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AGROECOLOGY IN DEVELOPING COUNTRIES

The Promise of a Sustainable Harvest

BY JULES PRETTY
something is fundamentally wrong with our agricultural and food systems. Despite great progress in increasing productivity in the last century, hundreds of millions of people remain hungry and malnourished. Further hundreds of millions eat too much or are eating the wrong sorts of food, which has led to a rise in a host of health problems, including obesity, heart disease, and diabetes. The health of the environment suffers, too: Degradation seems to accompany many of the agricultural systems we have evolved in recent years. Can nothing be done, or is it time for the expansion of another sort of agriculture, one that is founded more on ecological principles and is in harmony with people, their societies, and their cultures?

In the earliest surviving texts on European farming, agriculture was interpreted as two connected things, agrí and cultura, and food was seen as a vital part of the cultures and communities that produced it. Today, however, our experience with industrial farming dominates, with food now seen simply as a commodity and farming often organized along factory lines. Can we create sustainable farming systems that are efficient and fair and founded on a detailed understanding of the advantages of both agroecology—a science concerned with harnessing the interrelationships between organisms and the environment to benefit agriculture—and people’s capacity to cooperate?

As we advance into the early years of the twenty-first century, we have some critical choices. Humans have been farming for some 600 generations, and for most of that time the production and consumption of food has been intimately connected to cultural and social systems. Yet in the last two or three generations, we have developed hugely successful agricultural systems based largely on industrial principles, which are in turn based on the simplification of farm systems and a focus on productivity increases at all costs. These industrialized systems certainly produce more food per hectare and per worker than ever before but only look so efficient if we ignore the harmful side effects—the loss of soils, the damage to biodiversity, the pollution of water, and the harm to human health.

Persistent and New World Food Problems

But why should this idea of putting nature and culture back into agriculture matter? Surely we already know how to increase food production? Since the beginning of the 1960s, just prior to the Green Revolution in developing countries and a
short way into the most recent agricultural revolution in industrialized countries, there have been remarkable increases in food production. In four decades, total world food production grew by 145 percent. In Africa, it is up by 140 percent, in Latin America by almost 200 percent, and in Asia by a remarkable 280 percent. The greatest increases have been in China—an extraordinary fivefold increase, mostly occurring in the 1980s and 1990s. In the industrialized regions, production started from a higher base; yet in the United States, it still doubled over 40 years, and in western Europe it grew by 68 percent.3

Over the same period, world population has grown from three to six billion.4 Again, however, per capita agricultural production has outpaced population growth. Compared with people in 1961, each person today has 25 percent more food. But these aggregate figures hide important differences between regions (see Figure 1 below). For example, in Asia and Latin America, per capita food production has stayed ahead, increasing by 76 percent and 28 percent respectively. Africa, though, has fared badly, with food production per person 10 percent less today than in 1961. China performed best, a tripling of food production per person over the same period. Industrialized countries have seen a 40 percent increase in food production per person.5

Yet these advances in aggregate productivity have only brought limited reductions in the incidence of hunger. At the turn of the twenty-first century, nearly 800 million people were hungry and lacked adequate access to food. This is an astonishing 18 percent of all people in developing countries.6 Nonetheless, the world can celebrate some progress. Incidence of undernourishment stood at 970 million in 1970, comprising one-third of people in developing countries at the time. Since then, average per capita consumption of food has increased by 17 percent to 2,760 kilocalories (kcal) per day—good as an average but still hiding a great many people surviving on less: 33 countries, mostly in sub-Saharan Africa, still have per capita food consumption under 2,200 kcal per day (see Figure 2 on page 12).7 The challenge remains huge.

There is also significant food poverty in industrialized countries. In the United States, the largest producer and exporter of food in the world, 11 million people are food insecure and hungry, and a fur-

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**Figure 1. Changes in per capita agricultural production (1961–2000)**

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<thead>
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<th>Year</th>
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NOTE: This graph shows percent change in per capita agricultural production from 1961 to 2000, with 1961 figures representing 100 percent.

