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Farmers using push-pull technology to fight Striga weed and stemborers, photo by ICIPE

Agroecology: A Path to Realizing the Right to Food

By Olivier De Schutter, United Nations Special Rapporteur on the Right to Food

Agriculture is at a crossroads. For almost 40 years neither the private sector nor governments have invested in agricultural research. In recent years, agrifood companies have increased direct and vertical capital investment to lower costs and ensure the long-term viability of supplies. The global food price crisis of 2007-2008 is now pushing governments to act.

However, these efforts to combat hunger and malnutrition will fail if they do not improve livelihoods for the poorest—particularly small-scale farmers—in developing countries. And short-term gains will be offset by long-term losses if ecosystems are further degraded, threatening future ability to maintain current levels of production. Simply pouring money into agriculture will not be sufficient; we need to transition to low-carbon, resource-preserving agriculture. The question is *how*?

Agroecology can help achieve this goal by significantly improving agricultural productivity in poor, food-deficit countries, while preserving ecosystems and improving the livelihoods.

A Diagnosis

The global food price crisis has led to calls for increasing production. One estimate is that there is need for a 70% increase in overall agricultural production by 2050 (Burney et al. 2010). This assumes meat consumption will continue to increase from 82.28lbs/person/year in 2000 to over 114.4lbs/person/year by 2050, with 50% of total cereal production going to increasing meat production (FAO 2006). Feeding cereals to animals instead of people will consume the annual caloric needs of over 3.5 billion people (UNEP 2009a). Agrofuels are also diverting cereal crops for energy.

Today the main cause of hunger is poverty—not a shortage of food. Increasing incomes of the poorest is essential to ending hunger. We need to invest in agriculture, not only to meet growing needs, but also to reduce rural poverty. Because poverty remains so heavily concentrated in rural areas, GDP growth in agriculture is at least twice as effective in reducing poverty as GDP growth in other sectors (World Bank 2008). Only by supporting small farmers can we help break the vicious cycle that leads from rural poverty to expansion of urban slums.

The loss of biodiversity, unsustainable use of water, and pollution of soils and water all compromise the continuing ability of natural resources to support agriculture. Climate change, with more frequent and extreme weather events such as droughts and floods and less predictable rainfall, is already impairing the ability of certain regions to feed themselves and destabilizing markets. By 2080, 600 million additional people could be at risk of hunger as a direct result of climate change (UNDP 2007).

Industrial agriculture contributes to climate change, accounting for at least 13–15% of global, man-made greenhouse gas (GHG) emissions (Kasterine and David Vanzetti 2010). In fact, the intensity of GHG in industrial agriculture increases faster than its productivity. While agricultural emissions of methane and nitrous oxide grew by 17% between 1990 and 2005, cereal yields increased by only 6% (Hoffman 2010). Industrial agriculture is becoming *more* carbon-intensive. With no change in policy, the GHG emissions from agriculture could rise by 40% by 2030 (Smith et al. 2007).

Agroecology: A Solution to the Crisis of Industrial Agriculture?

Agroecology is now recognized as a way to address these challenges among an increasingly wide range of scientific experts (McIntyre et al. 2009) and international agencies such as the UN FAO, Bioversity International, and UNEP. Agroecology is the "application of ecological science to the study, design and management of sustainable agroecosystems" (Altieri 2007). It improves agricultural systems by mimicking natural processes, thus enhancing beneficial biological interactions and synergies among the components of agrobiodiversity. Common principles of agroecology include recycling nutrients and energy on-farm rather than relying on external inputs; integrating crops and livestock; diversifying species and genetic resources in agroecosystems over time and space from the field to landscape levels; and focusing on interactions and productivity across the agricultural system rather than growing large plots of single crops. Agroecology is highly knowledge intensive, based on techniques that are not delivered top-down, but rather developed through farmers' knowledge and experimentation. The diversity of species involved in agroecological practices (including animals) requires diversifying farm tasks.

Agroecology techniques have been developed and successfully tested in many regions (Pretty 2008). Integrated nutrient management limits the need to import inorganic and organic sources of nutrients and reduces nutrient losses by controlling erosion. Agroforestry incorporates multi-functional trees into agricultural systems. For example, in Tanzania, 350,000 ha of land have been rehabilitated through agroforestry in the western provinces of Shinyanga and Tabora (Pye-Smith 2010). Similar, large-scale projects are underway in other countries including Malawi, Mozambique and Zambia (Garrety et al. 2004). Water harvesting in drylands restores formerly abandoned and degraded lands to cultivation and improves the water productivity of crops. In West Africa, stone barriers built alongside fields decelerate and stop runoff water during the rainy season, thus improving water retention, replenishing water tables, and reducing soil erosion. Water retention capacity is multiplied 5-10 times, the biomass production multiplies by 10-15 times, plus livestock can feed on grass that grows along the stone barriers (Diop 2001). Integration of livestock, including dairy cattle, pigs and poultry, into farming systems provides protein for the family while fertilizing soils. Some farmers incorporate fish, shrimp and other aquatic resources into their farms in irrigated rice fields and fish ponds. These approaches introduce agricultural biodiversity (the diversity of crops, livestock, agroforestry, fish, pollinators, insects, soil biota and other components that occur in and around production systems) to achieve sustainable, diversified and productive farms.

