in India, the policy of supplying electricity to farmers virtually for free created no incentives for farmers to economise on how much water they were extracting (using electrically powered pumpsets) in order to irrigate their fields.

30 Forty-five per cent of sites reported dangerously high nitrate levels. Study quoted in *The Real Cost of Nitrogen Fertiliser in China*, Greenpeace China, 2010, greenpeace.org/canada/Global/canada/report/2010/8/Summary-En.pdf

31 Information in this section is from *IAASTD Sub-global Report, Volume II: East and South Asia and the Pacific*, 2.4.3.4

32 IPCC, Fourth Assessment Report, Working Group III, *Mitigation of Climate Change*, Figure 8.2, ipcc.ch/publications_and_data/ar4/wg3/en/figure-8-2.html

33 Manufacture and application emissions combined. See endnote 30.

34 IFAD, *Rural Poverty Report*, 2011, pp149-50.

35 ActionAid, *Five Out of Ten?: Assessing Progress Towards the African Union's 10 per cent Target for Agriculture*, 2009, actionaid.org/sites/files/actionaid/assessing_progress_towards_the_aus_10percent_budget_target_for_agriculture_june_2010.pdf

36 UK Food Group, *Securing Future Food: Towards Ecological Food Provision*, 2007, p9, ukfg.org.uk/pdfs/Securing_future_food.pdf

SECTION 3. WHAT IS SUSTAINABLE AGRICULTURE?

The Brundtland report defined 'sustainable development' as a type of development that 'meets the needs of the present without compromising the ability of future generations to meet their own needs'. It is an approach that seeks a balance between economic growth, social equity and environmental protection goals.[1] Extending this definition to farming, we can say that a sustainable model here is one that produces enough food to meet people's needs but does this in a way that conserves natural resources *and* enables progress towards social equity and poverty-reduction goals. A further component of sustainability in a farming context is resilience: how well is the system able to cope with shocks such as natural disasters, climate change and price fluctuations? Poor farmers need to be supported in ways that ensure that production and income losses from these shocks are minimised and that output is able to grow over the long term.[2]

Christian Aid believes that the current industrial, high-external-input model of agriculture, seen widely in the global North and in many parts of the global South, is unsustainable because it has not established a proper balance among the three goals. As the previous section showed, narrowly conceived production goals have tended to triumph over ecological and social equity goals. There is an urgent need to rebalance the way food gets produced, to take into account these issues.

But what are the exact characteristics of this alternative approach? What can be done at the farm level to put these ideas into practice? UK academics Jules Pretty and Rachel Hine provide the following explanation: 'A more sustainable agriculture seeks to make best use of nature's goods and services as functional inputs. It does this by integrating natural and regenerative processes, such as nutrient cycling, nitrogen fixation, soil regeneration and natural enemies of pests into food-production processes. It minimises the use of non-renewable inputs (pesticides and fertilisers) that damage the environment or harm the health of farmers and consumers. It makes better use of the knowledge and skills of farmers, so improving their self-reliance. And it seeks to make productive use of social capital – people's capacities to work together to solve common management problems, such as pest, watershed, irrigation, forest and credit management.'[3]

The most important elements of sustainable agriculture[4] are:

- diversification: cultivating a wider range of crops; introducing mixed systems of crops, livestock and aquaculture; and increasing biodiversity
- nutrient recycling ('waste' from one sub-system is used as input for another)
- maximum use of renewable, locally available resources (such as seeds)
- low-external-input/organic soil and crop management techniques, enabling a reduced reliance on, or complete avoidance of, synthetic fertilisers and pesticides (see Table 2 on next page)
- greater emphasis on farmer/community knowledge and their leadership of production and marketing strategies and technological development
- collective responses to shared problems.

Some examples of specific techniques and approaches are covered in more detail in Table 2.

Therefore one of the key characteristics of sustainable agriculture relates to the use of external inputs: **this model is 'low external input' in that it involves a reduced reliance on, or complete avoidance of, environmentally harmful external inputs, notably chemical fertilisers and pesticides.** Organic farming – that is farming that avoids all use of synthetic fertilisers, pesticides and pharmaceuticals – is one type of sustainable agriculture. It can either be certified or, in the case of many African and Asian smallholders, non-certified. Christian Aid is supporting sustainable agriculture across a spectrum ranging from conservation agriculture and IPM – both of which can involve a minimal level of chemical inputs – to organic farming, in a number of developing countries, including India, the Philippines, Cambodia, Zimbabwe, Mali and Burkina Faso.

In many respects, sustainable agriculture's biggest single input is knowledge: more specifically, knowledge of how to maximise the use of low-cost technologies and locally available materials for the benefit of the production system and the environment – for example, cultivating crops alongside trees to improve soil health and water retention rates (agroforestry), or replacing pesticides with natural pest control techniques. It is not an insular approach in that its impact is greatest when there is collaboration with agricultural research establishments, government extension services and – especially for marketing purposes – with other small producers. At the same time, it seeks to reinvigorate and build on traditional practices that have been forgotten or devalued in an era of external input-dependent agriculture.[5]

Table 2: Examples of sustainable agriculture techniques, by category (source: Christian Aid partner projects in Asia and Africa)

Crop diversification: avoiding large areas under a single crop; 'polyculture'	Agroforestry (mixing trees and crops) Intercropping Double and relay cropping (two main crops grown in same space during one season) Planting of more varieties of the same crop Crop rotation Indigenous food crops
Yield intensification	System of rice intensification
Soil and water conservation	Bunding Terracing Contour ploughing Planting pits (tassa, zai and demi-lunes) Zero or low tillage (see also conservation agriculture p.29) Rainwater harvesting Small-scale, community-managed irrigation projects Agroforestry Mulching Substituting organic materials and methods for synthetic fertilisers: - nitrogen-supplying cover crops ('green manure') - increased crop rotation - composting (including vermi-composting) - manure - biogas slurry - natural fertilisers made from fermented fruit juices, manure, fish bones, seaweed, and so on - biofertiliser (substance made from living micro-organisms) - crop residues Fishponds (for irrigation water)
Pest control	Substituting biological pest-control methods for pesticides: - pheromone traps - Intercropping/push-pull technology ('push' plants repel pests, 'pull' plants attract them, eg desmodium and napier grass for maize; marigold next to vegetables) - Promoting an increase in natural predators (eg parasitic wasps for millet head miner); - Homemade repellents (for example from neem leaves, chilli) Integrated pest management (farmers trained in ecology of the farm; natural pest-control methods promoted; lower use of pesticides)

Integration: mixing and linking arable, livestock and aquaculture	Using livestock and fish to control pests and weeds Source of manure for crops Biogas projects Introduction of small livestock/fish to bolster household food supply and income Planting crops, trees and shrubs for fodder
Seeds	Conserving, selecting and exchanging seeds (especially traditional varieties); community seed banks Multiplying, exchanging and selling seeds at the local level Participatory seed breeding
Structural changes	Kitchen gardens Fishponds Orchards Raised beds (especially for vegetable growing) Trellises and vertical-growing techniques Irrigation ditches and channels Tree embankments Improved methods of crop storage
Social processes and marketing	Farmer cooperatives Direct marketing schemes Setting up of new farmer groups/people's organisations Farmer-to-farmer training; group-based learning processes such as farmer field schools Credit and saving schemes

Seeds can either be an external input (if they are purchased) or an internal one (if farmers use their own seeds). The debate on seeds is complex and – with the exception of GM seeds – it is difficult to describe a seed technology as sustainable or not without consideration of the broader farming practices which accompany it (see box 'Seeds and sustainability' below). Modern varieties (MVs) – those bred in a laboratory by private seed companies and government research institutes – are often developed as part of a package of external inputs, which includes irrigation water, fertilisers and pesticides. As such, their use is often linked to the degrading of natural resources. The dependence on the full input 'package' can constitute a major barrier to MV adoption for poor farmers operating in marginal environments. A major benefit of traditional varieties is that they do not require chemical inputs.

Seeds and sustainability

For a seed technology to be considered sustainable, it must be affordable for farmers, respond to their needs, and not cause damage to the environment – in addition to its yield benefits. Traditional varieties (TVs, also known as local or farmer varieties) are indigenous seed/crop varieties that that have been cultivated by farmers over a long period of time in a particular agro-ecosystem. They are conserved, selected, exchanged and sometimes cross-bred by farmers. Modern varieties (MVs), also referred to as improved or high-yielding varieties, are seeds bred in formal research environments. They include hybrid and GM seeds but also open-pollinated varieties, which were the type of MV developed in the early stages of the Green Revolution. Between TVs and MVs there exists a wide range of intermediate varieties. The area of cropland under MVs grew rapidly during the Green Revolution. In Asia most cereals crops are now MVs. In Africa the adoption rate has been much lower. However, even here, MVs are widely used for maize production.

Despite their undoubted yield benefits, MVs are also tied to particular agricultural practices that tend to be resource-degrading. Although MVs do not require fertiliser to grow, they are bred to yield better when fertiliser is applied and therefore most farmers choose this approach. As we saw earlier, the overuse of fertilisers has negative implications for soil health. Also GM seeds are designed to be resistant to herbicides, so greater use of these is likely with this technology. Furthermore, when used as part of a monocropping system, MVs result in a decline in crop biodiversity – many traditional varieties have been lost because of this drive towards uniformity.

TVs do not require chemical inputs. They are often a better option for farmers operating in marginal environments who may not have easy access to irrigation and other inputs, and who wish to avoid exposure to economic risk.

Another issue is the renewability of seeds. Hybrid seeds only perform well for one cropping cycle. If second-generation hybrid seeds are reused, yields are much lower. This means that farmers have to buy new hybrid seeds each year. Patents or so-called 'plant varietal protection' legislation are also increasingly in place for hybrid and GM crops; for the earlier Green Revolution MVs, there were no patents and farmers could freely conserve these seeds. With traditional varieties there are no access restrictions for farmers – if farmers are able to save them, they are essentially a free resource.

Christian Aid views GM seeds, which for the most part are being used to grow non-food cash crops, such as cotton, or multi-purpose crops such as soya, rather than local food crops, as an unsustainable technology:

- because there are still significant concerns about their environmental and health impacts – many of these impacts are not yet fully understood
- because they are a costly option for poor farmers.

