NOURISHING THE WORLD SUSTAINABLY: SCALING UP AGROECOLOGY

Ecumenical Advocacy Alliance

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Contents

Credits

Written in collaboration by Dr Miguel Altieri, Andrew Kang Bartlett, Carolin Callenius, Christine Campeau, Kristen Elsasser, Paul Hagerman, Gary Kenny, Kato Lambrechts, Wilfred Miga, Jose Pablo Prado, Peter Prove, Nadia Saracini, and Karin Ulmer. Guidance was provided by members of the Ecumenical Advocacy Alliance Food Strategy Group.

Case studies were contributed by:
Brot fuer die Welt (Ingrid Ostermann)
Canadian Foodgrains Bank (Paul Hagerman)
Caritas India (Sunil Simon)
Christian Aid (Nadia Saracini and Ram Kishan)
Church Development Service in Germany (EED) (Stig Tanzmann)
ICCO (Emma Saavedra)
Instituto para una Alternativa Agraria (IAA) (Haydee Romero)
PELUM (Wilfred Miga)
United Church of Canada (Gary Kenny)

Edited by Peter Prove, Sara Speicher, EAA

Designed by Andrew O'Connor, EAA

Sean Hawkey/CWS

As we move farther into the second decade of the 21st century, the assumptions of a stable climate, abundant water and cheap energy that have fuelled modern industrial agriculture can no longer be maintained. Elements at the heart of industrial agriculture such as agrochemicals, fuel-based mechanization and irrigation are based on dwindling and increasingly expensive fossil fuels. Although the 'green revolution' style of agriculture doubled cereal production in many parts of the world, it has destabilized the natural resource base and drives much of the loss of biodiversity. Moreover, industrial agriculture contributes to 14% of total global greenhouse gas (GHG) emissions, damaging the environment and compromising the world's capacity to produce food in the future.[1] Add in the indirect sources from fossil fuel use in farm operations and through the production of pesticides and this percentage rises to more than 30%[2].

Our consumption patterns are disturbing. Today there are almost a billion hungry people on the planet[3], but hunger is caused by poverty (one-third of the world's population lives on less than $2 a day) and inequality (lack of access to land, seeds, and more), rather than scarcity due to lack of food production. At the same time, obesity causes 3.8 million deaths worldwide before the age of 60 and the number of deaths from obesity-related conditions is expected to climb to 5.1 million people by 2030[4]. In countries such as the United States, this means that the current generation of children could have shorter life expectancies than their parents due to their dietary choices and lifestyles[5].

Though threatened by advancing climate change, the world currently produces enough food to feed 10 billion people[6], which, according to the United Nations World Population

1 FAO, 2009.
2 Bellarby et al., 2008.
3 FAO's best estimate of the number of hungry people comes from 2010. The methodology FAO uses for calculating the prevalence of hunger is currently under revision, so no estimates were produced for 2011 (FAO and WFP 2010). "The percentage of hungry people is highest in east, central and southern Africa. Around three-quarters of undernourished people live in low-income rural areas of developing countries, principally in higher-risk farming areas. However, the share of the hungry in urban areas is rising. Of the total number of the 925 million chronically hungry people, over half are in Asia and the Pacific and about a quarter are in Sub-Saharan Africa." (See http://www.wfp.org/hunger/faqs).
4 R. Beaglehole et al., 2011.
5 S.J. Olshansky et al., 2005.
6 Holt-Gimenez, 2012.

Prospects, is close to the median variant of the population growth peak expected by 2050[7]. The bulk of industrially produced grain crops is used for biofuels and animal feed. It is also estimated that one-third of all food produced each year is wasted, either at the point of production (post-harvest losses resulting primarily from inadequate infrastructure for food storage, preservation, processing and transportation, education and training) or at the point of consumption (through negligent consumer habits)[8]. The call to double food production by 2050 is based on the assumptions that the consumption of meat will continue to grow, that we will continue to convert our grain into fuel, and that we will fail to act to reduce food waste.

In the midst of multiple global crises affecting food security, the concept and practice of agroecology has gained increasing attention worldwide in the last two decades. A recent major international scientific report, the International Assessment of Agricultural Knowledge, Science and Technology for Development[9], states that in order to feed the more than 9 billion people in 2050, we urgently need to adopt the most effective and sustainable farming systems, and recommends a shift towards agroecology as a means of sustainably boosting food production and improving the situation of the poorest people and communities.

Likewise, the UN Special Representative for the Right to Food, Olivier de Schutter, has compiled evidence demonstrating not only that agroecological approaches can provide enough food for us all[10], but that small-scale farmers can double food production within 10 years in critical regions by using agroecological methods[11]. Even the Consultative Group on International Agricultural Research (CGIAR), which historically has promoted input-driven 'Green Revolution' approaches, has recently identified agroecology as an approach offering important possibilities for raising productivity in different regions and in diverse social and environmental conditions[12]. Confronting the future food challenge effectively will require agricultural systems that exhibit high levels of diversity, integration, efficiency, resiliency and productivity – features that characterize agroecology[13].

AGRICULTURE, SMALL-SCALE FARMERS AND INDIGENOUS PEOPLES AND COMMUNITIES

Agriculture is intrinsically linked with issues of development and poverty reduction. Approximately 75% of the world's poor live in rural areas where agriculture is the main economic activity[14].

Eighty percent of the world's food is produced by 470 million farms, 85% of which are working on less than two hectares of land[15]. These small-

7 UN World Population Prospects, the 2010 Revision available at http://esa.un.org/wpp/Analytical-Figures/htm/fig_1.htm
8 FAO 2011.
9 IAASTD, 2009.
10 de Schutter 2010.
11 http://www.ohchr.org/en/NewsEvents/Pages/DisplayNews.aspx?NewsID=10819&LangID=E
12 CGIAR, 2012.
13 Holt Gimenez and Patel, 2009.
14 G-33, 2010.
15 Nagayets 2005.

scale farmers – who tend to use more sustainable farming practices – face a number of major challenges. They tend to be trapped at the bottom of a chain of intermediaries, merchants and transnational corporations, all of whom take a major cut from the value of the product. They also have less capacity to react to price volatility, and they struggle to compete when imports flood their markets. And without land rights, some farmers can easily lose their land under pressure from larger investors.

Many traditional farming communities and indigenous peoples have over generations developed agricultural systems that are productive and environmentally sustainable. Such traditional farmers domesticated thousands of crop species and millions of plant varieties, mostly grown without agrochemicals. While traditional agricultural knowledge and practice has in many places been lost or atrophied, such small diversified farming systems offer promising models for promoting biodiversity, conserving natural resources, sustaining yield without agrochemicals, providing ecological services and lessons for resilience in the face of environmental and economic change.

Traditional crop management practices used by many resource-poor farmers can lead to the conservation and regeneration of the natural environment, and offer a rich source of methods for adapting agricultural systems to local environmental, social and economic circumstances. Such traditional techniques tend to be context- and knowledge-intensive rather than relying on inputs such as fertilizers or pesticides. But clearly not all are effective or sufficient; therefore modifications and adaptations may be necessary.

Since the 1980s, thousands of projects launched by non-governmental organizations (NGOs), farmers' organizations and some academic and research centres reaching hundreds of thousands of farmers, have applied general agroecological principles to customize agricultural technologies to local needs and circumstances, improving yields while conserving natural resources and biodiversity. Agroecological management systems are "farmer-intensive", require peoples' participation and need to be tailored and adapted in a site-specific way to highly variable and diverse farm conditions[16].

WHAT IS AGROECOLOGY?

As an applied science, agroecology uses ecological concepts and principles for the design and management of sustainable agricultural systems in which natural, locally-available resources for soil fertility and biological control are privileged over costly external inputs such as chemical fertilizers and pesticides.[17] Agroecology takes greater advantage of beneficial on-farm interactions in order to reduce off-farm input use and to improve the efficiency of farming systems. Agroecological principles (Table 1, page 4) enhance functional biodiversity, which is integral to the maintenance of immune, metabolic and regulatory processes key to a functioning agricultural ecosystem[18]. Technological innovations are welcome, if their use improves productivity for farmers and does not harm the environment.

Agroecological principles take different technological forms depending on the environmental, social and economic circumstances of each farm or region.

16 Uphoff, 2002.
17 Altieri, 1995.
18 Gliessman, 1998.

Sean Hawkey/CWS

Diversification at a crop level may mean using a mixture of crop varieties that have different plant heights or different disease tolerance levels. At the field level it may be represented by various intercropping plots or intercropping between rows with "companion" plants that repel one another's natural enemies. On a landscape level, diversification may occur by integrating multiple production systems such as agroforestry systems, fallow fields, livestock, and forest remnants to create a highly heterogeneous land matrix.

Promoted diversification schemes (see Box 1, page 6) usually result in favourable changes in various components of the farming systems at the same time[19]. In other words, they function as an "ecological turntable" by activating key processes – such as nutrient and waste recycling, biological control to reduce the number of harmful insects with small animals or other insects, natural symbiotic reactions between plants, such as exuding toxic substances to assist in the growth, survival or reproduction of a neighbouring plant, etc. – essential for the sustainability and productivity of agro-ecosystems. Agroecological systems are not dependent on the use of capital or chemical inputs, but rather enhance the efficiency of biological processes such as

Table 1. Agroecological principles for the design of biodiverse, energy efficient, resource-conserving and resilient farming systems
▪ Enhance the recycling of biomass, with a view to optimizing organic matter decomposition and nutrient cycling over time.
▪ Strengthen the "immune system" of agricultural systems through enhancement of functional biodiversity – natural enemies, antagonists, etc.
▪ Provide the most favourable soil conditions for plant growth, particularly by managing organic matter and by enhancing soil biological activity.
▪ Minimize losses of energy, water, nutrients and genetic resources by enhancing conservation and regeneration of soil and water resources and agrobiodiversity.
▪ Diversify species and genetic resources in the agroecosystem over time and space at the field and landscape level.
▪ Enhance beneficial biological interactions and synergies among the components of agrobiodiversity, thereby promoting key ecological processes and services.

19 Gliessman, 1998.

Armin Paash/EAA

photosynthesis, nitrogen fixation, solubilisation of soil phosphorus, and the biological activity above and below ground. The "inputs" of the system are the natural processes themselves.

