Agroecology, Small Farms, and Food Sovereignty

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Global forces are challenging the ability of developing countries to feed themselves. A number of countries have organized their economies around a competitive export-oriented agricultural sector, based mainly on monocultures. It may be argued that agricultural exports of crops such as soybeans from Brazil make significant contributions to the national economies by bringing in hard currency that can be used to purchase other goods from abroad. However, this type of industrial agriculture also brings a variety of economic, environmental, and social problems, including negative impacts on public health, ecosystem integrity, food quality, and in many cases disruption of traditional rural livelihoods, while accelerating indebtedness among thousands of farmers.

The growing push toward industrial agriculture and globalization—with an emphasis on export crops, lately transgenic crops, and with the rapid expansion of biofuel crops (sugar cane, maize, soybean, oil palm, eucalyptus, etc.)—is increasingly reshaping the world's agriculture and food supply, with potentially severe economic, social, and ecological impacts and risks. Such reshaping is occurring in the midst of a changing climate expected to have large and far-reaching effects on crop productivity predominantly in tropical zones of the developing world. Hazards include increased flooding in low-lying areas, greater frequency and severity of droughts in semiarid areas, and excessive heat conditions, all of which can limit agricultural productivity.

Globally, the Green Revolution, while enhancing crop production, proved to be unsustainable as it damaged the environment, caused dramatic loss of biodiversity and associated traditional knowledge, favored wealthier farmers, and left many poor farmers deeper in debt.[1] The new Green Revolution proposed for Africa via the multi-institutional Alliance for a Green Revolution in Africa (AGRA) appears destined to repeat the tragic record left by the fertilizer dependent miracle seeds, in Latin America and Asia by increasing dependency on foreign inputs and patent-protected plant varieties which poor farmers cannot afford (for example, fertilizer costs went up approximately 270 percent last year) and on foreign aid.[2]

In the face of such global trends, the concepts of food sovereignty and ecologically based production systems have gained much attention in the last two decades. New approaches and technologies involving application of blended modern agroecological science and indigenous knowledge systems spearheaded by thousands of farmers, NGOs, and some government and academic institutions have been shown to enhance food security while conserving natural resources, biodiversity, and soil and water throughout hundreds of rural communities in several regions.[3] The science of agroecology—the application of ecological concepts and principles to the design and management of sustainable agricultural ecosystems—provides a framework to assess the complexity

of agroecosystems.This approach is based on enhancing the habitat both aboveground and in the soil to produce strong and healthy plants by promoting beneficial organisms while adversely affecting crop pests (weeds, insects, diseases, and nematodes).[4]

For centuries the agricultures of developing countries were built upon the local resources of land, water, and other resources, as well as local varieties and indigenous knowledge. This has nurtured biologically and genetically diverse smallholder farms with a robustness and a built-in resilience that has helped them to adjust to rapidly changing climates, pests, and diseases.[5] The persistence of millions of agricultural hectares under ancient, traditional management in the form of raised fields, terraces, polycultures (with a number of crops growing in the same field), agroforestry systems, etc., document a successful indigenous agricultural strategy and constitutes a tribute to the "creativity" of traditional farmers. These microcosms of traditional agriculture offer promising models for other areas because they promote biodiversity, thrive without agrochemicals, and sustain year-round yields. The new models of agriculture that humanity will need to include forms of farming that are more ecological, biodiverse, local, sustainable, and socially just. They will be rooted in the ecological rationale of traditional small-scale agriculture, representing long established examples of successful community-based local agriculture. Such systems have fed much of the world for centuries and continue to feed people in many parts of the planet.[6]

Fortunately, thousands of small traditional farms still exist in most rural landscapes of the third world. The productivity and sustainability of such agroecosystems can be optimized with agroecological approaches and thus they can form the basis of food sovereignty, defined as the right of each nation or region to maintain and develop their capacity to produce basic food crops with the corresponding productive and cultural diversity. The emerging concept of food sovereignty emphasizes farmers' access to land, seeds, and water while focusing on local autonomy, local markets, local production-consumption cycles, energy and technological sovereignty, and farmer-to-farmer networks.