We believe that farmers should have the flexibility to choose the technology that is most appropriate for them: this could be MVs or TVs. However, if farmers opt for MVs, there needs to be an increased focus on how to minimise the broader environmental impacts of this choice. And farmers will also need to assess whether the MV's performance is sufficiently better to justify the increased seed and other input costs.

Local rice varieties being multiplied by farmers in a field in west Bengal, India. Christian Aid partner DRCSC works through a network of local training centres in the state to promote the adoption of sustainable agriculture.

What follows is a more detailed description of just three of the techniques listed Table 2.

Technique 1: system of rice intensification (SRI)

SRI involves a completely new approach to rice cultivation. Farmers transplant rice seedlings at a younger age and give each one more space in which to grow in the field. Under organic SRI, they use compost, manure and mulch instead of chemical fertilisers to nourish the soil.[6] Weeds are controlled mechanically rather than by spraying herbicides. Instead of keeping the field permanently flooded, as is common for rice cultivation, farmers water the crop at regular intervals, just enough to keep the soil moist. This water-management approach helps with root development and allows aerobic soil organisms to develop.

SRI is now in use in 40 countries around the world and is delivering major benefits to smallholder farmers. SRI has a number of benefits:

- higher yields: it increases the number of tillers (stalks) per rice plant and the rice panicles are larger: hence there are more grains on each plant
- Water use is lower. This makes SRI suitable for drought-prone/low-rainfall areas [7]
- Production costs are on average 20 per cent lower per hectare due to the more limited use or complete absence of fertilisers [8]
- Rice plants are sturdier and therefore better able to withstand high winds, cold spells and drought
- there is greater resistance of SRI rice to pests and plant diseases [9]
- Soil and water quality is improved due to reductions in the use of agro-chemicals
- Fewer seeds are used per hectare, which lowers input costs for the farmer
- methane emissions are lower because the paddy field is not constantly flooded.

Technique 2: zai pits and stone bunds

Zai pits (or planting pits) are a technique used by farmers in Africa. They are pits dug close together in crop fields into which farmers sow their seeds. The pits concentrate rainfall runoff close to the plant roots. By digging the pits in advance of the rainy season, farmers maximise the amount of rainwater collected. Farmers can use much less fertiliser than on conventional fields, as fertiliser needs to be applied only in the pits themselves. The technique is often used together with minimum tillage and stone bunds; the latter are built around the edge of the field and slow down the flow of water in the rainy season. All these measures help to keep more water in the soil; they also lead to increases in valuable soil fauna, such as earthworms and termites, which improve soil structure and help with water drainage.

FAO studies, confirmed by Christian Aid partners' own projects (see Section 4), show that zai pits can produce significant yield increases, especially when combined with other methods of soil and water conservation. For example, in Tigray province of Ethiopia and in Mali, farmers who used zai pits have managed to treble agricultural yields after just one year.[10]

Technique 3: integrated farming system [11]

This system is common in humid, coastal regions of south Asia where there are problems of waterlogging and salinisation. (See case-study, p.36)

A pond is built on one part of the farm. The earth from the excavation is used to raise the level of the plots, which are devoted to vegetables and rice. The pond provides a source of irrigation and fish are raised in it. In the dry season, vegetables can also be grown on terraces around the pond. Channels are dug around the main plots or the farm perimeter to enable excess water to drain away during the monsoon. Embankments are created on which trees, such as banana, coconut, sesbania and neem, are planted. These trees help to strengthen the banks and produce fruit, fodder and raw materials for biological pest sprays. Saline-tolerant local rice varieties can be grown on any remaining low-lying plots. Small livestock, for example ducks and chickens, can be introduced, as well as organic methods of soil fertilisation, including vermi-composting and the planting of nitrogen-rich azolla.[12] The main benefits of this system are:

- the main rice crop and the vegetables are protected from flooding and also salinity; some rice can also be grown in saline conditions
- a greater volume and diversity of produce for example more vegetables; increased rice yield; various products from trees; eggs and meat; fish
- the ducks feed on pests in the rice field and excreta from the fish nourishes the soil
- reduced or zero use of pesticides and synthetic fertilisers.

Endnotes

1 The need to meet these other goals exists both now (an *intra*-generational dimension) and in the future (an *inter*-generational dimension).

2 An important focus of Christian Aid's work in the agricultural sector is improving food producers' ability to withstand disasters and also adapt to climate change. See *Adaptation Toolkit: Integrating Adaptation to Climate Change into Secure Livelihoods*, Christian Aid, 2009.

3 J Pretty, R Hine, *Reducing Food Poverty with Sustainable Agriculture: A Summary of New Evidence*, final report from SAFE-World Research Project, University of Essex, 2001, p11.

4 Other commonly used terms for this model of farming are agro-ecology and ecological agriculture.

5 An example of how sustainable agriculture can build on traditional practices would be mixed cropping and integrated farming. Mixed cropping is a practice that has been used for generations in India to reduce risk and ensure food security for farming families. Integrated farming, a sustainable farming technique, is an improvement on this in that it harnesses the benefits of a wider array of plants, animals, fish and micro-fauna for crop production, with waste from one process forming an input to another.

6 Fertilisers can be used alongside the new planting and water-saving techniques but the best results from SRI come when the farm goes organic.

7 Personal communication with Christian Aid partner, *Centre d'Etude et de Développement Agricole Cambodgien* (CEDAC).

8 N Uphoff, 'The System of Rice Intensification: using alternative cultural practices to increase rice production and profitability from existing yield potentials', *International Rice Commission Newsletter*, 55, Rome: FAO, 2007.

9 This was observed in recent field trials in Vietnam.

10 FAO, 'Optimising soil moisture for plant production: the significance of soil porosity', *Soils Bulletin 79*, Rome: FAO, 2003.

11 This example is based on the integrated farming model supported in west Bengal, India, by the Development Research Communication and Services Centre (DRCSC), which is a partner of Christian Aid.

12 Azolla is a nitrogen-rich cover crop that grows in water. It can also be used as fodder.

SECTION 4. THE BENEFITS OF SUSTAINABLE AGRICULTURE

So what can sustainable agricultural practices really achieve, in relation to the need for adequate production, improved incomes, food security, natural resource enhancement, and adaptation to climate change? This section outlines the benefits and demonstrates the clear advantages of re-balancing government and donor support towards these approaches.

a) Production [1]

As discussed in the introduction, increasing production in the places where food is most needed is a critical part of tackling hunger now and into the future. With the reduced availability of new land, future production increases will mainly have to come from increased yields and bringing degraded land back into full use. With appropriate support, sustainable approaches that make better use of the natural resource base and preserve it into the future, while reducing the costs of and dependency on external inputs, can offer yields than match or surpass those achieved from conventional approaches. This is a model that enables intensification to occur but in sustainable ways.

A growing body of evidence affirms the yield benefits of this approach. An influential study that assessed the effects for small farmers of introducing sustainable farming techniques was conducted by Pretty and Hine at the University of Essex in 2001. It gathered data from 286 cases in 57 developing countries. In the projects and initiatives surveyed, a total of 9 million farmers were shown to be involved in sustainable farming.[2] Production data did not exist for all the projects but for those where it was available the benefits were clear: for 4.4 million farmers on 3.6 million hectares, household food production grew on average by 1.7 tonnes per annum (a 73 per cent increase). For a separate, smaller category of farmers growing root crops (potato, sweet potato and cassava) the production gains were even higher at 150 per cent. And relative increases were higher at lower baseline yields, indicating greater benefits for poor farmers. Subsequent to this study, UNCTAD and UNEP reanalysed Pretty and Hine's data to assess the impacts in Africa. They found that the average yield increase was even higher for African projects than the global average: in Africa the increase was 116 per cent.[3] Other studies, such as one by Gibbon and Bolwig in 2007 have also found that conversion to organic production in tropical Africa has been associated with yield increases.[4]

Farmer Albert Nkomo looking over his fields of crops in Matabeleland, Zimbabwe. Albert has learnt new farming techniques from Christian Aid partner ZimPro.

A more recent study by Badgley et al, 'Organic agriculture and the global food supply,' compiled data from 293 studies of yields under organic methods versus those under conventional or low-intensive methods. (In developing countries, most of the comparisons were with crops grown using low-intensive – non-Green Revolution – methods.)[5] The studies covered a wide range of crops being grown in and on many different soil types and climates, and had been conducted in both developed and developing countries. The results clearly showed that yields from organic production easily surpass yields from low-intensive production methods in developing countries. In the developing countries studies, organic yields were 80 per cent higher than for crops grown using the (mainly) low-intensive methods. And in developed countries, the organic yields were only 8 per cent below those on conventional farms relying on high levels of external inputs.

The conclusions of these global-level studies are supported by strong evidence at the national level in developing countries of production benefits.

One example is that of a farming system, referred to as 'conservation agriculture', that has been adopted in a number of African countries. **Conservation agriculture** is a resource-saving approach to crop production based on the adoption of minimum or no tillage; the use of cover crops or mulching to improve soil fertility and water retention; more precise or no use of agrochemical inputs; crop diversification and crop rotation. While conservation agriculture is sometimes adopted with the use of chemical inputs, it is an approach that can significantly reduce their

use. For example, fertiliser use can be minimised because the technique allows for much smaller amounts than are used in conventional approaches to be concentrated around the plant roots. The use of cover crops or mulching to suppress weeds can reduce herbicide requirements; and natural pest control methods such as IPM can reduce the need for pesticides.

In **Zimbabwe**, Christian Aid partners Dabane Trust (DT) and Zimbabwe Project Trust (ZimPro) monitored the progress of 3,300 farming households who they had supported to introduce conservation agriculture. ZimPro found the majority of farmers practising conservation agriculture saw significant yield increases over the three-year period in which they were measured. During the first year, 70 per cent of farmers realised yield increases for their sorghum, millet and maize of 30-50 per cent, while 10 per cent achieved increases of up to 150 per cent. Farmers saw similar yield gains in the second and third years of the project. They also reported improvements to their household

Case study: Pioneers in Zimbabwe

Christian Aid partners ZimPro are pioneers of conservation farming. They are one of five Christian Aid partners working in a consortium to provide such support to farmers in the drought-prone Matabeleland South in the southern region of Zimbabwe. Conservation farming techniques mean that farmers can grow more food on small plots of land using the limited natural resources available to them.

