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Ecological agriculture is climate resilient

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Introduction

Agriculture is the most important sector in many developing countries and is central to the survival of millions of people. Most agriculture production in these countries involves small land holdings, mainly producing for self-consumption. Women are the key agricultural producers and providers. Hence agriculture is critical for food and livelihood security, and for the approximately 500 million smallholder households, totaling 1.5 billion people, living on smallholdings of two hectares of land or less (De Schutter, 2008). Smallholdings account for 85 percent of the world's farms.

However, climate change threatens the livelihoods and food security of billions of the planet's poor and vulnerable, as it poses a serious threat to agricultural production. Agriculture, in the dominant conventional and industrial models that are practiced today, is also a major contributor to greenhouse gas (GHG) emissions.

At the same time as they pose a huge climate threat, industrial agricultural systems are highly vulnerable to climate change. The industrial model and the crop varieties designed to work well within it depend on energy- and water-intensive irrigation as well as other fossil fuel-intensive inputs such as mechanized harvesting, fertilizers and pesticides. Highly vulnerable to reductions in the availability of fuel and water, and in the long-term economically unsound, the model will not survive (Vandermeer et al., 2009). Nothing less than a system change is needed in the face of the climate change threat.

A focus on the climate challenge to ecosystems and livelihoods is therefore needed, particularly as the adaptation needs of developing countries are paramount. As such, we should heed the call of the International Assessment of Agricultural Knowledge, Science and Technology for Development[1] (IAASTD, 2009) to the international community and national governments to systematically redirect agricultural knowledge, science and technology towards sustainable, biodiversity-based ecological agriculture and the underlying agroecological sciences.

This is because the ecological model of agricultural production, which is based on principles that create healthy soils and cultivate biological diversity and which prioritizes farmers and traditional knowledge, is climate resilient as well as productive. Ecological agriculture practices are the bases for the adaptation efforts so urgently needed by developing country farmers, who will suffer disproportionately more from the effects of climate change. Many answers lie in farmers' fields and farmer knowledge, for example, how to create healthy soils that store more water under drought conditions and how to grow a diversity of crops to create the resilience needed to face increased unpredictability in weather patterns.

Ecological agriculture to meet the climate challenge

Climate change will require a range of adaptation approaches across many elements of agricultural production systems, from small changes in the crop varieties grown to decisions to abandon cropping completely. For example in some rainfed regions in Africa, there just will not be enough predictable moisture to continue to grow crops; in these areas, agriculturalists may change to livelihood strategies based entirely on pastoralism, or they may need to move to other regions or to cities. In other areas more animals may be integrated into the farming system to reduce dependency on crop production (Jones and Thornton, 2008).

In all areas, farmers working to adapt to climate change will need to adopt new practices that help to increase the resilience of their cropping systems – through building healthier soils, increasing the biological diversity of the system and, particularly in rainfed regions (where most poor farmers farm), incorporating more water harvesting and water management

[1] The IAASTD is a comprehensive assessment of agriculture and was co-sponsored by the World Bank, FAO, UNEP, UNDP, WHO, UNESCO and GEF. Its reports, which drew on the work of over 400 experts, were approved by 58 governments in 2008.

techniques. These are practices that governments and other funding agencies must prioritize as they promote transitions to climate-resilient agricultural systems.

Building healthy soils

By increasing the health of soils, farmers can increase the water-holding capacity of the soil and the infiltration capacity – augmenting the speed at which water can percolate into soils and thus the ability to take more advantage of heavier rains that are expected under climate change (Tirado and Cotter, 2010). Moreover, by building healthier soils, farmers can increase productivity. Given that climatic changes will likely significantly reduce yields over time, any increase in productivity through better soil health and fertility will serve to moderate the productivity reduction expected. For example, research from 30-year side-by-side trials of conventional and organic farming methods (involving leguminous cover crops and/or periodic applications of manure or composted manure) at the Rodale Institute in the USA has shown that organic corn yields were 31 percent higher than conventional in years of drought[2].

Many well-established agroecological practices increase soil health and fertility, and with these, productivity. Prominent among these practices is the addition of manure or compost. At the same time that these additions bring necessary nutrients into the system, they also improve the structure of the soil, making it better able to hold onto both nutrients and water. And by improving the soil structure, water is able to infiltrate better, capturing more during periods of intense rainfall. Evidence from the Tigray region in Ethiopia shows that compost can increase crop yields significantly; on average, composted fields gave higher yields, sometimes double, than those treated with chemical fertilizers (Edwards et al., 2009).

Other ecological agriculture practices that can improve soil structure and increase fertility include growing green manures (crops that are tilled into the soil after they are grown to add nutrients and structure), cover cropping to add nutrients and keep soil covered during a fallow season, mulching, and crop rotation (Magdoff, 1998). These are all standard practices in agroecological systems, which work to increase fertility naturally, and use the diversity of the system to control pests and diseases, while increasing habitats for pollinators and other beneficial organisms.

