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Executive summary

As trends in investment in agriculture in poorer countries edge up, the combined effects of climate change, energy scarcity and water paucity now demand that we radically rethink our agricultural systems.

Business as usual will not do. An unprecedented combination of pressures is emerging to threaten the health of existing social and ecological systems. Population and income growth, urbanization, changing consumption patterns, stagnant yields, demand for land, feed, and biofuels, and the impact of climate change, biodiversity loss and environmental degradation are driving limited resources of food, energy, water and materials towards critical thresholds.

The combined effects of climate change, land degradation, cropland losses, water scarcity and species infestations may cause projected yields to be 5-25% short of demand by 2050, and 600 million additional people could be affected by malnutrition as a direct result of climate change by 2080.

The current food system is failing to feed the world adequately, and widespread poverty and inequality mean that many are too poor to access the food that is available. Despite there being enough food for everyone, an estimated 925 million people are hungry and another billion suffer from 'hidden hunger' and micro-nutrient deficiency, while 1.5 billion people are overweight and obese, and a third of all food for human consumption is lost, spoiled, or wasted.

Productivity gains from the Green Revolution have not always been sustainable over time and often came at a high social and environmental cost, including the depletion of soils, pollution of groundwater, biodiversity loss, high household debts, and increased inequality among farmers.

With case study evidences from Bangladesh, Cambodia, Indonesia and Pakistan, and citing global studies and surveys, this report argues that agro-ecology – or ecological agriculture – offers tools that can help the poorest communities to develop new, affordable, dynamic, low-carbon and locally-adaptable models of agricultural development to meet these multiple challenges. Recent research shows that agro-ecology is highly productive and holds great promise for the roughly 500 million food-insecure households around the world.

Agro-ecology is the application of ecological science to the study, design, and management of sustainable agriculture, and it is based on practices such as recycling biomass, improving soils

through green manures, mulches and bio-fertilisers, minimising water, nutrient and solar radiation losses, intercropping, mixed farming with a variety of crops and farm animals, and minimising the use of chemical fertilisers, herbicides and pesticides. We highlight:

Pakistan Ecological agriculture enabled 172,000 poor inhabitants in the remote Allai Valley in the Pakistani Himalayas rehabilitate and transform the environment, food security, livelihoods, incomes and social and gender relations following a devastating earthquake in 2005. Some 437 village committees trained thousands to adopt bio-fertilisers and bio-pesticides, cultivate organic vegetables, set up 35 women-run seed banks, plant a million soil-binding native trees, and establish commercial organic horticulture and floriculture enterprises.

Farm profits and productivity, food security, nutrition, health and education outcomes, employment opportunities, livelihoods, the environment and soil health all improved considerably. Vegetable cultivation expanded by 1,000 acres in the Allai Valley, 80% of households now cultivate their own vegetables, and rice and maize yields increased by 15-20%.

Bangladesh Over 21,000 poor men and marginalised women benefited considerably under a grass-roots scheme to tackle poverty and hunger through ecological agriculture in six remote districts of Bangladesh.

The Food Security for Sustainable Household Livelihoods (FoSHoL) project used participatory methods to market locally-adapted seeds, set up women-only rice grain banks, used integrated crop and pest management systems (mixed cropping, bio-insecticides), diversified into mini-fruit orchards, fishponds and tree nurseries, grew high-value vegetables on dikes, roadsides and embankments, set up homestead gardens and poultry rearing, established rice-fish culture, and established biodiversity centres and village-level savings and credit groups.

As a result, rice production increased by 5-10%, vegetable and fruit production rose by 25-40%, poultry and livestock production improved by 30-40%, fish production enhanced by 20-30%, and average net returns grew by 20-30%, because of higher value addition and cost savings from spending less on synthetic fertilisers and pesticides.

Cambodia About 50,000 resource-poor smallholders in Cambodia with plots of land of 0.2 to 0.6 hectares adopted a farmer-led and farmer-propagated ecological agricultural system to boost yields, incomes and self-reliance. Based on local knowledge, seeds, and varieties, and known as the Multi-Purpose Farm through Farmer (MPF-FA) initiative, the system includes the low-input production of rice, fruit trees, multi-purpose trees, perennial crops, seasonal crops, vegetables, fish, and farm animals. A recent survey of 107 farmers that adopted the low-input System of Rice Intensification (SRI) shows rice yields increased by 61%, the amount of costly rice seeds reduced by 53%, while the use of chemical fertilisers dropped by 72%. Other research over the last decade shows an increase in rice yields of 30-150%, and increases in farm profits by 300%.

Indonesia 114 smallholders recently established their own alternative markets and started selling organic vegetables directly to consumers and local supermarkets after setting up four village-based agro-ecology production co-operatives in Bogor district in Indonesia in 2010. Working with the Indonesia Peasant Union (Serikat Petani Indonesia, or SPI) villagers have clubbed together to form an organic compost network (using local chicken manure, sheep's dung and micro-

organisms), a farmer shop, transport network, and an organic retail outlet to sell crops like spinach, rice, bok choy, lettuce, long beans and cucumbers directly to locals and urban consumers in Bogor city and Jakarta. Costs are down and incomes are up under the profit-share scheme, and livelihoods, skills and knowledge have improved markedly, says SPI.

We found little attention has been paid to the most cutting-edge ecological farming methods – approaches that improve food production and farmers' incomes and livelihoods, while also protecting the soil, water, biodiversity and environment, and with a very low carbon footprint. Highly effective alternatives do exist, but the best options are not being promoted sufficiently at the highest political levels.

Recent high-level research shows agro-ecology or ecological agriculture:

Increases yields crop yields increased by an average of 79% in a survey of 286 ecological agriculture projects in 57 countries covering 37 million hectares on 12.6 million farms. Yields increased by 116% in projects in all of Africa, and by 128% in East Africa. A 2011 survey of 40 ecological projects in 20 African countries on 12.8 million hectares found yields increased by a factor of 2.13, and over a period of 3-10 years, resulted in an increase in aggregate food production of 5.79 million tonnes/year, equivalent to 557 kg per farming household.

Improves food and nutrition security 12,500 farm households in drought-prone Cheha in Ethiopia benefited from ecological agriculture on 5,000 hectares of land by introducing new varieties of vegetables and fruit and forest trees, organic manure for soil fertility, natural pest controls and affordable veterinary services. This resulted in a 60% increase in crop yields and a 70% improvement of overall nutrition levels. Other surveys show more diverse sources of food led to increased nutritional security for children and all members of the farmer household.

Reduces rural poverty for every 10% increase in farm yields, it is estimated there is a 7% reduction in poverty in Africa and more than a 5% poverty-reduction effect for Asia. Low cost 'push-pull' pest management systems have more than doubled maize yields from below 1 to 3.5 tonnes/hectare, and 30,000 smallholders have adopted them in Kenya, Uganda and Tanzania through town hall meetings and farmer field schools. Some 1.3 million Malawian smallholders have adopted agro-forestry by using local nitrogen-fixing trees and shrubs and increased maize yields from 1 tonne per hectare to 2-3 tonnes. Young men have gained employment rehabilitating degraded land through building tassas and zai planting pits in the West African Sahel.

Builds resilience co-construction and participatory research to improve local 'orphan' crops adapted for local conditions and climates are proving highly effective and adaptive to local growing conditions. Some 14,500 smallholders are benefiting from higher yields (up from 4.4 to 10 tonnes/hectare) and improved micro-nutrients in 19 new locally-adapted varieties of orange, sweet potato in Uganda and which can suit various local soil types and rainfall conditions. A pesticide-free and participatory-bred variety of tef (known as Quncho) has spread from 150 hectares to 50,000 hectares in four years through smallholder farmers' co-operatives and extension networks.

Has multiple benefits the revolutionary System of Rice Intensification (SRI) has spread via farmer-field schools, peasants' networks and led farmer field-based knowledge exchanges through

40 countries in Asia, Africa and Latin America. Substantial increases in yields and farm profits are achieved with 80-90% reductions in seed requirements, substantial reductions in the use of synthetic fertiliser and agrochemicals, and 25-50% less irrigation water.

Increases climate resilience a farmer-led organic composting, water harvesting and crop diversification approach in the arid and overgrazed Tigray region in Ethiopia has significantly increased yields for smallholders, increased climate resilience and brought multiple benefits to 18-20,000 small farmers and 100,000 poor beneficiaries, particularly female-headed households. Benefits include an improved hydrological cycle with raised water tables and permanent springs, improved soil fertility, rehabilitated degraded lands, increased incomes, increased biodiversity, and increased mitigation and adaptation to climate change. Zai pits, water harvesting, and agroforestry in Burkina Faso and Niger have re-greened 3 million hectares of land, restored soils, raised water tables and increased food production and climate resilience during dry spells.

Mitigates climate change agro-ecology can mitigate climate change by acting as a carbon sink and by reducing dependence on fossil fuels and other energy requirements, especially by reducing the use of nitrogen fertilisers. Ecological and organic agriculture reduces carbon dioxide emissions by between 48% to 60% and reduces energy requirements by 25-50% compared to conventional farming.

Empowers small-scale producers the active participation of small-scale farmers and producers is vital for the success of knowledge-intensive agro-ecology practices. Agro-ecology has been developed by grassroots peasants' groups and farmers' movements, and farmers' organisations, networks and co-operatives have demonstrated how they can rapidly 'scale up' successful agro-ecology initiatives from Brazil to Kenya and Cambodia, especially through forging links and developing trust with research institutions and extension bodies.

The United Nations Environment Programme (UNEP) suggests an additional investment of 0.16% of global GDP – equaling $198 billion – needs to be invested annually until 2050 in ecological agriculture, better storage, and smallholder-focused rural development to make a successful transition to an ecological agricultural system that will increase food availability to around 3,200 kcal per person per day by 2050 and be able to feed 9 billion people. FAO estimates it would cost $209 billion a year in such ecological approaches and rural development to achieve increases needed by 2050.

Conclusion

Beyond recognising informal and customary tenure rights and ensuring access to land, water, seeds, forests and fisheries for small-scale farmers, peasants and the landless in the face of an unprecedented modern-day land grab, governments have a key role to play in curbing the concentrated market power of multinational food and agribusiness corporations and in regulating food and agricultural markets.

Governments must also ensure key public goods, such as effective rural extension services, access to plant genetic resources and biodiversity, storage and transport facilities, rural infrastructure (roads, electricity, information and communications technologies), access to local

and regional markets, affordable credit and crop insurance, and smallholder-focused agricultural research and development, rural education and support to farmers' organisations and cooperatives.