Sarah Makuelo is preparing her fields for the coming rains and practices conservation-farming techniques to ensure a successful harvest, in Bulawayo, Zimbabwe. Lead farmers like Sarah help convince others to switch from traditional farming practices by showing them the results conservation farming can bring.

ZimPro identify lead farmers, who help to train and support other farmers in their community.

Farmers who practise these methods, including Sarah, Daissy, Lilian and Rolette, report that the amount they harvest doubles, trebles and even quadruples as they become more experienced in the techniques. Their families rely less on food aid during the lean period of the year when families tend to run out of food (beginning in October, with the worst period being January to March).

Sarah Makuelo is the head of a household of nine people; and the lead farmer in her conservation farming group. Sarah practices the principles of conservation farming meticulously and her harvests have multiplied as a result. Before adopting these practices, she says: 'A couple of times we went three days, even a week without food… many people on antiretroviral therapy died because they needed food for their medication to work. But this year I harvested 35 buckets of maize (700kg), three bags of sorghum, two bags of ground nuts and a bag of beans. Even now I have bags [of grain] in my house.'

Daissy Moyo and her family grow maize, groundnuts, sorghum and cowpeas. These techniques make best use of the water and other natural resources available in drought-prone areas where the land is dry. The family now has almost three times as much food to eat and sell, and has escaped extreme poverty. 'I started living here in 2005. What I harvested this last season, I never got before. I actually look and feel better – I had lost weight because of hunger and the kids [had] too.'

Lilian Moyo: 'In our group we are five women. We move from one farm to the next until we finish all the conservation plots. I joined ZimPro in 2005. In 2005 it was very laborious because we did not know what we were doing and the yields were very low. But now that we are used to farming the conservation-farming way we've seen the benefits; we can feed our families all year round. We plant maize, groundnuts, cowpeas and sorghum. We used to plant just maize.'

Rolette: 'I practise conservation farming and started in 2005. There is less weeding in conservation farming and it uses less manure. When I started conservation farming, in the first year I got four 90kg bags and this year I got 18 90kg bags. I've got better. If I plant using conventional methods I won't get a yield like a conservation-farming yield. ZimPro helps us: it teaches us about conservation farming's advantages. The other women in my cluster group are first timers so it helps them understand how to prepare the land and it also reduces the workload. We encourage other women to practise conservation farming but usually the response we get is that it is laborious. But that's not the case; when you get used to it, it's not difficult at all.'

food security.[6] Another survey in Zimbabwe compared conservation agriculture with conventional farming practices under high, normal and low rainfall situations and showed that farmers were achieving yields of between two and six times those achieved under conventional agricultural practices while also incurring reduced financial and labour costs because of the lower levels of inputs required.[7]

In **Tigray state** in Ethiopia, the introduction of **composting** has significantly increased yields for smallholders.[8] A survey was conducted of nearly 1,000 plots in 19 communities from 2000 to 2006. The researchers looked at cereal yields on three different types of plot: those where no inputs were used; those where composting was used; and those where chemical fertilisers were used.

The average yields for the whole 2000 to 2006 period are shown in the graph below.[9] As might be expected, yields were higher on the composting plots than the no-input plots. However, *the composting plots also outperformed the fertiliser plots.*

Figure 1: Average grain yields (kg/ha) for seven cereal crops, by plot type, 2000-06 inclusive, Tigray, Ethiopia

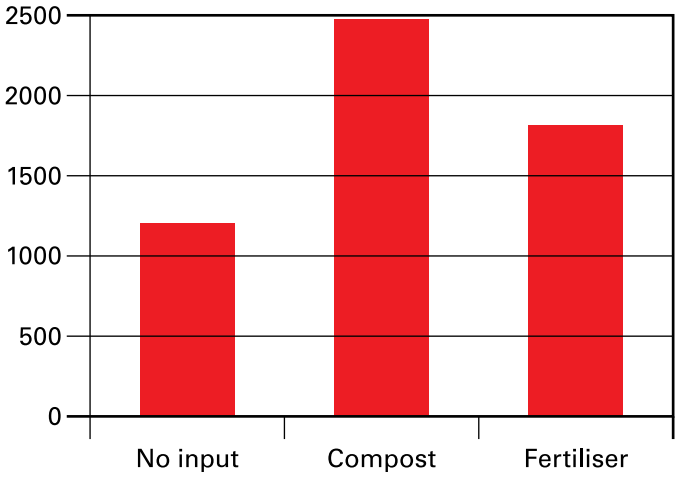

Table 3: Tigray survey data

	No input	Compost	Fertiliser
Grain yield (kg/ha)	1,200	2,473	1,812
Number of observations	327	290	222

In the **Philippines**, Christian Aid partner Panay Rural Development Centre Inc (PRDCI) is supporting rice farmers to adopt **low-external-input** approaches in Iloilo province. Farmers working with this NGO recorded a yield increase for rice of 1.16 tonnes/hectare in 2003 compared to the pre-adoption period.[10] PRDCI's partner institutes report similar yield increases for sugarcane and rice in Leyte, Cebu, Negros Oriental, Negros Occidental and Mindanao. A second example from the Philippines concerns a comparative study conducted in 2007 and 2008, which looked at a range of outcomes for small farmers who were working with the NGO network MASIPAG (the acronym means Farmer-Scientist Partnership for Agricultural Development).[11] MASIPAG is working in 45 out of the 79 provinces in the country and has a total membership of 35,000 farmers.[12] It supports farmer-led agricultural development, organic farming and also runs a participatory rice-breeding and selection programme, which is national in scope. In this study, 840 households were interviewed across the country. Respondents fell into three equally sized categories: those who had switched completely to organic farming; those who were making the transition to it (the 'conversion' group); and those who were using conventional methods. MASIPAG had been working with the first two groups. The average farm size for all the respondents was 1.5 hectares. The findings in relation to food security and incomes are dealt with in the next sub-section. However, in terms of yields, the study found that average rice yields were broadly similar for all three groups: between 3,287 and 3,478kg/ha. In other words, farmer-developed rice varieties grown with low-external-input methods delivered as good a yield as 'expert-bred' high-yielding varieties, despite the latter being backed up with fertilisers and pesticides.

b) Incomes and food security

To what extent do these production successes translate into real sustained improvements to farmers' incomes, household food security and poverty reduction? Again, the evidence suggests the increase in the quantity and diversity of food produced per farm tends to have positive impacts on household food security; and that, where farmers using low-external-input approaches are able to sell surpluses to local markets, their net incomes are greater because outgoings on synthetic fertilisers, pesticides and MV seeds are lower and their volume of sales has increased. The extent to which farmers are able to improve food production and raise incomes with low-cost, locally available inputs and technologies is of particular importance in times of high energy and fertiliser prices.

Other income benefits are that the incomes of farmers who have diversified production are less vulnerable to fluctuations in the price of a single crop when it comes to selling their produce; and that farmers who are part of an organic certification scheme are able to obtain a premium price for their produce.

Diversification (that is increasing the range of crops grown and introducing livestock) is also an important strategy for addressing micro-nutrient deficiencies in people's diets (including iron, zinc, iodine and vitamin A). Such deficiencies are a growing problem in the developing world [13] and they have been exacerbated by the shift to a 'simplified cereals-based production system'.[14] Sustainable agriculture can help by increasing the amount and variety of vegetables produced for home consumption or by adding more meat and fish to the household diet.

In 2008, UNCTAD and UNEP [15] examined the relationship between **organic agriculture** and food security in Africa, with a particular focus on **east Africa**. They documented 15 projects across that region where local organisations were working with farmers' group to support their adoption of organic approaches. In all cases, increased yields, combined with cost savings through minimising or eliminating external inputs, enabled farmers to increase their incomes, whether that be through selling to local or international markets, as well as to have direct access to more nutritious food for household consumption. Just one example is the Sustainable Agriculture Community Development Programme (SACDEP) in Kenya, which has worked for 13 years with over 30,000 smallholder farmers. It is currently training 4,500 farmers in eastern and central provinces of Kenya in soil fertility management, soil and water conservation techniques, farm-level seed conservation and environmentally-friendly pest and disease protection. Under SACDEP's programme productivity has been reported to increase by 50 per cent, giving the farmers food security and surplus produce to sell. Incomes have increased by 40 per cent, enabling farmers to meet basic needs such as paying school fees and medical expenses. On the basis of the evidence gathered in the report, the authors conclude 'organic agriculture can be more conducive to food security in Africa than most conventional production systems and … is more likely to be sustainable in the long term'.[16] The report recommended that, especially in low-income countries, donors and governments should focus their attention on helping farmers to improve production and raise yields with low-cost, locally available technology and inputs.

Returning to the two studies concerning rice farmers in the **Philippines** (see page 31), the findings in relation to incomes and food security were as follows.

MASIPAG:

- Eighty-eight per cent of the organic farmers said that their food security was 'better' or 'much better' than in 2000 – compared to 71 per cent of the conversion and 44 per cent of the conventional farmers. Nearly one in five of the conventional farmers reported worse food security than in 2000.[17]
- Households in the organic category were eating more vegetables, fruit, protein-rich staples and meat than in 2000.
- The organic farmers were growing on average 15 more types of crop than the conventional group.

The study also found clear income benefits for these farmers: the two MASIPAG groups had higher net incomes than the conventional farmers. This was mainly due to lower input costs [18] combined with rice yields that were matching those of the conventional group. Two-thirds of the conventional farmers reported stagnating or declining incomes in the period after 2000.

