USAID Program and Operations
Assessment Report No. 18

Agriculture and the Environment

A Synthesis of Findings

by

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October 1996

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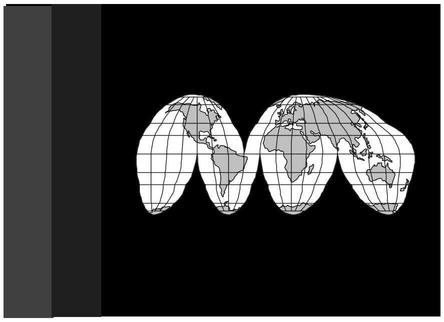
Table of Contents



Preface

IN THE SUMMER OF 1993, the Center for Development Information and Evaluation (CDIE) of the U.S. Agency for International Development initiated fieldwork to assess the impact of the Agency's programs in sustainable agriculture. The work was carried out in five countries: the Gambia, Jamaica, Mali, Nepal, and the Philippines. CDIE teams spent one month in each country interviewing representatives of donor agencies and nongovernmental organizations, government officials, and farmers and other beneficiaries of USAID-supported programs in sustainable agriculture.

In all five countries, USAID programs were designed to increase agricultural production while maintaining or enhancing the natural resource base. In three countries (Jamaica, Nepal, the Philippines), the task was to increase agricultural production on steep hillsides, where soil erosion was the main environmental problem. In the Gambia and Mali, salinization, loss of soil moisture, and soil erosion (but not on steep hillsides) were the predominant environmental problems. As would be expected, these different environmental problems required different solutions.

All five USAID programs had positive socioeconomic and environmental impacts. However, the degree of impact was greater in some countries than in others, and the evidence of impact was stronger in some countries than in others. The study concludes there need not be a trade-off between agricultural growth and conservation of the natural resource base on which that growth depends. That is, increased production need not be achieved at the expense of the environment: the two are complementary.

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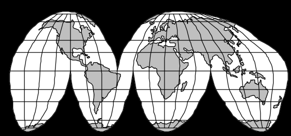
The study drew on technical expertise and logistical assistance of many people. Particularly important were the knowledge and experience of farmers, host country counterparts, and USAID Missions in the countries where fieldwork was carried out. Equally important was the expertise of Chris Seubert, of Global Vision, who assisted with the design of the overall assessment, fieldwork in the Gambia, and synthesis of the five case studies. Michael Calavan, chief of CDIE's Program and Operations Assessment Division, provided both substantive and editorial suggestions that improved the final report immeasurably.



Summary

BETWEEN 1975 and the year 2000 the world will have lost 22 percent of its high-potential agricultural land. That's 600,000 square miles, an area equal in size to Alaska. The loss is alarming because, as population pressures mount, agricultural production will have to expand onto medium- and low-potential lands that are not only less productive but also more fragile and susceptible to degradation.

Soil is degraded mainly through deforestation, agricultural activities, overgrazing, and overexploitation. Biophysical manifestations include erosion and loss of moisture-holding capacity. But more important, and more complex, are the social and economic aspects. Indeed, some view land degradation as a socioeconomic rather than biophysical problem. For example, population growth increases demand for land on which to grow crops, which often leads to deforestation, shorter fallow periods, and continuous cropping. Shortsighted economic policies often make the problem worse by encouraging farmers to clear new land for cultivation rather than to protect land already under cultivation. Insecure land tenure arrangements discourage farmers from making long-term investments needed for resource conservation.

In 1993–94 USAID's Center for Development Information and Evaluation assessed the Agency's activities in sustainable agriculture in the Gambia, Jamaica, Mali, Nepal, and the Philippines. In all five countries the main threats to sustainable agriculture—that is, agriculture that conserves and enhances rather than depletes natural resources—were soil erosion and watershed degradation. The evaluation found positive socioeconomic and environmental results, to varying degrees, in each country.

Program Elements

In each program assessed, USAID introduced specific conservation technologies. These technologies were designed not only to increase agricultural production but also to reduce soil erosion and improve watersheds. The Agency also supported three other kinds of interventions: improved environmental education and awareness, training and institution building, and an appropriate policy environment. Most important, though, was the introduction of appropriate technologies:

- In the Gambia, saltwater barriers and water retention dams permitted uncultivable land to be quickly brought back into production, increasing rice yields. In contrast, contour plowing, grass waterways, and terraces were less successful. They resulted in smaller yield increases, and the payoff materialized less quickly.