SOURCE: UN Food and Agriculture Organization.
Figure 2. Per capita food consumption, by region (1969–1999)

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NOTE: Food consumption is expressed as dietary energy supply in kilocalories (kcal) per capita, per day. Per capita food consumption below 2,200 kcal per day is a strong indication of the presence of undernourishment and food insecurity.

SOURCE: UN Food and Agriculture Organization.

ther 23 million are hovering close to the edge of hunger—their food supply is uncertain, but they are not permanently hungry. There are further signs that something is wrong. One in seven people in industrialized countries are now clinically obese, and five of the ten leading causes of death are diet-related: coronary heart disease, some cancers, stroke, diabetes mellitus, and arteriosclerosis. Alarming, the obese are outnumbering the thin in some developing countries, such as Brazil, Chile, Colombia, Costa Rica, Cuba, Mexico, Peru, and Tunisia. It is clear that agroecology alone cannot address this crisis, but its emphasis on connections in the food system, and increased awareness among consumers about food may help.

So, despite great progress, things will probably get worse for many people before they get better. As total population continues to increase, until at least the mid-twenty-first century, so the absolute demand for food will also increase. Increasing incomes will mean people will have more purchasing power, and this will increase demand for food. But as our diets change, so demand for the types of food will also shift radically. In particular, increasing urbanization means people are more likely to adopt new diets, consuming more meat and fewer traditional cereals and other foods—what Barry Popkin, professor at the University of North Carolina’s School of Public Health, calls the “nutrition transition.”

These dietary changes will drive a total and per capita increase in demand for cereals, both because there will be more livestock and because these animals consume so much feed. The bad news is that food consumption disparities between people in industrialized and developing countries are expected to persist. Currently, annual food demand in industrialized countries is 550 kg of cereal and 78 kg of meat per person. By contrast, in developing countries it is only 260 kg of cereal and 30 kg of meat per person. These gaps in consumption ought to be deeply worrying to us all, as any attempts to create more equitable outcomes without reducing consumption in industrialized countries may create more problems.

What Should We Do?

The conventional wisdom holds that any attempt to increase the food supply to feed the hungry of the world will require a redoubling of efforts to modernize agriculture. After all, modernization appears to have been successful. But there are major doubts about the capacity of such systems to produce the food where the poor and hungry people live. These communities need low-cost and readily available technologies to increase food production. A further challenge is that this increase in production needs to happen without further damage to the environment. This is where the ideas of agricultural sustainability come in.

Sustainable farming seeks to make the best use of nature’s goods and services without significant damage to the environment. It does this by integrating natural processes such as nutrient cycling, nitrogen fixation, soil regeneration, and natural enemies of pests into food production processes. It also minimizes the use of nonrenewable inputs that damage
the environment or harm the health of farmers and consumers. It makes use of the knowledge and skills of farmers, improving their self-reliance, and it seeks to make productive use of people’s collective capacities to work together to solve common management problems, such as pest, watershed, irrigation, forest, and credit management.

Sustainable agriculture is also multifunctional within landscapes and economies: It jointly produces food and other goods for farm families and markets, but it also contributes to a range of public goods, such as clean water, biodiversity, carbon sequestration in soils, groundwater recharge, and flood protection. Because sustainable agriculture also seeks to make the best use of its specific environment, technologies and practices must be locally adapted. They are most likely to emerge from new configurations of social relations, comprising relations of trust embodied in new social organizations and new horizontal and vertical partnerships between institutions. Equally important are new configurations of human capacity, comprising leadership, ingenuity, management skills, and the capacity to innovate—such as through the emergence of farmers’ groups and networks. Thus agricultural systems with high levels of social and human capital are more able to innovate in the face of uncertainty.

**Does Sustainable Agriculture Work?**

These are all fine ideas, but can they work in practice? Researchers at the University of Essex Department of Biological Sciences recently completed the largest survey of sustainable agriculture improvements in developing countries. The aim was to audit progress toward agricultural sustainability and assess the extent to which such initiatives, if spread on a much larger scale, could feed a growing world population that is already substantially food insecure. The survey looked at more than 200 projects in 52 countries, including 45 in Latin America, 63 in Asia, and 100 in Africa. It was calculated that almost 9 million farmers were using sustainable agriculture practices on about 29 million hectares, more than 98 percent of which emerged since 1990. These methods are working particularly well for small farmers; about half of those surveyed are in projects with a mean area per farmer of less than one hectare, and 90 percent in areas with less than two hectares each.