PRDCI:

Among the adopting farmers, the use of synthetic fertilisers and herbicides has been cut by half compared to before, and insecticide use by two-thirds. PRDCI also measured farmers' net incomes over the five-year period that followed the adoption of sustainable agriculture (1999-2003). They were shown to have grown by 11 per cent per annum – see Table 4.[19]

Table 4: Changes in annual income of PRDCI farmers, in pre- and post-adoption period

Year	Net income (pesos)
Pre-adoption (annual average)	21,587
1999	23,477
2000	29,220
2001	27,494
2002	31,250
2003	35,449

A celebrated case of sustainable agriculture leading to significant benefits for food security and incomes is that of the widespread adoption of **zai pit and stone bund technology** in **Burkina Faso**. During the early 1980s the country was facing a major drought, wells were running dry due to a depleted groundwater table, and the soil had low natural fertility. In many rural villages a quarter of the population migrated to urban areas. In this context, farmers started experimenting with zai pits and stone bunds (see page 27). The widespread adoption of this technology – a process supported in recent years by Christian Aid partner Reseau MARP – is estimated to have helped rehabilitate between 200,000 and 300,000 hectares of land and produce an additional 80,000 tonnes of food per year, enough to feed about 500,000 people.[20]

When farmers adopted these techniques, crops could survive dry spells and farmers were able to raise their yields from almost nothing to 300 to 400kg per hectare in a year of low rainfall and up to 1,500kg in a good year.[21] Farm households that previously faced food deficits for at least half of the year have reduced their deficit periods to two to three months or in some cases to zero. Farmers have also diversified their crops, so that while they continue to grow primarily millet and sorghum, they are also increasingly growing cowpea and sesame. Water levels in wells have improved and farmers have created small vegetable gardens adding to incomes and improving nutrition. There have also been clear cash benefits for women, who earned income from the sale of leaves from regenerated baobab trees, as well as the flowers of the kapok and fruits of shea nut and locust bean.[22]

Reseau MARP pioneered a number of dissemination models, including farmer-to-farmer learning, on-farm research in collaboration with scientists, and basic skills training. In terms of income benefits, Reseau MARP reports that profits generated by the farmers they are working with in Burkina Faso have been used to buy millet during the hungry season, cover school and health fees, and pay taxes and social expenditures. They were also reinvested in agro-pastoral production (buying goats and sheep) or buying equipment such as grain mills.

Another sustainable agriculture technique that has brought clear income as well as environmental benefits is **integrated pest management (IPM)**, which involves learning about the ecology of the field and favouring natural methods of combating pests. IPM does not prohibit the use of pesticides but it helps to minimise their use. IPM has been successfully introduced in many countries in southeast Asia; one of the main methods of its spread there has been the 'farmer field school' system. The introduction of IPM in **Vietnam** has brought positive income benefits for small farmers owing to better yields and lower input costs. An impact study funded by DANIDA examined the outcomes for 3,000 farming households who adopted IPM. It showed a 60 per cent reduction in insecticide sprayings. And incomes had increased owing to a combination of lower input costs and higher yields. The average reported increase for the winter-spring rice crop was US$80 per hectare.[23]

In a recent research project sponsored by the Indian Government and coordinated by Christian Aid partner Development Research Communication and Services Centre (DRCSC), data were collected on farms in different states of **India** where sustainable agricultural practices had been introduced, with the support of NGOs. Data on net income were available for 300 farms. The Biofarms study showed that net income had increased on 64 per cent of farms compared to the baseline year; for 44 per cent of farms it had more than doubled.[24] In terms of food security benefits, one of the strategies being used by DRCSC in west Bengal is to establish 'food forests': tracts of government-owned land that are leased out to landless people and used for the cultivation of diverse food crops and for raising fish and livestock (a mixed-farming system). The trees on these plots, as well as providing fruit, are also a source of fodder, firewood and medicine. The food forests are playing a vital role in averting hunger for these extremely poor families.

c) Soil and water conservation, on-farm biodiversity and crop health

Sustainable and organic soil- and crop-management practices, such as low or no tillage, the planting of cover crops, composting, the application of manure, crop rotations, agroforestry and IPM, help to build up nitrogen, organic matter and beneficial micro-organisms in the soil. Better soil structure means fewer problems such as compaction, erosion and nutrient-leaching. Chemical fertilisers, on the other hand, can cause a decline in soil organic matter and hence the nitrogen-supplying capacity of the soil, especially when used in excessive quantities over long periods. They are also a factor in the creation of nutrient imbalances in the soil (see Section 2).

Mulching, bunding and agroforestry are examples of techniques that keep more water in the soil, hence reducing the demand for water. This can be critically important in agricultural regions affected by drought or for any communities where access to irrigation water is limited. For example, in parts of Burkina Faso, the water table has risen by five metres due to improvements in soil management.[25]

Crops that grow in healthier soils and in biologically rich environments are also less vulnerable to pests and diseases. For example, a study from Yunnan province in China showed that the incidence of rice blast was lower when traditional varieties were introduced alongside hybrid rice.[26] And in Indonesia, pest attacks in rice fields have been reduced by reducing the use of broad-spectrum pesticides, which were killing off the natural enemies of these pests.

Restoring biodiversity to farms is an important policy goal because both crop and livestock diversity and the abundance of wild plants and species play an important role in maintaining a healthy farm ecosystem. In the Philippine study involving MASIPAG, organic farmers were found to be growing three times more varieties of rice and 15 more crop types than conventional farmers (see page 31), And in the Indian Biofarms study, farmers reported more insects in the soil and a rise in the number of local vegetable varieties being grown (see page 33).

Sustainable agriculture also enables land that has been degraded to be brought back into productive use. For example, in the Burkina Faso case cited above up to 300,000 hectares of land were restored through zai pit and bunding technologies. In western Tanzania, agroforestry has led to the rehabilitation of land on a similar scale in an area which former President Julius Nyerere once described as the 'Desert of Tanzania'.[27]

d) Resilience to natural disasters and climate change

Farmers in developing countries have historically faced a range of natural hazards which threaten crop production. However, climate change is adding to these problems. It is already increasing temperatures. It also appears to be worsening the severity of floods, droughts, cyclones and heavy rains, and altering rainfall patterns. For example, in parts of south Asia communities are already experiencing higher summer temperatures and a less regular onset of the all-important monsoon. These changes are having a major – and mainly negative – impact on agriculture in Africa and Asia. In a number of countries where Christian Aid partners work, farmers have already begun to shift working patterns and cropping cycles in response to these changes.

Sustainable agriculture increases farmers' resilience to natural disasters and helps them adapt to climate change. We list some examples here:

i) **Better soil management** is a key factor. This helps to retain water in times of drought – for example, in the Sahel rainfed crops grown using the zai pit system have been shown to survive for longer in drought conditions; but it also has benefits in periods of heavy rain: healthier soils act as a sponge, absorbing excess water and thereby reducing erosion and flood damage to crops. A study carried out in Nicaragua in the immediate aftermath of Hurricane Mitch in 1998 looked at how sustainably managed farms had fared compared to conventional ones in the hurricane. It showed that on the former there had been less soil erosion, fewer landslides and income losses were lower.[28] Techniques such as mulching also enable the soil to better withstand periods of intense heat.

ii) The **diversification of production systems**, and systems that are well-adapted to local conditions, reduce the risk of a complete harvest or income loss in the event of a natural disaster.

iii) **Use of traditional varieties**: in Niger and Mali, traditional pearl millet and sorghum varieties have been maintained by farmers over the past three decades. Despite periods of major drought and other environmental and social stresses, farmers have been able to maintain yields. This is a strong illustration of the importance of genetic diversity for ensuring farmers' resilience.[29]

iv) **Coping with saline intrusion**: in west Bengal, India, Christian Aid partner DRCSC is helping farmers living on the Ganges delta to cope with the intrusion of saltwater on to their land: sea-level rise due to climate change is also exacerbating the situation. One of the main techniques promoted is the construction of raised beds, which reduces salinity levels in the soil and helps restore yields. Farmers have also planted saline-tolerant, local rice varieties. (See also Section 3)

v) **New structures**, such as grain banks, seed banks and rainwater-harvesting systems, can help communities to overcome extended dry spells, drought or floods.

e) Lower greenhouse gas emissions

Agriculture is responsible for 14 per cent of global greenhouse gas emissions, including 58 per cent of global nitrous oxide (N_2O) emissions and 47 per cent of global methane (CH_4) emissions [30] – gases that have a much stronger warming effect than CO_2.[31] And when indirect emissions from farming are considered – for example CO_2 emissions from fertiliser manufacture and from the conversion of forests into farmland – then agriculture's share of total emissions is much higher. Although the principal responsibility for emissions reductions lies with industrialised countries (where per capita emissions are far higher), sustainable agriculture does present opportunities for developing countries to limit their emissions growth in future from this sector.

Sustainable agriculture contributes to lower emissions in a number of ways. First, the reduced use or complete avoidance of nitrogen fertilisers means that CO_2 emissions from their production and N_2O emissions from their application to the soil can be radically cut. Second, sustainable agricultural practices, such as low or zero tillage, composting, crop rotation and agro-forestry all help to 'sequester' carbon dioxide in the soil by increasing soil organic matter and limiting soil erosion. This is in contrast to heavily ploughed and eroded soils – both linked to conventional practices – which tend to sequester less. Third, increased tree and shrub cover in sustainable farming systems also means that more carbon dioxide gets 'locked' in above ground by vegetation. Fourth, techniques, such as SRI, which do not require rice fields to be flooded for long periods, may help to lower methane emissions as there is less anaerobic decomposition of soil matter (a major source of methane). And fifth, organic livestock systems are usually less intensive, which can help lower nitrous oxide and methane emissions.

The FAO has calculated that a switch to organic agriculture would mitigate between 40 and 65 per cent of current emissions from the farming sector.[32]

f) Community empowerment

Most successful examples of sustainable-agriculture in Africa and Asia involve a strong element of local-level institution-building and farmer-to-farmer networking. We see this process of 'social capital' formation as a core component of the sustainable-farming model that we present in this report. Of course, such institutions also exist in communities where conventional farming practices are the norm. However, participatory approaches have tended to be marginalised under the Green Revolution model (with farmers often acting as passive recipients of technology rather than as innovators). In contrast, they form an important part of the sustainable-agriculture model, which relies more on locally available knowledge, leadership by farmers and collaboration.

The process of building institutions for collective action may involve strengthening fora that already exist at the village level or the establishment of entirely new structures. Some examples of collective action are:

- community-managed seed selection, storage and exchange
- participatory seed breeding
- credit and savings groups
- farmer field schools and people's organisations and networks: for disseminating knowledge about sustainable farming techniques
- cooperatives and direct marketing groups
- water user groups.