- Two quite different technologies were introduced in Jamaica under two different projects. One project involved construction of terraces with heavy equipment on steep hillsides. It was expensive, complex, and clearly inappropriate. The other project promoted hand-planting of perennial trees. The technology was simple, inexpensive, and familiar to most farmers.
- In Mali, erosion barriers called rock lines proved successful. The concept was easy to understand, the technology was easy to learn, and farmers saw a rapid yield response.
- In Nepal, no single technology was adopted widely, probably because practices that were introduced—among them composting and gully erosion control—did not generate large economic benefits. Rather, they contributed to a noticeable but not dramatic improvement in yields or reduced erosion.
- In the Philippines, a method called sloping agricultural lands technology enabled farmers to produce crops without damaging the natural resource base. This technique involved agroforestry hedgerows that stopped soil erosion, created terraces, and improved soil fertility in uplands areas.

Little evidence emerged that environmental-awareness campaigns (posters, exhibitions, technical bulletins)—as distinct from site visits and other types of experiential learning—had any effect on the rate of technology adoption under any of the projects. Farmers took up the technologies not to avoid potential long-term negative effects of soil erosion but to achieve short-term economic benefits.

The extent to which institutions functioned well and local populations participated effectively helps explain why some programs were more successful than others. In the Gambia and the Philippines, USAID encouraged local participation and strengthened local communities, nongovernmental organizations, and farmer associations. These groups were important vehicles for disseminating new technologies, constructing and maintaining conservation infrastructure, and distributing inputs. Similar efforts in Jamaica, Mali, and Nepal were less successful. Even in the Gambia and the Philippines, however, insufficient funding clouds the prospects for sustaining local institutions.

Finally, appropriate economic policies were more important in Mali and the Philippines than in the Gambia, Jamaica, and Nepal. In Mali, USAID helped reduce fertilizer subsidies, giving farmers an incentive to use organic fertilizers that were cheaper and more environmentally friendly than chemical alternatives. In the Philippines, the Mission helped the government carry out a policy shift under which individual farmers gain 25-year rights to public land in upland areas. The rights encourage them to participate in, and benefit from, the conservation program. In the other three countries, the effect of economic policies on sustainable agriculture was neither positive nor negative.

Program Impact

Although results varied, most programs yielded significant benefits. All countries experienced increased crop yields, a clear economic benefit. Social benefits are exemplified in the Gambian village of Njawara, where the conservation infrastructure ended flooding. In Jamaica, the social security of participants improved, because coffee and cocoa trees provide an annual source of income over a period of 15 to 20 years.

The respective environments benefited as well. In the Gambia, the conservation structures protected 15 percent of lowland rice-growing areas from salinization. In Mali the rock lines resulted in decreased soil erosion and increased water retention. In Jamaica, tree planting combined with conservation infrastructure helped reduce soil losses on vulnerable hillsides. Participating areas in the Philippines saw increased terrace formation and soil stabilization. In Nepal multipurpose trees and fodder grasses helped stabilize slopes, and use of organic fertilizer improved soil quality.

All the technologies are replicable. The practices work well, are not complicated, and can be successfully extended to other areas with similar environmental problems and agro-climatic conditions. However, the institutional sustainability of these programs at the village level is questionable.

Management Recommendations

Four management recommendations emerge from the assessment.

1. Demonstrate economic benefits. Introduce conservation technologies that yield significant economic (as well as environmental) benefits in a relatively short time.

2. Use simple technology. Introduce conservation technologies that are easy to maintain and relatively inexpensive.

3. Support local institutions. Strengthen local organizations that supply inputs, technical advice, and markets to help ensure the sustainability of conservation programs.

4. Ensure secure tenure. Support soil and water conservation programs only when intended beneficiaries have secure access to land.

Glossary

CDIE	Center for Development Information and Evaluation (USAID)
FSDP	Farming Systems Development project (Philippines)
HAP	Hillside Agriculture project (Jamaica)
IRDP	Integrated Rural Development project (Jamaica)
NGO	nongovernmental organization
OHVN	Opération Haute Vallée du Niger (Mali)
RRDP	Rain-fed Resources Development project (Philippines)
SALT	sloping agricultural lands technology (Philippines)
RCUP	Resource Conservation and Utilization project (Nepal)
SWMP	Soil and Water Management project (the Gambia)

1 Introduction

IN 1992 USAID'S Center for Development Information and Evaluation (CDIE) began an assessment of the Agency's environmental programs. These programs include activities in sustainable agriculture, forestry, and biodiversity (the ''green'' realm); water and coastal resources (the ''blue'' realm); and energy conservation and urban and industrial pollution (the ''brown'' realm).

The first step was to undertake a desk study reviewing more than a hundred evaluations of USAID-funded environmental activities carried out during 1980–91 (USAID 1992). The study showed USAID authorized almost $1.1 billion during the 1980s to support environmental activities (see figure 1). Of this, activities in sustainable agriculture absorbed the most, $645 million (or 60 percent of total resources). (Sustainable agriculture can be defined as agriculture that provides for human needs while conserving or enhancing rather than depleting natural resources.) The remaining resources supported activities in forestry, biodiversity, energy development, urban and industrial pollution, and water and coastal resources.

