Managing Agricultural Intensification

by Peter B. R. Hazell

Many developing countries will need to double their food production by 2020 if they are to successfully feed their burgeoning populations. This will require maintaining, if not increasing, current rates of growth in national food production, and achieving this in sustainable ways that do not degrade the underlying natural resource base.

Past patterns of agricultural growth in developing countries give cause for concern. Most of the successful breakthroughs in productivity have occurred in more favored agro-ecological zones and have involved intensive use of irrigation water and modern inputs like fertilizers, pesticides, and improved seeds. For example, the Green Revolution, which has played a major role in enabling many developing countries to feed themselves since the mid-1960s, has been limited largely to irrigated rice- and wheat-growing regions. Agriculture based on the intensive use of modern inputs easily lends itself to mismanagement, with dire consequences for the environment, particularly when managed by millions of small farmers with little knowledge about new inputs. The problem may be worsened by well-meaning but often inappropriate government policies (such as input subsidies) or public institutions that themselves mismanage inputs (some public irrigation authorities, for example). The environmental consequences of input mismanagement and overuse include the destruction of beneficial insects, waterlogging and salinization of irrigated land, pollution of groundwater and rivers, poisoning of farm workers, and excessive dependence on a few improved crop varieties.

On the other hand, where governments have neglected to intensify agricultural production through use of modern technology, poverty and hunger have driven rural people to wreak havoc with land, forest, and water resources. When yields do not increase but populations do, poor farmers have little choice but to expand cultivation into less-favored and often environmentally fragile areas such as forests, hillsides, and wetlands.

As available land and water resources dwindle in many developing countries, future growth in food production will have to come from further intensification of agriculture in both the high- and low-potential areas. The high-potential areas will be crucial for meeting national food demands, particularly in the face of rapid urbanization. According to some estimates, the share of the urban population in low-income developing countries will approach 60 percent by 2020, compared with 35 percent today. Once divorced from the land, urban migrants will become totally dependent on marketed food production, most of which will have to come from the more favored agro-climatic areas. At the same time, millions of the poorest people will depend on rainfed agriculture, much of it in marginal areas, for their livelihood and food. Most will not have the option of buying food from other sources or of obtaining employment and income elsewhere. Increasing agricultural productivity where they live will be the only viable way of ensuring their food security and protecting the natural resources on which they depend. The
challenge for policymakers and the agricultural research community is to develop appropriate and sustainable methods of agricultural intensification for both kinds of regions.

**Appropriate Intensification for High-Potential Areas**

The current high yields in most high-potential areas not only must be sustained, but they must be increased if developing countries are to meet their food needs in the years ahead. Unlike the developed countries that now have agricultural surpluses, most developing countries cannot switch to low-input farming systems because they cannot afford the associated reduction in yields. Some critics of the Green Revolution have argued, for example, that India should return to pre-Green Revolution technologies. But if this were to happen, close to half the current population, some 400 million people, would go hungry. The only viable option is to find ways to manage modern farming methods that avoid negative environmental consequences.

The following major environmental problems are associated with intensification in high-potential areas:

1. Intensive use of irrigation water in areas with poor drainage can lead to a rise in the water table, which in turn causes waterlogging and salt buildup in the soil, especially in semi-arid and arid areas. Possibly 24 percent of the irrigated land worldwide is already affected by salinization to some degree. Waterlogging and salinization reduce yields and can eventually lead to a abandonment of irrigated land.

2. Perennial flooding of rice paddies and continuous rice culture lead to micronutrient deficiencies and soil toxicities, formation of hardpans in the soil, and a reduction in the nitrogen-carrying capacity of the soil. Work at the International Rice Research Institute shows that farmers must use increasing amounts of fertilizer over time simply to maintain existing yields in intensive paddy fields.

4. Excessive and inappropriate use of fertilizers and pesticides contributes to the deterioration of water quality, poses health hazards for humans, and leads to resistance of pests to pesticides. Farmers can become trapped into using more and more frequent sprayings to control pest damage.