When designed and managed with agroecological principles, farming systems become more diverse, productive, resilient and efficient (Box 2, page 6). Agroecological initiatives aim at transforming industrial agriculture partly by transitioning existing food systems away from fossil fuel-based production towards an alternative agricultural paradigm that encourages local/national food production by small and family farmers based on local knowledge, innovation, resources and solar energy. This implies access of small-scale farmers to land, seeds, water, credit and local markets, partly through the creation of supportive economic policies, financial incentives, market opportunities and agroecological technologies[20].

Agroecological systems are deeply rooted in the ecological rationale of traditional small-scale agriculture. These long-established examples of successful agricultural systems are characterized by a tremendous diversity of domesticated crop and animal species maintained and enhanced by soil, water and biodiversity management regimes, nourished by complex traditional knowledge systems[21].

Agroecology works in a circular system of production that emphasizes widespread recycling and reusing of natural resources. It reduces food waste by turning remnants into food for the soil through composting. It imitates the cyclical cycles of nature and incorporates its own sustainable water and waste management systems. In contrast, modern industrial agriculture is a linear system of production that relies on the extensive use of external inputs to produce more food using more chemical and other manufactured additives from outside the local natural system.

20 Vía Campesina, 2010.
21 Koohafkan and Altieri, 2010.

Box 1. Temporal and spatial designs of diversified farming systems and their main agroecological effects

Crop Rotations: Temporal diversity in the form of cereal-legume sequences; nutrients are conserved and provided from one season to the next, and the life cycles of insect pests, diseases, and weeds are interrupted.

Polycultures: Cropping systems in which two or more crop species are planted within certain spatial proximity result in biological complementarities that improve nutrient use efficiency and pest regulation, thus enhancing crop yield stability.

Agroforestry Systems: Trees grown together with annual crops in addition to modifying the microclimate, maintain and improve soil fertility as some contribute to nitrogen fixation and nutrient uptake from deep soil horizons while their litter helps replenish soil nutrients, maintain organic matter, and support complex soil food webs.

Cover Crops and Mulching: The use of pure or mixed stands of grass-legumes, for instance, under fruit trees, can reduce erosion and provide nutrients to the soil and enhance biological control of pests. Flattening cover crop mixtures on the soil surface in conservation farming is a strategy to reduce soil erosion and lower fluctuations in soil moisture and temperature, improve soil quality, and enhance weed suppression resulting in better crop performance.

Crop-livestock mixtures: High biomass output and optimal nutrient recycling can be achieved through crop-animal integration. Animal production that integrates fodder shrubs planted at high densities, intercropped with improved, highly-productive pastures and timber trees all combined in a system that can be directly grazed by livestock enhances total productivity without need of external inputs.

(Altieri 1995, Gliessman 1998)

Box 2. Emerging attributes of agroecologically designed and managed farming systems

Diversity: As diversity increases, so do opportunities for coexistence and for beneficial interactions between species that can enhance agro-ecosystem sustainability. Greater diversity improves resource-use efficiency in agro-ecosystems. Intermingled crops possess an associated resistance to herbivores as there is a greater abundance and diversity of natural enemies of insect pests (Andow 1991).

Efficiency: Diversified systems tend to be efficient in capturing sunlight, in using rainfall and in mobilizing and tightly cycling nutrients, exhibiting close efficient energy flows.

Self-sufficiency: A consequence of efficiency and diversity is that agroecological systems are self-sufficient requiring mostly inputs of sunlight, rainfall and locally generated nutrients and energy.

Self-regulation: Because of the great diversity of organisms, outbreaks of diseases, insects or weeds that severely damage plants are uncommon. In addition, diverse plants have a number of defense mechanisms that help protect them from attack.

Resiliency: Biodiversity enhances the resilience of agro-ecosystems mainly because biodiversity provides “insurance” or a buffer, against environmental fluctuations as different species respond differently to fluctuations, leading to more predictable production levels.

Productivity: There is a positive effect of biodiversity on plant biomass production associated with increasing effects of complementarity between plant species translated in better use of soil resources or regulation of pest populations.

(Altieri, 2012)

OTHER SUSTAINABLE FARMING METHODS

A number of different methods have been developed with the aim of achieving biodiverse, resilient, productive and resource efficient agriculture. Conservation (using no or minimum tillage) agriculture, sustainable intensification, organic farming and agroecological systems are some of the proposed approaches, each aiming to serve as a foundation for a sustainable food production strategy. Although goals of all approaches may be similar, technologies proposed (high versus low input), methodologies (farmer-led versus market-driven, top-down versus bottom-up) and scales (large-scale monocultures versus biodiverse small farms) differ. Thus, end results differ as well.

For example, sustainable intensification – a system of farming that aims to increase yield from the same area of land while reducing negative environmental impact – could still be capital and input-intensive industrial agriculture with research mainly aimed at major crops (monocropping). If systems are managed as monocultures that are in turn dependent on external biological and/or organic inputs, they do not meet the aspirations of agroecological principles. This 'input substitution' approach essentially follows the same paradigm of conventional farming: that is, overcoming the limiting factor but this time with biological or organic inputs. Many of these "alternative inputs" have become commoditized; therefore farmers continue to be dependent on input suppliers, cooperative or corporate[22].

Farming systems that do not challenge the monoculture approach to farming and rely on external inputs and export-led agricultural development, offer little to small farmers who in turn become dependent on external inputs and foreign and volatile markets.


Paul Jeffrey/EAA

22 Rosset and Altieri, 1997.

When one examines the basic attributes that a sustainable production system should exhibit (Box 3), it can be seen that agroecological approaches meet most of the main attributes and requirements[23]. Similarly by applying the set of questions listed in Table 2 to assess the potential of agricultural interventions in addressing pressing social, economic and ecological concerns, it is clear that most existing agroecological projects are contributing to sustainable livelihoods by improving the natural, human, social, physical and financial capital of target rural communities[24].

Box 3. Requirements of agroecologically based agricultural systems
1. Use local and improved crop varieties and livestock breeds so as to enhance genetic diversity and adaptation to changing biotic and environmental conditions.
2. Avoid the unnecessary use of agrochemical and other technologies that adversely impact the environment and human health (e.g. heavy machineries, transgenic crops, etc.).
3. Ensure efficient use of resources (nutrients, water, energy, etc.), reduced use of non-renewable energy and reduced farmer dependence on external inputs.
4. Harness agroecological principles and processes such as nutrient cycling, biological nitrogen fixation, allelopathy (the effect of one plant on another through its release of biochemicals), biological control via promotion of diversified farming systems and harnessing functional biodiversity.
5. Make productive use of human capital in the form of traditional and modern scientific knowledge and skills to innovate and use social capital through recognition of cultural identity, participatory methods and farmer networks to enhance solidarity and exchange of innovations and technologies to resolve problems.
6. Reduce the ecological footprint of production, distribution and consumption practices, thereby minimizing greenhouse gas (GHG) emissions and soil and water pollution.
7. Promote practices that enhance clean water availability, carbon sequestration, and conservation of biodiversity, soil and water conservation, etc.
8. Develop capacity to cope with rapid and unforeseeable change based on the need to sustain a balance between long-term adaptability and short-term efficiency.
9. Strengthen adaptive capacity and resilience of the farming system by maintaining agroecosystem diversity, which not only allows various responses to change, but also secures key farming functions.
10. Recognize the dynamic conservation of agricultural heritage systems that supports social cohesion and a sense of pride and reduces migration.

(Koohafkan et al., 2011)

23 Altieri, 2002; Gliessman, 1998; UK Food Group, 2010; Parrott and Marsden, 2002; Uphoff, 2002.
24 Koohafkan et al., 2011.

Table 2. A set of guiding questions to assess if proposed agricultural systems are contributing to sustainable livelihoods
1. Are they reducing poverty?
2. Are they based on rights and social equity?
3. Do they reduce social exclusion, particularly for women, minorities and indigenous people?
4. Do they protect access and rights to land, water and other natural resources?
5. Do they favour the redistribution (rather than the concentration) of productive resources?
6. Do they substantially increase food production and contribute to household food security and improved nutrition?
7. Do they enhance families' water access and availability?
8. Do they regenerate and conserve soil, and increase (maintain) soil fertility?
9. Do they reduce soil loss/degradation and enhance soil regeneration and conservation?
10. Do practices maintain or enhance organic matter and the biological life and biodiversity of the soil?
11. Do they prevent pest and disease outbreaks?
12. Do they conserve and encourage agrobiodiversity?
13. Do they reduce greenhouse gas emissions?
14. Do they increase income opportunities and employment?
15. Do they reduce variation in agricultural production under climatic stress conditions?
16. Do they enhance farm diversification and resilience?
17. Do they reduce investment costs and farmers dependence on external inputs?
18. Do they increase the degree and effectiveness of farmer organizations?
19. Do they increase human capital formation?
20. Do they contribute to local/regional food sovereignty?

(Koohafkan et al., 2011)

AGROECOLOGY & RESILIENCE TO CLIMATIC CHANGES

Agroecology can increase farmers' ability to adapt to climate change and to help them cope in the aftermath of natural disasters. This is done by building up the farm's natural defences through improved water management, enhanced nutrient management, better soil management and diversified production system.

For example, sustainable and organic soil and crop management practices such as low tillage, planting of cover crops, the application of manure, crop rotations, and agroforestry help to build up nitrogen, organic matter and beneficial micro-organisms in the soil. Better soil structure means fewer problems such as compaction, erosion and nutrient leaching. It also keeps more water in the soil. This is critical for areas where climate change is already resulting in higher temperatures and lower precipitation.

Diversified farming systems such as agroforestry, silvopastoral and polycultural systems provide a variety of examples of how complex agro-ecosystems are able to adapt and resist the effects of climate change. The high structural complexity of agroforestry systems have been shown to buffer crops from large fluctuations in temperature[25] thereby keeping the crop closer to its optimum conditions. In the case of coffee, the more shaded systems have also been shown to protect crops from decreasing precipitation and reduced soil water availability because the tree cover is able to reduce soil evaporation and increase soil water infiltration[26].

Intensive silvopastoral systems (ISS) for livestock production combine fodder shrubs planted at high densities under trees and palms with improved pastures. Combined benefits of water regulation, favourable microclimate, biodiversity, and carbon stocks in these ISS not only provide environmental goods and services for livestock producers but also greater resilience to climate change. For example, at the El Hatico farm in the Valle del Cauca, Colombia, 2009 was the driest year in a 40-year record, with precipitation dropping by 44% compared to the historical average. Despite a reduction of 25% in pasture biomass, the fodder production of trees and shrubs remained constant throughout the year, neutralizing the negative effects of drought on the whole system. In response to the extreme weather, the farm had to adjust its stocking rates and increase energy supplementation. In spite of this, the farm's milk production for 2009 was the highest on record with a surprising 10% increase compared to the previous four years. Meanwhile, farmers in other parts of the country reported severe animal weight loss and high mortality rates due to starvation and thirst[27].