Sometimes apparently minor innovations provide high returns. In Kenya, researchers and farmers developed the "push-pull" strategy to control parasitic weeds and insects that damage crops. This technique "pushs" away pests from corn by interplanting it with insect-repellent crops like *Desmodium*, while "pulling" them towards small plots of Napier grass, a plant that excretes a sticky gum which both attracts the pest and traps it. The system not only controls pests, but has other benefits as well because *Desmodium* is livestock feed. This push-pull strategy doubles maize yields and milk production, while improving soil structure and fertility. The system has already spread to more than 10,000 households in East Africa through town meetings, national radio broadcasts and farmer field schools (Kahn et al. 2011).

Agroecology's productivity

Agroecological techniques can significantly improve yields. Jules Pretty et al. compared the impacts of 286 recent sustainable agriculture projects in 57 poor countries covering 37 million ha (3% of the cultivated area in developing countries). They found that agroecology increased productivity on 12.6 million farms, with an average crop increase of 79%, while improving the supply of critical environmental services (Pretty et al. 2006). Significantly, there was a 116% increase for all African projects and a 128% increase for the projects in East Africa (UNCTAD and UNEP 2008).

Agroecology's ability to increase incomes for small-scale farmers

One advantage of agroecology is the reliance on locally-produced inputs. Many African soils are nutrient-poor and heavily degraded. But supplying nutrients to the soil does not require expensive commercial fertilizers. In fact applying on-site livestock manure or growing green manures on degraded soils is often better. Farmers can also plant trees that take nitrogen out of the air and "fix" it in their leaves and subsequently incorporate into the soil. A tree such as *Faidherbia* *albida*, a nitrogen-fixing acacia species indigenous to Africa and widespread throughout the continent, performs such a function (World Agroforestry Center 2009).

The use of nitrogen-fixing trees avoids dependence on synthetic fertilizers, the price of which has been increasingly high and volatile over the past few years, exceeding the price of food commodities even when food prices reached a peak in July, 2008. This allows whatever financial assets a household has to be used on other essentials such as education or medicine.

Agroecology diminishes dependence on external inputs, and thus on subsidies and loans, commercial fertilizers and pesticides. Diversified farming systems produce their own fertilizers plus their own pest control, thus diminishing need of pesticides (Altieri and Nicholls 2004). The availability of locally- adapted seeds, planting materials and livestock breeds also has multiple advantages for farmers, while providing a diversity of major crops such as maize, rice, millet, sorghum, potato and cassava. This is particularly beneficial for small-scale farmers (especially women) who have low or no access to credit, no capital, or who can not afford commercial fertilizer.

A study on agroforestry in Zambia involving intercropping or rotation between various trees and maize showed that the net benefit of agroforestry practices is 44-58% superior to non-fertilized, continuous maize production. And while subsidized, fertilized maize was the most financially profitable of all the soil fertility management practices, subtracting government's 50% subsidy on fertilizer sharply reduces the difference in profitability between fertilized maize and agroforestry from 61% to just 13%. More importantly, agroforestry practices yielded higher returns per unit of investment cost than continuous maize fields with or without fertilizer. The study noted that "in rural areas where road infrastructure is poor and transport costs of fertilizer are high, agroforestry practices are most likely to outperform fertilized maize in both absolute and relative profitability terms" (Ajayi et al. 2007a).

The contribution of agroecology to rural development and other sectors of the economy

Agroecology contributes to rural development because it is more labor intensive and most effectively practiced on relatively small plots of land. While governments have generally prioritized labor-saving policies, increasing employment in rural areas of developing countries where underemployment is currently massive and demographic growth remains high, may make agroecology advantageous and might decrease rural to urban migration.

Agroecological approaches are fully compatible with gradually mechanizing farms. The need to produce equipment for conservation agricultural techniques such as no-till and direct seeding could create jobs in the manufacturing sector. This is particularly true in Africa which still imports most of its equipment. But increasingly African countries manufacture simple equipment such as jab planters, animal-drawn planters and knife rollers.

Small-scale agroecological agriculture can be especially beneficial to other economic sectors if it is broad-based and increases incomes of farming households; not just enriching large landowners who rely on large-scale, heavily mechanized plantations. Increased incomes in rural areas will raise demand for locally-traded goods or services, especially if agricultural growth is widely spread across large segments of a very poor population (Christiansen 2011).

Agroecology contributes to improving nutrition

Green Revolution approaches in the past have focused primarily on boosting cereal crops (rice, wheat and maize) in order to avoid famines. However, these crops are mainly a source of carbohydrates, containing relatively little protein and few of the other nutrients essential for adequate diets. The shift from diversified cropping systems to industrial cereal-based farming contributed to micronutrient malnutrition in many developing countries (Demment et al. 2003); of the over 80,000 plant species available to humans, only three (maize, wheat and rice) supply the bulk of our protein and energy needs (E. Frison et al. 2006). Nutritionists increasingly insist on more diverse agroecosystems to ensure a more diversified nutrient-rich diet.