An increasing reliance on a few carefully bred crop varieties leads to loss of genetic diversity and to increased vulnerability to pest- and weather-related risks. In some cases, millions of hectares of land are planted to the same wheat or rice variety.

These environmental concerns are real but not inevitable consequences of agricultural intensification. There is considerable scope for redressing them, for example, through better design and management of irrigation systems to reduce waterlogging; through water pricing or creation of property rights and markets in water to create economic incentives to reduce excessive use; through rotation of other crops with rice (especially in the dry season) to better maintain irrigated soils; through integrated use of natural predators, selective pesticides, and pest-resistant
varieties to avoid the buildup of pest resistance; through improved soil testing services and fertilizer application methods; through creation of gene banks and regionally diversified crop breeding programs to increase the range and variety of high-yielding varieties available to farmers; through policy reforms to appropriately modify economic incentives at the household level to promote proper management of modern inputs; and through farmer education. Considerable technological and policy research at national and international levels is already focused on these problems, and global and national gene banks have already been established for the main cereal crops. There is every reason to be confident that sustainable farming systems for the Green-Revolution areas can be developed without sacrificing high productivity. But this will require a continued commitment to agricultural research by governments and donors, and greater environmental awareness in setting research priorities and making public policy decisions.

**Appropriate Intensification for Fragile Lands**

Population growth and poverty in many rainfed lands have reached the point where serious resource degradation is occurring. Until recently, natural resources were generally abundant in these areas, and farmers could allow damaged resources time to recover through rotations and shifting cultivation. Moreover, many of the more fragile lands were not farmed at all. Today, they must support moderate to high population densities, providing not only increasing amounts of food but basic essentials such as fuelwood, water, and housing. Their ecosystems have lost much of their ability to rebound from stresses such as droughts.

In the long term, migration and economic diversification will be needed to provide a better balance between people and natural resources in fragile areas, but current trends in population and nonfarm employment are such that the absolute number of agriculturally dependent people will continue to grow for some decades yet. Therefore, the need to increase the productivity of fragile lands and to diversify the sources of rural livelihood is urgent.

Reliable nonagricultural sources of income will be a critical component of stable livelihood systems for most farmers. However, because agricultural growth is the prime driving force behind the rural nonfarm economy, interregional migration and remittances are likely to provide the most important sources of nonfarm income for many fragile areas, at least during the initial stages of regional economic development.

Intensification strategies for fragile lands will have to be different from the Green Revolution model. Poor infrastructure, drought risk, and lower yield response render high use of modern inputs uneconomic. At the same time, the poor soils of fragile lands cannot sustain intensive monocultures of annual crops. Intensification strategies must emphasize management of soil fertility and organic matter, moisture conservation, erosion control, and nutrient recycling. These typically require mixed farming systems that integrate annual crops with perennial crops, farm trees, and livestock.

The kind of research needed to develop appropriate technologies and practices will be more site-specific than in high-potential areas, and will involve farmers in its design and implementation. Sustainable resource management in many fragile areas will often require reform of property
rights, both to assure secure rights over settled farmland and to strengthen community rights over common property resources such as grazing areas, forests, and woodlots. More effective communal organization will also be necessary for managing common-property resources, for undertaking soil erosion control and moisture conservation programs, and for dealing with public institutions that are intended to serve fragile areas (especially research, extension, and credit agencies).

Because intensification programs of this kind will be complex and site-specific, results may be slow to realize and difficult to assess. Donors and national governments will need to be patient and persistent in their efforts.

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"A 2020 Vision for Food, Agriculture, and the Environment" is an initiative of the International Food Policy Research Institute (IFPRI) to develop a shared vision and consensus for action on how to meet future world food needs while reducing poverty and protecting the environment. Through the 2020 Vision initiative, IFPRI is bringing together divergent schools of thought on these issues, generating research, and identifying recommendations. The *2020 Briefs* present information on various aspects of the issues.