The $645 million authorized to support sustainable agriculture was distributed among the geographic regions as follows: 47 percent supported activities in Africa; 23 percent, in Asia; 21 percent, in Latin America; and 5 percent, in the Near East. Four percent supported centrally funded activities (see figure 2).

Sustainable agriculture projects were identified by five descriptive terms used in the USAID database: 1) sustainable agriculture, 2) watershed management, 3) agroforestry, 4) integrated pest management, and 5) range and livestock management. If any project included one or more of these components, it was defined as a sustainable agriculture project.

CDIE then selected five countries in which to conduct fieldwork to assess impacts of USAID-supported sustainable agriculture programs. Those countries were the Gambia, Jamaica, Mali, Nepal, and the Philippines. In all five, the main sustainable agriculture problems concerned soil erosion and watershed degradation. The country studies dealt only peripherally, or not at all, with integrated pest management and range and livestock management.

The desk study emphasized several themes germane to USAID's sustainable agriculture portfolio and in some sense to the entire environmental portfolio. First, few sustainable agriculture projects supported by the Agency in the 1980s were designed specifically to achieve environmental or natural resource objectives. This partly reflects the fact that the Agency's main objectives at that time were to reduce poverty, boost agricultural productivity, or increase export earnings. Today's projects take a much more holistic view of agriculture and the environment, recognizing the need for sustainable food-production systems. Thus, although many projects were designed to decrease soil loss, this environmental benefit was secondary to the potential economic benefit.*

Figure 1. Total Authorization for USAID Environmental Projects, by Sector, 1980-91
total authorization = $1,079 million

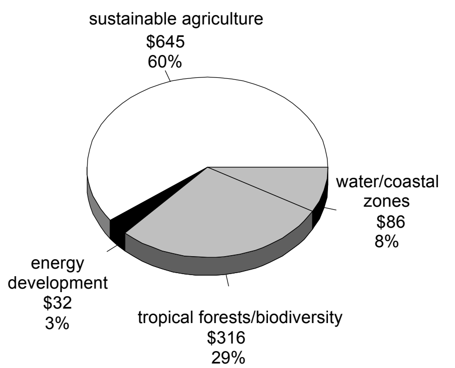
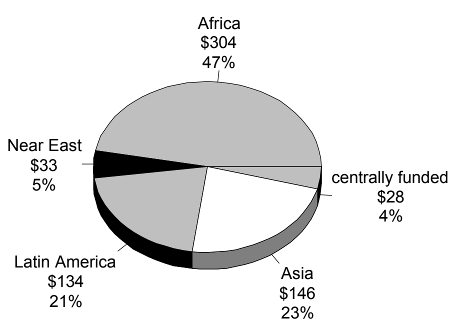


Figure 2. Authorizations for Sustainable Agriculture Projects, by Region, 1980-91



Second, sustainable agriculture projects almost always involve a potential trade-off between development objectives and conservation objectives. This is because economic development tends to use resources as distinct from environmental activities, which conserve resources. An issue associated with almost all sustainable agriculture projects is how best to achieve a balance between short-term production, on the one hand, and long-term protection of natural resources (on which future production and future generations depend), on the other.

Third, the desk study revealed that many USAID-supported projects in sustainable agriculture had a positive environmental impact, but it is difficult to measure that impact, let alone attribute it to USAID. This is because most projects attempting to address soil erosion, for example, took no measurements of erosion rates before, during, or after project implementation. This is not surprising. Actual measurements of soil erosion are difficult and expensive. They must be carried out over many years, usually decades.

Finally, USAID has used four main approaches to support environmental activities, including sustainable agriculture, worldwide:

- New technologies to help solve or ameliorate specific environmental problems
- Education and awareness about the effects of environmental degradation and the benefits of conservation
- Institution building at the local and national levels, for both the public and private sectors, including nongovernmental organizations
- Economic (and related) policiesthat provide financial incentives to encourage

* A similar finding emerges from CDIE's assessment of energy conservation programs (forthcoming, fall 1996).

sound environmental practices and to discourage environmental degradation USAID has also helped improve ownership of and access to land and other agriculture resources, sometimes through policy reform, sometimes through institutional strengthening, and sometimes as a distinct fifth approach to supporting sustainable agriculture. Because of the land-based nature of resource use and the long-term nature of resource conservation, land ownership and land-use rights are critical to sustainable agriculture programs.

A central objective for each of the case studies was to assess the relative importance of each of these approaches to improving soil and water conservation.