The team at the University of Essex found improvements in food production are occurring through one or more of four different mechanisms:

- intensification of a single component of a farm system with little change to the rest of the farm, such as home garden intensification with vegetables and/or tree crops, vegetables on rice bunds, and introduction of fish ponds or a dairy cow;
- addition of a new productive element to a farm system, such as fish or shrimp in paddy rice, or agroforestry, which pro-

Sustainable agriculture projects bring many tangible benefits—for example, Guatemalan farmers planted the velvet bean (left), a legume, with their maize crop to enrich the soil. But many projects have also given confidence to people—particularly women (below)—as they have gained new skills and awareness.
vides a boost to total farm food production and/or income, but which does not necessarily affect cereal productivity:

- better use of nature to increase total farm production, especially water (by water harvesting and irrigation scheduling), and land (by reclamation of degraded land), leading to additional new dryland crops and/or increased supply of additional water for irrigated crops, thus increasing cropping intensity; and
- improvements in per hectare yields of staples through the introduction of new regenerative elements into farm systems, such as legumes and integrated pest management, and new and locally appropriate crop varieties and animal breeds.

Thus, a successful sustainable agriculture project may substantially improve domestic food consumption or increase local food barters or sales through home gardens, fish in rice fields, or better water management—without necessarily affecting the per hectare yields of cereals. Home garden intensification occurred in one-fifth of the projects, but given its small scale, it accounted for less than 1 percent of the area. Better use of land and water—giving rise to increased cropping intensity—occurred in one-seventh of the projects and was applied by one-third of the farmers in one-twelfth of the area. The incorporation of new productive elements into farm systems, mainly fish and shrimp in paddy rice, occurred in 4 percent of the projects and accounted for the smallest proportion of farmers and area. The most common mechanisms were yield improvements with regenerative technologies or new seeds/breeds; these occurred in 60 percent of the projects and were applied by more than one-half of the farmers in about 90 percent of the area.

What is happening to food production? The survey results showed that sustainable agriculture has led to an average 93 percent increase in per-hectare food production. The relative yield increases are greater at lower yields, indicating greater benefits for poor farmers and for those missed by the recent decades of modern agricultural development (see Figure 3 on this page). The increases are quite remarkable; most agriculturalists would be satisfied with any technology that can increase annual productivity by even 1 or 2 percent. It is worth restating: These projects are seeing close to a doubling of per-hectare productivity over several years, and this still underestimates the additional benefits of intensive food production in small patches of home gardens or fish ponds.

These aggregate figures also understate the benefits of increased diversity in the diet as well as increased quantity. Most of these agricultural sustainability initiatives have seen increases in farm diversity. In many cases, this translates into increased diversity of food consumed by the household, including fish protein from rice fields or fish ponds; milk and animal products from dairy cows, poultry, and pigs kept in the home garden; and vegetables and fruit from home gardens and farm microenviro-

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**Figure 3. Crop yield changes in sustainable agriculture projects/initiatives**

- **maize**
- **sorghum/millet**
- **beans/soya/peas/groundnut**
- **rice**
- **wheat**
- **potato/sweet potato/cassava**
- **cotton**
- **vegetables**
- **no change**

**NOTE:** Data was taken from 98 projects.

ments. Although these initiatives are reporting significant increases in food production—some as yield improvements and some as increases in cropping intensity or diversity of produce—few are reporting surpluses of food being sold to local markets. This is because of a significant elasticity of consumption among rural households experiencing any degree of food insecurity. As production increases, so also does domestic consumption, with direct benefit particularly for the health of women and children. In short, rural people are eating more food and a greater diversity of food, and this does not show up in the international statistics.