Observations of agricultural performance show that resilience to climate disasters is closely linked to the level of on-farm biodiversity, a major feature of agroecological systems. A survey conducted in Central American hillsides after Hurricane Mitch showed that farmers using diversification practices such as cover crops, intercropping and agroforestry suffered less damage than their conventional monoculture neighbours. The survey, spearheaded by the Campesino a Campesino movement, mobilized 100 farmer-technician teams to carry out paired observations of specific indicators on 1,804 neighbouring sustainable and conventional farms. The study spanned 360 communities and 24 departments

25 Morais et al., 2006.
26 Lin 2007
27 Murgueitio et al 2011.

in Nicaragua, Honduras and Guatemala. It was found that sustainable plots had 20% to 40% more topsoil, greater soil moisture and less erosion and experienced lower economic losses than their conventional neighbours[28]. Similarly in Sotonusco, Chiapas, coffee systems exhibiting high levels of vegetation complexity and plant diversity suffered less damage from Hurricane Stan than more simplified coffee systems[29]. Forty days after Hurricane Ike hit Cuba in 2008, researchers conducted a farm survey in the Provinces of Holguin and Las Tunas and found that diversified farms exhibited losses of 50% compared to 90% or 100% in neighbouring monocultures. Likewise agroecologically managed farms showed a faster productive recovery (80%–90% 40 days after the hurricane) than monoculture farms[30].

More research is still needed to better understand the impacts of long-term higher temperatures and changes in precipitation patterns on plants, animals, pests and diseases. However, in countries where temperatures are already close to the upper threshold of crop tolerance, climate change will reduce yields. Higher temperatures will also likely encourage weed and pest proliferation. Long-term changes in precipitation patterns will likely increase crop failures and reduced production. In the meantime, agroecological agriculture provides the best available solution to farmers in the face of climate change.


Paul Jeffrey/EAA

28 Holt-Gimenez 2000.
29 Philpott et al. 2008.
30 Rosset et al. 2011.

Paul Jeffrey/EAA

Case Study:
IMPROVING LIVES THROUGH CLIMATE RESILIENT AGRICULTURE

Cases of farmer suicides in India have risen markedly in recent years due to distress among small-scale farmers. Caritas India realized that, among many other reasons, climate change and variation is one of the major causes of this distress. They began to promote climate resilient agricultural measures through FARM (Facilitating Agricultural Regeneration Measures) in farmer suicide hit Vidarbha area of Maharashtra, Telengana region of Andhra Pradesh and Wayanad in Kerala.

Globalization and the entry of corporations into farming has worsened the situation of smallholder farmers throughout India causing farmers to lose their rights over the basic resources for agriculture like seeds, land and water, and obliging them to rely on external sources for agricultural inputs. Agro-business corporations are promoting varieties that are non-compatible to the local micro-climate due to which farmers are facing crop failure. One example is the promotion of Bt. Cotton in India. Many suicide cases in Vidarbha are due to cotton crop failure. In response, Caritas India promoted the protection of natural resources and encouraged the community to use locally sourced resources for agriculture. Caritas has proved through its interventions that the local cotton varieties are much more reliable and climate resilient.

Similarly, Caritas India is engaged in more than 50 projects on Natural Resource Management. Caritas is also promoting local seed varieties which would be used in varying climate scenarios like early sowing varieties, late sowing varieties, short duration varieties etc. Water harvesting and conservation is helping farmers to provide life saving irrigation to their crop. Integrated pest and nutrient management practices are helping communities to overcome the problems of pests and insects that are also increasing due to climate change. Communities are also engaged in jointly managing the resources like water, forest and community land.

Improved leadership capacities of farmers are also helping increase their advocacy and access to their rights and facilities from the Government.

EVIDENCE OF THE FOOD SECURITY POTENTIAL OF AGROECOLOGICAL SYSTEMS

With sound principles on paper, the question raised by supporters and critics alike is how effective agroecological methods are in practice.

The first global assessment of agroecologically-based projects and/or initiatives throughout the developing world[31] documented clear increases in food production over some 29 million hectares, with nearly 9 million households benefiting from increased food diversity and security. However, many of the South American examples used are derived from large farms that do not conform fully to agroecological principles, and thus the data must be used cautiously.

Nevertheless, sustainable agriculture practices reported in the study led to 50-100% increases in per hectare cereal production (about 1.71 megagrams per year per household – an increase of 73%) in rain-fed areas typical of small farmers living in marginal environments (a total area of about 3.58 million hectares, cultivated by about 4.42 million farmers). In the 14 projects with roots as main staples (potato, sweet potato and cassava), the 146,000 farms on 542,000 hectares increased household food production by 17 tonnes per year (an increase of 150%). Such yield enhancements are a true breakthrough for achieving food security among farmers isolated from mainstream agricultural institutions.

A 2007 study compiled research from 293 different comparisons to assess the overall efficiency of organic versus conventional agricultural systems. The researchers found that, in developed countries, organic systems on average produce 92% of the yield produced by conventional agriculture. However, in developing countries organic systems produce 80% more than conventional farms. Reasons given for the difference include that the materials needed for organic farming are more accessible to farmers in developing countries. Those farmers may buy the same seeds as conventional farms use in rich countries, but they cannot afford the fertilizers and pesticides needed for intensive agriculture. However, organic fertilizer can be produced on their own farms[32].

Using data from the UN Food and Agriculture Organization, the study team then estimated what would happen if farms worldwide were to switch to organic methods today. The world currently produces the equivalent of 2786 calories per person per day. The researchers found that under an organic-only regime, farms could produce between 2641 and 4381 calories per person per day. The upper numbers took into account the higher yields that would be obtained in developing countries, and the details of which crops are grown where. Nutritionists recommend that people consume between 2100 and 2500 calories a day.

Africa

The IAASTD report on Sub-Saharan Africa provides and refers to a growing body of evidence demonstrating that investing in agroecological

31 Pretty et al, 2003.
32 Badgley et al, 2007.

approaches can be highly effective in boosting production, incomes, food security and resilience to climate change and empowering communities[33].

A meta-analysis conducted by UNEP–UNCTAD (2008) assessing 114 cases in Africa revealed that the conversion of farms to organic methods increased agricultural productivity by 116%. In Kenya, maize yields increased by 71% and bean yields by 158%. Moreover, increased diversity in food crops available to farmers resulted in more varied diets and thus improved nutrition. Also the natural capital of farms (soil fertility, levels of agrobiodiversity, etc.) increased over time after conversion.

The UK Government commissioned the Foresight Global Food and Farming Futures Project[34], which conducted an analysis of 40 projects and programmes in 20 African countries where sustainable crop intensification was promoted during the 1990s–2000s. The cases included crop improvements, agroforestry and soil conservation, conservation agriculture, integrated pest management, horticulture, livestock and fodder crops, aquaculture and novel policies and partnerships. By early 2010, these projects had documented benefits for 10.39 million farmers and their families and improvements on approximately 12.75 million ha. Food outputs by agroecology via the use of new and improved varieties was significant as crop yields rose on average by 2.13-fold[35]. Most households substantially improved food production and household food security. In 95% of the projects where yield increases were the aim, cereal yields improved by 50–100%. Total farm food production increased in all. The additional positive impacts on natural, social and human capital are also helping to build the assets base so as to sustain these improvements in the future.

Although some of the yield gains reported in the study depended on farmers having access to improved seeds, fertilizers and other inputs, food outputs improved mainly by diversification with a range of new crops, livestock or fish that added to the existing staples already being cultivated. These new system enterprises or components included: aquaculture for fish raising; small patches of land used for raised beds and vegetable cultivation; rehabilitation of formerly degraded land; planting of fodder grasses and shrubs that provide food for livestock (and increase milk production); raising of chickens and zero-grazed sheep and goats(in which grass is harvested and fed fresh to animals); new crops or trees brought into rotations with maize or sorghum; adoption of short-maturing varieties (e.g. sweet potato and cassava) that permit the cultivation of two crops per year instead of one[36].