Section 2 provides background on worldwide trends in land degradation. It also identifies the main causes of soil degradation by geographic region and summarizes the principal USAID approaches to reducing soil degradation in each of the five countries. Section 3 offers plausible explanations for the observed impacts in the four main approaches used by the Agency to promote sustainable agriculture. Section 4 summarizes impacts of the programs, both socioeconomic and environmental. Section 5 assesses program performance in effectiveness, efficiency, and sustainability and replicability. Section 6 offers management recommendations.

2 Background

AGRICULTURE BOTH CONTRIBUTES to and suffers from land degradation. What are the ramifications of land degradation for the future? This section examines this question and outlines USAID's main strategies for addressing the problem.

Land Degradation: Causes and Effects

Land degradation looms as a serious global problem. Between 1975 and the year 2000, the world will lose 155 million hectares (600 thousand square miles) of high-potential land (including cropland, grassland, and forestland). This represents 22 percent of total high-potential land (Buringh and Dudal 1987, as reported in Craswell 1993) and an area slightly larger than Alaska.

Figure 3 shows estimated shifts in land use during the 25-year period ending in 2000 for three classes of land (cropland, grassland, and forestland) and three levels of potential use (high, medium, and low). High-potential land will decrease for all three classes. Medium- and low-potential land will increase for cropland and grassland but decrease for forestland. In fact, all three levels of forestland are expected to decrease, from 800 million hectares to 360 million, a decline of 55 percent.

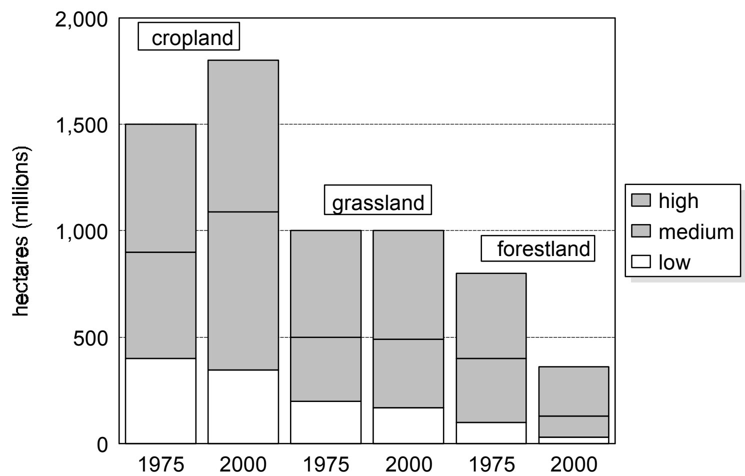
Much of this forestland is being converted to cropland, usually of medium or low potential. In Southeast Asia, for example, the last three decades have seen millions of hectares of valuable and productive tropical forest converted to cropland and grassland of low or zero production potential. At the same time, high-potential cropland is being converted to medium- and low-potential cropland. In sub-Saharan Africa, for example, millions of hectares of cropland have been lost to overexploitation caused by reduced fallow periods. Acreage devoted to grassland in all three classes is expected to remain about constant. The production potential of grasslands has, however, been reduced as a result of overgrazing.

Clearly, soil degradation and productivity losses are occurring faster than new land is being brought into production.* Equally apparent, degradation of land, coupled with in-

* New land is being made available for crop production mainly from forest clearing and to a lesser extent from land reclamation (including desalinization, irrigation, and drainage).

creased population, has resulted in reduction in productive land per capita (Netherlands Ministry of Foreign Affairs 1993). Because remaining productive land is under increasing pressure, agricultural production will continue to expand onto marginal and environmentally fragile lands. It will become even more difficult to increase food and fiber production to keep pace with population growth while protecting the natural resource base.

Figure 3. Land-Use Classes and Potential, 1975 and 2000



Source: Craswell 1993

Oldeman (1991) has identified four major causes of soil degradation: deforestation, overgrazing, agricultural activities, and overexploitation. Figure 4 shows their estimated occurrence in four regions. Deforestation is the main cause of soil degradation in Asia and South America, accounting for 41 percent in both regions. In contrast, deforestation is nil in North America and accounts for only 14 percent of soil degradation in Africa. Overgrazing is the main threat to soil stability in Africa (49 percent) and explains 26–30 percent of degradation in the other three regions. Agricultural activities account for 24–27 percent of soil degradation in Africa, Asia, and South America, and for 66 percent in North America. Overexploitation is a relatively minor cause of soil degradation in all four regions: North America (4 percent), South America (5 percent), Asia (6 percent), and Africa (13 percent).

Because the relative importance of the various causes of soil degradation differs substantially among regions, there is need to tailor conservation programs to foster local solutions for local problems. Sustainable agriculture programs in parts of South America and Asia, for example, should concentrate on deforestation, whereas those in Africa should deal with overgrazing.