Recommendations

Over 1,400 civil society organisations from 32 countries in the International Food Security Network (IFSN) and partner organisations such as the Indonesia Peasant Union (SPI), the Sungi Development Foundation, and the Centre d'Etude et de Development Agricole Cambodian (CEDAC) are calling for major new investment and support to scale-up smallholder-focused agro-ecology and ecological agriculture to help tackle poverty, hunger and climate change. We urge the world leaders to:

Support and strengthen small-scale farmers', peasants' and producer groups and cooperatives to enable them to further advocate for and scale-up agro-ecology and ecological approaches

Make reference and incorporate agro-ecology and ecological agriculture into comprehensive national strategies for the realisation of the right to food and ensure they are devised through the participation of small-scale producers and civil society stakeholders and that they prioritise the needs of women and men small-scale producers.

Ensure references to agro-ecology and ecological agriculture are included in the agriculture sector of national adaption plans of action (NAPAs) and in the list of nationally appropriate mitigation actions (NAMAs) adopted by countries to tackle climate change.

Significantly increase and re-orientate public spending in agriculture towards agro-ecology and ecological agriculture and towards the provision of public goods, such as small-scale focused extension services, agricultural research and rural infrastructure.

Support participatory research and plant breeding that combines indigenous and traditional knowledge with science and modern technology. Include schemes designed specifically for women and support its dissemination through existing farmers' organisations, movements and networks.

Phase out input subsidy schemes for agro-chemicals (such as fertilisers and pesticides) in favour of subsidies to promote ecological agriculture.

Photo: Hillol Sobhan / IFSN

Unprecedented pressures

Agriculture is at a crossroads. For almost three decades, investment in agriculture in poorer countries has been desperately low and insufficient, and - directly related to this - development assistance declined steadily to reach its lowest point in 2006. OECD aid to agriculture declined from 20% of official development assistance in 1979 to just 3.7% in 2006, when global aid for agriculture totaled only around $5.7 billion a year.[1]

But this neglect appears to be changing and the trends reversing. Global aid to agriculture has picked up slightly to $9.1 billion in 2008-9[2] and foreign direct investment in agriculture went from an average of $600 million annually in 1989-1991 to an average of $3 billion in 2005-2007.[3] The shock of the 2007-2008 food price crisis led to the establishment or strengthening of further government-led initiatives, such as the L'Aquila Food Security Initiative, the Global Agriculture and Food Security Program (GAFSP) or NEPAD's Comprehensive Africa Agriculture Development Programme (CAADP).

Governments worldwide have pledged to reinvest massively in agriculture over the last few years, and this is welcome news. But as the UN Special Rapporteur on the Right to Food, Olivier De Schutter, says 'the key question is not only *how much,* but *how.'*[4]

The choice between agricultural development models has immediate and long-term consequences and the question of who produces the world's food and who will have secure access to it are central.

This crossroad moment for agriculture, of course, is characterised by more than a gradual reversal of historically low investment. The combined effects of climate change, energy scarcity and water paucity now demand that we radically rethink our agricultural systems.

Business as usual will not do. An unprecedented combination of pressures is emerging to threaten the health of existing social and ecological systems.[5] Across the world, continued population growth, urbanisation, income growth, changing consumption patterns, stagnant yields, demand for land, feed, and biofuels, and the profound impact of climate change, biodiversity loss and

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environmental degradation are driving limited resources of food, energy, water and materials towards critical thresholds.[6]

The UN Environment Programme (UNEP) warns that the combined effects of climate change, land degradation, cropland losses, water scarcity and species infestations may cause projected yields to be 5-25% short of demand by 2050.[7]

By 2080, 600 million additional people could be affected by malnutrition as a direct result of climate change, and drought-affected areas in sub-Saharan Africa could expand by 60–90 million hectares.[8]

The stresses in the food system are evident today. The devastating food price spike of 2007-2008 and the surge in food prices to record levels in early 2011 portend rising and more frequent threats to global food security.[9] The International Food Policy Research Institute (IFPRI) estimate that real prices could increase by 59% for wheat, 78% for rice and 106% for maize by 2050, and volatile and rising food prices, they say, reflect the 'relentless underlying pressures on the world food system', driven by population, income growth and by reduced productivity.[10]

And it is abundantly clear that the current food and distribution system is failing to feed the world adequately and denies hundreds of millions their full enjoyment of the right to food. Despite there being enough food available today to feed everyone (currently some 2,800 Kcal per person per day),[11] the total number of hungry people in 2010 was estimated at 925 million – more than it was 40 years ago – with 578 million hungry in Asia and the Pacific, and 239 million in sub-Saharan Africa.[12] About another billion people also suffer from 'hidden hunger' and micronutrient deficiency – where they lack essential micro-nutrients such as vitamin A, iron, zinc, or iodine[13] – because of poor and un-nutritious diets caused by poverty, inequality or a lack of access to nutritious food or the means to buy or produce it. Conversely, over-consumption and fatty, sugary, and over-nutritious diets mean that about 1.5 billion people are now overweight and obese worldwide.[14]

Unprecedented challenge

With the population projected to rise to 9.3 billion by 2050,[15] experts say global demand for cereals could increase by 70% by then, and by almost 100% in developing countries.[16] If trends continue, demand for animal feed will increase by 42 per cent of the total cereal demand increase and more meat will be consumed, rising from 37.4 kg per person a year in 2000 to 52 kg per person by 2050. To meet demand, the global population of bovine animals is projected to increase from 1.5 to 2.6 billion animals by 2050, and poultry numbers will more than double.[17]

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In addition, demand for biofuels is set to explode. The International Energy Agency projects that biofuels could provide 27% of total global transport fuel by 2050 (up from 3% at present) and contribute in particular to the replacement of diesel, kerosene and jet fuel.[18] Overall, it is estimated that a staggering 100-650 million hectares of biofuels may be needed to meet projected global demand by 2050.[19]

At the same time, supply constraints are intensifying. Climate change is projected to hit yields of rain-fed agriculture in some African countries by 50% by 2020[20] and by 30% in central and south Asia by 2050. A recent IFPRI analysis of climate change impacts on agriculture to 2050[21] indicated dramatic negative effects on productivity, with reduced food availability and human well being in all developing regions.[22]

Water depletion and soil degradation are now major threats and constraints, too. Agriculture already accounts for 70% of all freshwater withdrawals from rivers and aquifers, and in arid regions, non-renewable fossil aquifers are being depleted and over-pumped, and cannot be replenished, such as in Egypt, Libya and the Punjab.[23] Demand for water for agriculture could rise by over 30% by 2030 and total global water demand could double by 2050 owing to pressures from industry and urbanisation.[24]

The impact of high input agriculture means that degraded soils are a huge problem. About 2 billion hectares of the world's agricultural land is now degraded from deforestation, salinisation and inappropriate farming practices,[25] and 1.5 billion people depend on ecosystems that are undergoing degradation.[26]

However, in most developing countries there is little room for expansion of arable land. Virtually no spare land is available in South Asia and the Near East/North Africa, and where land is available, in Sub-Saharan Africa and Latin America, more than 70% suffers from soil and terrain constraints.[27]

Access to food

Entrenched poverty, growing inequality and inadequate access to food and resources are the great barriers to achieving the right to food for all. Most people are hungry not because there is too little food available, but because they are too poor to buy the food that is available.[28] Ensuring greater access to food – the ability to produce or purchase food – highlights the central role of poverty reduction in the fight against hunger and depravation. Poverty and food insecurity are still mostly concentrated in rural areas, where people depend directly or indirectly on agriculture,

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fisheries or forestry for their incomes as well as their food. Reducing rural poverty and improving rural livelihoods can also stem urbanisation and increased urban poverty.[29]

Reducing hunger and malnutrition starts with much fairer access to resources, employment and incomes in rural areas. Agriculture, especially smallholder and family farms, can play a key and catalytic role in the improvement of rural livelihoods. Around 500 million small farms in developing countries face a variety of resource limitations – such as extremely poor access to land, forests, water and other natural resources, and weak land and tenure rights – that result in insufficient access to food and nutrition.[30] Many of these smallholders are women, who face additional constraints due to discrimination and cultural factors and unequal access to productive resources compared with men.[31]

Only bold action and sustained efforts to democratise and rebuild food systems taken by leaders on multiple fronts – such as at the UN Rio+20 'Earth Summit' – will ensure that we can increase access to food and feed the world, and future generations, fairly, sustainably and equitably, and with the world's natural resources, forests, and biodiversity preserved and enhanced.

Agro-ecology – or sometimes also known as ecological agriculture or sustainable agriculture – offers principles, methods and tools that can help us develop new, dynamic and locally-adaptable models of agricultural development to meet these multiple challenges, and recent research shows that it is highly productive and holds great promise for the roughly 500 million food-insecure households around the world.[32]

While reducing chronic food waste (a third of all food for human consumption is currently lost, spoiled or wasted worldwide)[33] and tackling over-consumption and the diversion of enormous quantities of grains for animal feed and biofuels away from human consumption is absolutely essential, this must be coupled with major new support for women and men smallholder farmers and producers and a paradigm shift towards climate-resilient ecological agriculture to enable us sustainably to confront poverty, hunger and climate change challenges head on.

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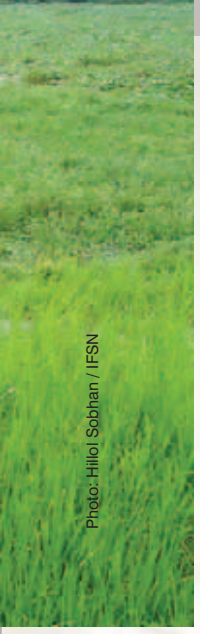

Photo: Hilol Sobhan / IFSN

Agriculture matters

Smallholders and peasants play a vital role in global food systems, producing more than half of the world's food supply,[34] and 80% of the food supply in developing countries.[35] Three out of four poor people in developing countries live in rural areas and agriculture is a source of livelihoods for an estimated 86% of rural people. It provides jobs for 1.3 billion smallholders and landless workers, 'farm-financed social welfare' during urban shocks, and a foundation for viable rural communities. Of the developing world's 5.5 billion people, 3 billion live in rural areas. Of these rural inhabitants an estimated 2.5 billion are in households involved in agriculture, and 1.5 billion are in smallholder households.[36]

It is ironic and doubly sad then that half of all undernourished people, three-quarters of malnourished African children and the majority of people living in absolute poverty are found on small farms.[37]

But increasing food production and pouring money into agriculture will not be sufficient. What is most important is to take steps that facilitate the transition towards a highly adaptive, low-carbon, resource-preserving type of agriculture that specifically benefits the poorest farmers through higher incomes and improved access to safe and nutritious food.[38] This will only happen by choice and design, through strategies and programmes backed by strong political will, involving the meaningful participation of smallholder farmers and peasants' and producer organisations and informed by a right-to-food approach.