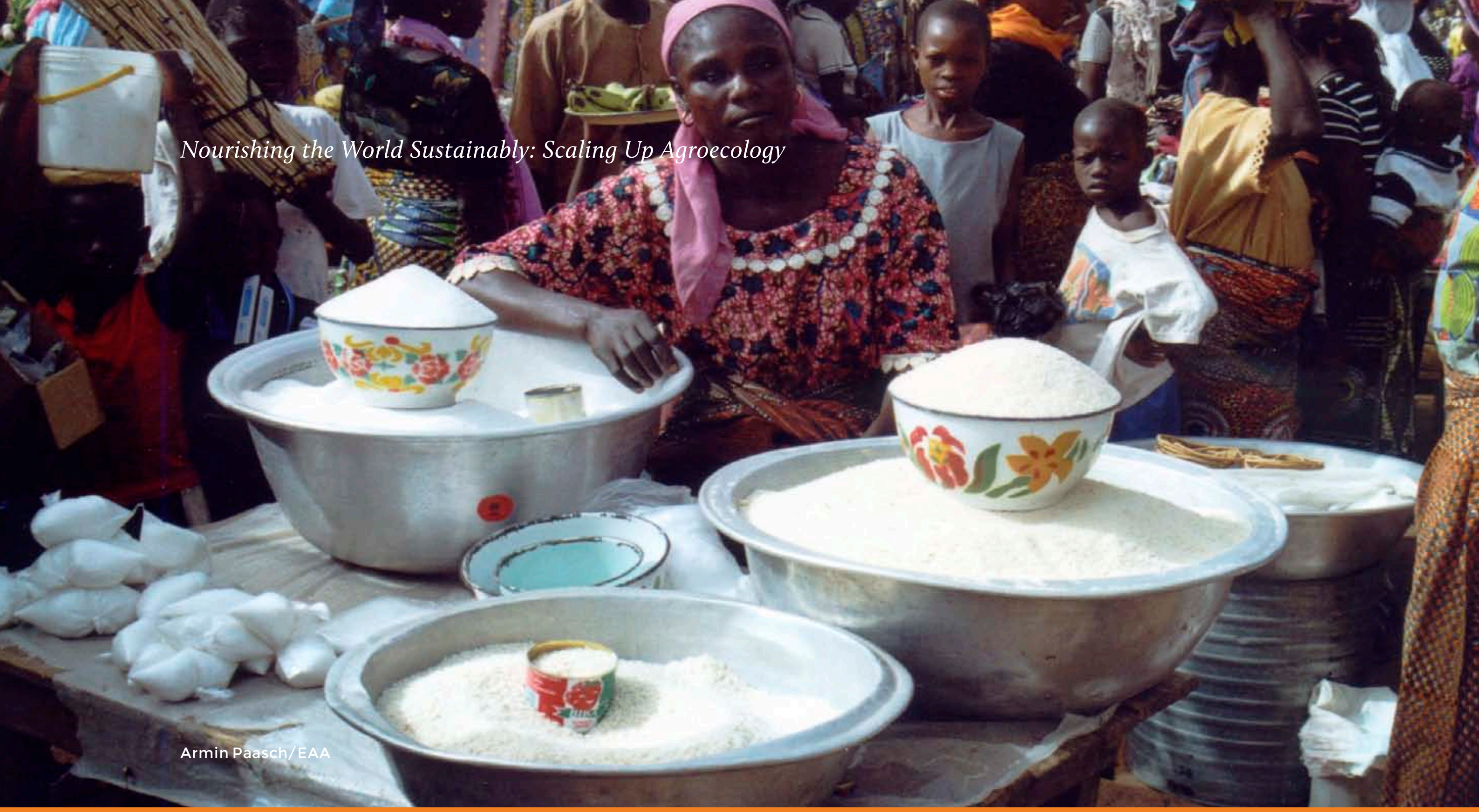
One of the most successful diversification strategies has been the promotion of tree-based agriculture. Agroforestry of maize associated with fast growing and nitrogen-fixing shrubs (e.g. Calliandra and Tephrosia) has spread among tens of thousands of farmers in Cameroon, Malawi, Tanzania, Mozambique, Zambia and Niger resulting in a total maize production over a five year period of 8 tonnes compared with 5 tonnes obtained under monoculture[37]. Another agroforestry system in Africa is one dominated by Faidherbia trees, a nitrogen-fixing acacia species indigenous to Africa that improves crop yields and protects crops from dry winds and land from water erosion. In the Zinder Regions of Niger, there are now about 4.8 million hectares

33 IAASTD 2009, Christian Aid 2011.
34 The Project was sponsored by the UK Government's Department for Environment, Food and Rural Affairs (Defra) and Department for International Development (DFID). Project findings published on 24 January 2011. See www.webarchive.nationalarchives.gov.uk/ + http://www.bis.gov.uk/foresight/our-work/projects/current-projects/global-food-and-farming-futures/about-the-project.
35 Pretty et al., 2011.
36 Pretty et al 2011.
37 UK Government's Foresight Project, 2011.

of Faidherbia-dominated agro-ecosystems. The foliage and pods from the trees also provide much-needed fodder for cattle and goats during the long Sahelian dry seasons. Encouraged by the experience in Niger, about 500,000 farmers in Malawi and the southern highlands of Tanzania maintain Faidherbia trees in their maize fields[38].

Another major innovation in southern Africa is Conservation Agriculture (CA), which is based on three agroecological practices: minimum soil disturbance, permanent soil cover and crop rotations. These systems have spread in Madagascar, Zimbabwe, Tanzania and other countries reaching no less than 50,000 farmers who have dramatically increased their maize yields to 3-4 metric tonnes per hectare while conventional yields average between 0.5 and 0.7 metric tonnes per hectare[39]. Improved maize yields increase the amount of food available at the household level, but also increase income levels.

38 Reij and Smaling, 2008.
39 Pretty et al., 2011.



Armin Paasch/EAA

Case Study:
CONSERVATION AGRICULTURE IN ZIMBABWE

Christian Care, a Zimbabwean development agency supported by the Canadian Foodgrains Bank and the United Church of Canada, has been raising awareness and training farmers to adopt conservation farming methods in order to develop self-sustaining capacities to provide for their food, seeds, nutrition and health needs.

Conservation agriculture reduces soil erosion and improves soil water retention and nutrient recycling. Thus, it improves productivity and resilience, contributing to food security and climate change adaptation. Yields on fields farmed by conservation methods have increased significantly year on year, far outperforming conventionally farmed fields, while requiring fewer chemical inputs and less capital investment.

Conservation agriculture has positively impacted many. A farmer from Chirumhanzu stated that the methods "gave me the ability to be as good as everybody else"[1], while the regional chief for Maware Ward, Chirumhanzu, noted that the key contribution from this project was the mulch. He said: "We have been digging from way back to our ancestors, but the mulching came from Christian Care"[2]. And indeed, farmers have noticed that with heavy mulch layer, they do not have issues with compaction and weed pressure, resulting in increasing yields year after year.

Essie Mpofu, a lead farmer from Malandu West ward, Nkayi district, also shares her story:

"I have five children and two attend school. I heavily rely on the orchard I have in my homestead and farming as source of livelihood.

I learnt conservation farming from Christian Care and I was taught to use mulch, an essential element needed to keep soil moist. I applied mulch to my plot gradually over time. As a family, we worked hard to achieve at least a 50% mulch cover on our plot. I noticed that because of the mulch, my crop resisted the high heat and experienced less moisture stress than maize under conventional farming, which is very important as we experience drought often.

At the end of my second year, I managed to harvest three times more with these new farming methods compared to conventional farming. With the extra harvest, I donated 10kgs to our own community seed bank and kept some for my own planting in the next season, thereby not depending on the market to buy seed.

I see a lot of improvement in the soil. It has more nutrients and is less affected by erosion. This season, I harvested 480 kg from the conservation plot while I only got 20kg from my old plot.

My family is happy with the yields and the quality of crops and neighbours are inspired to take up conservation farming the next year. We are grateful for the knowledge Christian Care has given us."[3]

[1] Conservation Farming in Zimbabwe – Evaluation report, January 2011, p. 19
[2] Conservation Farming in Zimbabwe – Evaluation report, January 2011, p. 22
[3] Peace Mail, Volume 4, Issue 6


Armin Paasch/EAA

Case Study:
SUCCESSFULLY SCALING UP AT PELUM

The Participatory Ecological Land Use Management (PELUM) is a regional network of over 207 civil society organisations, operating in 10 countries – Botswana, Kenya, Lesotho, Malawi, Rwanda, South Africa, Tanzania, Uganda, Zambia and Zimbabwe.

In a bid to scale up agroecology, PELUM has been conducting capacity building initiatives in the countries where they operate. At present they have been able to train 120 farmer trainers, who in turn were able to train at least 50 lead farmers each. Each lead farmer also is able to train group members. At present, PELUM has managed to reach out to over 5 million smallholder farmers in the East and Southern African region. Aspects that they are trained in include conservation agriculture, mulching, organic soil improvement, water harvesting, composting, agro forestry, integrated pest management, organic gardening, and animal integration and record keeping.

Out of the trainings, PELUM has successfully created over 130 demonstration sites in the region demonstrating agro ecology forms of farming. Farmers have in some cases recorded an improvement in yields in maize from 0.5 metric tonnes per hectare to 4 metric tonnes per hectare and have been able to improve on their garden output due to improved moisture levels after introducing mulching. This has also significantly improved the nutrition of farmers because of the diverse crop varieties they grow.

Animal integration has also proved to be beneficial, as most farmers no longer need to buy artificial fertilizers for their garden. Farmers have testified that they have gained a general improvement in both income and nutrition by making composts from animal droppings. From animals, farmers get milk and meat.

Through ecological organic gardens the farmers have been able to grow a wide range of vegetables and by intercropping and strip cropping they have been able to grow a huge number of vegetables on a small piece of land which they never could before. From the garden they have managed to gain a reasonable and consistent income of 15 to 25 USD per day, which has improved.

Ecological organic conservation farming is one approach in which farmers have been trained. Here farmers are told to practice minimum tillage and to use mulch for soil cover and to use organic soil improvement methods such as composting, intercropping with legumes and liquid green manures. This has made farmers less dependent on inputs from governments and loans to purchase the expensive input such as synthetic fertilizers. Use of composts and manure has improved the soil status and the soil is now able to hold moisture for a much longer time as well as support soil organisms which help to improve the soils. They say the soils have become richer and they possess a darker colour a sign of good nutrient holding capacity. There has been reduced weed infestation due to the mulch. This has led to farmers benefiting more from their field than before. Use of ecological organic conservation farming has also reduced the labour needs which give time for women to do other household chores as well as have time to rest.

Asia

Pretty and Hine (2009) evaluated 16 agroecological projects/initiatives across eight Asian countries and found that some 2.86 million households have substantially improved total food production on 4.93 million hectares, resulting in greatly improved household food security. Proportional yield increases are greatest in rain-fed systems, but irrigated systems have seen small cereal yield increases combined with additional productive system components (such as fish in rice, vegetables on dykes).

The System of Rice Intensification (SRI) is an agroecological methodology for increasing the productivity of irrigated rice by changing the management of plants, soil, water and nutrients (Stoop et al 2002). It has spread throughout China, Indonesia, Cambodia and Vietnam reaching more than a million hectares with average yield increases of 20-30%. The benefits of SRI, which have been demonstrated in over 40 countries include: increased yield at times > 50%, up to 90% reduction in required seed, up to 50% savings in water. SRI principles and practices have also been adapted for rain-fed rice as well as for other crops such as wheat, sugarcane and teff, among others, with yield increases and associated economic benefits.[40]

What probably can be considered the largest study undertaken on sustainable agriculture in Asia analyzed the work of MASIPAG, a network of small-scale farmers, farmers' organizations, scientists and non-governmental organizations (NGOs). The study compared findings from 280 full organic farmers, 280 in conversion to organic agriculture and, as a reference group, 280 conventional farmers[41]. Researchers found that food security was significantly higher for organic farmers. Full organic farmers ate a more diverse, nutritious and secure diet. Reported health outcomes were also substantially better for the organic group. The study revealed that the full organic farmers have considerably higher on-farm diversity, growing on average 50% more crops than conventional farmers, better soil fertility, less soil erosion, increased tolerance of crops to pests and diseases, and better farm management skills. The group also had, on average, higher net incomes that have increased since 2000 in contrast to stagnant or declining incomes for the reference group of conventional farmers. Per hectare net incomes of the full organic farmers were one and a half times higher than those of conventional farmers. On average, they had a positive annual cash balance for households compared to conventional farmers who experienced a deficit in the household cash balance. This means the organic farmers were less indebted than their conventional counterparts. The findings of the study summarized in Table 3 show good outcomes particularly for the poorest in rural areas. The livelihoods (defined as net income plus subsistence) of the poorest quarter of organic farmers are one and a half times higher than the income of the poorest conventional farmers. Net income plus subsistence value of crops calculated on a per hectare basis also shows a clear, highly statistically significant advantage for the organic farmers revealing higher productivity in the organic farms.