Statistics cited by Lal and Pierce (1991) underscore that continued deforestation and soil degradation are issues of utmost concern. The authors point out that

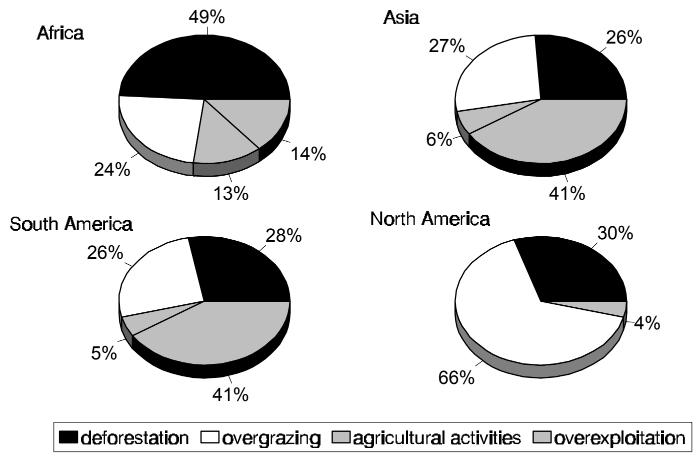
- Soil erosion has irreversibly destroyed an estimated 430 million hectares worldwide, about 30 percent of currently cultivated land area.

- The current rate of land degradation is 5–7 million hectares a year and may increase to 10 million by the year 2000.

- Soil degradation of one type or another affects one third of the earth's land surface.

- Natural erosion accounts for the loss of 9.9 billion tons of soil a year; by con-

Figure 4. Causes of Soil Degradation, by Region



Adapted from Oldeman 1991 and World Resource Report,1992-93

trast, human activity strips away 26.0 billion tons a year.

- In 1986, per capita arable land was 0.3 hectares. Yet an estimated 0.5 hectares (about the size of a football field and one end zone) are needed, together with a modest level of inputs, to produce an adequate diet. Current needs, it appears, are not being met.
- Per capita arable land is expected to decline to 0.23 hectares by the year 2000 and to 0.15 hectares by 2050. This raises the question of how the world will satisfy its food needs in the future.
- Per capita grain production increased by 13 percent per decade during the 1950s, decreased by 2 percent in the 1980s, and is projected to decrease by 7 percent in the 1990s.

Although worldwide trends in resource degradation are clear, specific actions needed to halt or reverse those trends are not. Biophysical characteristics of land degradation are manifested in many ways. They include soil erosion (due to wind and water), loss of soil fertility (from leaching and acidification), loss of plant cover (the main effect of desertification), loss of moisture-holding capacity (largely due to loss of organic matter), development of impermeable subsurface layers (hardpans), and loss of plant diversity. Farmers are among the first affected by such changes.

But the social and economic circumstances under which farmers operate are as important as, and often more complex than, the biophysical changes they face. Indeed, many view soil degradation as a many-faceted socioeconomic rather than a biophysical problem (Blaikie 1985). Among the socioeconomic factors affecting farmers is population growth, which increases demand for land on which to grow crops. This often leads to deforestation or shorter fallow periods. Continuous cropping increases demand for fertilizer to maintain soil quality.

At the same time, shortsighted economic policies often encourage clearing new land for cultivation, rather than protecting and improving land already under cultivation. Insecure land tenure arrangements also discourage farmers from making long-term investments so often needed to conserve resources. What's more, farmers are sometimes not even aware of the benefits of protecting their resource base.

USAID Sustainable Agriculture Programs

In the 1960s and early 1970s, USAID agriculture programs were directed toward increasing food production to meet the developing world's rapidly expanding population. In the late 1970s and early 1980s, concern for the environment increased, particularly for the resource base on which agriculture depends. USAID agriculture programs continued to evolve so they now encompass the much broader concept of sustainable agriculture.

It is now generally understood that programs to halt soil erosion and other land degradation must include viable technical packages, appropriate government policies and economic incentives, secure land tenure, farmer education and community participation, and adequate support systems.

In each of the five countries surveyed, USAID had introduced technologies designed to increase agricultural production while they decreased soil erosion and improved watersheds, achieving both economic and environmental benefits. Thus Agency programs were designed to obviate the potential trade-off between development and conservation.

In most countries USAID also supported complementary interventions—specifically, promoting education and awareness, strengthening institutions, and improving the policy environment. But among all the interventions, introducing appropriate technologies was fundamental in helping explain the relative success or failure of programs. It is important to understand at the outset what these technologies were designed to accomplish.

In the Gambia under the Soil and Water Management project (1978–91), four technologies were supported, two in the lowlands, two in the uplands:

1. Saltwater intrusion dikes stop intrusion of water from saline estuaries of the Gambia River, helping reclaim formerly saline soils for agricultural production. In addition, they impound runoff water at the mouth of small streams flowing into the saline estuaries. This raises the freshwater table in swamplands farthest from the estuary and, by flushing out salts, reduces salinity of soils closest to the estuary.