SEARICE is a civil society organisation working with farming communities in southeast Asia.[33] It helps to link small farmers with formal research bodies in the area of seed-breeding. Unlike conventional seed-breeding, where the institute decides on which variety will be selected and then supplies this to farmers, under the participatory model sponsored by SEARICE, farmers set the selection criteria according to their own needs, test the seeds in their fields, and are the principal owners of the final selected varieties.[34] These partnerships have helped to produce **farmer-bred seed varieties** in a range of countries, including Bhutan, Vietnam, Laos and the Philippines. The farmer-bred varieties are 'resistant to pest and diseases, do

not depend on chemical inputs and have shorter maturity periods – characteristics that lower production costs and increase productivity'.[35] Some varieties have also been bred to tolerate drought and flood conditions. In the Philippines, SEARICE partners released over 200 farmer-bred varieties in eight years (1996 to 2004), four times more than the number of hybrid lines developed by the government's own institute the Philippine Rice Research Institute.[36]

In Andhra Pradesh, India, the Deccan Development Society (a Christian Aid partner) has been at the forefront of efforts to empower dalits, who are victims of caste-based discrimination. They have assisted approximately 5,000 dalit women to gain access to land, which they are farming sustainably. They are not only meeting the food needs of their own households, but have also set up a food-rationing system that is benefitting destitute community members.

In Burkina Faso, the widespread land rehabilitation and food security benefits outlined earlier (see page 33) required **collective action to organise labour** for constructing and maintaining terraces and small-scale dams, and to agree on user rights and responsibilities. This led to the creation of new community bodies whose aim was to manage the land regeneration work. Through the establishment of these groups, farmers were able to attract investment from the state and donors for tools, study tours and the subsidised transportation of stones.[37]

Case study: From crisis to surplus

Sukomol and Alpana Mondal at home in India with their youngest son, Pallab.

One couple in India made the switch to sustainable farming in the midst of a serious family crisis.

Sukomol and Alpana Mondal live with their two sons on a 0.7 hectare farm in Biswanathpur, a village on the Ganges delta in west Bengal, India. Their youngest son, Pallab, who is four, has a disability. The Mondals fell into debt because they were having to pay various costs relating to their son's treatment at hospital. The only way they could afford this was to take out high-interest rate loans and sell most of the produce from the farm. This created a severe food shortage for the family.

In the middle of this crisis, in 2006, the Mondals decided to make a switch to an integrated farming system (see also p.28), having seen its positive effects on other farms in the area. These farms had received support from a local training centre that is linked to a wider network of centres coordinated by Christian Aid partner DRCSC. With similar help from the centre, the Mondals constructed a pond and a new drainage system consisting of a main channel through the rice field with smaller channels around the perimeter linking to the pond. The earth was used to raise the level of several of their plots. A gradual transition was made to organic paddy cultivation using SRI methods. Native species of carp and catfish were introduced in the pond and channels, and crops such as cowpea and bitter gourd grown on trellises over the water.

More than 20 different crops are now being grown, including various spices, vegetables, oilseeds and pulses. 'Live fences' of mango, banana and coconut trees were also planted around the farm's edge. The Mondals also introduced vermi-composting, began to save more seeds, and increased the number of livestock they kept.

Five years on, the Mondals' situation has been transformed. They have managed to pay off two-thirds of their debt. Their income has increased: surplus vegetables are sold at the market, earning them an extra 12,000 rupees per annum (approximately £170). Spices, fruit from the trees, seeds and seedlings are all being sold. They no longer use chemical inputs, which has lowered production costs. Instead they use compost, manure and other organic inputs. In the first two years there was a dip in rice production but it is now back up to pre-transition levels – 680kg per bigha per year (in west Bengal a bigha is a unit of land equivalent to 0.13 hectares).

The Mondals hardly ever have to buy food now – they can rely on a steady supply of rice, fruit, fish and vegetables throughout the year. This has improved the family diet. The water from the pond is used to irrigate a winter paddy crop as well as the vegetable plot. The effects of flooding and water-logging (major problems in this region) are lessened by the use of raised beds. Other farmers now come to visit the Mondals to learn from them about the new techniques.

At the beginning of the conversion process, the centre and DRCSC gave advice on farm design, lent seeds and equipment to the family for the first year, and also organised a small interest-free loan so that the family could hire extra labour for the construction work. The sum was later paid back to the centre and used as part of its revolving fund, which helps other farmers in the area.

Increasing smallholders' **access to climate and meteorological knowledge** is another example of the positive relationship between sustainable agriculture and community empowerment. From 2008 to 2010 Christian Aid partner INADES worked with four communities in central Tanzania to increase their understanding of future climate risks and improve their ability to combine their own seasonal indicators with formal, met office seasonal forecasts. This led to the community members involved forming farmer field schools to test new drought-resistant, open-pollinated varieties of maize and sorghum and various tillage techniques. Each farmer field school established a locally made, low-cost rain gauge with technical support from Dodoma Meteorological Station, which enabled farmers to improve their recording of rainfall and expanded the local network of registered measuring stations. Group members considered the increased use of manure to be the most important resilience-building measure, highlighting the importance of expanding sustainable-agricultural approaches.[38]

Although there is still a lack of research regarding the differential impacts on women and men of these approaches, there is some evidence that the approach can be **empowering** where **women** assume a new role in the production process and where this translates into greater decision-making power. For example, they may take on responsibility for intensified vegetable production in 'home gardens' (these plots are an important source of food for farming families, especially during leaner periods of the year) or they may be involved in small-scale livestock rearing. Women are also often in charge of the preservation and improvement of local crop varieties – a practice that is highly compatible with sustainable agriculture. In addition, by helping to increase a household's food intake, sustainable agriculture improves the health (and productivity) of all members of the family and funds otherwise diverted to buying in food can be spent on other essentials.[39]

g) Regeneration of rural economies and labour impacts

Successful farms generate rural wealth. Increased farming household incomes mean less forced migration, more money to be spent on local labour and basic services and demand for goods and services from local businesses. Many studies have concluded that successful small-holder farming is the economic activity most likely to reduce rural poverty. For example, the World Bank estimated in a 2008 report that agricultural growth in GDP is at least twice as effective in reducing poverty as growth in any other sector.[40]

One specific benefit for local economies of sustainable agriculture is the potential for an increase in jobs in those sectors supplying inputs for organic farming practices: for example, worms for vermi-composting, manure, saplings and organic fertilisers.

The labour benefits of sustainable agriculture have been debated – and often the approach has been labelled as more labour intensive. However, Robert Tripp, in his recent comprehensive study of low-external-input technologies (LEIT) stated that:

'It is inaccurate to characterise LEIT as necessarily labour-intensive. Some examples of LEIT require no more labour than the farmer's present practice, and some types (such as certain variants of conservation tillage) are attractive precisely because they save labour. But it remains true that the success of LEIT is often dependent on the efficient organisation of the labour supply.' [41]

Christian Aid partners' experience has been that:

- Many techniques do require an initial investment of time for learning new skills, though this can be reduced with appropriate extension support.
- Over time many of the techniques are in fact labour-neutral or labour-saving. This is the case for SRI and conservation agriculture (see for example the case study, page 30).[42]
- During the initial transition phase, low-external-input methods can be more labour-intensive if construction work is required on the farm, for example digging planting pits, building ponds and raised beds and planting trees. But once the new system is established, the labour demand drops.

If farmers can afford to hire labour for construction tasks, this also gives a boost for the local economy, helping to stem seasonal labour migration out of rural areas. For instance, in Burkina Faso, rather than migrating, work teams of young men specialised in land-rehabilitation techniques, such as zai pits, travel from village to village to work for farmers. They are paid to dig the zai pits and construct stone bunds that help improve the land and transform yields.[43] Government can also play a role by funding construction work, including via public works schemes. This has occurred in India thanks to the National Rural Employment Guarantee Act, which guarantees a minimum of 100 days work per year for unemployed people in rural areas. In some countries communal labour schemes exist – this is another way that individual farmers can get help for the changes needed.

Endnotes

1 Production can be measured either in terms of yields for individual crops –the quantity of the edible part of the crop produced on a given area of land, often expressed in kg or tonnes per hectare – or in terms of total farm production.

2 The most common types of improvement were the better use of locally-available natural resources (88 per cent of projects); human capital building through learning programmes (92 per cent); diversifying by adding new regenerative components, such as IPM and legumes (59 per cent); and group action (55 per cent). J Pretty, R Hine, *Reducing Food Poverty with Sustainable Agriculture: A Summary of New Evidence*, p13.

3 UNEP-UNCTAD Capacity Building Task Force on Trade, Environment and Development (CBTF), *Organic Agriculture and Food Security in Africa*, New York/Geneva: United Nations, 2008, p16.

4 P. Gibbon and S Bolwig: *The Economics of Certified Organic Farming in Tropical Africa: A Preliminary Assessment, Danish Institute for International Studies, Working Paper 2007/3.*

5 C Badgley et al, 'Organic agriculture and the global food supply', *Renewable Agriculture and Food Systems*, 2007, 22(2), pp86-108.

6 Christian Aid and ZimPro, *Internal Evaluation Report*, 2010.

7 International Crops Research Institute for the Semi-arid Tropics (ICRISAT) data, cited in Zimbabwe Conservation Agriculture Task Force, *Farming for the Future: A Guide to Conservation Agriculture in Zimbabwe*, 2009, p12.

8 The information for this section is drawn from S Edwards *et al, Impact of Compost Use on Crop Yields in Tigray, Ethiopia*, FAO, 2007, p5 and p8.

9 The crops were barley, durum wheat, finger millet, hanfets, maize, sorghum and teff.

10 Yield for pre-adoption period: 6.49 tonnes; yield in 2003: 7.65. Data supplied by PRDCI.

11 L Bachmann, E Cruzada, S Wright, *Food Security and Farmer Empowerment: A Study of the Impacts of Farmer-led Sustainable Agriculture in the Philippines*, MASIPAG, 2009.