However, too much of the current policy debate on food security, climate change and agriculture assumes that high-external-input industrial agriculture and related biotechnology and chemical packages are the best and only options for feeding a growing global population. The concentrated power of extremely powerful agribusiness and agrochemical corporations have created and maintain this image through aggressive advertising, lobbying and support for research institutions, universities, governments and multilateral organisations.[39]

Stagnant yields

The Green Revolution – initially developed in Mexico and then in South Asia and spreading further beyond to Latin America in the 1960s, and based on high yielding varieties of wheat, rice and maize, irrigation, and the extensive use of expensive synthetic fertilisers and pesticides – succeeded in improving yields in the breadbasket regions where it was implemented. Between 1975 and 2000, for example, cereal yields in South Asia increased by more than 50%, while poverty declined by 30%.[40]

But the productivity gains were not always sustainable in the longer term and they often came at a high social and environmental cost, including the depletion of soils, pollution of groundwater, high

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household debts, and increased inequalities among farmers.[41] The extensive use of mono-cropping also led to a disastrous erosion of biodiversity, exacerbating trends which have seen about 75% of plant genetic resources lost over the past century. Alarmingly, if trends continue a third of today's diversity could disappear by 2050.[42]

So where will improved incomes, enhanced biodiversity, and greater access to safe and nutritious food for poor, hungry and marginalised communities come from? Just as demand is intensifying, agricultural yields are plateauing and stagnating. Since the 1950s, the growth of agricultural production has been based largely on the growth of yields per hectare. Since then, the total cultivated area grew relatively little, from 1.4 billion to 1.5 billion hectares between 1950 and 2005, and yet production increased at a rate unprecedented in human history; crop yields grew by 115% in the period between 1967 and 2007.[43]

Experts warn that much of this growth, however, has been closely linked to the increased and unsustainable use of agro-chemicals and synthetic fertilisers, and much of it since 2000 is very closely correlated to increases in the use of nitrogen fertilisers.[44]

Currently, actual yields for rice in China, India and Indonesia and for wheat in Mexico have reached about 80% of their yield potential, and experts say the situation is particularly acute for rice, where yield trends show evidence of stagnation in several Asian regions.[45]

Annual growth in wheat yields slipped from about 5% a year in 1980 to 2% in 2005; yield growth in rice and maize fell from more than 3% to around 1% in the same period.[46] As such, FAO say the overall rate of growth in agricultural production is expected to fall to 1.5% between now and 2030 and further to 0.9% between 2030 and 2050, compared with 2.3% per year since 1961.[47]

What is urgently required is major reinvestment to increase sustainable production where three quarters of poor people actually live and work - in often remote, marginal, impoverished rural communities, and on 500 million small farms of less than two hectares[48] - to truly tackle poverty, build adaptive climate resilience, rebuild healthy soils, and ensure access to safe and nutritious food.

This shift must occur using less energy and fewer green house gas emissions (GHG), and it must be considerably more water efficient. It must increase biota and organic matter to replenish degraded or depleted soils, and it must actively enhance biodiversity and focus on the neglected needs of women, because agriculture is now the main economic activity of between 48-79% of women worldwide,[49] and more than 70% of smallholders in sub-Saharan Africa are women.[50]

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41. De Schutter, (2011) *The new green revolution: How twenty-first-century science can feed the world*, The Solutions Journal, Vol 2, Issue 4, August 2011
42. FAO (2011) *Save and grow - A policymaker's guide to the sustainable intensification of smallholder crop production*, Rome: FAO
43. UK government (2011) *Foresight. The future of food and farming*, London: UK Government Office for Science
44. HLPE (2011) *Price volatility and food security*, Rome: High Level Panel of Experts to the Committee on World Food Security (HLPE)
45. HLPE (2011) *Price volatility and food security*, Rome: High Level Panel of Experts to the Committee on World Food Security (HLPE)
46. FAO (2009) *Feeding the world, eradicating hunger*. Background document for World Summit on Food Security, Rome, November 2009. Rome: FAO
47. 'Farming must change to feed the world', FAO press release, 4 February 2009
48. Nagayets, O (2005) *Small farms: Current status and key trends*, Information brief prepared for the Future of Small Farms, Research workshop, Wye College, June 26-29, 2005. International Food Policy Institute (IFPRI), 2020 Vision Initiative and Overseas Development Institute (ODI)
49. FAO (2011) *The state of food and agriculture, Women in agriculture: Closing the gender gap for development*, Rome: FAO
50. UNEP (2012) *Towards a green economy, Pathways to sustainable development and poverty eradication*, Nairobi: UNEP

Effective alternatives

Since 2008 some major reinvestment efforts have been channeled into a slightly modified version of the Green Revolution without fully considering the previous impacts of such approaches and the other great contemporary challenge of climate change. In contrast, little attention has been paid to the most cutting-edge ecological farming methods – approaches that improve food production and farmers' incomes and livelihoods, while also protecting the soil, water, and environment, and with a very low carbon footprint.

Highly effective alternatives do exist, but the best options are simply not being promoted sufficiently by leaders at the highest political levels.

That said, the evidence and results speak for themselves, and an increasingly wide range of high-level reports and exhaustive scientific assessments endorse the multiple benefits of smallholder-based ecological agriculture, including from the UN Food and Agriculture Organization (FAO),[51] the UN Environment Programme (UNEP),[52] the UN Conference on Trade and Development/UNEP,[53] and the UN/World Bank-sponsored International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD).[54]

The five-year IAASTD global assessment involved 400 scientists, experts and 900 multi-stakeholders and concluded that current fossil-fuel-based agricultural practices have led to serious degradation of land, water, biodiversity and eco-systems, and called for a radical paradigm shift towards smallholder-based agro-ecology – or ecological agriculture – with a particular focus on those least served by previous approaches, such as resource-poor farmers, women and ethnic minorities.[55]

51. See: FAO (2011) *Save and grow - A policymaker's guide to the sustainable intensification of smallholder crop production*, Rome: FAO; or Niggli U et al(2009) Low greenhouse gas agriculture, mitigation and adaptation potential of sustainable farming systems, Rome: FAO
52. See UNEP (2012) *Towards a green economy, Pathways to sustainable development and poverty eradication*, Nairobi: UNEP; and UNEP (2009) *The environmental food crisis*, Nairobi: UNEP
53. UNEP-UNCTAD (2008) *Organic agriculture and food security in Africa*, New York and Geneva: UNEP/UNCTAD
54. IAASTD (2008) *Agriculture at a crossroads*, International Assessment of Agricultural, Knowledge, Science and Technology for Development, Washington DC: IAASTD
55. IAASTD (2008) *Agriculture at a crossroads*, International Assessment of Agricultural, Knowledge, Science and Technology for Development, Washington DC: IAASTD

What is agro-ecology?

Agro-ecology is the application of ecological science to the study, design, and management of sustainable agriculture.,[56,57] It is both a science and a set of tools and practices, and it is based on these five ecological principles.

- Recycling biomass and balancing nutrient flow and availability
- Securing favorable soil conditions for plant growth through enhanced organic matter
- Minimising losses of solar radiation, water, and nutrients through micro-climate management, water harvesting, and soil cover
- Enhancing biological and genetic diversification on cropland, and
- Enhancing beneficial biological interactions and minimising the use of pesticides.[58]

As a set of agricultural practices, agro-ecology seeks ways to enhance agricultural systems by mimicking natural processes, thus creating beneficial biological interactions among components of the agro-ecosystem.

The main principles include recycling nutrients and energy on the farm, rather than introducing external inputs; integrating crops and livestock; diversifying species and genetic resources in agro-ecosystems over time and space; and focusing on interactions and productivity across the agricultural system, rather than focusing on individual species.[59]

Agro-ecology is highly knowledge-intensive and context specific, and is based on techniques that are not delivered top-down but are co-constructed and co-developed by farmers and researchers and scientists on the basis of farmers' indigenous and traditional knowledge and experimentation in diverse local ecological contexts.

Prof Jules Pretty, a prominent academic on ecological agriculture, highlights seven main approaches:[60]

1. **Integrated pest management (IPM),** which uses ecosystem resilience and diversity for pest, disease and weed control, and seeks only to use pesticides when other options are ineffective.
2. **Integrated nutrient management,** which seeks both to balance the need to fix nitrogen within farm systems with the need to import inorganic and organic sources of nutrients, and to reduce nutrient losses through erosion control.
3. **Conservation tillage,** which reduces the amount of tillage, sometimes to zero, so that soil can be conserved and available moisture used more efficiently.
4. **Agroforestry,** which incorporates multifunctional trees into agricultural systems, and collective management of nearby forest resources.
5. **Aquaculture,** which incorporates fish, shrimps and other aquatic resources into farm systems, such as into irrigated rice fields and fishponds, and so leads to increases in protein production.

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56. Altieri, M (1995) *Agroecology: The science of sustainable agriculture*, 2nd edition, Westview Press, Boulder, CO
57. Gliessman, S, (1998) *Agroecology: Ecological processes in sustainable agriculture*, Ann Arbor Press, Chelsea, MI
58. Altieri, M (2002) *Agroecology: the science of natural resource management for poor farmers in marginal environments*, Agriculture, Ecosystems and Environment 1971, 1-24 (2002)
59. De Schutter (2010) *Report submitted by the Special Rapporteur on the right to food*, Olivier De Schutter, Human Rights Council sixteenth session, agenda item 3, A/HRC/16/49
60. Petty, J (2008) *Agroecological approaches to agricultural development*, Background paper for the *World Development Report 2008*, Washington: World Bank

Photo: Hillol Sobhan / IFSN

6. **Water harvesting in dry land areas,** which can mean formerly abandoned and degraded lands can be cultivated, and additional crops grown on small patches of irrigated land owing to better rainwater retention.

7. **Livestock integration into farming systems,** such as dairy cattle, pigs, and poultry, including using zero-grazing cut and carry systems.

In summary, Prof Pretty says an ecological production system would exhibit most or all of the following attributes:[61]

i. Utilising crop varieties and livestock breeds with a high ratio of productivity to use of externally- and internally-derived inputs.

ii. Avoiding the unnecessary use of external inputs.

iii. Harnessing agro-ecological processes such as nutrient cycling, biological nitrogen fixation, allelopathy, predation and parasitism.

iv. Minimising use of technologies or practices that have adverse impacts onthe environment and human health.

v. Making productive use of human capital in the form of knowledge and capacity to adapt and innovate, and social capital to resolve common landscape-scale problems.

vi. Quantifying and minimising the impacts of system management on externalities such as greenhouse gas emissions, availability of clean water, carbon sequestration, biodiversity, and dispersal of pests, pathogens and weeds.

Such approaches also contribute to the delivery and maintenance of a range of valued public goods, such as clean water, carbon sequestration, flood protection, groundwater recharge and landscape amenity value.[62]

61. Pretty, J (2011) *Foresight project on global food and farming futures, Synthesis report C9: Sustainable intensification in African agriculture – analysis of cases and common lessons*, London: UK government, Office for Science

62. Pretty, J (2011) *Foresight project on global food and farming futures, Synthesis report C9: Sustainable intensification in African agriculture – analysis of cases and common lessons*, London: UK government, Office for Science

Benefits of agro-ecology

Agro-ecology increases yields

Today, ecological agriculture has successful applications on all continents. The widest study conducted on these approaches, led by Prof Jules Pretty of the University of Essex, compared the impacts of 286 recent ecological agriculture projects in 57 poor countries covering 37 million hectares (3% of the cultivated area in developing countries).