Soil Health Improvements

Agricultural sustainability starts with the soil, seeking to reduce soil erosion and to make improvements to soil physical structure, organic matter content, water-holding capacity, and nutrient balances. Soil health is improved through the use of legumes, green manures for organic matter additions to the soil, and cover crops; incorporation of plants with the capacity to release phosphate from the soil into rotations; use of composts and animal manures; adoption of zero-tillage practices; and use of inorganic fertilizers where needed.

One of these examples, the practice of zero-tillage, seems to break one of the fundamental rules of agriculture. Since the birth of farming, farmers have been plowing or tilling the soil. Yet in the past decade, Latin American farmers have found that eliminating tillage can be highly beneficial, and many in Africa have adopted no-till or only shallow cultivations for rice production. After harvest, the crop residues are left on the surface to protect against erosion. At planting, seed is slotted into a groove cut into the soil. Weeds are controlled with herbicides or cover crops. This means that the soil surface is always covered, and the soil itself no longer inverted.

The fastest uptake of these minimum-till systems has been in Brazil, where there are some 15 million hectares under plantio direto (also called zero-tillage even though there is some disturbance of the soil) mostly in the three southern states of Santa Catarina, Rio Grande do Sul, and Paraná but also in the central Cerrado. In neighboring Argentina, there are more than 11 million hectares under zero-tillage, up from less than 100,000 hectares in 1990, and Paraguay has another 1 million hectares of zero-tillage.

In Brazil, the transformations in the landscape and in farmers’ attitudes are equally impressive. Many of the Clubes Amigos da Terra (literally, “friends of the land clubs”), which are essentially farmers organized into groups, have been closely involved in this transformation. According to Landers, “Zero-tillage has been a major factor in changing the top-down nature of agricultural services to farmers towards a participatory, on-farm approach.” There are many types of farmers’ groups: local (farmer microcatchment and credit groups), municipal (soil commissions, friends of the land clubs, commercial farmers, and farm workers’ unions), multimunicipal (farmer foundations and cooperatives), river basin (basin committees for all water users), and state and national level groups (state zero-tillage associations and the national zero-tillage federation).

This is the critical message: Improve the soil and the whole agricultural system’s health improves along with it. Even if this is done on a very small scale, people can benefit substantially. In Kenya, the Association for Better Land Husbandry (ABLH), Manor House, and other...
nongovernmental organizations found that farmers who constructed double-dug beds in their gardens could produce enough vegetables to see them through the hungry dry season. Raised beds are improved with composts and green and animal manures. A considerable investment in labor is required, but the better water-holding capacity and higher organic matter means that these beds are more productive and better able to sustain vegetable growth through the dry season. Once this investment is made, little more has to be done for the next two to three years. Women in particular are cultivating many vegetable and fruit crops, including kale, onion, tomato, cabbage, passion fruit, pigeon pea, spinach, pepper, green bean, and soya. According to one review of 26 communities working with ABLH in Kenya, 75 percent of participating households are now free from hunger during the year, and the proportion having to buy vegetables had fallen from 85 percent to 11 percent.

For too long, agriculturalists have been skeptical about these organic and conservation methods. They say the methods require too much labor, are too traditional, and have no impact on the rest of the farm. Yet from the perspective of women involved in such projects, the impacts are very real. In Kakamega, which is in western Kenya, Joyce Odari has 12 raised beds on her farm. They are so productive that she now employs four young men from the village. She says, “If you could do your whole farm with organic approaches, then I’d be a millionaire. The money now comes looking for me.” She is also aware of the wider benefits: “My aim is to conserve the forest, because the forest gives us rain. When we work our farms, we don’t need to go to the forest. This farming will protect me and my community, as people now know they can feed themselves.” Clearly, the spin-off benefits are substantial: Giving women the means to improve their food production means that food gets into the mouths of children, who in turn suffer fewer months of hunger and are less likely to miss school.

**Improved Water Efficiencies**

The proper management of water is also essential for agriculture. If there is either too much or too little water, crops and animals die. However, if it is carefully managed, landscapes—even in very wet or dry places—become productive. About 20 percent of the world’s cropland is irrigated, allowing food to be produced in dry seasons when rainfall is in short supply but sunlight is abundant. In some parts of the tropics, farmers produce three crops each year, and altogether, irrigated lands produce 40 percent of the world’s food. Most farmers, however, are entirely dependent on rainfall, an input that is becoming increasingly erratic and uncertain in the face of climate change.