12 Ibid, p7.

13 Today over half of women in India and two-fifths in Indonesia suffer from anaemia, caused by a lack of iron. 'Quality, not quantity: why small doses of vitamins could make a huge difference to the world's health, *Economist*, 26 March 2011.

14 Report submitted by Olivier De Schutter, special rapporteur on the right to food, UN Human Rights Council, 20 December 2010, p12.

15 UNCTAD/UNEP, *Organic Agriculture and Food Security in Africa*, 2008.

16 Ibid.

17 These figures relate to Luzon and Mindanao only. This question was not asked in the third region, Visayas.

18 Input costs were 10,453 pesos per year for conventional farmers, whereas they fell to just 1,119 pesos/annum for farmers who adopted organic practices. Three-quarters of organic farmers reported that their income had increased since 2000.

19 Data supplied by PRDCI. Regarding the methodology for measuring incomes, farmers who adopted organic practices, representing 15 per cent of the total, were selected at random each year.

20 C Reij, G Tappan, M Smale, *Agroenvironmental Transformation in the Sahel: Another Kind of Green Revolution*, International Food and Policy Research Institute (IFPRI), November 2009.

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SECTION 5. SCALING UP

In the previous section we highlighted the various benefits of sustainable agriculture for African and Asian smallholders: increased food production, improved food security and farmer incomes, the enhancement of the natural resource base, increased resilience to natural disasters and climate change and stronger levels of social capital in farming communities. However, without appropriate policy support and investment, these initiatives, which have so much potential, risk remaining localised and marginalised.

This section is divided into two parts. The first looks at the current state of play regarding government and donor support for sustainable agriculture. The second considers what new measures need to be taken.

The current scenario

There are a number of examples of where African and Asia governments have actively promoted the scaling up of sustainable approaches. For example:

- The **Indonesian Government** supported the introduction of IPM from the late 1980s onwards, with the assistance of the UN's Food and Agriculture Organisation. One of the triggers for the policy change was the widespread pest outbreaks that had been occurring on rice fields where pesticides were being sprayed liberally. Insects had developed a resistance to the pesticides being used, while their natural predators were being killed off by the same applications, resulting in major yield losses.[1] The government responded by banning broad-spectrum pesticides and instead supported an IPM programme using the farmer field school model to disseminate the techniques. An estimated 1.2 million Indonesian farmers received IPM training between 1989 and 1999 through the farmer field schools and their knowledge was passed on to other farmers. A repeat of the large-scale pest outbreaks of the 1970s and 1980s has been avoided.[2]
- The introduction of the SRI technique for growing rice in **Cambodia** offers a good example of how governments can lend support to sustainable agriculture. Although not originally a government initiative, the Cambodian Government began supporting the scaling up of SRI during 2005 and 2006. This helped to increase the number of farmers who adopted it. The number of SRI farming households in Cambodia has grown from just 28 in 2000 to an estimated 100,000 today – 4.6 per cent of the population. SRI is now being practised (albeit not exclusively) in one in every five Cambodian villages. The Cambodian agriculture ministry reported that in 2006 the yields from SRI rice in the country were 3.7 tonnes per hectare compared to 2.5 tonnes per hectare for rice grown using conventional methods.[3]

Kamong Cham, Cambodia: Norm Pary threshes the recent rice harvest. Thanks to the system of rice intensification – an approach promoted by Christian Aid partner CEDAC – Pary and his family have been able to increase their rice yields while using one-third less seed than they used to sow.

- In **Tigray state in Ethiopia**, since 1998, the local government Bureau of Agriculture and Rural Development has adopted natural composting as part of its extension package. By 2007 at least 25 per cent of the farmers in the region were making and using compost. Between 2003 and 2006 grain yield for the region almost doubled from 0.71 million to 1.35 million tonnes and, since 1998, there has also been a steady decrease in the use of chemical fertiliser from 137,000 to 82,000 tonnes. The approach is now being promoted in other regions of the country, particularly through the Community-based Participatory Watershed Development project of the Ministry of Agriculture, and the Land Rehabilitation Project of the Environmental Protection Authority, which has been supported through three successive phases of the Country Cooperation Programme of UNDP.[4]
- In **Burkina Faso** the adoption of zai pits and stone bund technology, while started by farmers, has been promoted and supported by the government as well as donors and NGOs. For example, the government supported awareness raising of the benefits among farmers, promoting more widespread adoption, and invested in rural feeder roads so farmers could transport their produce.

- In India the **state of Rajasthan** provides support for watershed and soil management and incentives for biofertilisers.[5]
- The **Philippines** government ended its fertiliser subsidy programme in 2009 and has introduced a 'balanced fertilisation strategy', aimed at promoting combinations of location-specific combinations of inorganic and organic fertilisers.[6]
- In **Kenya**, the government has been supporting a nationwide programme of soil and water conservation (known as the Catchment Approach) since the 1970s.

These kinds of examples are promising and have made real impacts, but none of these countries has yet put sustainable agriculture at the heart of their policy frameworks. The only countries to do so are Switzerland and Cuba, where sustainable agriculture has become official government policy – see box on the Cuban experience.

In most cases efforts to scale up sustainable approaches have been impeded by a number of barriers – institutional, economic and political. In the case of Africa, as stated by UNEP/UNCTAD 'organic agriculture is not directly and specifically supported by agricultural policy in most African countries; indeed, it is sometimes actively hindered by policies advocating the use of high external input farming practices. If organic agriculture and its associated positive side effects are to be scaled up, an enabling policy environment is critical.' [10] In Asian countries, the amount that farmers pay for fertilisers is kept low by large government subsidies and this subsidy has become very costly for these countries owing to the exponential rise in world fertiliser prices. Taking one example, the Indian Government has recognised the problem of soil degradation on farmland but its main response to date has been only to propose the re-balancing of fertiliser subsidies in favour of more phosphorus and potassium (at present more subsidies are given to nitrogen fertilisers, which create macro-nutrient imbalances in the soil). This arguably misses the opportunity to undertake a more fundamental reform of farm subsidies, which would involve using more public money and policy instruments to support sustainable soil and crop management practices.

Cuba

In the 1990s after the collapse of the Soviet bloc, the Cuban Ministry of Agriculture declared an 'Alternative Model' as the official policy for agriculture. The policy focuses on supporting resource-conserving technologies that substitute local knowledge, skills and resources for the external inputs that the country had been importing from the Soviet Union. The policy also promotes the diversification of agriculture, the use of IPM to replace pesticides, widespread training of farmers to spread knowledge of these techniques and the promotion of better cooperation among farmers. Many biological control methods are proving more efficient than pesticides. The use of cut banana stems baited with honey to attract ants, which are then placed in sweet potato fields, has led to the complete control of sweet potato borer by the predatory ants. There are 173 vermicompost centres (the production of natural compost using worms), which grew from 3,000 to 93,000 tonnes in four years. Crop rotations, green manuring, intercropping and soil conservation are all more common as a result of the policy.[7] By the mid-1990s food shortages precipitated by the Soviet Union's collapse had been overcome, with the 1996 to 1997 growing season producing the highest ever production of 10 basic food items, a result primarily driven by small farmers.[8] And many farmers have commented on the noticeable drop in acute pesticide poisoning incidents since the end of the 1980s.[9]

The UK government and the European Union

UK policy

In 2009, the Department for International Development (DFID) made a welcome commitment to increase agriculture spending, allocating £1.1bn for agriculture over three years, as part of the UK's contribution to the overall commitment of the G8 countries made at the l'Aquila summit, to scale up agriculture spending to US$20bn. At the same time, the government set out its vision for the future of Africa's agriculture sector in a 2009 White Paper, *Our Common Future*, which recognised the importance of revitalising agriculture in low-income countries, and committed to ensuring that food and agriculture are given the 'highest global attention'. Such statements and associated funding increases are welcome if they are delivered on and if the funding is channelled towards providing real solutions that include the approaches this report has outlined.

Yet, while the current government has promised to maintain the 2009 spending commitment, there has been a lack of clarity on the detail. In addition, of DFID's stated priorities, agriculture is not a priority area in its own right and does not warrant a mention in the DFID business plan for 2011 to 2015, but is tackled as a sub-theme within 'wealth creation' [11]. To subsume agriculture under 'wealth creation' risks failing to adequately capture the multifunctionality of agriculture and its integral links with food security, livelihoods and the environment. If the focus remains primarily on already commercially viable farmers, this could leave out of the picture the poorest and most marginalised farmers who, with the appropriate support, could be increasing their yields, food security and incomes through low-cost approaches that build their adaptation to climate change and their economic and environmental resilience.

The Conservative party's Green Paper on international development, published in 2009, stated that yield and productivity increases were the main aim of UK aid for agriculture, with support for increased food production – including through support for 'the research and development of new technologies to deal with changing weather patterns' – to be combined with support for improved nutrition programmes and social safety nets. However, the document made no mention of sustainability or of the importance of promoting the low-cost farmer-led technologies that are necessary for sustainable agricultural development. Neither did it talk about the role and importance of smallholder and women farmers or food security.

DFID appears to direct a disproportionate amount of its resources on costly Green Revolution technologies that are deemed to solve the problems of hunger and climate change. For example, DFID's research spending on agriculture, which has increased by 60 per cent over the past three years [12] (a trend we would welcome in principle), is very largely directed through the Consultative Group on International Agricultural Research (CGIAR) institutes (86 per cent for 2008 to 2013). These research centres tend to focus on developing silver bullet technologies, including biotech, and have a reputation for not including farmers adequately in their work. This reputation is borne out by a World Bank report, which concludes that 'Donor efforts, including those of the CGIAR, have been largely supply- rather than demand-driven, and they have not adequately reflected the constraints on small-scale farmers.' [13] An external evaluation of DFID's approach in its 2005 White Paper concluded that there had been a poor uptake of such 'improved technologies' by farmers.

DFID is currently funding a number of projects that involve a mix of conventional seed breeding and genetic modification, usually in partnership with other donors, multinational seed companies and CGIAR research institutes. Examples include projects to develop rust-resistant wheat, flood-proof 'scuba' rice and water-efficient maize.[14] However, the extent of collaboration with farmers in these projects is unclear and we would argue that DFID should be investing more in alternative and lower cost approaches to increasing farmers' resilience that are already proven to succeed.