They found such interventions increased productivity on 12.6 million farms, with an average crop yield increase of 79%, while also improving the supply of important environmental services.[63]

Disaggregated data from this research showed that average food production per household rose by 1.7 tonnes per year (up by 73%) for 4.42 million small farmers growing cereals and roots on 3.6 million hectares, and that increase in food production was 17 tonnes per year (up 150%) for 146,000 farmers on 542,000 hectares cultivating root crops (cassava, potato and sweet potato).[64] All crops in the study showed water use efficiency gains, and of the projects with pesticide data, 77% resulted in a decline in pesticide use by 71% while yields grew by 42%.[65]

This database of 286 projects was then re-analysed by United Nations Conference on Trade and Development (UNCTAD) and UNEP to produce a summary of the impacts of 114 organic and agro-ecology projects in Africa. Based on the principles of local adaption by smallholders and continuous experimentation and readjustment, they found average crop yields were even higher than the global average of 79% and increased by 116% for all African projects, and showed an increase of 128% for projects in East Africa.[66]

The UNCTAD/UNEP study also focused on 15 cases from Africa and found multiple benefits for smallholders, food and nutrition availability, and the environment – leading to a buildup of natural, human, social, financial and physical capital in farming communities. They found:[67]

63. Pretty J et al (2006), *Resource-conserving agriculture increases yields in developing countries*, Environmental Science and Technology, 40:4, 2006, pp.1114-1119. The 79% figure refers to 360 reliable yield comparisons from 198 projects. Some 25% of these projects reported a 100% increase or more.
64. De Schutter (2010) *Report submitted by the Special Rapporteur on the right to food*, Olivier De Schutter, Human Rights Council sixteenth session, agenda item 3, A/HRC/16/49
65. Pretty J et al (2006), *Resource-conserving agriculture increases yields in developing countries*, Environmental Science and Technology, 40:4, 2006, pp.1114-1119.
66. UNCTAD/UNEP (2008) *Organic agriculture and food security in Africa*, New York/Geneva: UNCTAD/UNEP
67. UNCTAD/UNEP (2008) *Organic agriculture and food security in Africa*, New York/Geneva: UNCTAD/UNEP

An increase in food availability and improved nutrition higher yields led to greater access to food throughout the year and more diverse sources of food led to increased nutritional security for children and all members of the farmer household

Increase in household income organic and ecological agriculture had a positive impact on reducing poverty, with smallholders saving money through less fertiliser and pesticide use, extra income from selling surpluses, and adding value through processing

Increase in education, skills, health all farmers gained increased knowledge of ecological methods, health benefits from more nutritious food, and greater resilience to external threats such as droughts, floods and landslides

Benefits to community the formation of farmers' groups and co-operatives lowered costs and increased knowledge and trust amongst farmers

Infrastructure improvements 40% reported improvements to physical infrastructure (e.g. transport and communications) and greater access to markets

Benefits to natural environment all but one of the cases reported benefits to soil fertility, water retention and supply, flood control and biodiversity.

Agro-ecology improves food and nutrition security

The UNCTAD/UNEP study, for example, highlights that 12,500 farm households in drought-prone Cheha in Ethiopia have benefited from ecological agriculture on 5,000 hectares of land by introducing new types of crops (vegetables) and trees (fruit and forest), organic manure for soil fertility, natural pest controls and affordable veterinary services. This has resulted in a 60% increase in crop yields and a 70% improvement of overall nutrition levels, and the area – which was once entirely reliant on emergency food aid – now produces a food surplus.[68]

The most recent large-scale study draws similar conclusions. Research for the UK Government's Foresight Global Food and Farming Futures project in 2011 reviewed 40 ecological agriculture projects in 20 African countries where ecological agriculture was adopted at scale in the 2000s. Projects included participatory plant breeding on hitherto neglected 'orphan' crops (such as cassava, plantain, sweet potato, tef and pigeon pea), soil conservation, integrated pest management (IPM), aquaculture, livestock and fodder crops, and agro-forestry. By early 2010, these 40 projects documented benefits for 10.4 million farmers and their families, and improvements on approximately 12.8 million hectares. Crop yields more than doubled on average – by a factor of 2.13 – over a period of 3-10 years, resulting in an increase in aggregate food production of 5.79 million tonnes per year, which is equivalent to 557 kg per farming household.[69]

The effect of boosting yields like this can be significant. On average, the contribution of agriculture to raising the incomes of the poorest is estimated to be at least 2.5 times higher than that of non-agriculture sectors in developing countries. Underscoring the relationship between increasing yields and return on labour with poverty, it is estimated that for every 10% increase in farm yields, there was a 7% reduction in poverty in Africa and more than a 5% poverty-reduction effect for Asia.[70]

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68. UNCTAD/UNEP (2008) *Organic agriculture and food security in Africa*, New York/Geneva: UNCTAD/UNEP
69. Pretty, J (2011) *Foresight project on global food and farming futures, Synthesis report C9: Sustainable intensification in African agriculture – analysis of cases and common lessons*, London: UK government, Office for Science
70. UNEP (2012) *Towards a green economy, Pathways to sustainable development and poverty eradication*, Nairobi: UNEP

Photo: SDF Pakistan

Case study 1 Allai Valley, Pakistan

An ecological and organic agriculture-focused initiative to rehabilitate the remote and rugged earthquake-hit Allai Valley near the Karakorum Highway in the Pakistani Himalayas has transformed the environment, food security, livelihoods and social relations of 172,000 poor inhabitants of this mountain valley since 2007.[71]

The highly-mountainous Allai Valley in Battagram in northern Pakistan was devastated by a powerful earthquake in 2005, and much of the destruction was exacerbated by environmental degradation – such as soil erosion and deforestation caused by illegal logging – which led to widespread and lethal landslides during the earthquake.

Against a backdrop of extremely high rates of poverty, deprivation and food insecurity, and traditionally governed along feudal lines and by powerful clerics and under an especially strict version of Sunni Islam (many women were secluded through purdah and not allowed to visit relatives, for example), the Partnership for Recovery and Development of Allai (PRDA) worked through the Sungi Development Foundation to set up a village-based movement to help repair and reforest the valley and to diversify livelihoods and food security options through an integrated range of low-cost ecological-based agricultural systems and approaches.

Working through a new network of 437 both male and female-governed village committees, thousands of men and significantly women smallholders improved their ecological and organic farming skills and knowledge through on-farm demonstration plots and thousands of ecological farming skills training sessions and farmer-to-farmer knowledge visits and exchanges.[72]

Moving away from simply mono-cropping rice and wheat and transporting key produce and vegetables into the Allai Valley, the villagers set up 35 women-managed local-variety seed banks and learnt to use cow-dung and yeast-based bio-fertilisers and local wood-ash, tobacco and chilli-based bio-pesticides to diversify into growing year-round organic vegetables in home gardens and for markets to generate income (such as broccoli, spinach, turnip, potatoes, tomatoes, okra, French beans and peas).

They also revived traditional and pesticide-free wild honeybee keeping, established fruit orchards, agro-forestry, poultry-rearing and peasantries, introduced Mott grass as fodder, replanted over a million native and soil-binding trees, tidied up 10 food bazaar markets, set up the fair trade-based Sungi Organics private enterprise

71. Sungi (2011) Project completion report, Partnership for recovery and development of Allai (PRDA), Environment, Livelihoods and Sanitation sectors, January 2007 to March 2011, Submitted to Save the Children US, June 2011 (available on request)

72. Sungi (2011) Project completion report, Partnership for recovery and development of Allai (PRDA), Environment, Livelihoods and Sanitation sectors, January 2007 to March 2011, Submitted to Save the Children US, June 2011 (available on request)

and moved into organically-certified commercial horticulture and floriculture (such as brinjal, walnuts, garlic and gladiolus) and coaxed others out of illegal logging and into growing high-value crops, and reduced the previously endemic use of cutting down local torchwood for lighting and firewood by establishing 18 micro hydro-electric generators to supply electricity after dark.

The initiative has had a remarkable impact. Most significantly, the emergence of thousands of poor and secluded women into the governance structures and participatory development of the Allai Valley has been radically transformative for social and cultural relations. Farm profits and productivity, food security, nutrition, health and education outcomes, employment opportunities, livelihoods, the environment and soil health have all improved considerably, according to recent assessments of the PRDA.[73] Vegetable cultivation has expanded by 1,000 acres in the valley, 80% of households now cultivate their own vegetables, and maize and rice yields have increased by 15-20% under improved organic methods, according to the Sungi Development Foundation.[74]

Agro-ecology reduces rural poverty

Seemingly minor innovations can provide large returns, and help reduce rural poverty and boost employment. In East Africa, farmers and researchers devised and co-constructed the 'push-pull' integrated pest management (IPM) strategy to control parasitic stemborer insects and parasitic Striga weeds that damage the crops.

The technique involves intercropping locally-available silver leaf Desmodium, a fodder legume, with maize and Napier grass to provide both immediate and long- term benefits. Semiochemicals produced by the Desmodium roots repel (push) devastating pests like the maize stemborer, while scents produced by the grass attract (pull) the stemborer moths and encourage them to lay eggs in the Napier grass instead of in the maize.

Napier grass planted on the perimeter of the field produces a gummy substance that traps the stemborer larvae so, once they hatch, only a few survive to adulthood, thus reducing their numbers. Desmodium also produces chemicals that stimulate germination of parasitic Striga weed seeds, but then prevents them from attaching successfully to maize roots. The Striga eventually dies and the number of Striga seeds in the soil is also reduced. Besides being a excellent ground cover, *Desmodium* provides high-value fodder for livestock and it is a nitrogen-fixing legume (fixing up to 100kg of nitrogen per hectare per year) that improves soil moisture retention and organic soil content matter.