Small Farmers as Key Actors for Regional Food Security

In Latin America, there were about 16 million peasant production units in the late 1980s, occupying close to 60.5 million hectares—34.5 percent of the total cultivated land. The peasant population includes 75 million people representing almost two-thirds of Latin America's total rural population. The average farm size of these units is about 1.8 hectares, although the contribution of peasant agriculture to the general food supply in the region is significant. These small units of production were responsible for 41 percent of the agricultural output for domestic consumption and for producing at the regional level 51 percent of the maize, 77 percent of the beans, and 61 percent of the potatoes.[7] The contribution to food security of this small-farm sector is today as crucial as twenty-five years ago.

Africa has approximately 33 million small farms, representing 80 percent of all farms in the region. The majority of African farmers (many of them are women) are smallholders, with two-thirds of all farms below 2 hectares and 90 percent of farms below 10 hectares. Most small farmers practice "low-resource" agriculture which is based primarily on the use of local resources, but which may make modest use of external inputs. Low-resource agriculture produces the majority of grains, almost all root, tuber, and plantain crops, and the

majority of legumes. Most basic food crops are grown by small farmers with virtually no or little use of fertilizers and improved seed.[8] This situation, however, has changed in the last two decades as food production per capita has declined in Africa. Once self-sufficient in cereals, Africa now has to import millions of tons to fill the gap. Despite this increase in imports, smallholders still produce most of Africa's food.

In Asia, China alone accounts for almost half the world's small farms (on 193 million hectares), followed by India with 23 percent, and Indonesia, Bangladesh, and Vietnam. Of the majority of more than 200 million rice farmers who live in Asia, few cultivate more than 2 hectares of rice. China has probably 75 million rice farmers who still practice methods similar to those used more than 1,000 years ago. Local cultivars, grown mostly on upland ecosystems and/or under rain-fed conditions, make up the bulk of the rice produced by Asian small farmers.[9]

Small Farms Are More Productive and Resource Conserving

Although the conventional wisdom is that small family farms are backward and unproductive, research shows that small farms are much more productive than large farms if total output is considered rather than yield from a single crop. Maize yields in traditional Mexican and Guatemalan cropping systems are about 2 tons per hectare or about 4,320,692 calories, sufficient to cover the annual food needs of a typical family of 5-7 people. In the 1950s the *chinampas* of Mexico (raised growing beds in shallow lakes or swamps) had maize yields of 3.5-6.3 tons per hectare. At that time, these were the highest long-term yields achieved anywhere in Mexico. In comparison, average maize yields in the United States in 1955 were 2.6 tons per hectare, and did not pass the 4 tons per hectare mark until 1965.[10] Each hectare of remaining chinampa can still produce enough food for 15-20 persons per year at a modern subsistence level.

Traditional multiple cropping systems provide as much as 20 percent of the world food supply. Polycultures constitute at least 80 percent of the cultivated area of West Africa, while much of the production of staple crops in the Latin American tropics also occurs in polycultures. These diversified farming systems in which the small-scale farmer produces grains, fruits, vegetables, fodder, and animal products in the same field or garden out-produce the yield per unit of single crops such as corn grown alone on large-scale farms. A large farm may produce more corn per hectare than a small farm in which the corn is grown as part of a polyculture that also includes beans, squash, potatoes, and fodder. But, productivity in terms of harvestable products per unit area of polycultures developed by smallholders is higher than under a single crop with the same level of management. Yield advantages can range from 20 percent to 60 percent, because polycultures reduce losses due to weeds (by occupying space that weeds might otherwise occupy), insects, and diseases (because of the presence of multiple species), and make more efficient use of the available resources of water, light, and nutrients.[11]

By managing fewer resources more intensively, small farmers are able to make more profit per unit of output, and thus, make more total profits—even if production of each commodity is less.[12] In overall output, the diversified farm produces much more food. In the United States the smallest two-hectare farms produced $15,104 per hectare and netted about $2,902 per hectare. The largest farms, averaging 15,581 hectares, yielded $249 per hectare and netted about $52 per hectare. Not only do small- to medium-sized farms exhibit

higher yields than conventional larger-scale farms, but they do this with much lower negative impacts on the environment, as research shows that small farmers take better care of natural resources, including reducing soil erosion and conserving biodiversity. However, an important part of the higher per hectare income of small farms in the United States is that they tend to by-pass middlemen and sell directly to the public, restaurants, or markets. They also tend to receive a premium for their local, and frequently organic, products.