Despite a long history of agricultural systems and cultures built upon complex water management systems—including irrigated rice cultures of Asia, Roman cultivation of Libya, irrigated Mesopotamia and Egypt, and floodwater-farming cultures of the Papago, Hopi, and Navajo peoples in what is now the U.S. Southwest—water as a common resource is still today undervalued and undermanaged. There is great scope for improvement and, once again, farmers in many developing countries are leading the way. Through better social organization, they are finding that shared management and cooperation can lead to greater returns for whole systems.

Water harvesting has wide application in the drylands. In northern India, in the uplands of Gujarat, Rajasthan, and Madhya Pradesh, land degradation is severe, soils are poor, and agricultural production is so low that most families can survive only if one of their members goes to work in the city. However, best sustainable practices may achieve considerable success in the long term. The Indo-British Rainfed Farming project, for example, works with 230 local groups in 70 villages on water harvesting, tree planting, and grazing land improvements. Basic grain yields of rice, wheat, pigeon peas, and sorghum have increased from 400 to 800–1,000 kg per hectare, and the
increased fodder-grass production from the terrace borders is valued highly for the livestock. The improved water retention has resulted in water tables rising by one meter over three to four years, meaning that an extra crop is now possible for many farmers.

In this scenario, as well as in many other areas, women are the major beneficiaries. P. S. Sodhi of the Gram Vikas Trust (a nongovernmental organization based in Udaipur, India, that works closely with communities) puts it this way: “In these regions, women never had seen themselves at the front edge of doing things, making decisions, and dealing with financial transactions. The learning-by-doing approach of the project has given them much needed confidence, skills, importance, and awareness.” The wider benefits of a transformed agriculture are also evident, because, says Sodhi, “The project has indirectly affected migration as people are gaining more income locally through the various enterprises carried out in the project. People are now thinking that they must diversify more into new strategies. There has also been a decline in drawing on resources from the forests.”

Water harvesting has also restored the landscape in some parts of sub-Saharan Africa, further evidence that many such practices are not complex or costly and can be applied in some of the poorest communities. In central Burkina Faso, 100,000 hectares of abandoned and degraded lands have been restored with the adoption of tassas and zaï, local names for the 20–30 cm holes dug in surface-hardened soils that are filled with manure to promote termite activity and enhance infiltration. When it rains, water is channeled by simple stone bunds to the holes, which fill with water. Seeds of millet or sorghum are then planted in the holes. Normally, cereal yields in these regions are precariously low, rarely exceeding 300 kg per hectare. Yet lands using the tassas and zaï technique now produce 700–1,000 kg per hectare. Chris Reij, a researcher at the Free University in Amsterdam, found that the average family in Burkina Faso using these technologies had shifted from being in annual cereal deficit amounting to about 650 kg—equivalent to six and one-half months of food shortage—to producing a surplus of 150 kg a year.

**Zero-Pesticide Farming**

Modern farmers have come to depend on a great variety of insecticides, herbicides, and fungicides to control the pests, weeds, and diseases that threaten crop and animal productivity. Though integrated pest management dates back to the 1950s, a significant paradigm-shifting moment occurred in the early 1980s when Peter Kenmore and his colleagues in Southeast Asia found—contrary to what might be expected—that pest attack on rice was directly proportional to the amount of pesticides used.

The reason for the pest population increase was simple: Pesticides were killing the natural enemies of insect pests, such as spiders and beetles, and were also causing the spread of resistance among the pests. When pest predators are eliminated from agroecosystems, pests are able to expand in numbers very rapidly. This finding led the Indonesian government in 1986 to ban 57 types of pesticides for use on rice and to launch a national system of farmer field schools to teach farmers the benefits of biodiversity in fields. One million farmers have now attended about 50,000 field schools in Indonesia, the largest number in any Asian country. The outcomes in terms of...
human and social development have been remarkable, and farmer field schools are now being deployed in many parts of the world. Most agriculturalists now believe that irrigated rice growing in areas with a relatively high level of biodiversity can, for most of the growing season and depending on natural (pest, climate) cycles, be grown without pesticides.