Increased fodder gained under the push-pull system increases income-generating milk production and the approach more than doubles maize grain yields from below 1 to 3.5 tonnes per hectares in East Africa. The system increases biodiversity and reduces pesticide use, and improves soil fertility through nitrogen fixation, natural mulching, improved biomass and control of erosion.[75]

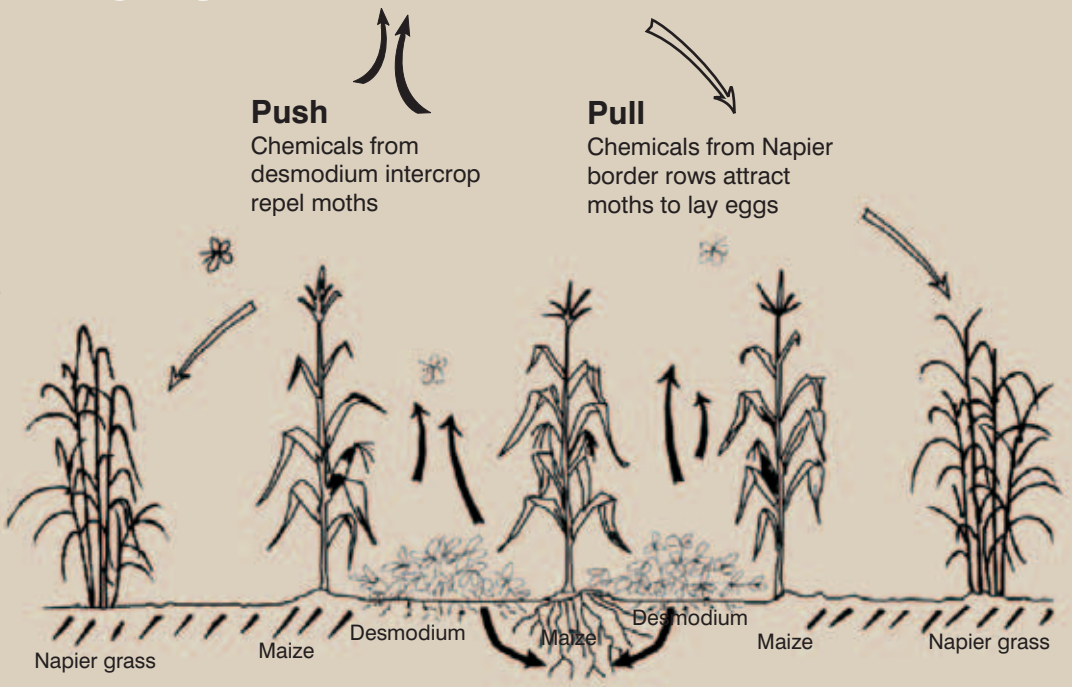
An economic analysis of a push-pull field trial in East Africa with 21,300 small farmers revealed a benefit-cost ratio of 2.5 to 1. Income returns for labour were $3.7 per person a day with push-pull as opposed to US$1 per person a day with their previous maize mono-cropping practice. Gross revenues ranged between $424-US$880 per hectare under push-pull and $81.9 to $132 per hectare in maize mono-cropping.[76]

73. Sungi Development Foundation (2011) Project completion report, Partnership for recovery and development of Allai (PRDA), Environment, Livelihoods and Sanitation sectors, January 2007 to March 2011, Submitted to Save the Children US, June 2011 (available on request)
74. Personal communication with Nasir Khan, executive director of Sungi Development Foundation, 21 May 2012
75. Khan Z et al (2011) *Push—pull technology: a conservation agriculture approach for integrated management of insect pests, weeds and soil health in Africa*, International Journal of Agricultural Sustainability
76. UNEP (2012) *Towards a green economy, Pathways to sustainable development and poverty eradication*, Nairobi: UNEP

How Push-Pull Works

Push-Pull is a novel approach in pest management that uses a repellent intercrop and an attractive trap plant. Insect pests are repelled from the food crop and are simultaneously attracted to a trap crop. Maize is intercropped with a legume, silverleaf desmodium (*Desmodium uncinatum*), and napier grass (*Pennisetum purpureum*) is planted around the intercrop. Both plants provide quality fodder for livestock. Therefore, farmers using Push-Pull technology for pest control not only reap three harvests (maize, napier grass and desmodium), they also dramatically reduce the devastating effects of the parasitic weed *Striga hermonthica* through the effects of desmodium.

Source: www.push-pull.net



Push-pull has been adopted by 30,000 smallholder farmers over the last decade in Kenya, Uganda and Tanzania on 15,000 hectares, and it is envisaged that another 100,000 households could benefit over the next five years as it spreads by means of town hall meetings, radio broadcasts and farmer field schools.[77]

In Japan, smallholder farmers found that ducks and fish were as effective as pesticide for controlling insects in rice paddies, while providing valuable protein for their families. The ducks eat weeds, their seeds, insects and other pests, and thereby reducing weeding labour – which was otherwise done by hand by women – and the duck droppings provide useful plant nutrients.[78] The approach has been adopted in China, India and the Philippines, and in Bangladesh the International Rice Research Institute reports 20% higher crop yields and net incomes have increased by 80% on a cash cost basis.[79]

And agro-ecology is also gaining ground in Malawi, where the introduction of agro-forestry and nitrogen-fixing trees and shrubs has improved soil fertility and seen maize yields increase significantly from 1 tonne per hectare to 2-3 tonnes per hectare.[80]

By enhancing on-farm fertility production, ecological approaches like agro-forestry reduce farmers' reliance on external inputs and state fertiliser subsidies, make smallholders less dependent on local retailers and moneylenders, and allow more income to be spent on food, health and education.[81]

77. Khan Z et al (2011) *Push—pull technology: a conservation agriculture approach for integrated management of insect pests, weeds and soil health in Africa*, International Journal of Agricultural Sustainability
78. De Schutter (2010) *Report submitted by the Special Rapporteur on the right to food*, Olivier De Schutter, Human Rights Council sixteenth session, agenda item 3, A/HRC/16/49
79. Van Mele P et al (2005) *Integrated rice-duck: a new farming system for Bangladesh, Innovations in rural extension: case studies from Bangladesh*, Oxfordshire, UK/Cambridge, USA: CABI publishing
80. Garrity D et al (2010) *Evergreen agriculture: a robust approach to sustainable food security in Africa*, Food Security, Food Security (2010) 2:197–214
81. De Schutter (2010) *Report submitted by the Special Rapporteur on the right to food*, Olivier De Schutter, Human Rights Council sixteenth session, agenda item 3, A/HRC/16/49

By mid 2009, more than 120,000 poor Malawian farmers had received materials and participated in training in the traditional practice of intercropping Acacia species Faidherbia alibida canopy trees and Gliricidia coppice shrubs in amongst maize, and of introducing short-lived leguminous shrubs such as Sesbania sesban and Tephrosia candida to improve soil fertility during fallow periods. Support from Ireland has enabled the extension of the programme to 40% of Malawi's districts, benefiting 200,000 households and 1.3 million of the poorest people.[82]

In addition to increasing soil fertility and crop yields, these agro-forestry systems were observed to suppress weeds, improve water filtration, and increase the amount of soil carbon. There is also evidence that agro-forestry systems that incorporate Gliricidia, Tephrosia, Faidherbia and other leguminous cover crops assist rural populations to adapt their agriculture to the adverse effects of climate change. Research and farmer interviews indicate that these systems increased the grain harvest during serious droughts. Smallholders obtained at least a modest yield during drought seasons while farmers not using these practices experienced crop failure.[83]

Finally, many of these ecological approaches tend to require more labour inputs than conventional farming (e.g. from comparable levels to as much as 30% more), creating jobs in rural areas and a higher return on labour inputs. This is especially important for poorer countries, where large numbers of poor people continuously leave rural areas in search of jobs in cities and growing proportions of young people are imposing enormous pressures for job creation. The UNEP estimates that proper and sustained investment in ecological agriculture could create 47 million additional jobs over the next 40 years.[84]

Case study 2 Women gain from agro-ecology in Bangladesh [85]

Thousands of poor men and marginalised women have benefited considerably under a grass-roots scheme to tackle poverty and hunger through ecological agriculture in Bangladesh.

The Food Security for Sustainable Household Livelihoods project (FoSHoL) targeted 21,656 resource-poor and marginal farm households over five years to mid 2009 in six poor and remote districts of Bangladesh.[86]

Participant households were organised into 813 village-based Sustainable Livelihood groups, which received training and support to transform into village-based farmers' organisations. Each group comprised 20-30 participating households, 60% of which were represented by women.

The self-organised village-level FoSHoL groups engaged in skills training and carried out a range of integrated activities and ecological farming approaches to help boost production, raise incomes, lower costs, improve soils, increase climate resilience and disaster-preparedness, and gain better access to local markets.

Poor women in particular increased their mobility, earnings and access to employment, and their household and wider social self-confidence improved markedly.

82. Garrity D et al (2010) *Evergreen agriculture: a robust approach to sustainable food security in Africa*, Food Security, Food Security (2010) 2:197–214
83. Garrity D et al (2010) *Evergreen agriculture: a robust approach to sustainable food security in Africa*, Food Security, Food Security (2010) 2:197–214
84. UNEP (2012) *Towards a green economy, Pathways to sustainable development and poverty eradication*, Nairobi: UNEP

Photo: Amiruzzaman / ActionAid

"We have found the courage to come out of our houses," was one female participant's typical response to how FoSHoL had improved their lives, and "now we can come forward and speak in front of men. We can even speak to officials and strangers," was another.

Using participatory methods, working with organisations such as the Bangladesh Rice Research Institute (BRRI), and adopting, experimenting and testing ecological practices in their own fields, the groups:

Produced and marketed high-quality rice (facilitated through a new network of 98 community-based rice seed traders/entrepreneurs and through a seed processing centre run by the Central Farmer Alliance);

Improved access to environmentally-friendly farming techniques and inputs – such as using home-made organic fertilisers and pesticides and integrated crop and integrated pest-management (ICM and IPM) systems (such as mixed cultivation, plant-based insecticides, relay and intercropping, line sowing and improved seed bed preparation);

Diversified livelihoods by increasing access to property resources in their villages, such as fishponds, tree nurseries and mini fruit orchards;

Grew, processed and marketed higher-value vegetables (such as sweet gourd, brinjal, taro, cucumber and red amaranth) on homestead gardens or open fields, and on collective land such as dikes, roadsides and embankments;

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85. All from ActionAid (2011) *The long road from household food security to women's empowerment, Signposts from Bangladesh and The Gambia, ActionAid: London; and Project completion report, May 1, 2005-April 30, 2009*, FoSHoL: AA, Food Security Enhanced through rights promotion & sustainable livelihoods training, Cris Food/2003/056-503), ActionAid: London

86. The six participating districts were Khulna, Kurigam, Noakhali, Patuakhali, Satkhira and Sunamganj.

Established rice-fish culture and communal or individual pond fish culture (with fish such as silver carp, ruhi, katla and mrigel);

Established homestead and backyard vegetable gardening to improve household nutrition and tackle intra-household food intake inequality;

Set up women-only village-level rice grain banks (known as 'the fistful of rice', because women would deposit a 250g fistful of rice at its weekly meetings) to access seed as an additional safety net during lean periods;

Set up village-level savings and credit groups, FoSHol Bazaar farmers' markets, and bio-diversity centres, to preserve and distribute valuable species and genetic resources such as turmeric, ginger, neem and aloe vera;

Enhanced skills for homestead poultry and livestock rearing (such as chickens, ducks, goats, sheep and pigs), and set up a network of 170 community livestock vaccinators (60% of whom were women);

Built organisation capacity, by promoting skills in effective communication, negotiation and mobilisation to better access to services, government entitlements, information and resources from public and private bodies.