2. Water retention dams capture rainfall runoff, impounding some of the water that flows into streams immediately after it rains. This raises the water table and creates additional areas for flooded rice production close to the dams. It also increases moisture availability for rice production farther upstream from the dams.

3. Contour berms are mounds of earth about one meter high and two or more meters at the base that run along the topographic contour of a field. They control upland erosion by stopping water from flowing downslope. They also allow rainfall runoff, which otherwise would be lost, to infiltrate the soil.

4. Grass waterways are usually built along with contour berms on upland fields. Grass is planted along waterways to hold soil in place, preventing soil loss and damage to fields by stopping gully erosion that often accompanies heavy rains.

In Mali three technologies were introduced under three projects: Haute Vallée du Niger I (1978–87), Haute Vallée du Niger II (an integrated rural development project, 1988–97), and the Farming Systems Research and Extension project (1985–94). The technologies introduced were

1. Improved rock lines. Bands of piled rocks were constructed along the contours of sloping fields in a manner that improved on local practices. Like the contour berms in the Gambia, rock lines control rainfall runoff and reduce soil erosion. The project organized all farmers in a given location to help one another install and maintain the rock line systems. Rock lines are more effective when an entire watershed is involved rather than isolated fields.

2. Environmentally sound alternatives to use of chemical fertilizers (which cause soil acidity). These involve stabling animals, improving corrals, and developing composting

and manure pits. In addition, fertilizer subsidies were reduced, encouraging farmers to use organic rather than chemical fertilizers.

3. Improved streak-resistant maize varieties. These provide more reliable yields while requiring lower fertilizer and pesticide applications than varieties previously used.

Two quite different technologies were supported in Jamaica under two different initiatives, the Integrated Rural Development project (IRDP) and the Hillside Agriculture project (HAP).

IRDP (1977–84) used heavy earth-moving equipment to construct terraces, ditches, and waterways (often made of concrete) to control soil erosion on steeply sloping terrain. In contrast, HAP (1987–97) gives farmers perennial tree seedlings (primarily coffee and cocoa) that, when planted on steep hillsides, both help control soil erosion and provide farmers with a source of income.

Trees in general protect watersheds by 1) reducing the flow of water over the soil, 2) blunting the forces of wind and rain, and 3) contributing to the buildup of organic matter on the soil surface. Tree roots protect watersheds by 1) holding soil in place, 2) providing channels that increase percolation of water into the soil, and 3) binding soil, preventing its loss from gravity and water flow.

The Hillside Agriculture project has also introduced more direct soil-conservation practices, including the following: 1) Individual plant basins. When combined with plant material left on the soil surface, these depressions help reduce sheet erosion, increase percolation, and supply organic matter to improve fertility. 2) Ditches, grass or wooden barriers, and reinforced contours. In addition to reducing erosion and improving percolation, these structures help channel excess water off fields. 3) Gully plugs. These small dams, consisting of rocks, sticks, and the like, reduce water velocity in the vertical channels that drain water from the fields and roads. 4) Tree cuttings. Placed along contour lines, they reduce erosion.

In the Philippines a method known as SALT—sloping agricultural lands technology—was introduced under two projects: the Farming Systems Development project (1981–90) and the Rain-fed Resources Development project (1982–91).

SALT involves cultivation of crops in ‘‘alleyways’’ between hedgerows of leguminous trees planted along the hillside on the contour. The leguminous trees (like coffee and cocoa trees in Jamaica) and nitrogen-fixing cover crops halt soil erosion on the hillsides. Over time (three to eight years, depending on the slope of the hillside and degree of erosion), soils in alleyways level into terraces. The biomass of the hedgerows improves fertility on the terraces and increases yields of crops such as beans, maize, and cassava.

In Nepal, five practices (or technologies) were introduced under two projects: the Resource Conservation and Utilization project (1980–89) and the Rapti Development project (1980–87, 1987–94). The practices introduced were 1) building dams in gullies and planting grass and vegetative cover on eroded agricultural land, 2) allowing marginal rain-fed land to regenerate, 3) rehabilitating common lands with multipurpose trees and fodder grasses to increase biomass that could be used for compost, 4) stall-feeding livestock to permit farmyard manure to be collected and used to improve soil fertility, and 5) recycling wastewater to irrigate off-season vegetables as cash crops.

3 Program Elements

EACH CASE STUDY SOUGHT to explain the impact of four interventions USAID has supported to one degree or another in each country. These interventions, as discussed earlier, were designed to introduce or promote

- Specific soil and water conservation technologies
- Improved education and awareness
- Training and institution building
- An appropriate policy environment

This section examines the relative importance of each.