40 See http://sri.ciifad.cornell.edu/countries/cambodia/camcedacimpact03.pdf.

41 Bachmann et al., 2009.

Table 3. Main findings of the MASIPAG study on farmers practicing farmer-led sustainable agriculture
More food secure: 88% of organic farmers find their food security better or much better than in 2000 compared to only 44% of conventional farmers. Of conventional farmers, 18% are worse off. Only 2% of full organic farmers are worse off.
Eating an increasingly diverse diet: Organic farmers eat 68% more vegetables, 56% more fruit, 55% more protein rich staples and 40% more meat than in 2000. This is an increase between 2 and 3.7 times higher than for conventional farmers.
Producing a more diverse range of crops: Organic farmers on average grow 50% more crop types than conventional farmers.
Experiencing better health outcomes: In the full organic group 85% rate their health today better or much better than in 2000. In the reference group, only 32% rate it positively, while 56% see no change and 13% report worse health.

(Bachmann et al. 2009)

Paul Jeffrey/EAA

Case Study:
ECO-FARMING IN SRI LANKA

Future in Our Hands Development Fund (FIOH) has been working to promote ecological agriculture in some of the most economically poor divisions in the Uva Province of Sri Lanka since 2007. Prior to the introduction of ecological agriculture to these areas, the excessive use of agro-chemicals, intensive tillage and monocultures had severely damaged the ecosystem and soil, and malnutrition, food insecurity and the deterioration of farming families' health had become widespread.

Under the FIOH project, 600 farmers have shifted towards ecological agriculture and have experienced overall improvement in farming ecosystems, including: increased water retention in soil; cleaner ground water; reduced soil erosion; healthier soils; improved productivity and biodiversity; improved self-esteem of the local people; and improved satisfaction with farming.

In one eco-farm in Mahiyanganaya, Uva Provence, a shallow, temporary well that had once only provided water during the wet season remained full of water, despite the fact that the area had been subjected to more than two months without rain. The farmer explained that his soil had improved its water holding capacity as the permanent vegetation with an increased number of plant species established itself.

Paul Jeffrey/EAA

Paul Jeffrey/EAA

Case Study:
LOW EXTERNAL INPUT APPROACHES IN THE PHILIPPINES

In the Philippine province of Iloilo, Panay Rural Development Centre Inc. (PRDCI), a partner of EAA member Christian Aid, is supporting rice farmers to adopt low-external-input approaches. In 2003, the rice farmers working with PRDCI recorded yields of 1.16 tonnes per hectare more than the yields recorded prior to the implementation of the project. Similar yield increases have been reported by PRDCI's partners working with sugarcane and rice in five additional provinces.

Under the PRDCI-supported programme, farmers cut their use of synthetic fertilisers and herbicides by half, and the use of insecticides by two-thirds. Farmers' net incomes grew by 11% per annum following the adoption of sustainable agriculture practices. More specifically, prior to the adoption of sustainable agriculture practices in 1999, farmers netted an annual average of 21,587 pesos. Five years later, the average income was 35,449 pesos per annum.

Nicole Benz

Case Study:
SUSTAINABLE LIVELIHOODS FOR POOR PRODUCERS (SLIPP), BANGLADESH

Traidcraft and their Bangladeshi partner Development Wheel, together with eight local partners, namely Grameen Manobic Unnayan Sangstha, Gono Kallayan Parishad, Gram Unnoyan Songstha, Unit for Social Advancement, Jana Kollan Prochasta, Women Development Organization, Activity for Reformation of Basic Needs and Sabolambi Unnoan Somiti have established the SLIPP project in Northern Bangladesh, one of the poorest parts of the country. After comprehensive field research, they realized that farmers estimate and apply fertilizers and pesticides erroneously. This is based on the belief that application of more fertilizers will result in better yield. As a result, the level of organic content in the soil is at a critical low of 1% with a depleting ground water table. This in turn translated into extremely vulnerable farming communities.

To address this issue, the most relevant and viable solution identified was soil testing and the use of compost fertilizer. However, taking into account the availability and multiple use of local resources, farmers were encouraged to create their own compost fertilizer by mixing cow dung with poultry litters, water hyacinth and kitchen waste for example. Indeed, cow dung is also used for cooking fuel. SLIPP has proven to be a true success story, and a scalable one too, with results that went beyond expectations.

Badsha Miah, a vegetable farmer from Rajendrapur village, Netrokona is just one of the people whose life changed dramatically for the better as a result of participating in the project. Like many others, he cultivates vegetables to support his family. Badsha attended various training workshops organized by local service providers which, as part of SLIPP, have encouraged farmers both to test their soil in order to define the right amount of fertilizer to be applied and to use organic fertilizer. Based on the results, advice and support, Badsha adapted his practice: he reduced the fertilizer cost by 30% and switched cow dung for organic compost. When harvesting time came, Badsha was very happy and said:

"I did not know about the importance and role of compost fertilizer and soil testing on soil health. Now I know the composting process and application, soil collection procedure and sampling for soil testing, and overall fertilizer management. As a result, this season I got 25% higher production and enhanced profit almost double from the same land!"

Even better, in addition to selling his vegetables at the market, Badsha also has traders come directly to his field to buy produce. Moreover, he is planning to increase his production of compost and sell it to neighbouring farmers. Badsha's example has encouraged other farmers to change their practices as well.


Nicole Benz

Latin America

Since the early 1980s rural producers in partnership with NGOs and other organizations have promoted and implemented alternative, agroecological approaches featuring resource-conserving yet highly productive systems, such as polycultures, agroforestry, and the integration of crops and livestock[42].

An analysis of several agroecological field projects in operation during the 1990s (these initiatives now involve almost 100,000 farming families and cover almost 100,000 hectares of land) showed that traditional crop and animal combinations can often be adapted to increase productivity when the biological structuring of the farm is improved and labour and local resources are efficiently used (Table 4, pages 24-25). In fact, most agroecological technologies promoted by NGOs improve traditional agricultural yields, increasing output per area of marginal land from 400–600 to 2000–2500 kilogram per hectare–1, enhancing also the general agrobiodiversity and its associated positive effects on food security and environmental integrity. Some projects emphasizing green manures and other organic management techniques can increase maize yields from 1–1.5 tonnes per hectare–1 (a typical yield for a farmer working in highland areas) to 3–4 tonnes per hectare–1.

A 2004 IFAD study which covered a total of 12 farmer organizations that comprise about 5150 farmers and close to 9800 hectares, showed that small farmers who shifted to organic agricultural production in all cases obtained higher net revenues relative to their previous situation. Many of these farmers produce coffee and cacao under very complex and biodiverse agroforestry systems.

42 Altieri 2009.

Table 4. Agroecological projects in Latin America

NGO	*Characteristics of Intervened area*	*Agroecological and socioeconomic constraints*	*Goals of the agroecological strategy*	*Technical components of the strategy*	*Impacts and/or achievements*
SEMTA (Bolivia)	Pacajes Province, Altiplano (3,500–3,800 m.a.s.l.) Potato, cereals, Andean crops, bovine/ovine cattle, alpacas	Frost, low soil fertility, erosion, deforestation, drought. Generalized poverty, low access to credit, public services, and markets.	Slow environmental degradation process and regenerate productive potential	Organically managed mud-built greenhouses for vegetable production. Terracing, crop rotations for erosion control. Reforestation with native species. Improvement/management of native pastures.	Early production of vegetables under greenhouses resulted in premium prices in nearby La Paz markets, increasing income of participating farmers.
CIED (Puno - Peru)	Altiplano (3,500 m.a.s.l.) Natural pastures (ichu), Andean crops, potato, cattle, camelids	Frost, droughts, flooding, soil and, genetic erosion, low productivity. Poverty and marginalization	Food self-sufficiency, conservation of natural resource base, rescuing of traditional technologies	Rehabilitation of waru-warus and terraces (andenes). Crop rotations. Reintroduction of alpaca. Improved cattle management and sanitation.	Waru-warus ensure potato production in the midst of frost, therefore reducing risks in food production.
IDEAS (San Marcos - Peru)	Inter-andean valleys of Cajamarca (18 C, 450 mm rainfall). Potato, maize, cereals, cattle.	Steep slopes, erosion, and seasonal drought. Poverty, low access to good land.	Design of self-sufficient farming system. Rescuing and enriching traditional technology. Soil and water conservation.	Predial design with rotation and polycultures. Organic soil management. Management of small mammals and poultry.	Organic crop production has proved viable, stabilizing yields without use of toxic chemicals.

NGO	*Characteristics of Intervened area*	*Agroecological and socioeconomic constraints*	*Goals of the agroecological strategy*	*Technical components of the strategy*	*Impacts and/or achievements*
PTA/ CTAQ (Brazil)	Northeastern Brazil, semi-arid tropics. Eight-11 dry months. Perennial cotton, maize, beans.	Rapid organic matter photo-decomposition, low biomass production, low soil fertility, hardpan, and salinity. Poverty, low access to land, marketing problems.	Improve traditional shifting cultivation system (rozado). Offer new productive options for vegetable, fruit, and animal diversification. Water harvesting and conservation. Improved management of animals, in-situ conservation ofW local germ plasm.	Agrosilvopastoral management of catinga (xeric natural vegetation). Design of rotations, agroforestry schemes and polycultures.	Water harvesting techniques and design of drought tolerant cropping systems has enhanced productive potential in semi-arid areas.
CPCC (Paraguay)	Subtropical serrania (600–800 m.a.s.l.) Cassava, maize, peanuts, beans, cotton, sugarcane and rice.	Subtropical drought (4-6 months), low soil fertility. Low income, small landholdings	Design of agroforestry systems, soil conservation and diversification of production.	Community tree nursery. Forest enrichment, soil conservation in slopes, organic soil management.	Agroforestry systems have enhanced production of multiple resources and reverted deforestation
INDES (Agentina)	Dry subtropical area (600 mm). Cotton and subsistence crops (maize, squash, cassava).	Drought, high temperatures, wind erosion, low soil fertility. Poverty, unemployment, lack of credit.	Food self-sufficiency. Optimize use of local resources.	Rationalize cotton based rotations. Improve soil cover to avoid erosion. Use of adapted crop variety.	Diversification schemes have brought new crops into production, challenging dominance of cotton.