As a result of these ecological improvements and better collective management, rice production rose 5-10%, vegetable and fruit production improved by 25-40%, poultry and livestock production improved by 30-40%, fish production enhanced by 20-30%, and average net returns grew by 20-30% because of higher value addition and from cost savings from spending much less on synthetic fertilisers and pesticides.

Overall, food and nutritional intake at the household level improved (with increased fish, eggs, fruit and vegetables available throughout the year), income and earnings increased for poor families through trading and commercialising agricultural produce, and seasonal food scarcity declined considerably, as did skipping meals in its entirety for FoSHoL participants.

Uzzala Rani and her family, from Apuar Khatta village, were used to going hungry before joining FoSHoL, often only eating one meal a day and having to beg for rice. “My poultry and cultivation efforts have added to my family income – so now my husband values my opinion, which is a big change. My family has begun to eat more and we do not face hunger now as we produce our own food.”

Photo: Ahmruzzaman / ActionAid

Agro-ecology builds resilience

Participatory local research to improve local 'orphan' crop varieties and animals adapted to local conditions and used traditionally by poor communities is proving highly effective and adaptive. Studies suggest such investments in agricultural knowledge, science and technology across crops, countries and regions can have an extremely high return on investment (ROI) – on average as high as 40-50% – and these returns have not declined over time.[87]

Participatory and co-construction approaches – including participatory research, varietal testing and co-breeding – which link smallholder farmers in their fields with researchers and scientists from research institutes were central to the success of all 11 relevant cases in Africa (out of 40) reviewed by Prof Jules Pretty in 2011.[88]

Improvements to largely neglected orphan crops have benefited many poor families and communities, who had not been able to access genetic material in the past. New constructs, such as orange sweet potato, have improved the health of people with vitamin A deficiency. In Uganda, the International Potato Center (CIP), with smallholders and its National Agricultural Research Organisation partners, has developed 19 new varieties of orange and non-orange sweet potatoes in the last decade, resulting in yields increasing from 4.4 to 10 tonnes per hectare. The range of plant materials allows small farmers to fit a variety to their own specific planting times, soil types and rainfall conditions. In Mozambique, consumption of orange sweet potato has been shown to substantially increase serum retinol concentrations in children, and the cultivation of orange-fleshed sweet potato in Uganda has now spread to 14,500 farmers on 11,000 hectares.[89]

Tef is another neglected orphan crop, especially as it is only grown in Ethiopia. Although it is grown on 8.5 million hectares, average yields are only 1 tonne per hectare. However, a new variety called Quncho was developed through participatory varietal selection, plant breeding and on-farm seed multiplication involving smallholders and the Debre Zeit Agricultural Research Centre. An extension network of farmers' cooperatives, seed growers' association and civil society organisations (CSOs) helped extend the Quncho variety from 150 hectares to 50,000 hectares over four years (to 2009), and yields have grown impressively from 1 to 2.2 tonnes per hectare, even though farmers need to use no pesticides and only a few herbicides.[90]

Cassava is another major staple that has been neglected by agricultural research. But its productivity is threatened by new diseases, especially in Uganda, where both cassava mosaic virus and brown streak virus have spread since the 1990s, hitting yields. Locally-developed disease-resistant varieties were co-developed and introduced by the National Crops Resources Research Institute with new ecological management practices such as water troughs between rows of cassava.

87. UNEP (2012) *Towards a green economy, Pathways to sustainable development and poverty eradication*, Nairobi: UNEP
88. Pretty, J (2011) *Foresight project on global food and farming futures, Synthesis report C9: Sustainable intensification in African agriculture – analysis of cases and common lessons*, London: UK government, Office for Science
89. Pretty, J (2011) *Foresight project on global food and farming futures, Synthesis report C9: Sustainable intensification in African agriculture – analysis of cases and common lessons*, London: UK government, Office for Science
90. Pretty, J (2011) *Foresight project on global food and farming futures, Synthesis report C9: Sustainable intensification in African agriculture – analysis of cases and common lessons*, London: UK government, Office for Science

The new early-maturing varieties can be harvested between 6-12 months (rather than 19 months), and yields have improved fivefold to 15 tonnes per hectare. Farmers and civil society groups worked with the research system to add value by setting up processing centers to wash, peel, chip and pack the cassava into 1kg bags for sale, and many farmers have taken a share in the factories and women have set up business groups, which have increased economic returns to rural areas.[91]

Case study 3 SPI Bogor Production Cooperative, Indonesia [92]

Some 144 male and female smallholders recently established their own alternative markets and started selling organic vegetables directly to consumers and local supermarkets after setting up four village-based agro-ecology production co-operatives in Bogor district in Indonesia. Working with the Indonesia Peasant Union (Serikat Petani Indonesia, or SPI) villagers have clubbed together to form an organic compost network (using local chicken manure, sheep's dung and micro-organisms), a farmer shop, transport network, and organic retail outlet to sell crops like spinach, rice, bok choy, lettuce, long beans and cucumbers directly to locals and urban consumers in Bogor city and Jakarta. Costs are down and incomes are up under the profit-share scheme, and livelihoods, skills and knowledge have improved, says SPI.

91. Pretty, J (2011) *Foresight project on global food and farming futures, Synthesis report C9: Sustainable intensification in African agriculture – analysis of cases and common lessons*, London: UK government, Office for Science

92. Author interview with Putro Kurniawan, Serikat Petani Indonesia (SPI), 1 June 2012

Agro-ecology has multiple benefits

System of Rice Intensification (SRI)

Smallholder-led farmer-to-farmer learning of new techniques as well as new agro-ecological knowledge is also central to agro-ecological adoption and adaption. Good social networks generate collective action and adaptive management and most ecological approaches (such as IPM and integrated plant and pest management – IPPM) aim to build trust, solidarity, and social and human capital through the widespread use of farmer field schools (FFS) and field-based knowledge exchanges.

The System of Rice Intensification (SRI) is a resource-conserving but intensifying set of practices designed for well-watered environments, which has spread from Madagascar since 1983 through farmer field schools to 40 countries in Asia, Africa and Latin America.

Its key principles are that rice seedlings should be transplanted when young and widely spaced to permit more growth of roots and canopy, and soils should be kept moist rather than flooded and saturated with water. Farmers use organic composts, manure and green mulches to nourish the soil, weeding is carried out mechanically rather than by spraying herbicides, and smallholders are encouraged to experiment with these techniques to adapt to local conditions. Increased yields are achieved with 80-90% reductions in seed requirements and 25 to 50% less irrigation water.[93]

Other benefits include greater resistance to pests and diseases, resistance to drought and storm damage, less pollution of soil and water resources and reduced methane emissions (a potent Green House Gas - GHG). In Cambodia, more than 80,000 families now use SRI practices, which are reported as leading to a doubling of rice yields, substantial reductions in the use of fertilisers and agrochemicals, and increases in farm profits of 300%.[94]

Photo: U Boon Thein / ActionAid

93. IFAD (2010) *Rural poverty report 2011*, Rome: IFAD
94. IFAD (2010) *Rural poverty report 2011*, Rome: IFAD

Photo: CEDAC Cambodia

Case study 4 — Multi-purpose Farm through Farmer Association (MPF-FA), Cambodia

Around 65% of the Cambodian population (or 9 million people) depends mainly on rice farming for their livelihoods,[95] however, many have been unable to produce enough rice to meet their families' year-round consumption needs.

Relying largely on rain-fed agriculture, and with average rice farm landholdings of only 1.3 hectares and national average yields of 2.9 tonnes of rice per hectare in 2009-10,[96] it is not entirely surprising that under-nutrition levels are 32%[97] across the country and that Cambodia was ranked 139th – out of 187 – on the UNDP's Human Development Index in 2011.[98]

To increase their productivity, some farmers were encouraged to use high-input chemical fertilisers and pesticides which have proven to be expensive and harmful for people's health, soil quality and the entire agro-ecosystem.

To address these problems the Centre d'Etude et de Development Agricole Cambodian (CEDAC) introduced the 'Multi-Purpose Farm through Farmer Association' (MPF-FA) initiative in 2003.

The MPF-FA was designed to promote an integrated and low-external input small-scale farming system – including the production of rice, fruit trees, multi-purpose trees, perennial crops, seasonal crops, vegetables, farm animals, and fish.

Based on building on local knowledge, seeds and varieties, and with an emphasis on the initiative being farmer-led and farmer-propagated, the MPF-FA is a system for improving the livelihoods of smallholder farmers, with field sizes ranging from 0.2 to 0.6 hectares, and who cannot produce enough to feed their families.

95. IATP and Asian Farmers' Associations for Sustainable Rural Development (2011), *Agroecology and advocacy: Innovations in Asia*, Quezon, Philippines: AFA and Minneapolis, US: IATP
96. IATP and Asian Farmers' Associations for Sustainable Rural Development (2011), *Agroecology and advocacy: Innovations in Asia*, Quezon, Philippines: AFA and Minneapolis, US: IATP
97. FAO and WFP (2012) *FAO/WFP Crop and food security update mission to Cambodia*, Report, 17 April 2012, Rome: FAO and Rome: WFP
98. UNDP (2011) Human Development report 2011, Sustainability and Equity: A Better Future for All, New York: UNDP

Now there are approximately 50,000 successful MPF-FA smallholder farmers across Cambodia under the direct support of CEDAC and the spin-off Farmer and Nature Network (FNN)[99] and particular elements of the approach – such as the System of Rice Intensification (SRI) – were officially endorsed by the Cambodian government in 2005 and included in the national strategy for agricultural development in 2006.

Based on improving the knowledge and skills of farmers in managing plants, water, soils and nutrients, the MPF-FA has several components:[100]

Ponds and canals play a multiple role in storing water as a reservoir for growing crops, protecting rice plants during short drought periods, growing vegetables and farming fish.

Filling the upper land with the displaced soil from digging ponds and canals is important for integrating the production of crops and animals. In this filled land, farmers can plant fruit trees, perennial plants and vegetables, while also raising pigs, chickens and ducks.

Building bund dikes soil from digging ponds and canals is used to protect communities from floods, demark plots of land and protect rice paddies and fish, and to prevent soil erosion.

System of Rice Intensification (SRI) is an ecological approach revolutionising rice production in Cambodia and beyond. Farmers produce rice on slightly smaller plots in an affordable way by using the best farmer-selected local seeds, organic composts, bio-slurry, natural pesticides and more regular hand-weeding. Seedlings are transplanted when young, and the rice clumps are planted shallow (only 1-2 cm) and are more widely spaced to permit more growth. Soils are kept moist rather than saturated.