Many other countries have reported large reductions in pesticide use. In Vietnam, two million farmers have cut pesticide use from three sprays to one per season; in Sri Lanka, 55,000 farmers have reduced use from three applications to one-half per season; and in Indonesia, one million farmers have cut use from three sprays to one per season. In no case has reduced pesticide use led to lower rice yields. Many farmers are now able to grow rice entirely without pesticides: one-fourth of field school-trained farmers in Indonesia, one-fifth to one-third in the Mekong Delta of Vietnam, and three-fourths in some parts of the Philippines.

The key to success for farmers to reduce dependence on pesticides is biological diversity. Pests and diseases thrive in monocultures, where there is an abundance of food and no natural enemies to check their growth. Resistance to pesticides inevitably develops within pest populations and spreads rapidly unless farmers are able to continually introduce new products. Moreover, when a harmful element is removed from an agricultural system and biodiversity is manipulated to provide free pest-management services, then further options for redesign are possible. Traditionally in Southeast Asia, rice paddies were important sources of fish protein, and fish living in fields helped in nutrient cycling and pest control. But increased use of pesticides killed off the fish, eliminating these important benefits. Without pesticides, however, the fish can be reintroduced.

The premise that biologically diverse systems can provide enough food—particularly for farmers with few resources—has given rise to emerging new fields of scientific study. An excellent example of this is an intercropping project in Kenya. Researchers from the International Centre for Insect Physiology and Ecology (ICIPE) and the U.K. group Rothamsted Research found that when moth larvae known as the stem borer (Chilo spp.) fed on maize, the plants produced semiochemicals—chemicals that relay certain cues to insects or other organisms—that increased foraging and attack by parasitic wasps. Somewhat fortuitously, the researchers also found that a vari-
ety of local grasses used for livestock fodder and soil erosion control (napier and molasses grasses, *Pennisetum purpurean* and *Melinis minutiflora*, respectively) released the same chemicals. The interactions are complex: Napier and sudan (*Sorghum sudanensis*) grasses release different chemicals that attract stem borers to lay their eggs on the grass instead of the maize—so planting these two grasses near a maize crop would decrease the likelihood of a stem borer infestation in the actual crops. In addition, two other plants, the above-mentioned molasses grass and a legume (*Desmodium spp*.), repel the adult stem borers. Moreover, *Desmodium* not only fixes nitrogen but is allelopathic (toxic) to the parasitic witchweed, *Striga hermonthica*—a plant that in some areas has caused greater losses than the stem borers.

Researchers on the ICIPE/Rothamsted project call the redesigned and diverse maize fields *vitu sukuma*, or “push-pull” in Swahili. The methods clearly work: More than 2,000 farmers in western Kenya have adopted maize, grass-strip, and legume-intercropping systems and have at the same time increased maize yields by 60 to 70 percent. The sad truth is that for 30 years the official advice to maize growers in the tropics has been to create monocultures for modern varieties of maize and then to apply pesticide and fertilizer to make them productive. Yet this simplification eliminated a vital, low-cost pest management system that the grasses and legumes provide. The upshot of all this is that the *vitu sukuma* systems are effective examples of integrated pest management, and although they involve complex and diverse interactions, they are cheap because they do not rely on costly purchased inputs.

**Changing Whole Systems**

What is not yet known is whether a transition to sustainable agriculture—delivering greater benefits at the scale occurring in these projects—will result in enough food to meet current food needs in developing countries, let alone future needs after continued population growth and adoption of more urban and meat-rich diets. But what we are seeing is highly promising. There is also scope for additional confidence, as evidence indicates that productivity can grow over time if natural, social, and human assets are accumulated.