The inverse relationship between farm size and output can be attributed to the more efficient use of land, water, biodiversity, and other agricultural resources by small farmers. So in terms of converting inputs into outputs, society would be better off with small-scale farmers. Building strong rural economies in the Global South based on productive small-scale farming will allow the people of the South to remain with their families in the countryside. This will help to stem the tide of out-migration into the slums of cities that do not have sufficient employment opportunities. As the world's population continues to grow, redistributing farmland may become central to feeding the planet, especially when large-scale agriculture devotes itself to feeding cars through growing agrofuel feedstocks.

Small Farms Represent a Sanctuary of Agrobiodiversity Free of GMOs

Traditional small-scale farmers tend to grow a wide variety of cultivars. Many of these plants are landraces, more genetically heterogeneous than formal modern varieties, and grown from seed passed down from generation to generation. These landraces offer greater defenses against vulnerability and enhance harvest security in the midst of diseases, pests, droughts, and other stresses.[13] In a worldwide survey of crop varietal diversity on farms involving twenty-seven crops, scientists found that considerable crop genetic diversity continues to be maintained on farms in the from of traditional crop varieties, especially of major staple crops. In most cases, farmers maintain diversity as insurance to meet future environmental change or social and economic needs. Many researchers have concluded that variety richness enhances productivity and reduces yield variability. Given the penetration of transgenic crops into centers of diversity, at issue is the possibility that traits important to indigenous farmers (resistance to drought, competitive ability, performance in polycrop systems, storage quality, etc.) could be traded for transgenic qualities (e.g., herbicide resistance) which are of no importance to farmers that do not use agrochemicals.[14] Under this scenario, risk will increase and farmers will lose their ability to produce relatively stable yields with a minimum of external inputs under changing environments. The social impacts of local crop shortfalls, resulting from changes in the genetic integrity of local varieties due to genetic pollution, can be considerable in the margins of the developing world.

It is crucial to protect areas of peasant agriculture free of contamination from GMO crops. Maintaining pools of genetic diversity, geographically isolated from any possibility of cross fertilization or genetic pollution from uniform transgenic crops, will create "islands" of intact genetic resources to act as safeguards against the potential ecological failure derived from the Second Green Revolution increasingly being imposed with programs such as the Gates-Rockefeller AGRA in Africa. These genetic sanctuary islands will also serve as the only source of GMO-free seeds that will be needed to repopulate the organic farms in the North that will inevitably be contaminated by the advance of transgenic agriculture. The small farmers and indigenous

communities of the Global South, with the help of scientists and NGOs, can continue being the creators and guardians of a biological and genetic diversity that has enriched the food culture of the whole planet.

Small Farms Are More Resilient to Climate Change

Most climate change models predict that damages will disproportionally affect the regions populated by small farmers, particularly rainfed agriculturalists in the third world. However, existing models at best provide a broad-brush approximation of expected effects and hide the enormous variability in internal adaptation strategies. Many rural communities and traditional farming households, despite weather fluctuations, seem able to cope with climatic extremes.[15] In fact many farmers cope and even prepare for climate change, minimizing crop failure through increased use of drought tolerant local varieties, water harvesting, extensive planting, mixed cropping, agroforestry, opportunistic weeding, wild plant gathering, and a series of other traditional farming system techniques.[16]

In traditional agroecosystems the prevalence of complex and diversified cropping systems is of key importance to the stability of peasant farming systems, allowing crops to reach acceptable productivity levels in the midst of environmentally stressful conditions. In general, traditional agroecosystems are less vulnerable to catastrophic loss because they grow a wide variety of crops and varieties in various spatial and temporal arrangements. Researchers have found that polycultures of sorghum/peanut and millet/peanut exhibited greater yield stability and less productivity declines during a drought than in the case of monocultures.