Technological Change

Improved technology is generally crucial in changing farming practices so they are more conducive to soil conservation. A broad range of soil and water conservation technologies exist ‘‘on the shelf,’’ and in most cases techniques are well understood and results are predictable. The improved practices (among them composting, tree planting, building terraces, and constructing saltwater intrusion dikes) all work well.

The key is getting farmers to implement these approaches—and here the human element comes into play. In addition to conserving the natural resource base, an improved technology, if it is to be adopted, must provide an economic benefit. Preferably it is an easily observed benefit with a short- or medium-term payoff. The technology also needs to be compatible with existing demands for labor and with skill levels of farmers. Finally, farmers must be given an opportunity to learn about the technology and determine for themselves if it is appropriate for their particular conditions.

Two technologies were introduced in the lowlands of the Gambia: saltwater intrusion dikes and water retention dams. They were uniformly successful, for two reasons. First, they permitted uncultivable land to be brought back into production for a crop (rice) that was of particular interest to the community, especially women. (In the Gambia, women are typically the rice growers.) Second, rice yields increased significantly.

Less successful were contour plowing, grass waterways, and terraces introduced in the uplands. They resulted in much smaller yield increases, and payoffs for investing in their construction came only over the medium to long term. Furthermore, they were usually promoted for plots growing millet, cow peas, and grain sorghum—crops farmed less intensively than is lowland rice. Still, these technologies can prevent flooding and stop gully erosion, and in villages where these problems were severe, they were readily adopted.

Rock lines proved successful in Mali. The concept was easy to understand, the technology easy to learn. Rock lines conserve moisture, a critical factor helping to boost grain yield. Farmers saw a rapid yield response the first season after investing labor to construct the barriers.

Like many conservation practices, rock lines are most effective when laid down for an entire watershed rather than just a few farms or fields. This highlights the importance of having community organizations coordinate implementation of such techniques. It is often more difficult for villagers to learn how to organize themselves to construct rock lines on a large scale than it is to learn the techniques of their actual construction. This was the case in Mali, where inadequate village organization sometimes hampered widespread adoption of an otherwise successful technology.

Stabling livestock and developing manure pits was less successful and adoption less widespread. This was largely because the practice is more appropriately targeted to livestock owners who are also active in crop production and want to improve soil fertility. In Mali's Sahel, as perhaps in other parts of the Sahel, this was not always the case.

Conservation technologies introduced under two projects in Jamaica were quite different, as was their relative success. The Integrated Rural Development project promoted construction of terraces with the use of heavy equipment, whereas the Hillside Agriculture project promoted planting perennial trees with the use of manual labor. The former was expensive and complex; the latter, relatively inexpensive and simple. The former was clearly inappropriate, as some farmers actually lost productive land. The latter was familiar to most farmers, was consistent with existing cropping patterns, and provided significant short-term benefits.

Under IRDP, many farmers constructed terraces and other erosion control structures because of external incentives (cash payments) but did not maintain them because many of the technologies were inappropriate. Under the Hillside Agriculture project, farmers planted perennial trees on steep hillsides primarily to increase yields and cash income. At the same time, though, the techniques increased soil cover and reduced exposure to heavy rainfall, reducing soil erosion from runoff.

In the Philippines, more so than in other countries, introduction of the right technology, whereby farmers could produce crops without damaging the environment and natural resource base, was critical to success. Sloping agricultural lands technology, the agroforestry hedgerow technique introduced by USAID, was clearly an appropriate technology. SALT stopped soil erosion, improved soil fertility, and reversed land degradation on infertile, steep slopes of the nation's uplands. Pivotal to adoption and spread was the successful training of beneficiaries in community organization. Another reason farmers adopted SALT was the lack of alternative opportunities for wage employment. When such opportunities were available, farmers generally did not invest the labor necessary to adopt the improved agroforestry practices.

In Nepal no single technology was widely adopted. Improved practices the Mission introduced—composting, tree planting, gully erosion control, and stall-feeding livestock—generated neither large economic benefits nor large yield increases. Reductions in erosion and improvements in yield were noticeable, though not dramatic.

Education and Awareness

Education and awareness is the second type of intervention USAID has supported to make farmers sensitive to the long-run problems of land degradation.

Site visits and word of mouth were used to educate farmers in the Gambia about improved land reclamation technologies. Once villagers actually saw these methods being used in neighboring villages, they understood how water retention dams and saltwater intrusion dikes could improve their own lands. They became eager to learn to apply these techniques. Environmental awareness campaigns of a more general nature—exhibitions, posters, technical bulletins—were less effective. To be sure, these tools can be important in promoting environmental protection and improved sustainable technologies, but in the absence of hands-on experience their effect is limited.