(Altieri 2009)

In the states of Parana and Santa Catarina, Brazil, thousands of hillside family farmers use cover crops to minimize soil erosion and weed growth, which exhibit positive effects on the soil's physical, chemical and biological properties[43]. By using cover crop mixtures including legumes and grasses, mulch biomass can reach 8000 kilogram per hectare and a mulch thickness of 10 cm leading to 75% or more inhibition of weed emergence. Maize yields have risen from 3 to 5 tonnes per hectare−1 and soybeans from 2.8 to 4.7 tonnes hectare−1 without using herbicides or chemical fertilizers.[44]

In Cuba, it is estimated that agroecological practices are used in 46%-72% of the peasant farms producing over 70% of the domestic food production, e.g. 67% of roots and tubers, 94% of small livestock, 73% of rice, 80% of fruits and most of the honey, beans, cocoa, maize, tobacco, milk and meat production[45]. As shown in Table 6 small farmers using agroecological methods obtain yields per hectare sufficient to feed about 15-20 people per year with energy efficiencies of no less than 10:1[46]. Another study[47] shows that small farmers using integrated crop-livestock farming systems were able to achieve a three-fold increase in milk production per unit of forage area (3.6 tonnes per hectare per year) as well as a seven-fold increase in energy efficiency. Energy output (21.3 gigajoules per hectare per year) was tripled and protein output doubled (141.5 kilograms per hectare per year) via diversification strategies of specialized livestock farms.

Perhaps the most widespread agroecological effort in Latin America promoted by NGOs and farmer organizations is rescuing traditional or local crop varieties (*variedades criollas*) via community seed banks, and their exchange through hundreds of seed fairs (*ferias de semillas*) in central and south America, particularly in Mexico, Guatemala, Nicaragua, Peru, Bolivia, Ecuador and Brazil. For example in Nicaragua the project *Semillas de Identidad* which involves more than 35,000 families on 14,000 hectares have already recuperated and conserved 129 local varieties of maize and 144 of beans[48].

An increasing number of indigenous groups or *cabildos* in the Andean and MesoAmerican countries have adopted agroecology as a fundamental strategy for the conservation of germ plasm and the management of agriculture in their autonomous territory. These efforts are tied to their struggle to preserve their land and cultural identity.

43 Petersen et al 1999.
44 Altieri et al 2011.
45 Machin et al, 2010, Rosset et al 2011.
46 Funes-Monzote, 2009.
47 Funes-Monzote et al, 2009.
48 http://www.swissaid.org.co/kolumbien/global/pdf/campa_a_28.05.08.pdf.

Sean Hawkey/CWS

Case Study:
SIERRA PRODUCTIVA IN PERU

In the 1980s, extreme drought throughout South America led to severe poverty problems in various South American regions, including Peru. With a view towards the necessary "next steps", an integral programme co-funded by EAA member ICCO was designed and implemented by the Institute for Alternative Agricultures (IAA).

The "Productive Sierra" (Sierra Productiva) programme, which unites Fair Economic Development and Food Nutrition Security approaches, first addresses food security problems in the local population by improving access to water, diversifying production at the household level, and improving the well-being of the households' producers. Once people attain food security and empowerment, the approach shifts to the establishment of economic initiatives. Throughout the programme, the "Farmer to Farmer" (Campesino a Campesino) methodology is applied, training local men and women to become specialized in production or commercialization issues and to teach and disseminate their knowledge through example.

This methodology has led to the achievement of numerous visible results, including the reduction of poverty in seven Peruvian provinces, and the success produced by combining nutrition, sustainable agriculture, investment in smallholder farmers and active involvement of women cannot be denied. Through the programme, 50,000 families consisting of 250,000 persons have overcome poverty. Women are taking active roles in transforming milk into yogurts, cheese and cakes. Producers are forming associations in order to improve their negotiation capabilities for better prices and market-supply contracts. One local potato producer in the village of Chahuay, Cusco used to have to travel for more than a day to the closest market to buy his vegetables. Now, he grows his own vegetables, without use of chemicals, and sells to his neighbours.

SCALING UP AGROECOLOGICAL INNOVATIONS: CHALLENGES & OPPORTUNITIES

The cases reported above show that in Africa, Asia and Latin America there are many NGO and farmer-led initiatives promoting agroecological production that have demonstrated a positive impact on the livelihoods of millions of people living in small farming communities in various countries. Agroecology has consistently proven capable of sustainably increasing productivity and has far greater potential for fighting hunger, particularly during economic and climatically uncertain times that in many areas are becoming the norm[49].

With so many proven on-farm social, productive and ecological benefits, the relatively limited adoption and dissemination of agroecological innovations begs two questions: (1) If agroecological systems are so profitable and efficient, why have they not been more widely disseminated and adopted? and (2) How can agroecological approaches be multiplied and scaled up?

Research and practice have in fact demonstrated that there is nothing fundamental preventing wide-scale adoption of agroecological methods but that it is largely dependent on an effective knowledge exchange among farmers. The scaling up of agroecology is based on a "bottom-up" approach, using and building upon the resources already available: local people, their knowledge and their domestic natural resources. Successfully scaling up agroecology depends heavily on enhancing human capital and empowering communities through training and participatory methods that seriously take into account the needs, aspirations and circumstances of smallholders.

Most initiatives to scale up agroecology have involved capacity building emphasizing training, farmer field schools, on-farm demonstrations, farmer-to-farmer exchanges, exchange visits and other activities. These activities have been the cornerstone of the NGO extension approach and have been successful in reaching farmers with formal training in ecological agricultural practices.

But the issues involved in promoting agro-ecology are complex. There is limited availability of fuel for cooking, which places competing and more urgent demands on manure and crop residues. Encouraging farmers to use green manure crops, compost, rice straw and water hyacinth as alternative methods for developing soil fertility or afforesting farmland to provide fodder and fuel does little to address the structural issues that underline the lack of access of farmers to land, wood, water and other vital resources. Changes in policy that improve access to these resources are therefore necessary to confront the root causes of poverty.

Researchers have identified a number of constraints that discourage adoption and dissemination of agroecological practices[50], ranging from technical issues such as lack of information by farmers and extension agents to policy distortions, market failure, lack of land tenure and infrastructural problems (Box 4). In order to further spread agroecology among farmers it is essential to overcome part or all of these constraints. Major reforms must be made in policies, institutions, and research and development agendas to make sure that

49 De Schutter 2010.
50 Alonge and Martin, 1995.

agroecological alternatives are widely adopted, made equitably and broadly accessible, and multiplied so that their full benefit for sustainable food security can be realized. Farmers must have better access to local-regional markets, government support such as credit, seeds and agroecological technologies. A major constraint to the spread of agroecology has also been that powerful economic and institutional interests have backed research and development for the conventional agroindustrial approach, while research and development for agroecology and sustainable approaches has in most countries been largely ignored[51].

Case Study:
THE POTENTIAL AND THE CONSTRAINTS TO SCALING UP AGROECOLOGY

The NGO AS-PTA engaged along with family farmers in southern Brazil in the search for alternatives to conventional maize production. In 2008-2009, one of the driest conventional maize producing area exhibited an average yield loss of 50%. However the producers who had switched to incorporating agroecological practices in their production systems (use of local seeds + green manures + rockdust + minimum tillage) experienced smaller losses – around 20% – with significantly lower average production costs. Based on the data collected in the study, an estimate was made of the positive impacts of a hypothetical public programme supporting agroecological transition in the region. Taking into account a total population of 48,000 farming families, the potential for increases in the regional production of basic grains (maize + beans) was around 170,000 tonnes with average increases of US $563 in the annual income of family farms. Although these represent rough estimates, they highlight the technical and economic potential of scaling up low-cost agroecological technologies, thus responding to the financial crisis facing family farming in southern Brazil, which emerged in the 1990s with the liberalization of agricultural markets. Unfortunately the Brazilian state has opted to allocate ever more funds to programmes aimed at modernizing family farming on the basis of the scientific-technological precepts of the Green Revolution. To this end it created and systematically extended the scale of Pronaf (National Family Farming Support Program), a public programme that ended up providing easy credit for purchasing agrochemicals and motorized equipment. In this case, as in many other cases all over the world, non-conducive policies undermined the dissemination of agroecology.

51 Altieri 2002.

Box 4. Major constraints that limit the dissemination and adoption of agroecological approaches by farmers
Farmers' knowledge and information needs: Agroecological practices are highly complex and management intensive thus adopting them imposes a need for increased learning.
Lack of information about agroecological practices: Many farmers lack enough information about technical issues and the economic viability of agroecological farming and need to be sure that it represents an economically viable option in order to adopt.
Lack of practical knowledge from researchers and extension agents about agroecology: Due to their lack of knowledge, change agents are doubtful of sustainable agriculture and less interested in promoting the concept. Public research and extension agents are increasingly being influenced by private interests to promote conventional approaches rather than agroecology.
Site specificity of agroecology: Agroecological principles have universal applicability but the technological forms through which those principles become operational depend on the prevailing environmental and socio-economic conditions at each site. Such site specificity requires local research and innovation.
Lack of farmers' organizations: An absence of social networks for farmers for collective experimentation and exchange of agroecological information is an important constraint for the adoption and dissemination of agroecological innovations.
Economic barriers: Some common economic factors constraining farmers are the uncertainty of profitability, cost of making the conversion, loss of productivity during transition, increased labour demanded and perceived increased risk associated with agroecological adoption. Even if green markets where to be developed, from the perspective of individual landholders, many of the environmental services provided by agroecological systems, such as biodiversity conservation, carbon sequestration, and water conservation, are externalities and therefore do not really act as incentives for adoption as they cannot capture the derived economic benefits.
Biased agricultural policies: National policies not supportive of agroecological approaches are largely responsible for sustainable agriculture remaining in the margins. In most countries there is a continuous policy failure in providing the adequate economic environment needed for the transition to agroecological production systems. Some farmers' organizations perceive the promoting of niche (organic and/or fair trade) markets for the rich in the North as exhibiting the same problems of any agroexport scheme that does not prioritize food sovereignty, often perpetuating dependence and at times hunger.
Market failures caused by domestic policies are often a great obstacle for advancement of agroecology. Low commodity prices, caused in part by continued subsidization of agriculture in much of the developed world, reduce the incentives to invest in agroecological innovations. The real prices of agricultural products are so low that it is very difficult for farmers to obtain the capital needed to make the change to sustainable agriculture. Each time food prices increase, a significant number of family and small-scale farmers are forced to leave the market due to the low price they receive for their products and, in part, the high cost of inputs, principally fertilizers. The deregulated market, privatization and free market treaties negatively affect both small farmers and consumers. The situation is aggravated by the systematic elimination of the national production capacity by the promotion of agroexports and biofuels partly stimulated by government subsidies.
Land tenure issues: Lack of access to land or insecure land tenure is an important barrier to adopting sustainable practices in developing countries. Insecure property rights make it difficult for farmers to adopt agroforestry and soil conservation schemes or to establish contracts for carbon sequestration.
Infrastructure problems: For a more widespread adoption of sustainable practices, countries must invest in appropriate market options, transportation, and communications. In many countries lack of sufficient quantities of organic fertilizers or seeds for cover crops and green manures can be the most difficult barrier to overcome for widespread implementation of agroecology.