One way of expressing such experimental results is in terms of "over-yielding"—occurring when two or more crops grown together yield more than when grown alone (for example, when one hectare of a mixture of sorghum and peanuts yields more than a half hectare of only sorghum plus a half hectare of only peanuts). All the intercrops over-yielded consistently at five levels of moisture availability, ranging from 297 to 584 mm of water applied over the cropping season. Quite interestingly, the rate of over-yielding actually increased with water stress, such that the relative differences in productivity between monocultures and polycultures became more accentuated as stress increased.[17] Many farmers grow crops in agroforestry designs and shade tree cover protects crop plants against extremes in microclimate and soil moisture fluctuation. Farmers influence microclimate by retaining and planting trees, which reduce temperature, wind velocity, evaporation, and direct exposure to sunlight and intercept hail and rain. In coffee agroecosystems in Chiapas, Mexico temperature, humidity, and solar radiation fluctuations were found to increase significantly as shade cover decreased, indicating that shade cover was directly related to the mitigation of variability in microclimate and soil moisture for the coffee crop.[18]

Surveys conducted in hillsides after Hurricane Mitch hit Central America in 1998 showed that farmers using sustainable practices such as the legume "mucuna" cover crop, intercropping, and agroforestry suffered less "damage" than their conventional neighbors. The study spanning 360 communities and 24 departments in Nicaragua, Honduras, and Guatemala showed that diversified plots had 20 to 40 percent more topsoil, greater soil moisture, less erosion, and experienced lower economic losses than their conventional neighbors.[19] This points to the fact that a re-evaluation of indigenous technology can serve as a key source of information on adaptive capacity and resilient capabilities exhibited by small farms—features of strategic importance for

world farmers to cope with climatic change. In addition, indigenous technologies often reflect a worldview and an understanding of our relationship to the natural world that is more realistic and more sustainable than those of our Western European heritage.

Enhancing the Productivity of Small Farming Systems Through Agroecology

Despite the evidence of the resiliency and productivity advantages of small-scale and traditional farming systems, many scientists and development specialists and organizations argue that the performance of subsistence agriculture is unsatisfactory, and that agrochemical and transgenic intensification of production is essential for the transition from subsistence to commercial production. Although such intensification approaches have met with much failure, research indicates that traditional crop and animal combinations can often be adapted to increase productivity. This is the case when ecological principles are used in the redesign of small farms, enhancing the habitat so that it promotes healthy plant growth, stresses pests, and encourages beneficial organisms while using labor and local resources more efficiently.

Several reviews have amply documented that small farmers can produce much of the needed food for rural and neighboring urban communities in the midst of climate change and burgeoning energy costs.[20] The evidence is conclusive: new agroecological approaches and technologies spearheaded by farmers, NGOs, and some local governments around the world are already making a sufficient contribution to food security at the household, national, and regional levels. A variety of agroecological and participatory approaches in many countries show very positive outcomes even under adverse environmental conditions. Potentials include: raising cereal yields from 50 to 200 percent, increasing stability of production through diversification, improving diets and income, and contributing to national food security (and even to exports) and conservation of the natural resource base and biodiversity. This evidence has been reinforced by a recent report of the United Nations Conference on Trade and Development stating that organic agriculture could boost African food security. Based on an analysis of 114 cases in Africa, the report revealed that a conversion of farms to organic or near-organic production methods increased agricultural productivity by 116 percent.

Moreover, a shift towards organic production systems has enduring impact, as it builds up levels of natural, human, social, financial, and physical capital in farming communities. The International Assessment of Agricultural Knowledge, Science and Technology (AKST) commissioned by World Bank and the Food and Agriculture Organization (FAO) of the United Nations recommended that an increase and strengthening of AKST towards agroecological sciences will contribute to addressing environmental issues while maintaining and increasing productivity. The assessment also stresses that traditional and local knowledge systems enhance agricultural soil quality and biodiversity as well as nutrient, pest, and water management, and the capacity to respond to environmental stresses such as climate.

Whether the potential and spread of agroecological innovations is realized depends on several factors and major changes in policies, institutions, and research and development approaches. Proposed agroecological strategies need to target the poor deliberately, and not only aim at increasing production and conserving natural resources. But they must also create employment and provide access to local inputs and local markets. Any serious attempt at developing sustainable agricultural technologies must bring to bear local knowledge

and skills on the research process.[21] Particular emphasis must be given to involving farmers directly in the formulation of the research agenda and on their active participation in the process of technological innovation and dissemination through Campesino a Campesino models that focus on sharing experiences, strengthening local research, and problem-solving capacities. The agroecological process requires participation and enhancement of the farmer's ecological literacy about their farms and resources, laying the foundation for empowerment and continuous innovation by rural communities.[22]