Sustainable agriculture systems appear to become more productive when human capacity increases, particularly in the form of farmers’ capacity to innovate and adapt their farm systems for sustainable outcomes. Sustainable agriculture is not a concretely defined set of technologies, nor is it a simple model or package to be widely applied or fixed with time. It needs to be conceived of as a process for social learning. Lack of information on agroecology and necessary skills to manage complex farms is a major barrier to the adoption of sustainable agriculture.

A major problem is that we know much less about these resource-conserving technologies than we do about the use of external inputs in modernized systems. So it is clear that the process by which farmers learn about technology alternatives is crucial. If they are enforced or coerced, then they may only adopt new methods for a limited period. But if the process is participatory and enhances farmers’ ecological literacy of their farms and resources, then the foundation for redesign and continuous innovation is laid.

But successes are still regretfully in the minority, and time is short, the challenge simply enormous. A change to agricultural sustainability clearly benefits poor people and environments in developing countries. Such people, in the end, have more food, are better organized, are able to access external services and power structures, and have more choices in their lives. But change may also provoke secondary problems. For example, building a road near a forest can help farmers reach markets for the sale of diverse farm produce but may also aid illegal timber extraction. Equally, short-term social conflict may be necessary for overcoming inequitable land ownership, so as to produce better welfare outcomes for the majority.

Projects may be making considerable progress on reducing soil erosion and increasing water conservation by adopting zero-tillage techniques but may continue to rely on applications of herbicides. In other cases, improved organic matter levels in soils may lead to increased leaching of nitrate into ground water. In areas where land must be closed off to grazing for rehabilitation, people with no other source of feed may have to sell their livestock; and if cropping intensity increases or new lands are taken into cultivation, then the burden of increased workloads may fall particularly on women. Finally, additional incomes arising from sales of produce may go directly to men in households, who are less likely than women to invest in children and the household as a whole.

**Getting the Policies Right**

Most of the sustainable agriculture improvements seen in the past decade have arisen despite existing national policies. Many of these policies will need major reform. There has clearly been increasing global recognition of the need for policies to support sustainable agriculture, but although almost every country would now say it supports sustainable agriculture, the evidence points toward only patchy reforms. Only three countries—Cuba, Switzerland, and Bhutan—have given explicit national support for sustainable agriculture, putting it at the center of agricultural development policy and integrating policies accordingly. Cuba has a national policy for alternative agriculture; Switzerland has three tiers of support to encourage environmental services from agriculture and rural development; and Bhutan has a national environmental policy coordinated across all sectors.

Some countries, such as India, Brazil, and Sri Lanka, have seen subregional support at state level for zero-tillage, watershed and soil management, and participatory irrigation management.
much larger number of countries have reformed elements of agricultural policies through new regulations, incentives and/or environmental taxes, and administrative mechanisms. These reforms are having considerable—although partial—effect. These include catchment approaches for soil conservation and bans on selected pesticides, combined with national programs for farmer field schools and integrated pest management in rice; support for soybean processing and marketing; and regional integration of agricultural and rural policies. But most countries have not yet explicitly put sustainable agriculture at the center of their policy frameworks.

Food poverty remains a daily challenge for more than 800 million people, despite great progress with industrialized agriculture. Hunger still accompanies increased food productivity. We know how to increase food production with modern methods and fossil fuel-derived inputs, but there has already been great progress, despite the belief of skeptics that the poor cannot be able agricultural systems improve soil and countries. Sustainable agriculture, in seeking to make the best use of nature’s goods and services combined with people’s own capacities for collective action, offers many new opportunities. There has already been great progress, despite the belief of skeptics that the poor cannot be innovative or paradigm-breaking. Sustainable agricultural systems improve soil health, increase water efficiency, and make the best use of biodiversity for control of pests and diseases. When put together, there are important synergistic interactions, improving system performance as a whole. Sadly, however, there remain many confounding factors that will make wider adoption and transitions difficult without substantial policy reform.

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NOTES
10. Ibid.

18. Pretty, note 1 above.
19. A microcatchment is a small watershed of up to 500 ha.
20. Pretty, note 1 above.
22. J. Pretty, note 1 above.
24. Pretty, note 1 above.
26. Pretty, note 1 above.
31. Pretty, note 1 above.