The diversity of species on agroecological farms, as well as in urban or suburban agriculture, is an important asset in this regard. Indigenous fruits contribute on average about 42% of the natural food-basket that rural households rely on in southern Africa (Campbell et al. 1997). Not only is this an important source of vitamins and other micronutrients; it may also be critical for sustenance during lean seasons. Nutritional diversity is of particular importance to children and women.

Agroecology and climate change

Agroecology supports the health of our ecosystems by providing habitat for wild plants, supporting genetic diversity and pollination, and supplying and regulating water. It also improves resilience to climate change. Climate change means more extreme weather-related events. The use of agroecological techniques can significantly cushion the negative impacts of such events: resilience is strengthened through agricultural biodiversity. Following Hurricane Mitch in 1998, farming plots cropped with simple agroecological methods (including rock bunds or dikes, green manure, crop rotation and the incorporation of stubble, ditches, terraces, barriers, mulch, legumes, trees, plowing parallel to the slope, no-burn, live fences, and zero-tillage) had on average 40% more topsoil, higher field moisture, less erosion and lower economic losses than similar plots on farms not using agroecology. On average, agroecological plots lost 18% less arable land to landslides than conventional plots, and had a 49% lower incidence of landslides, and 69% less gully erosion (Holt-Giménez 2002).

With more frequent and severe droughts and floods expected, agroecological farming techniques are better equipped to handle them. The agroforestry program developed in Malawi protected farmers from crop failure after droughts, thanks to the improved soil filtration it allowed (Akinnifesi et al. 2010). On-farm experiments in Ethiopia, India, Brazil and the Netherlands demonstrated that the physical properties of organic farm soils improved drought resistance in crops (Eyhord et al 2007; Landers 2007). In addition, agroecology's diversity of species and farm activities mitigates risks of extreme weather events, as well as those posed by the invasion of new pests, weeds and diseases sure to result from global warming.

Agroecology also puts agriculture on a path to sustainability, by delinking food production from our reliance on fossil energy (oil and gas). And it contributes to mitigating climate change, both by increasing carbon sinks in soil organic matter and above-ground biomass, and by reducing greenhouse gases (GHGs) through direct and indirect energy use. The IPCC has estimated the global technical mitigation potential for agriculture to be 5.5-6 Gt of CO_2—equivalent per year by 2030 (IPCC 2007). 89% of this can come from carbon sequestration in soils by storing carbon as soil organic matter (humus); 9% from methane reduction in rice production and livestock/manure management; and 2% from nitrous oxide reduction through better cropland management (Hoffman 2009).

Scaling up agroecology

We urgently need to reorient agricultural development towards systems that use fewer external inputs linked to fossil energies and that use plants, trees and animals in combination, mimicking nature instead of industrial processes.

Governments have a key role to play. A shift towards sustainable agriculture entails transition costs, since it requires that farmers learn new techniques. A successful transition largely depends on the farmers themselves taking the lead. Governments should encourage learning from farmer to farmer, in farmer field schools, or through farmers' movements such as the *Campesino-a-Campesino* movement in Central America and Cuba (Holt-Giménez 2005; Rosset et al. 2011) Farmer field schools have been shown to significantly reduce pesticide use, as chemical inputs are replaced by knowledge. Large-scale studies in Indonesia, Vietnam and Bangladesh recorded 35-92% reductions in insecticide use in rice, and 34-66% reductions in pesticide use in combination with 4-14% better yields recorded in cotton production in China, India and Pakistan after farmers were trained in agroecology (Burg and Jiggins 2007).

Improving dissemination of knowledge from farmer to farmer transforms the nature of knowledge itself, making it the product of a network. Governments should encourage farmers, particularly small-scale farmers living in the most remote areas and on the most marginal land, to identify innovative solutions, working with experts towards a co-construction of knowledge that primarily benefits them, rather than only benefiting the better-off producers. First, it enables public authorities to benefit from the experience and insight of farmers. Rather than treating smallholder farmers as beneficiaries of aid, they should be seen as experts with knowledge that complements formalized expertise. Second, farmer participation can ensure that policies and programs are truly responsive to the needs of vulnerable groups who will question projects that fail to improve their situation. Third, participation empowers the poor (a vital step towards poverty alleviation) because lack of power is a source of poverty, as marginal communities often receive less support than the groups that are better connected to government. Poverty exacerbates this lack of power, creating a vicious circle of further disempowerment. Fourth, policies co-designed with farmers have a high degree of legitimacy and thus encourage better adoption by other farmers.

The participation of food-insecure groups in policies that affect them should become a crucial element of all food security policies, from policy design, to assessment of results and decisions on research priorities. This is key to enforcing the right to food. Agroecology offers the best chance of improving the situation of millions of food-insecure peasants.

This backgrounder is a condensation of a chapter in Food First's upcoming book, *Food Movements Unite*. More excepts can be read at:
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398 60TH STREET • OAKLAND, CALIFORNIA 94618 USA • TEL: (510) 654-4400 • EMAIL FOODFIRST@FOODFIRST.ORG

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