Equitable market opportunities must also be developed, emphasizing local commercialization and distribution schemes, fair prices, and other mechanisms that link farmers more directly and with greater solidarity to the rest of the population. The ultimate challenge is to increase investment and research in agroecology and scale up projects that have already proven successful to thousands farmers. This will generate a meaningful impact on the income, food security, and environmental well-being of all the population, especially small farmers who have been adversely impacted by conventional modern agricultural policy, technology, and the penetration of multinational agribusiness deep into the third world.[23]

Rural Social Movements, Agroecology, and Food Sovereignty

The development of sustainable agriculture will require significant structural changes, in addition to technological innovation, farmer-to-farmer networks, and farmer-to-consumer solidarity. The required change is impossible without social movements that create political will among decision-makers to dismantle and transform the institutions and regulations that presently hold back sustainable agricultural development. A more radical transformation of agriculture is needed, one guided by the notion that ecological change in agriculture cannot be promoted without comparable changes in the social, political, cultural, and economic arenas that help determine agriculture.

The organized peasant and indigenous-based agrarian movements—such as the international peasant movement La Vía Campesina and Brazil's Landless Peasant Movement (MST)—have long argued that farmers need land to produce food for their own communities and for their country. For this reason they have advocated for genuine agrarian reforms to access and control land, water, and biodiversity that are of central importance for communities in order to meet growing food demands.

Vía Campesina believes that in order to protect livelihoods, jobs, people's food security, and health as well as the environment, food production has to remain in the hands of small-scale sustainable farmers and cannot be left under the control of large agribusiness companies or supermarket chains. Only by changing the export-led, free-trade based, industrial agriculture model of large farms can the downward spiral of poverty, low wages, rural-urban migration, hunger, and environmental degradation be halted. Social rural movements embrace the concept of food sovereignty as an alternative to the neoliberal approach that puts its faith in an inequitable international trade to solve the world's food problem. Instead, it focuses on local autonomy, local markets, local production-consumption cycles, energy and technological sovereignty, and farmer-to-farmer networks.

"Greening" the Green Revolution will not be sufficient to reduce hunger and poverty and conserve biodiversity. If the root causes of hunger, poverty, and inequity are not confronted head-on, tensions between

socially equitable development and ecologically sound conservation are bound to accentuate. Organic farming systems that do not challenge the monoculture nature of plantations and rely on external inputs as well as foreign and expensive certification seals, or fair-trade systems destined only for agro-export, offer very little to small farmers that become dependent on external inputs and foreign and volatile markets. By keeping farmers dependent on an input substitution approach to organic agriculture, fine-tuning of input use does little to move farmers toward the productive redesign of agricultural ecosystems that would move them away from dependence on external inputs. Niche markets for the rich in the North exhibit the same problems of any agro-export scheme that does not prioritize food sovereignty, perpetuating dependence and hunger.

Rural social movements understand that dismantling the industrial agrifood complex and restoring local food systems must be accompanied by the construction of agroecological alternatives that suit the needs of small-scale producers and the low-income non-farming population, and that oppose corporate control over production and consumption. Given the urgency of the problems affecting agriculture, coalitions that can rapidly foster sustainable agriculture among farmers, civil society organizations (including consumers), as well as relevant and committed research organizations are needed. Moving toward a more socially just, economically viable, and environmentally sound agriculture will be the result of the coordinated action of emerging social movements in the rural sector in alliance with civil society organizations that are committed to supporting the goals of these farmers movements. As a result of constant political pressure from organized farmers and others, politicians will, it is hoped, become more responsive to developing policies that will enhance food sovereignty, preserve the natural resource base, and ensure social equity and economic agricultural viability.

Notes

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As a political movement, agroecology is an action agenda to achieve food sovereignty led by small-scale food producers and their allies. It is a growing movement to completely transform our system of production, distribution and consumption rather than conform to industrial models.Â Resistance to factory and livestock farming is also growing. Meat is at the centre of some of our worldâ€™s greatest ecological and public health threats: deforestation, habitat destruction, water scarcity, climate change, water pollution, diet-related disease, antibiotic resistance, intolerable animal cruelty and more.