(Alonge and Martin, 1995)

APPROACHES FOR SCALING UP AGROECOLOGY

Farmer-to-farmer networks

What started as localized agroecology efforts in several isolated rural areas expanded to thousands of peasant communities throughout the world. In Latin America, a key factor in agroecological expansion was the Campesino a Campesino (CAC) movement, which is a horizontal process of exchange of ideas and innovations among farmers. It was via the CAC method that soil conservation practices were introduced in Honduras, and hillside farmers adopting the various techniques tripled or quadrupled their yields from 400 kilograms per hectare to 1,200–1,600 kilograms. This tripling in per-hectare grain production has ensured that the 1,200 families that participated in the programme have ample grain supplies for the ensuing year[52].

Organized social rural movements such as the international Via Campesina comprising 150 local and national organizations in 70 countries, the one million families Landless Workers Movement (MST) in Brazil, and others such as ANAP in Cuba have massively adopted agroecology as their approach to food production. What constituted the soul of the Cuban agroecological revolution, which led to the highest ever food production in the decade after the collapse of the Soviet Union, previously the main supplier of inputs for Cuban farming, was the adoption of agroecological methods by 110,000 family farmers[53].

In less than a decade the active participation of small farmers in the CAC process of agroecological innovation and dissemination produced a major impact through farmer-to-farmer models that focus on sharing experiences, strengthening local research and problem-solving capacities. One of the best examples of this approach are the Farmer Field Schools (FFS) which consist of a group-based learning process used by a number of governments, NGOs and international agencies collaborating in the promotion of agroecological methods. A successful FFS was highlighted by the FAO Intercountry Programme for the Development and Application of Integrated Pest Control in Rice in South and South-East Asia launched in 1980. Farmers carried out experiential learning activities that helped them understand the ecology of their rice fields via simple experiments, regular field observations and group analysis. Thousands of farmers reported substantial and consistent reductions in pesticide use and in many cases there was also a convincing increase in yield attributable to the effect of training. Integrated Pest Management (IPM) Farmer Field School programmes, at various levels of development, are now being conducted in over 30 countries worldwide.[54]

Similar initiatives have been set up to build farmers' capacities to conserve precious natural resources and promote sustainable agricultural practices throughout Asia. The intra-regional programme Sustainable Agriculture and Farmers Rights (SAFaR) run by Caritas Asia is based on farmers' exchanges on sustainable agriculture. SAFaR brings together grassroots farmers to learn from one another through group visits to each other's farms. Then, once solutions have been shared and others developed, they assist farmers in learning how to advocate for their rights through yearly conferences with their government officials. SAFaR participating countries are divided into two regions, South and Southeast Asia and encompass members from Bangladesh, India, Nepal, Pakistan, Sri Lanka, Cambodia,

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52 Altieri, Funes and Peterson, 2011.
53 Rosset et al, 2011.
54 See http://www.fao.org/docrep/006/ad487e/ad487e02.htm

Paul Jeffrey/EAA

Case Study:
SHARING KNOWLEDGE FOR ENVIRONMENT-FRIENDLY FARMING IN INDIA

Caritas India has been working on promoting climate friendly farming systems in various parts of the country. They are in the process of setting up a Centre for Environmental Studies in Social Sector (CESSS) in Vidarbha with support from Caritas Spain, to meet the capacity building needs of the farmers and civil society organizations and Caritas partners in India. Through this centre they are promoting Farmers Field School (FFS) where farmers are engaged in developing their own methods to improve the productivity and conserve the environment. Through this centre, farmers from about 20 villages have formed farmers groups and are engaged in organic farming. During the first year of intervention, the farmers of FSS have taken record yield in crops, which has boosted their morale and commitment to organic farming as very economical and environment friendly.

the Philippines, Indonesia, Myanmar, Thailand, Hong Kong and Mongolia. Since 1995, SAFaR is contributing towards strengthening farmers' networks for the promotion of sustainable agriculture techniques that are economically viable, environmentally sound and socially just.

NGO-led initiatives

Since the early 1980s, hundreds of agroecologically-based projects incorporating research, awareness-raising and training of farmers have been implement by NGOs and church-based groups throughout the developing world. The initiatives inorporate elements of both traditional knowledge and modern agricultural science. A variety of projects exist featuring resource-conserving yet highly productive systems, such as polycultures, agroforestry, soil conservation, water harvesting, biological pest control and the integration of crops and livestock, etc. Approaches to training farmers on agroecological methods and disseminating best practices encompass a great variety, including methods such as field days, on-farm demonstrations, training of trainers, and farmers' cross-visits. Much of the spread of Conservation Agriculture in southern Africa reaching over 50,000 farmers has been attained via one or more these methods.

However, despite the successes of these initiatives, there is a need for increased collaboration among the various actors (farmers organizations, NGOs, academic institutions and research centres) in order to scale these actions up.

The benefits of effective coordination would be triple-fold: Financial and human resources would be maximized because duplication of efforts would be reduced; knowledge-based technologies could be improved through the wider sharing of evidence-based best practices; and training and field implementation would have a wider and more rapid geographic reach because greater networks could rapidly disseminate agroecological knowledge.

Case Study:
REGIONAL NETWORKS ADVOCATE FOR POLICY BASED ON EXPERIENCE

Operational since 1995, Participatory Ecology Land-Use Management (PELUM), a member driven regional network of over 207 civil society organizations in Botswana, Kenya, Lesotho, Malawi, Rwanda, South Africa, Tanzania, Uganda, Zambia and Zimbabwe, promotes agroecology as a sustainable way of farming. Their vision is that smallholder farming communities are self-organized and able to make choices towards an improved quality of life that is socially, economically and ecologically sustainable.

PELUM has contributed to policy change at national, regional and continental level so that decision makers support ecological agriculture and include it in national plans and continental frameworks such as the Comprehensive Africa Agriculture Development Programme (CAADP) and the Common Market for Eastern and Southern Africa (COMESA).

As a result, organic ecological agriculture has been introduced in the African Union Commission (AUC) framework. PELUM has also been instrumental in the creation of an AUC initiative called the Ecological Organic Agriculture (EOA) initiative for Africa. PELUM is an active member of the EOA initiative and is implementing some of its projects. This initiative is in response to the African Heads of States and Government decision EX.CL/Dec.621 (XVII) on organic farming.

PELUM's advocacy with CAADP and other national, regional and continental initiatives and policies is based on experience that including smallholder farmers and their support organizations in agriculture research for development (ARD) improves the relevance and uptake of ecological agriculture innovation systems.

Case Study:
MARGINALIZED WOMEN FARMERS CONTRIBUTE TO SUSTAINABLE AGRICULTURAL POLICY IN INDIA

The Deccan Development Society (DDS) was established in 1983 in Medak district of Hyderabad, the capital city of Andhra Pradesh. Within two decades, DDS activities have spread to 75 villages in five mandals in Medak district. The initial aim to build local leadership and disseminate appropriate technologies soon developed into a wider vision of enabling local communities to develop in an autonomous way and particularly to improve their control over local food systems. DDS has a special focus on socially excluded communities such as Dalits, and works with women to support local organizations or sanghams that are networked and operate democratically. The experience of DDS illustrates how even the most marginalized women can play a key role as advocates for change.

Thousands of women farmers linked to DDS have been instrumental in a campaign with the Millet Network of India for the inclusion of millets in the definition of food grains in the Indian Food Security Bill and decentralized public distribution system. These women smallholders have over many years demonstrated in practice the potential of millets to contribute to food security, nutrition and productivity in drought-prone and poor soils, and have advocated for these changes based on their experience and knowledge. A film documenting these efforts has been produced by the DDS Community Media Trust. Millets are grown on marginal lands by some of the poorest and most marginalized communities - the Dalits, the Adivasis and the women in the dryland and hilly regions.

Millet cultivation does not demand any external inputs and most importantly, is based on farmers' local knowledge. Millets are inherently biodiverse, coming in many different varieties, and they are generally grown in combination with a host of pulses, legumes, vegetables and oil seeds. Perhaps most importantly, millets can provide nutritious crops from some of the most marginal lands, enabling poor farmers to make the most of very limited resources. (Christian Aid)

Paul Jeffrey/EAA

Developing local markets

There are thousands of initiatives throughout the world aimed at closing the circuits of production and consumption via development of local farmers markets and community supported agriculture. One of the most promising examples is Rede Ecovida in southern Brazil, which consists of a network among organized family farmers, supportive NGOs and consumers whose objective is to promote agroecological alternatives and develop solidarity markets that tighten the circle between local producers and consumers, ensuring local food security and keeping the generated wealth in the community (van der Ploeg 2009). Presently Ecovida encompasses 180 municipalities and approximately 2,400 families of farmers (around 12,000 persons) organized in 270 groups, associations and cooperatives. They also include 30 NGOs and 10 ecological consumers' cooperatives. All kinds of agricultural products are cultivated and sold by the Ecovida members, for example vegetables, cereals, fruits, juice, fruit-jelly, honey, milk, eggs and meat. In 2003, sales amounted to 13,750,000 USD; 27% of the sales were to local independent markets, 20% for export, 19% to the institutional market and 34% for other markets like supermarkets, shops, agro industries etc.[55]

Government policies

To ensure rural food security, poor communities must have access to land, seeds, water and other resources. Farmers must be assured of full ownership over their land, rather than customary tenure or informal use right, so that they can be encouraged to invest in the long-term sustainability rather than fearing that it might one day be lost to industrial or urban developers or large scale agricultural business. This must be accompanied by initiatives that enable the creation of, and access to, local food networks and food markets that return fair prices for smallscale producers, promote a broader use of agricultural biodiversity, and protect peasants from global trade policies and dumping that impact negatively on the strategic position of domestic producers in national food systems.