DFID does support some projects that are more aligned with the approaches outlined in this report. For example, it has funded a 'push-pull' technology project in Kenya (push-pull is a method of controlling pests and weeds in maize and sorghum cultivation without the need for pesticides).[15] It has also provided some support to conservation agriculture. This is welcome. Yet, it is unclear what percentage of its spending goes to supporting such approaches, and its greater attention seems to go towards more input-intensive approaches, through CGIAR and also through its support of AGRA.

Another major shortfall is the lack of spending on extension services, which are essential for disseminating the knowledge-intensive, farmer-led approaches outlined in this report. While DFID is generous with its funding of research, it neglects extension almost entirely.

There is an urgent need therefore for DFID to prioritise agriculture and food security in ways that are inclusive of the approaches and the marginalised farmers documented in this report. In a number of respects, we believe DFID should align its strategy more closely with that of the European Union.

The EU

The EU recently approved a new Food Security Policy Framework, which set out the kind of support that will be given to developing country agriculture through its development budget. In contrast to the UK government's position, the framework puts sustainability and the resilience of smallholder farming systems at the heart of future EU and member state support for food and agriculture in developing countries: it states that 'investments in the smallholder sector yield the best in terms of poverty reduction and growth', while also stressing that intensification approaches should be 'ecologically-efficient'.[16] They should include optimising agricultural inputs, IPM and improved soil and water management. The framework states that research and innovation must have clear benefits for small farmers and that any technologies promoted should be sustainable and compatible with national capacities to regulate risks. A focus on nutrition in agricultural projects is key.[17] The policy framework also acknowledges the importance of collaboration between the formal scientific establishment and farmers when undertaking research to improve seeds and agricultural practices – especially to validate the traditional knowledge of farmers – and that public research needs to have clear benefits for smallholder farmers. Further, it stresses the role of biodiversity (especially diversified food crops and local varieties) in increasing the resilience of farmers to climate change and shocks. The document is explicit that technologies that are not sustainable or that carry risks that cannot be managed should not be promoted in public research.

The policy framework is not perfect – it addresses neither the concern regarding the impact of the EU's own trade and agricultural policies on developing world farmers, nor the effect of global intellectual property rules on national seed laws; nor does it state which farm technologies are unsustainable – but it represents a departure from business-as-usual.

What measures are needed?

In order to enable the scaling up of the approaches documented in this report, Christian Aid believes that governments and donors need to support the following interventions and reforms.

Public investment

Investment in agriculture needs to be massively scaled up, but the direction of this spending is as important as the quantity.

First, governments and donors need to meet their commitments to increase investment in agriculture. In the case of donors this means at a minimum meeting the l'Aquila commitments – in DFID's case £1.1bn over three years. For African governments it means meeting their Maputo commitments to invest 10 per cent of their budgets on agriculture, and, for Asian governments, also a substantial increase in the proportion of national budgets allocated to farming (in 2008 it stood at just 4 per cent).

Second, and most importantly, an increasing proportion of investment should be channelled towards supporting the scaling up of sustainable approaches, so that they form a central part of national agriculture strategies. The development and implementation of agriculture strategies must be conducted in ways that put farmer associations and networks and relevant CSOs at the centre. Sustainable approaches should be built into revived public research and extension programmes. Governments, backed up by donors, could also re-balance their subsidies away from resource-degrading technologies towards resource-enhancing, sustainable ones. Support to farmers to help them make transition to sustainable agriculture would be especially useful in early years when yields sometimes dip as new approaches are being adopted and in cases where transition costs make it difficult for farmers to move quickly from chemical-dependent to sustainable approaches. For example, governments could consider subsidies for farmers who adopt nitrogen-fixing systems – these systems may take some time to produce results, especially agro-forestry systems – and farmers need support and financial incentives (in the form of subsidies, climate finance and other sources) to continue farming with these techniques. Subsidies could also be used to encourage, reward and acknowledge farmer innovations in sustainable technologies.

Research

Scaling up sustainable agriculture will require both increasing investments in research from governments and donors and also a re-orientation of that research spending.[18]

Numerous studies show that investments in agricultural research provide good economic returns and can reduce poverty.[19] The CAADP programme of 2003 called on African countries to double their annual spending on agricultural research within 10 years – to US$4.6 billion by 2015, entailing a rise of 7.2 per cent a year.[20] And as donors in recent years have pledged aid increases to agriculture, some, notably the UK, have announced rises in aid for agricultural research.

However, even more important than the quantity, it is the focus of research spending that matters. Much agricultural research is currently focused on developing crop varieties – notably, hybrid and GM seeds – that require greater use of chemical fertiliser and pesticides. It is estimated that only 7-13 per cent of world agriculture research is focused on natural resource management, while developed countries spend less than 1 per cent of their research budgets on organic farming.[21] In most developing countries, especially in Africa, there are few efforts to involve farmers – and even fewer to involve women farmers – in the design of research programmes. A further problem is that when new crop varieties are developed that could benefit farmers, they are poorly disseminated to farmers, especially poorer ones, through (under-resourced) extension services.

Agricultural research needs to be re-oriented towards supporting sustainable agriculture, and there are numerous ways to achieve this, as articulated in, for example, the IAASTD report[22] and by the Transforming Agriculture Research for Development initiative.[23] The focus of research should be on:

- Approaches that benefit small-scale farmers, especially women farmers, and promote food security.
- Crop varieties that reduce the need for agro-chemical inputs and the generation of organic materials from local trees and shrubs to replace these inputs, among other areas.
- Improving the productivity of local seeds and crop varieties, taking into account traditional knowledge, growing practices, land use and soil fertility management.[24]
- Developing (and reducing the cost of) simple tools and technology to increase farm productivity and reduce the burden of work, such as small-scale irrigation equipment in farm production or simple processing equipment for post-harvest value addition.

Critical to all these processes is the much greater involvement of farmers – especially women farmers – in choosing, designing and participating in research programmes and in helping to disseminate their results.

Agricultural extension

Public extension services in developing countries have been severely under-funded over the past two decades, by both governments and donors. Many governments slashed staff and services under pressure from donors while, according to OECD aid figures, donors spent a miniscule US$34 million a year on extension in the 10 years from 1996 to 2005, amounting to just 1 per cent of their (already very low) agricultural aid.[25] In recent years, there has been increasing investment in extension by some donors and governments, yet in many developing countries extension services still suffer from poor quality, low salaries and morale, ageing staff, numerous vacancies and, most importantly, little outreach to farmers. The result has been that only a small proportion of farmers in many developing countries now see any extension officers. Those that do tend to be men, and larger-scale farmers:

- In India, for example, around 29 per cent of men but only 18 per cent of women farmers have access to extension services.[26]
- In Bangladesh, 44 per cent of rural women have no access to extension services – of the rest, 22 per cent see an extension officer rarely, 19 per cent occasionally and 15 per cent frequently.[27] The main beneficiaries of extension services there are large or medium-sized farmers.[28]
- In Liberia, an IFAD report notes that 'extension workers tend to exclusively focus on male farmers for crop support services'.[29]
- In Ethiopia 23 per cent of farmers report seeing an extension officer in the past year (27 per cent of men; 20 per cent of women).[30]

Having good public extension services is critical to promoting agricultural development, but it is even more important in making the transition towards sustainable agriculture. Farmers need advice and information on new, improved techniques and farming approaches to maximise yield as well as knowledge of new research coming through from agriculture research projects and more information on markets and prices for their outputs. Much of this advice and information needs to be location-specific given that soils and crops differ substantially within countries, meaning that extension services cannot be top-down and prescriptive but must be decentralised and adaptive to local circumstances and needs. This means considerable re-training of existing staff in sustainable approaches. Governments also need to make more efforts to recruit more women extension officers into the service.

But much knowledge of 'new' approaches will come from farmers themselves, and local knowledge. Increased efforts must be made to ensure that farmers shape the extension service to ensure it is based on real needs. Farmers' groups and producer organisations need to be strengthened, partly in order to articulate their 'demand' for extension services. Farmer field schools, which offer a group-based learning process for small farmers, are becoming a key public extension approach in some countries, such as in Tanzania, Uganda and Indonesia, and such approaches could be further scaled up. Experience from Christian Aid's partners' work shows that this process of local social capital formation is a vital ingredient of successful programmes.

Land

Governments will also need to address land-tenure systems as a crucial pre-requisite to increasing adoption of sustainable agriculture. In Africa, over 90 per cent of land is formally owned by national governments and smallholder producers who farm the land have only customary tenure or informal use rights. In Asia incomplete agrarian reforms in many countries mean that landless people are still being denied access to land; and smallholders face increasing uncertainties due to declining incomes and the loss of land to industrial and urban developers and larger scale agri-businesses. Insecure land rights are a major challenge and disincentive to any vulnerable farmer seeking to make investments in improvements to farms and farming systems. For farmers seeking to shift towards sustainable approaches, this becomes even more of an issue, because of the investments of time and labour required to make longer-term improvements in land and farm systems. Since the full benefits of sustainable practices tend to accrue over several years, secure tenure that provides the incentive for farmers to invest their labour and capital is vital for their success.

Markets

If governments and donors are to scale up appropriate support for smallholder farmer-led sustainable agricultural production, as we are calling for, this must be accompanied by initiatives that enable the creation of and access to markets that return fair prices for producers. Through

supporting farmer cooperatives, which are able to negotiate fairer prices with buyers; through investing in market infrastructure, ranging from roads, and drying and storage facilities, to price information systems; and through focusing on strengthening local markets for staple food products – which must include maintaining policy space within trade agreements to protect these markets from cheap imports – governments and donors can give farmers greater incentives to invest in improving their productivity via sustainable approaches.

The upward trend in global food prices, which is predicted to continue for many years, highlights the risks for national food security of relying upon global markets for food. Building stronger national and regional markets is therefore both critical to national food security as well as to farmers' incomes and livelihoods.