A recent survey by CEDAC of 107 farmers in Takeo and Kampong Speu shows rice yields increased by 61% under SRI, the amount of costly rice seeds they used reduced by 53%, while the use of expensive chemical fertilisers dropped by 72%.[101] Other research over the last decade shows an increase in rice yields of 30-150%,[102] and increases in farm profits of 300%.[103]

Farmer Associations and Farmer to Farmer exchanges increasing the strength of smallholder farmer's associations through village-based organisations or self help groups has allowed smallholders to share and exchange cropping techniques, knowledge, skills, labour and market information.

Many local networks have set up savings and loans groups to circumvent ruinous money lending, and CEDAC has supported and trained a 100-strong cadre of key SRI farmers and farmer-promoters to coach, mentor or demonstrate methods to other farmers or stakeholders, such as high-ranking government officials. Farmer to Farmer Exchanges have already trained a further 500 lead farmers across 10 provinces across Cambodia.

Smallholder Ros Mao, from Chompol village in Tramkok, adopted MPF-FA approaches in 2003 on his 0.48 hectare plot of land, and he has gone from struggling to feed his five-member family to becoming a demonstration farmer producing a steady marketable oversupply of a range of food, including rice, chickens, pigs, frogs and fish, plus cucumber, watermelon and pumpkins.[104]

99. ActionAid (2011) *Climate resilient sustainable agriculture, Experiences from ActionAid and its partners*, Johannesburg: ActionAid
100. ActionAid (2011) *Climate resilient sustainable agriculture, Experiences from ActionAid and its partners*, Johannesburg: ActionAid
101. IATP and Asian Farmers' Associations for Sustainable Rural Development (2011), *Agroecology and advocacy: Innovations in Asia*, Quezon, Philippines: AFA and Minneapolis, US: IATP
102. IATP and Asian Farmers' Associations for Sustainable Rural Development (2011), *Agroecology and advocacy: Innovations in Asia*, Quezon, Philippines: AFA and Minneapolis, US: IATP
103. IFAD (2010) *Rural poverty report 2011*, Rome: IFAD
104. ActionAid unpublished note, 2011

Tigray Project – organic compost and water harvesting

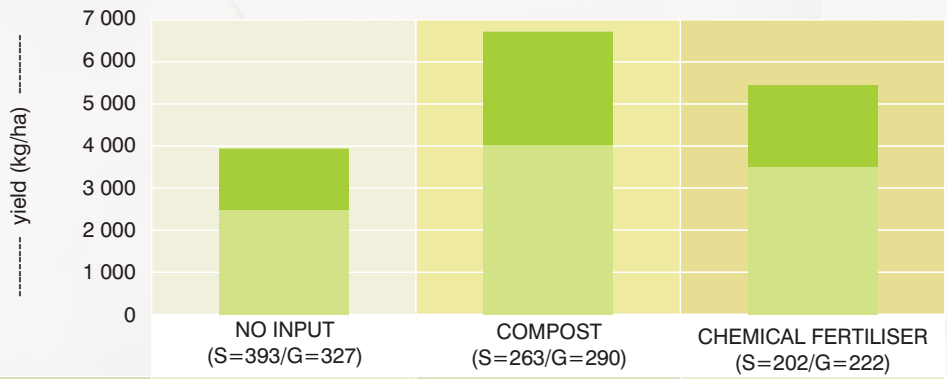
The introduction of integrated and farmer-led organic composts, water harvesting and crop diversification approaches in the poor, arid and overgrazed Tigray region in Ethiopia have significantly increased yields for smallholders and brought multiple benefits to 18-20,000 small farmers and 100,000 poor beneficiaries, particularly female-headed households.[105]

Smallholders made compost pits, dug community ponds, harvested water from rivers and small dams, used bio-pesticides based on indigenous knowledge, conserved soil, restricting free range grazing, fed animals from cut grass and woody plants, promoted bee keeping, supported female-headed and elderly families (the poorest of the poor) with spice seeds and training in raising fruit and forage trees for sale to their neighbours, trained unemployed girls to equip them with skills to earn an income, shared experiences through cross visits, and supported the use of new and easy to manage technologies such as treadle pumps.

A survey was conducted of nearly 1,000 plots in 19 communities from 2000 to 2006 and seven cereal crops yields were compared on three types of plot; those where no inputs were used; those that used organic composts; and those where chemical fertilisers were used.[106]

The average yields for the period are shown in the graph below, and significantly the organically composted plots (in the middle) had higher average yields for the seven cereal crops during the survey compared to the plots that used chemical fertilisers.

Average grain and straw yields (kg/ha) for seven cereal crops, based on the averages for each crop, Tigray, 2000–2006



	NO INPUT (S=393/G=327)	COMPOST (S=263/G=290)	CHEMICAL FERTILISER (S=202/G=222)
grain	1 200	2 473	1 812
straw	2 477	4 073	3 404

s=number of observations for straw yield
g=number of observations for grain yield

FAO: Climate change and food systems resilience in sub-Saharan Africa (2011)

105. FAO (2011) *Climate change and food systems resilience in sub-Saharan Africa*, Rome: FAO
106. FAO (2011) *Climate change and food systems resilience in sub-Saharan Africa*, Rome: FAO

Among the benefits demonstrated in the Tigray Project and highlighted by FAO are increased yields and productivity of crops, an improved hydrological cycle with raised water tables and permanent springs, improved soil fertility, rehabilitated degraded lands, increased incomes, increased biodiversity, and increased mitigation and adaptation to climate change.[107]

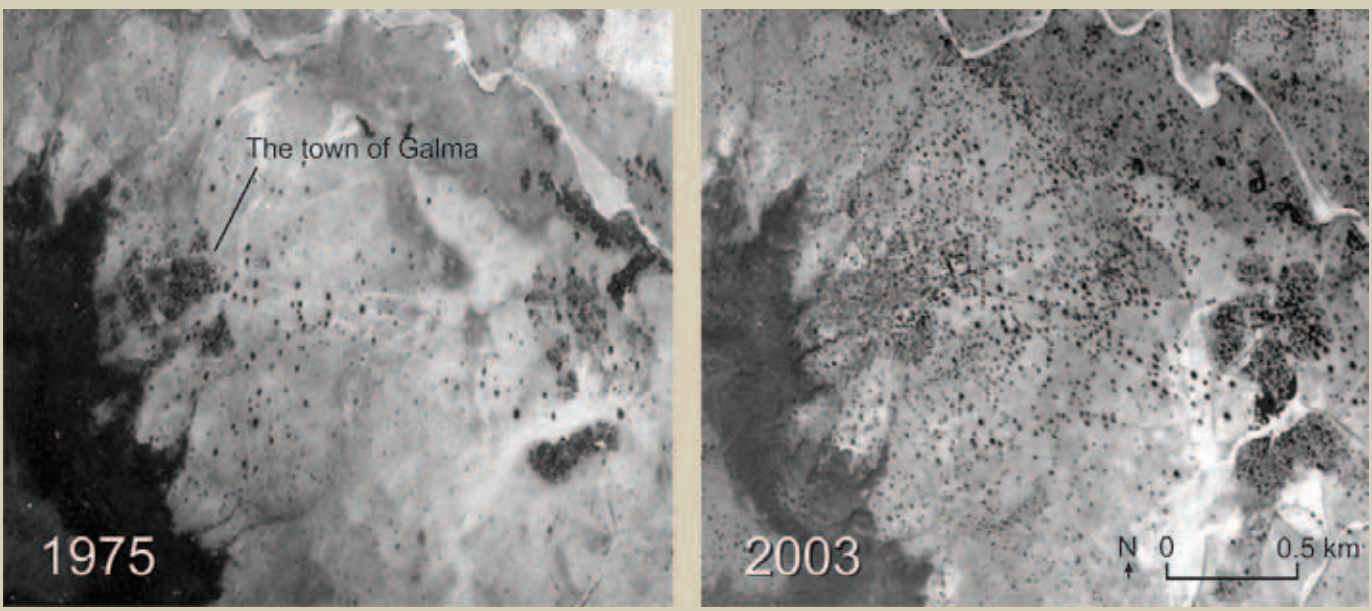
The Tigray project is farmer-led, and builds on the local technologies and indigenous knowledge of the farming communities. Local communities have been empowered and they have now developed legally-recognised bylaws to govern their land and other natural resources management activities. Support from the Ministry of Agriculture and Rural Development has helped boost the project, and further support will be crucial as the organic composting approach is 'scaled-up' to other parts of Ethiopia.[108]

Agro-ecology increases climate resilience

Zai pits

The use of traditional planting pits – known as zai pits and 'tassas' – has seen a remarkable transformation and re-greening in the West African Sahel, particularly in Burkina Faso and Niger. Soil conservation and rainwater harvesting have used zai and tassas, half-moon structures and stone contour bunds to capture water and focus it on millet and sorghum. Trees have been added to the landscape as formerly barren lands were rehabilitated, and some 300,000 hectares of previously degraded land has been rehabilitated in Niger. Satellite images below show the transformation since the 1970s. In total, 3 million hectares have been improved with soil conservation and the cultivation of 120 million new trees.[109]

Satellite photographs of Tahou province in Niger, showing increased tree cover



Source: Reij and Smaling (2008), UNEP (2008)

107. FAO (2011) *Climate change and food systems resilience in sub-Saharan Africa*, Rome: FAO
108. FAO (2011) *Climate change and food systems resilience in sub-Saharan Africa*, Rome: FAO
109. Pretty, J (2011) *Foresight project on global food and farming futures, Synthesis report C9: Sustainable intensification in African agriculture – analysis of cases and common lessons*, London: UK government, Office for Science

In Burkino Faso's Central Plateau, smallholders rehabilitated 200,000-300,000 hectares of land and produced an additional 80,000-120,000 tonnes of food per year, enough to feed half a million people.[110,111]

In some parts, the water table has risen by five metres, indicating a positive environmental externality from the agricultural improvement.[112]

When farmers adopted these techniques, climate resilience increased as crops could survive dry spells and yields grew from nearly nothing to 300-400 kg per hectare during a year of low rainfall and up to 1,500kg in a good year. Farm households that previously had food deficits for half the year have reduced their deficit period to two to three months, or in some cases to zero. Farmers have also diversified from growing just millet and sorghum into cowpea and sesame, and the amount of time women spent collecting firewood fell from 2.5 hours a day to only half an hour daily.[113] Women have earned income from the sale of leaves from regenerated baobab trees and groups of young men specialized in rehabilitating land through tassas and zai planting pits have gained employment and go from village to village to satisfy farmers' interest in improving degraded land.[114]

Evidence indicates that agro-ecology farming improves resilience to climate change. Climate change means more extreme weather-related events. According to the International Panel on Climate Change (IPCC), the likely changes in weather patterns related to global warming are:

- Contraction of snow-covered areas and shrinking of sea ice
- Sea level rises and higher water temperature
- Increased frequency of hot extremes and heat waves
- Heavy precipitation events and an increase in areas affected by droughts floods and landslides
- Increased intensity of tropical cyclones (typhoons and hurricanes)[115]

Local communities face rising temperatures, lower and erratic rainfall, melting glaciers, more severe storms, cyclones, hurricanes and wildfires, more frequent droughts and floods, and intensify desertification.