Governments must create an enabling policy environment for this to work, as was done by the government of Brazil. In Brazil there are about 4.8 million traditional family farmers (about 85% of the total number of farmers) that occupy 30% of the total agricultural land of the country. Such family farms control about 33% of the area sown to maize, 61% of that under beans, and 64% of that planted to cassava. One of the many policies of the Ministry of Rural Development (MDA) is the public purchasing programme *Programa de Aquisiçao de Alimentos* (PAA) created in 2003. The PAA improves the livelihoods of smallholder farmers through the creation of a stable demand platform for their produce, such as school meal programmes and hospitals. This allows small holders to bypass the trade categories or necessary volume requirements that would otherwise arise when selling their produce to a trader. A similar programme includes the sale of milk. In the scope of four programme lines, farmers are given a purchase guarantee for specific quantities at specific prices making their operations more economically viable and secure.

Governments must also improve infrastructure, such as roads, and access to critical resources including financial assets, up-to-date information about commodity pricing, storage and handling facilities to reduce waste from post harvest losses so that farmers' produce can reach markets.

Governments need to make weather information available to farmers, including small food producers and pastoralists, in a form that is useful to them. The private sector and financial institutions should be encouraged to play a useful role in this by offering affordable weather insurance to farmers.

55 See http://www.ifoam.org/about_ifoam/standards/pgs_projects/pgs_projects/15649.php

Stig Tanzmann/EED

Case Study:

OVER 30 YEARS OF AGROECOLOGY IN SOUTHERN BRAZIL

In 1978 EED (Church Development Service in Germany) partner organisation CAPA (*Centro de Apoio ao Pequeno Agricultor*, Centre for the support of small holder farmers) was founded by the IECLB (Igreja Evangélica de Confissao Luterana no Brasil). In the late 1970s the situation of the many smallholder farms in the southern states of Paraná, Santa Catarina and Rio Grande do Sul became very difficult. It was becoming clear that the "Green Revolution" did not work for most smallholders, and the young generation were leading an exodus from the farms, to escape the poisonous work in the tobacco monocultures.

CAPA was founded to find new answers to stop this exodus and to conserve the rich agro-biodiversity of southern Brazil. CAPA started by teaching alternative farming methods without pesticides and chemical fertilisers, and today has the goal that all the farmers they are working with get certified as organic producers.

A key element of CAPA is to form cooperatives. Most of these cooperatives become autonomous. One of the largest of these cooperative now has more than 3,000 members. CAPA gained a lot of experience in local marketing, especially in setting up local food markets and on the certification of organic products. They co-founded ECOVIDA, one of the major labels for organic food in Brazil.

In the late 1980s CAPA successfully lobbied the local government of Rio Grande do Sul to create institutional markets. This meant that the regional government started to buy products for its canteens, schools and its social welfare programmes from the local smallholder's agroecology farms and at a 30% higher price. This system of the institutional markets had been tested already in the countryside where mayors related to the IECLB and CAPA opened the school canteens and gardens for agroecological products and production. Finally the farmers had a secure and growing market and through the schools the idea of alternative farming was spread even further.

When the PT (*Partido dos Trabalhadores*) and Lula came to power in 2003 this programme was scaled up for the whole country through the Zero Hunger Program. From 2003 to 2010 the Brazilian State bought about three million tons of food, when possible from small holders or agro-ecological farmers. In the state of Santa Catarina, for example, a CAPA-supported cooperative accounts for all the maize of the local Zero Hunger Program. For agroecological farmers this means that the demand for their products is high and growing. So more and more farmers are turning to agroecological farming methods and more cooperatives are being formed.

Governments must significantly increase their funding for and re-orient their research focus towards multiple-benefit approaches to agriculture, with priority emphasis on agroecological practices and systems that strengthen resilience, conserve natural resources and maintain natural ecological processes that support food production systems and the needs of small food producers over time. In Zambia, over 70% of the government's agriculture budget goes into fertilizer support programmes at the expense of other core functions. In Malawi, it accounts for 60% of the Ministry of Agriculture's budget[56]. These resources could be better spent through education and scaling up farmer-to-farmer networks.

Linking national research systems with civil society organizations that are implementing action-based research with this orientation would generate better evidence. This research should be farmer-led, including especially women, from the initial decision stage on what to research to the design and implementation.

There is also an important role for governments to play in providing incentives for farmers to adopt resource-conserving technologies and reviving public agroecological research and extension programmes suited to the needs and circumstances of smallholder farmers, their associations and networks. The improvement of extension services should, in particular, be

55 Success in Reducing Hunger: Lessons from India, Malawi and Brazil, 2011, International Food Security Network, p 9.

56 Via Campesina 2010.

carried out through existing farmers support organizations and farmers networks.

In general terms, there is a need for enhanced appreciation among policy makers of the potential and indeed the benefits of agroecology in delivering increased productivity, climate resilience and thus food security that most of our governments are grappling with.

Transforming the global agricultural system

Many farmer and indigenous-based organizations and movements, such as *Via Campesina*[56], advocate for a more radical transformation of agriculture, one guided by the notion that ecological change in agriculture cannot be promoted without comparable changes in the social, political, cultural and economic arenas. Excessive trade liberalization is driving farmers off their land and is the principal obstacle to local economic development and food security. Changes in the export- and investment-led, free-trade based, industrial agriculture model of large farms are needed to address the downward spiral of poverty, low wages, rural-urban migration, hunger and environmental degradation. Many of these movements embrace the concept of food sovereignty, which focuses on local autonomy, local markets and community action for access and control of land, water, agrobiodiversity, energy and other aspects of central importance for local communities to be able to produce food sustainably.

While critiquing the impact of international trade, a constructive utilization of the international agricultural marketplace must also be envisaged. A significant scaling up of agroecology will only be possible by pressuring national governments to support fair food systems and better control of multinational companies. Countries must create and retain the necessary policy space to ensure small-scale food producers have the capacity, ability and access they need for productive and resilient farms.

CONCLUSION, AND WAY FORWARD

Agroecology works. The experience of farmers and food-producing communities around the world using agroecological methods has provided a growing body of evidence of the economic, social and environmental benefits of these methods. Agroecological approaches have delivered increased food production and improved income for farmers, and enhanced food security and nutrition for the communities they feed. These approaches have very low transaction costs and exhibit huge returns on investment. By the same means, agroecology delivers the social benefits associated with poverty reduction and community empowerment. And in a context of global climate change and environmental degradation, agroecology delivers the environmental benefits of lower resource use, reduced environmental impacts both on- and off-farm, and protection of biodiversity, while at the same time enhancing resilience against the shocks associated with accelerating climate change.

Replicating industrial-scale monocropping and food production utilizing fossil-fuel based synthetic inputs throughout the world is neither desirable nor possible. It is time to challenge our assumptions regarding food production and consumption and face up to planetary boundaries and limits to productivity.

Agroecology is scalable. It has been spread and applied by many farming communities around the world, primarily through a process of farmer-to-farmer knowledge sharing. Its main inputs and investments are information and best practice, knowledge of local conditions, and the natural resources of local eco-systems. It is not dependent in the long run on chemical fertilizers, pesticides or transgenic crops, which are costly for small-scale farmers and often resource-depleting. It can be, and indeed already has been, scaled up to reach millions of farmers and millions of hectares in Africa, Asia and the Americas. The challenge now is to equip a much larger proportion of the world's smallholder farmers – who produce most of the world's food – with agroecological knowledge and skills.

But agroecological methods of food production – and the local traditional knowledge and ongoing farmer-to-farmer exchange of best practice on which they are founded – have not attracted the investment for research or support for broader information networking among smallholder farmers that would be required for more massive scale-up.

Agroecology can feed the world. Despite the expansion of environmentally destructive high-intensity industrial 'Green Revolution' agriculture, most of the food consumed worldwide is still produced by smallholder farmers. By increasing the nutritional yield and reducing the environmental impact of smallholder farms through the application of agroecological methods, while at the same time addressing the issues of food waste and market access for smallholder farmers, the challenge of feeding nine billion people by 2050 can be met – sustainably.

Agroecology will be necessary, if we are to find a viable path through the intertwined challenges of future food security, and climate change mitigation and adaptation. In the context of climate change, business as usual in the field of food production is not an option. Agroecology offers the prospect of sustainable food production to meet the needs of a still growing global population, while at the same time reducing the GHG emissions from the agricultural sector, building resilience to already unavoidable climate change, protecting biodiversity, and sustaining communities and rural livelihoods.

The key steps forward if we are to pursue this path will include:

1) **Much greater investment in research on agroecological food production methods**, building on traditional knowledge and existing best practice, for the purpose of enhancing smallholder-based, low-emission, high-productivity agriculture in the context of climate change.

2) **Increased support for the establishment and expansion of farmer-to-farmer networks at local levels throughout the developing world**, for the sharing of information and best practices in agroecological food production, as the key instrument for scaling up agroecological food production in food insecure areas.

3) **Enabling policy environments at national and international levels**, recognizing the central role of smallholder farmers in global food security and supporting smallholder-based agroecological food production, and agroecological extension programs at national and local levels.

4) **Increased support for the establishment and expansion of smallholder farmers' collectives**, to improve market opportunities and the collective capacities of smallholder farmers and their communities.

5) **More effective regulation and management of the negative impacts of corporate influence of agricultural policy and practice**, including the unconstrained promotion of dependence on proprietary technologies such as transgenic crops and chemical fertilizers.

6) **More focused and effective attention to reducing food waste throughout the food supply chain**, from point of production (especially by improving local access to storage, processing and transportation infrastructure for smallholder farmers in the developing world) to point of consumption (especially by challenging consumer behaviours and the waste resulting from quality standards in the developed world).

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Ecumenical Advocacy Alliance

150 route de Ferney
P.O. Box 2100
1211 Geneva
Switzerland

+41 22 791 6723
+41 22 710 2387
info@e-alliance.ch
www.e-alliance.ch