Seed laws

National seed laws should not be devoted to providing seed companies with legal protection for the sole right to sell 'their' seeds. Instead, laws must primarily focus on promoting farmers' rights and their access to seeds of their own choosing, be they modern or traditional varieties. Seed laws must give maximum scope to farmers to re-use, exchange and even sell (albeit at a local level) MVs developed by seed companies. They should also enshrine the right of farmers to freely breed, sell and exchange traditional varieties. The IAASTD report,[31] the FAO guidelines[32] and the EU's food security policy framework all emphasise the importance of these approaches. Seed companies need to be regulated sufficiently by governments to ensure that they do not hold monopolistic positions in national seed markets and have undue influence over government policy in this area. Developing countries should also be supported to resist the pressure upon them to align their domestic seed legislation with international agreements that introduce intellectual property rights in the plant-breeding sector, such as the International Convention for the Protection of New Varieties of Plants and the WTO agreement on Trade-related Aspects of Intellectual Property Rights (TRIPS).

The private sector

The private sector has a potentially important role in supporting sustainable agriculture that needs to be encouraged and harnessed by governments. Banks, for example, could be better encouraged to provide key financial services to farmers promoting sustainable agriculture, such as low-cost credit services or affordable weather insurance. Small and medium enterprises (SMEs) that are already playing a role in providing some extension services could also be encouraged to include sustainable agriculture approaches in their portfolios. SMEs could also provide smallholder farmers with a range of products such as small-scale irrigation technology, low-cost energy products, various inputs associated with organic farming, as well as business support services. In addition, private sector research into new technologies, for instance crop varieties that reduce the need for chemical inputs, could be better shared with public institutions and developed on in close collaboration with farmers themselves. Transnational corporations (TNCs) and national food retailers could do more to encourage organic smallholders in developing countries, sourcing more from them in long-term supplier relationships.

At the same time, governments need to put in place the appropriate regulatory frameworks to ensure the private sector contributes to and does not undermine sustainable agriculture. Governments and donors must place limits on TNCs and national companies promoting fertiliser and pesticide, along with patented seeds, as the solution to hunger and agricultural development. Effective national competition policies are required to ensure that a small number of companies do not dominate markets and they do not have a disproportionate influence on national policy-making. Tighter controls on advertising are needed. Governments could also consider ways of encouraging the private sector to invest in minimising the overuse of fertilisers, for example through taxes that internalise the costs of environmentally damaging levels of fertiliser run-off. Governments must also ensure proper testing of these technologies in terms of their impacts on the environment and human health. Private agro-dealers should not replace the government extension service as a source of advice on inputs for farmers, and need to be properly trained in the safe use of chemicals. Finally, national laws in developed countries need to be strengthened to hold companies legally liable for the environmental impact of their activities abroad.

Endnotes

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CONCLUSION AND RECOMMENDATIONS

In this report, we have used evidence from Africa and Asia, including from projects involving Christian Aid's partners, to argue that it is possible to increase production and to meet food security and income needs, through agro-ecological approaches that put farmers in the driving seat. Such approaches provide a more viable and sustainable pathway than the scaling up of a Green Revolution model that is over-reliant on external inputs.

While recognising the significant achievements of the Asian Green Revolution, we have highlighted several major drawbacks of this approach. In Asia, intensive farming practices, especially the monocropping of rice and wheat with chemical inputs, have contributed to widespread soil degradation. This is now affecting rates of yield growth in cereal crops and it is has pushed up the cost of farming for Asian smallholders, who are becoming increasingly dependent on unaffordable inputs. For example, farmers are having to apply increasing quantities of fertilisers to the soil to keep yields high. This is one of the factors behind increasing levels of debt. In Africa, where similar approaches were tried out in the past, maize monocropping led to a loss of traditional grains and farm biodiversity that had been critical to food security.

Despite this, in Africa, AGRA and other major donors, as well as African governments themselves, are rolling out a Green Revolution for Africa that places too much emphasis on chemical inputs and hybrid seeds as the solution to the continent's food problems. This risks repeating the mistakes of the Asian Green Revolution and sidelining more sustainable, alternative farming systems.

Meanwhile, farmers can and are helping themselves by adopting practices that reduce input costs, while diversifying farm production and maintaining or improving yields. Increasing production using affordable, farmer-led technologies is probably the most direct way of tackling hunger and poverty in rural areas where the percentage of the population engaged in agriculture is high, while also producing surpluses that – with appropriate market infrastructure – can help meet the food needs of urban populations as well.

Sustainable agriculture also offers practical ways for farmers, agri-businesses and governments to avoid or address the negative environmental impacts of the Green Revolution model. Sustainable approaches limit the greenhouse gas emissions that arise from the use of nitrogen fertilisers, intensive livestock production and irrigated rice cultivation. At the same time they provide a solution to the growing problems of the over-exploitation of groundwater supplies, biodiversity loss, soil degradation and water pollution.

But these approaches need major support of government and donors if they are to reach a sufficient scale to be effective.

The future of agriculture lies in balancing production needs with equity and environmental goals. Aiming for productivity gains in the absence of due attention to these broader requirements is an increasingly risky strategy for policy-makers: soil degradation, the contribution of the sector to global warming, and extreme rural poverty are all evidence of this. There is an increasing body of evidence that demonstrates the benefits of sustainable agriculture when it is put into practice, as we have shown in this report. So the path forward is clear but the question remains, are governments and donors up for the journey?

Recommendations:

DFID, the EU and other donors should:

- Meet and increase funding commitments for agriculture, with priority given to supporting sustainable, smallholder farming:
  - DFID should honour its commitment to spend £1.1bn on food security and agriculture over three years (2009/10 to 2011/12) and budget for further increases as overseas development assistance rises. But, above all, it should outline a strategy for spending this money that enables the scaling up of proven, sustainable approaches (see below)
  - in their budgeting for food security and agriculture in developing countries, the EU and member states should ensure the prioritisation of sustainable agriculture and support to small farmers and their organisations. Future EC country programme support in this area should be in line with the priorities of the new Food Security Policy Framework
  - all donors should set out plans to allocate a minimum of 10 per cent of ODA to agriculture and food security to match the 10 per cent commitment made by African governments in the Maputo Declaration of 2003.
- Within research budgets, place a greater emphasis on low-cost, sustainable and farmer-led technologies, such as the promotion of indigenous and local varieties of crops that do not require agro-chemicals; participatory seed breeding; organic methods of soil fertilisation (for example cover crops, composting, crop rotation, agro-forestry, low/zero tillage); polycultures; mixed livestock-arable-aquaculture systems; soil/water conservation measures (for example bunding, zai pits, mulching, the system of rice intensification); cheap, labour-saving tools; and natural pest-control techniques.
- Support more research partnerships involving collaboration among poor farming communities, extension services and agricultural scientists.
- Ensure research programmes examine what kinds of sustainable agriculture techniques, equipment and crops can most benefit women.
- Significantly boost funding for extension services, in particular for training and dissemination of the sustainable approaches in this report: support countries' efforts to reinvigorate these services in the most marginal (and hunger-prone) agricultural zones.
- Integrate a nutritional dimension into agricultural programmes: this could involve increasing the diversification of smallholder agriculture, promoting micronutrient-rich food, especially local varieties, monitoring nutrition-related outcomes, and supporting agricultural research that is conducted from a nutrition perspective.
- Refrain from pushing developing countries, in particular in EU trade agreements, to align their domestic seed legislation with international accords such as UPOV and TRIPS because these limit farmers' ability to save and exchange seeds and sell them locally.
- Ensure that trade agreements do not restrain governments from protecting their agricultural sectors from subsidised imports and import surges that undercut domestic producers and are a disincentive for them to invest in sustainable production.
- Given its proven adaptation and mitigation benefits, ensure that smallholder, sustainable agriculture is one of the sectors that receives public funding under new North-South 'climate finance' initiatives.

Asian and African governments should:

- Increase the percentage of budgets directed towards agriculture, with a greater focus on sustainable agriculture. In the case of African governments this would include meeting the 2003 Maputo commitments to allocate 10 per cent of budgets to agriculture. In Asia, governments should reverse the recent decline in support to the sector and return to 1990 funding levels (8.5 per cent of state spending).
- Progressively re-orientate subsidies and funds towards sustainable, resource-enhancing and affordable farming approaches that work well for small-scale farmers with limited assets and incomes – see examples above.
- Support more research – led by farmers – on sustainable agriculture, in the same areas mentioned above.
- Revamp extension services with a greater focus on farmer-to-farmer knowledge transfer and group-learning processes. These services should support the adoption of the agro-ecological practices outlined in this report; they should also target women farmers, who have been particularly neglected in existing extension services. Coverage should be increased in the most marginal, hunger-prone regions.

- Ensure that land and other natural-resource policies create incentives for the adoption of agro-ecological approaches: for example, smallholder farmers need guaranteed security of tenure and landless people access to land; and rural communities as a whole should play a stronger role in the sustainable management of natural resources, including land, water, fisheries and forests.
- Recognise the central role that women farmers can play in scaling up sustainable approaches by increasing:
  - their participation in agricultural research (see above)
  - their involvement in and influence over extension services and local decision-making bodies.
- Strengthen local and regional markets in staple foodstuffs, by supporting farmers' organisations such as cooperatives; investing in roads, processing and crop storage facilities, and providing targeted price information and weather/climate forecasting services.
- Ensure that national seed laws give maximum scope to farmers to save, re-use, exchange and sell locally seeds of their choosing – including both local varieties and modern varieties (MVs) developed by seed companies.
- Put in place incentives to harness the potential of the private sector to contribute to sustainable farming; as well as regulatory frameworks to ensure that a small number of transnational corporations (TNCs) or other companies do not dominate markets; and that their promotion of fertilisers, pesticides and MV seeds do not sideline sustainable approaches.
- Prioritise sustainable agriculture in national plans on climate change adaptation, and food security and nutrition.
- Limit the amount of pesticides used in farming by investing in natural methods of pest control; phase out highly hazardous pesticides; [1] and in order to protect the health of small-scale users in tropical climates, and in line with section 3.5 of the FAO *Code of Conduct on the Distribution and Use of Pesticides*, avoid using pesticides 'whose handling and application require the use of personal protective equipment that is uncomfortable, expensive or not readily available'.

Endnote

1 See this list of highly hazardous pesticides drawn up by the Pesticides Action Network (PAN) International in 2011, pan-germany.org/download/PAN_HHP-List_1101.pdf

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