Smallholders, forest dwellers and pastoralist communities must adapt now to disappearing seasons and new pests and pathogens, they must defend and replant forests, rebuild soil fertility and water retention capacities and adjust water harvesting techniques and farm practices to ensure smallholders can grow more crops per drop of water.[116]

Agro-ecology can cushion the negative impacts of such events, for resilience is strengthened by the use and promotion of agricultural biodiversity at ecosystem, farm system and farmer field levels, that are used in many agro-ecological approaches.[117]

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110. IFPRI (2009) *Agro environmental transformation in the Sahel: Another kind of green revolution*, Washington: IFPRI
111. Christian Aid (2011) *Healthy harvests: The benefits of sustainable agriculture in Africa and Asia*, London: Christian Aid
112. Pretty, J (2011) *Foresight project on global food and farming futures, Synthesis report C9: Sustainable intensification in African agriculture – analysis of cases and common lessons*, London: UK government, Office for Science
113. IFPRI (2009) *Agro environmental transformation in the Sahel: Another kind of green revolution*, Washington: IFPRI
114. De Schutter (2010) *Report submitted by the Special Rapporteur on the right to food*, Olivier De Schutter, Human Rights Council sixteenth session, agenda item 3, A/HRC/16/49
115. IPCC (2008) *Intergovernmental Panel on Climate Change Fourth Assessment Report*, Geneva: IPCC
116. World Bank (2009) *World Development report 2010, Development and climate change*, Washington: World Bank
117. Biodiversity International and The Christensen Fund (2010) *The use of agro biodiversity by indigenous and traditional agricultural communities in adapting to climate change*, Synthesis paper, Platform for Agrobiodiversity Research – Climate change project, Rome: Biodiversity International

Following Hurricane Mitch in 1998, for example, a study of 180 smallholder communities across Nicaragua showed that farming plots cropped with simple agro-ecological methods – such as green manure, rock bunds, dikes, crop rotation or the incorporation of ditches, stubble, ditches, terraces, barriers, legumes, trees, zero-tillage and plowing parallel to the slope – had on average 40% more topsoil, higher field moisture, less erosion and lower losses than control plots on conventional farms. On average, agro-ecological plots lost 18% less arable land to landslides than conventional plots, and had 69% less gully erosion compared to conventional ones.[118]

Agro-ecology can mitigate climate change

Agro-ecology can also mitigate climate change by acting as a carbon sink and by reducing dependence on fossil fuels and other energy requirements, especially by reducing the use of nitrogen fertilisers.[119] Conventional fossil-fuel based high-input agriculture directly releases into the atmosphere large quantities of three different greenhouse gases – carbon dioxide, methane and nitrous oxide – amounting to around 10-12% of global anthropogenic GHG emissions annually.[120] More recent estimates put the figure at 14%.[121]

FAO notes that ecological and organic agriculture reduces carbon dioxide emissions by between 48% to 60% and reduces energy requirements by 25-50% compared to conventional farming.[122] Ecological practices such as agroforestry, carbon-rich mulching or composting and recycling crop residues also help to sequester carbon dioxide in soils and increase soil organic matter, while increased forestation and vegetation helps mitigate carbon dioxide emissions too.

UNEP highlights that agriculture has the potential to function as a net carbon sink in the next 50 years, and they approximate that if only all the small farms on the planet employed ecological or sustainable practices, they might sequester a total of 2.5 billion tonnes of carbon annually.[123]

Agro-ecology empowers small producers

The participation of small-scale farmers and producers is vital for the success of knowledge-intensive agro-ecological practices. Agro-ecology has been developed by grassroots peasants' groups and farmers' movements – from MST (Landless Workers' Movement) in Brazil, to PELUM (Participatory Ecological Land Use Management) in Africa, MASIPAG (Farmer-Scientist Partnership for Development Incorporation) in the Philippines and La Via Campesina worldwide – and the experience of these peasants-led groups and networks with agro-ecological techniques helps to build social capital in the form of trust, solidarity and collective action and cooperation for the common good.

Farmer-to-farmer learning and training and farmer field schools have been proven to reduce pesticide use and instead disseminate and replace external inputs with continuous learning and valuable farmer knowledge. The success of SRI and push-pull systems are largely due to

118. Holt-Gimenez E (2002) *Measuring farmers' agroecological resistance after Hurricane Mitch in Nicaragua: A case study in participatory, sustainable land management impact monitoring*, Agriculture, Ecosystems and the Environment, 93:1-2, 2002, pp.87-105
119. ActionAid (2012) *Asia at the crossroads, Prioritising conventional farming or sustainable agriculture?*, London: ActionAid
120. Smith P et al (2007) *Agriculture. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge; United Kingdom and New York, USA
121. FAO (2009) *Climate change, and bioenergy challenges for food and agriculture. High Level Expert Forum – How to feed the world in 2050*, Rome: FAO
122. Niggli U et al (2009) *Low greenhouse gas agriculture, Mitigation and adaptation potential of sustainable farming systems*, Rome: FAO
123. UNEP (2012) *Towards a green economy, Pathways to sustainable development and poverty eradication*, Nairobi: UNEP

demonstration of fields managed by lead or model farmers and partnerships with national research institutes.

Social capital – in the form of groups termed community, participatory, joint, de-centralised and co-management – are considered a prerequisite for the adoption of sustainable behaviors, such as agro-ecology. States can support and build on these grassroots networks and initiatives, and some have done so to varying degrees.

Low-cost and based on using locally-available materials and traditionally available plant genetic resources, agro-ecology is hence particularly well-suited for resource-poor small-scale farmers and communities and it has proved particularly effective where poorer farmers have been using relatively low levels of agro-chemical inputs with traditional farming methods.[124] It is particularly good for mitigating and managing environmental risks (such as pests, droughts and soil erosion) and farmers also say they value the increased stability of yields achieved through ecological approaches as much as the increased yields. Grassroots farmers' organisations, networks and cooperatives have also demonstrated how they can rapidly 'scale up' successful agro-ecology approaches from Brazil to Kenya and Cambodia, and especially through forging links and building trust with national research institutions and rural extension bodies.

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

Conclusion

The unsustainable impacts of conventional high-input agriculture are become increasingly recognised. Many international organisations – such as FAO, IFAD, UNEP and UNCTAD – are catching up with grassroots farmers' and peasants' movements and are calling for the adoption of agro-ecology and ecological agriculture, to varying degrees.

Many policy makers, however, still remain to be convinced that investing in agro-ecology or ecological agriculture can be as productive and profitable as conventional high-input systems.

But local communities are not waiting around for them. Extensive highly credible surveys and scientific assessments and further case study evidence in this report from Bangladesh, Cambodia, Indonesia and Pakistan shows how grassroots communities are co-creating their own highly productive and climate adaptive low-external input ecological production systems in the face of mounting resource constraints, increasingly volatile and steadily rising food prices, and accelerating climate change.

Farmers and peasants are exchanging knowledge, demonstrating and learning new skills, organizing themselves and experimenting and innovating – with highly productive and all-round food access, and environmentally and socially impressive results.

The Asian Development Bank Institute estimates it would cost only $32-$38 per year to shift a smallholder with one hectare of land out of poverty by engaging in ecological agriculture – with training costs estimated at $6-$14 per farmer a year.[125] They also earlier estimated that it would cost only a modest $7.50 to take a family out of poverty in Laos by adopting SRI ecological farming practices.[126]

Overall, UNEP models suggest an additional investment of 0.16% of global GDP – equaling $198 billion – needs to be invested annually until 2050 in ecological agriculture, storage facilities, and smallholder-focused rural development to make a successful transition to an ecological agricultural system that will increase food availability to around 3,200 kcal per person per day by 2050 and be able to feed 9 billion people.[127] Similarly, FAO estimates it would cost $209 billion a year in such ecological approaches and rural development to achieve production increases needed by 2050.[128]

Beyond recognising communal and customary tenure rights and ensuring access to land, water, seeds, forests and fisheries for small-scale farmers, peasants and the landless in the face of an unprecedented modern-day land grab, governments have a key role to play in curbing the concentrated market power of multinational food and agribusiness corporations and in regulating food and agricultural markets.

Governments must also ensure key public goods, such as effective rural extension services, access to plant genetic resources and biodiversity, storage and transport facilities, rural infrastructure (roads, electricity, information and communications technologies), access to local and regional markets, affordable credit and crop insurance, and smallholder-focused agricultural research and development, rural education and support to farmers' organisations and cooperatives.[129]

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125. Asian Development Bank Institute (2010) *The costs of achieving the Millennium Development Goals through adopting organic agriculture*, Tokyo: ADBI
126. Asian Development Bank Institute (2008) *Organic crops or energy crops? Options for rural development in Cambodia, and the Lao People's Democratic Republic*, Discussion paper 101, Tokyo: ADBI
127. UNEP (2012) *Towards a green economy, Pathways to sustainable development and poverty eradication*, Nairobi: UNEP
128. FAO (2009) *Feeding the world, eradicating hunger. Background document for World Summit on Food Security*, Rome, November 2009, Rome: FAO
129. De Schutter (2010) *Report submitted by the Special Rapporteur on the right to food*, Olivier De Schutter, Human Rights Council sixteenth session, agenda item 3, A/HRC/16/49

Recommendations

Over 1,400 civil society organisations from 32 countries in the International Food Security Network (IFSN) and partner organizations such as the Indonesia Peasant Union (SPI), the Sungi Development Foundation, and the Centre d'Etude et de Development Agricole Cambodian (CEDAC) are calling for major new investment and support to scale-up smallholder-focused agro-ecology and ecological agriculture to help tackle poverty, hunger and climate change. We urge the world leaders to:

Support and strengthen small-scale farmers', peasants' and producer groups and cooperatives to enable them to further advocate for and scale-up agro-ecology and ecological approaches

Make reference and incorporate agro-ecology and ecological agriculture into comprehensive national strategies for the realisation of the right to food and ensure they are devised through the participation of small-scale producers and civil society stakeholders and that they prioritise the needs of women and men small-scale producers.

Ensure references to agro-ecology and ecological agriculture are included in the agriculture sector of national adaption plans of action (NAPAs) and in the list of nationally appropriate mitigation actions (NAMAs) adopted by countries to tackle climate change.

Significantly increase and re-orientate public spending in agriculture towards agro-ecology and ecological agriculture and towards the provision of public goods, such as small-scale focused extension services, agricultural research and rural infrastructure.

Support participatory research and plant breeding that combines indigenous and traditional knowledge with science and modern technology. Include schemes designed specifically for women and support its dissemination through existing farmers' organizations, movements and networks.

Phase out input subsidy schemes for agro-chemicals (fertilisers and pesticides) in favor of subsidies to promote ecological agriculture.

Photo: Ahiruzzaman / ActionAid