Building resilience through diversity

System resilience can be built through increasing biological diversity (Altieri and Koohafkan, 2008). Practices that enhance biodiversity allow farms to mimic natural ecological processes, enabling them to better respond to change and reduce risk. Experience suggests that farmers who increase diversity suffer less damage during adverse weather events, compared to conventional farmers planting monocultures (Altieri and Koohafkan, 2008; Ensor, 2009; Niggli et al., 2009).

In cropping systems diversity can be increased through increasing the variety of crops grown at one time on the parcel of land, and by adding trees and/or animals into the system. Farmers can also increase the diversity of the system by increasing crop diversity itself – growing different varieties of the same crop that have different attributes, for example shorter season varieties that may be beneficial if the season is shortened by inadequate rainfall, or varieties that provide more nutritious forage for animals. Supporting soil health increases the diversity of organisms in the soil, which are responsible for benefits such as increased access to nutrients and reduction of overall disease burden. Diverse agroecosystems can also adapt to new pests or increased pest numbers (Ensor, 2009).

It is important to note here the role of women, as they play a key role in managing biodiversity, and thus in adapting to climate change. For example, women in Rwanda produce more than 600 varieties of beans; in Peru, Aguaruna women plant more than 60 varieties of manioc (CBD 2009).

Emphasizing water management and harvesting techniques

Adapting to climate change will require even more emphasis than is currently given to improving water management and water harvesting in rainfed regions. Many traditional techniques already in use to improve rainwater use efficiency can be shared using farmer-to-farmer methods.

For example, the zaï techniques of the Sahel have received much attention: water pits used by farmers in Burkina Faso and Mali to reclaim thousands of hectares of degraded lands in the last decades. Farmers have become increasingly interested in the zaï as they observe that the pits efficiently collect and concentrate runoff water and function with small quantities of manure and compost. The practice of zaï allows farmers to expand their resource base and to increase household security. Yields obtained on fields managed with zaï are consistently higher (ranging from 870 to 1,590 kg/ha) than those obtained on fields without zaï (average 500–800 kg/ha). There are many other successful traditional water-harvesting techniques in

[2] http://www.rodaleinstitute.org/fst30years/yields

active use around the world by farmers in rainfed environments, a number of them described in detail by Altieri and Koohafkan (2008).

Increasing productivity in the face of climate change

Given the threats of climate change to crop yields, it is important that agriculture practices are able to maintain and even increase productivity. Fortunately, the practices that enhance climate resiliency that are found in ecological agriculture also work to raise productivity, primarily because they improve soil structure and increase fertility.

For example, in a comprehensive meta-analysis, Badgley et al. (2007) examined a global dataset of 293 examples and estimated the average yield ratio (organic : non-organic) of different food categories for the developed and developing world. On average, in developed countries, organic systems produce 92 percent of the yield produced by conventional agriculture. In developing countries, however, organic systems produce 80 percent ***more*** than conventional farms. The data also suggest that leguminous cover crops could fix enough nitrogen to replace the amount of synthetic fertilizer currently in use.

Many other specific examples exist of ecological agriculture practices increasing productivity. These are summarized in Lim (2009). Some examples that focus on ecological agriculture practices particularly important for increasing climate resilience are highlighted:

- Soil and water conservation in the drylands of Burkina Faso and Niger have transformed formerly degraded lands. The average family has shifted from being in cereal deficit of 644 kg per year (equivalent to 6.5 months of food shortage) to producing an annual surplus of 153 kg.
- Projects in Senegal promoted stall-fed livestock, composting systems, green manures, water harvesting systems and rock phosphate. Yields of millet and peanuts increased dramatically by 75–195 percent and 75–165 percent respectively.
- More than 1,000 farmers in low-soil-fertility areas in the North Rift and western regions of Kenya increased maize yields to 3,414 kg/ha (71 percent increase in productivity) and bean yields to 258 kg/ha (158 percent increase in productivity) as compared to traditional agriculture, by incorporating soil fertility management, crop diversification and improved crop management.
- Forty-five thousand families in Honduras and Guatemala have increased crop yields from 400–600 kg/ha to 2,000–2,500 kg/ha using green manures, cover crops, contour grass strips, in-row tillage, rock bunds and animal manures.
- The states of Santa Catarina, Paraná and Rio Grande do Sul in southern Brazil have focused on soil and water conservation using contour grass barriers, contour ploughing and green manures. Maize yields have risen from 3 to 5 tonnes/ha and soybeans from 2.8 to 4.7 tonnes/ha.
- The high mountain regions of Peru, Bolivia and Ecuador are some of the most difficult areas in the world for growing crops. Despite this, farmers have increased potato yields by threefold, particularly by using green manures to enrich the soil. Using these methods, some 2,000 farmers in Bolivia have improved potato production from about 4,000 kg/ha to 10,000–15,000 kg/ha.

Towards climate resilience through ecological agriculture

Adaptation of agricultural systems to changing climates is an enormous challenge that will take the concerted effort of governments, researchers and farmers, working together and starting immediately. Because temperatures will continue to rise over the coming decades, we find ourselves in a race against time, to an unknown destination. The effort to create climate-resilient agricultural systems must be prioritized at all levels – from the local to the global, with an important role for national governments to coordinate efforts. Lack of well-coordinated and well-funded adaptation strategies threatens the lives and livelihoods of millions.

An essential component of climate-resilient agriculture, as explained above, is ecological agriculture. To move on the road to a climate-resilient agriculture, agricultural practices and policies, at the national and international levels, must be systematically and urgently redirected towards ecological agriculture, in order to ensure it can reach its full potential, especially in addressing this enormous challenge.

Farmers, in particular women who make up the majority of the world's small producers, must play a key role on the road to climate-resilient agricultural systems. To do so, they must be integrated into the research and development systems and given tools to do their own on-farm research and the capacity to share their knowledge with other farmers in farmer-to-farmer networks. The challenges facing agriculture are too great to ignore the important potential of farmers, their knowledge and their innovation skills to contribute in the creation of climate-resilient agricultures.

In stark contrast to the positive role that farmers will play in creating climate-resilient systems are the few transnational companies that make up the world seed, agrochemical and biotechnology markets. These companies have a vested interest in maintaining a monoculture-focused, carbon-intensive industrial approach to agriculture, which is dependent on external inputs (Hoffmann, 2011). In 2004, the market share of the four largest agrochemical and seed companies reached 60 per cent for agrochemicals and 33 per cent for seeds, up from 47 per cent and 23 percent in 2007 respectively (World Bank, 2008). Efforts are needed to address the challenges this situation raises.

Five essential elements are crucial to move towards climate resiliency:

1. **Increasing investment in ecological agriculture**

Ecological agriculture practices contribute to resilience and increase adaptive capacity through: improving and sustaining soil quality and fertility; developing and supporting communal water conservation and water catchment systems; enhancing agricultural biodiversity; and developing and supporting agroforestry systems, including conversion of degraded lands to perennial small-scale agroforestry. Governments must specifically reorient agriculture policies and significantly increase funding to support climate-resilient ecological agriculture.

2. **Managing climate risks and reducing vulnerability**

Public financing and transfer of appropriate technologies by developed counties are needed, not only for the adoption of ecological agriculture but also to put in place the required infrastructure, communications, and other enabling conditions to ensure that developing countries can adapt to climate change. Governments and funding agencies must focus on building adaptive capacity and resilience, thereby reducing vulnerability, as well as improve social safety nets to enable farmers and the rural poor to be able to cope with climate-related disasters. This includes implementing a range of policies that support the economic viability of small-scale agriculture and thus reduce their vulnerability. Special attention and specific support should be given to women farmers.

3. **Stopping climate-destructive agriculture by dismantling perverse incentives and subsidies that promote unsustainable and high-emissions agriculture**

Current agriculture polices are geared to promote conventional agriculture practices that are responsible for the bulk of agricultural greenhouse gas emissions. Perverse incentives, including those perpetuated under the current international trade regime governed by the World Trade Organization and bilateral free trade agreements, entrench this unsustainable system. Agricultural incentives and subsidies therefore need to be redirected away from climate-destructive monocultures and climate-harmful inputs (e.g., synthetic fertilizers) towards climate-resilient practices of the small-farm sector.

4. **Implementing a research and knowledge-sharing agenda towards ecological agriculture and climate resilience**

Too often, national and global agricultural research agendas have been dominated by conventional agriculture approaches and the promise of new technologies. Ecological agriculture has been sidelined; yet it has thrived and has proven successful despite the lack of public support (Pretty, 2006). Farmers' knowledge is a basic and important component of the research/development continuum and research from the scientific community should complement and build on this knowledge. Research and development efforts must be refocused towards ecological agriculture in the context of climate change, while at the same time strengthening existing farmer knowledge and innovation. Moreover, current agriculture research is dominated by the private sector, which focuses on crops and technologies from which they stand to profit most from and which perpetuate climate-vulnerable and GHG-intensive industrial, input-dependent agriculture, rather than solutions for the challenges facing developing country farmers.

5. **Building supportive international policy frameworks**

A range of international institutions can make positive contributions by supporting and enabling the adoption of climate-resilient, ecological agriculture, including the Food and Agriculture Organization, the World Food Program, the International Fund for Agricultural Development, the CGIAR centres, the World Meteorological Organization and the UN Framework Convention on Climate Change. These institutions should support the range of efforts to be undertaken at national and regional levels described above, and cooperate and coordinate efforts to mobilize necessary resources at the international level.

Conclusion

The world needs climate-resilient agriculture.

Agricultural adaptation and food security in a changing climate will provide the world with a Red Queen challenge – it will take all the running we can do just to keep in the same place, just to continue to produce the same amount of food as we do currently.

Prioritizing agricultural adaptation and the link to food security then must be paramount. This necessary emphasis should be explicitly reflected in the UNFCCC approach to and work on adaptation, both within the context of the recently established Adaptation Framework and within consideration of the means needed for implementation: financial resources, technology transfer and capacity building.

Clearly, ecological agriculture is and should be central to agricultural adaptation. Ecological agriculture ***is*** climate resilient, and the benefits to farmers in developing countries in particular would be manifold. Concerted effort is therefore needed to facilitate the transition to ecological agriculture. Anything less would put the lives and livelihoods of millions at risk.

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