Many villagers in Mali were aware of the importance of rock lines and other soil and moisture conservation techniques. The way these technologies were extended to farmers in Mali was similar to the way the dams and barriers were extended in the Gambia. Site visits and other types of experiential learning were key to adoption, whereas public awareness campaigns and the mass media were not. However, Malian villagers expressed disappointment with the extension system, viewing it as top-down with a heavy bias toward one-way communication and insufficient opportunity for feedback.

In Jamaica, attempts to create greater awareness among the rural population about long-term negative effects of watershed degradation seem to have had little effect, one way or the other, on adoption of technologies introduced by the Mission. Farmers adopted the conservation technologies not because of potential long-term benefits from reduced soil erosion but because of short-term benefits promised to those who participated. IRDP paid farmers to construct terraces; the Hillside Agriculture project gave farmers seedlings, fertilizer, and technical advice as long as they agreed to plant the seedlings, use the fertilizer, and take the advice. Short-term economic benefits, not awareness about watershed degradation, induced farmers to adopt conservation technologies.

Site visits and experiential learning were also used to encourage technology adoption in the Philippines. Once farmers became aware of agroforestry hedgerows, they understood how the rows could be applied on their own farms. But planting trees along the contour on steep slopes and learning techniques for pruning and mulching required training. Farmer training centers were used to teach these techniques and also served as focal points for improving community organization and management skills. Local nongovernmental organizations played a central role in conducting training needed to implement the new technology.

The importance of hands-on and experiential learning techniques was also evident in Nepal. In addition, plays and role-playing were used to build awareness among the many villagers who could not read.

Institution Building

The Agency's third strategic intervention is strengthening national and local institutions, often by providing technical assistance and training and by supporting community organizations.

In the Gambia strong national and local institutions were important to the success of the program. USAID created and supported for 13 years the Soil and Water Management Unit. Competent and committed technical advisers were recruited to staff the unit during the critical period immediately after its establishment. At the same time, USAID supported a strong training component. Of 27 Gambians who received training, 19 were still working with the unit in 1993, while 7 had been seconded to other agriculture divisions and 1 had retired.

USAID also sought to strengthen local institutions and encourage participation. In fact, the linkage between peoples' participation and benefits derived from such participation was a critical factor in the overall success of the program. Local communities decided at the outset to distribute benefits equitably among participants. To this end, each adult woman received at least one plot of land in the area to be reclaimed for rice cultivation. This stimulated widespread participation in construction and maintenance of the saltwater intrusion dikes and other conservation measures.

In Mali, USAID supported development of village-level organizations, including local cooperatives, that gradually supplanted the large, autonomous regional development authority, Opération Haute Vallée du Niger. OHVN, a powerful parastatal, was created to provide services for tobacco and, later, cotton production.

OHVN has abandoned its original top-down approach and now works with local village associations in program development and implementation. In 1993, for example, the authority was assisting 178 village-level associations and 59 local groups, compared with 47 in 1988 and only 11 pilot organizations in 1984. These local organizations use group solidarity as collateral for acquiring credit and for negotiating more favorable bulk prices and delivery terms for production inputs.

In Jamaica, IRDP sought to strengthen national-level institutions by providing technical assistance and training for extension officers in the Ministry of Agriculture and by strengthening institutions that provided agricultural marketing and credit services. IRDP also established local development committees, but these did not emphasize farmer involvement and were short lived.

In contrast, the Hillside Agriculture project assumed, optimistically, that capacity already existed at national institutions such as the Coffee Board, Cocoa Board, and the Agriculture Ministry's extension service to deliver agricultural inputs and market outputs and provide technical advice. Instead, the project directed its attention toward local institutions. Local management committees were created to select beneficiary farmers and provide regular management. Farmer involvement with the committees was required. As with IRDP, however, local participation was weak, partly because of ambiguous links between participation and benefits. The local management committees generally became nonfunctional after each subproject ended.

In the Philippines as well, USAID fostered and strengthened local institutions, especially nongovernmental organizations (NGOs), to disseminate sloping agricultural lands technology and to supply credit, plant materials, and other essential inputs and services. Community participation was emphasized, and under the Rain-fed Resources Development (RRDP) project the Mission developed local farmer associations that made credit available and affordable as long as farmers adopted recommended upland farming practices.

USAID helped establish NGOs in upland areas that now number in the thousands. Though operating on low budgets, NGOs were experienced in fieldwork and had the skills to undertake activities in sustainable agriculture. The Mission also created local centers to train farmer leaders, farmer groups, line-agency personnel, and a cadre of project staff who were motivated, competent, and committed. Under RRDP, more than 15,000 extension agents and farmers attended courses on SALT. More than a thousand farmers attended similar courses under the Farming Systems Development project.

Both projects in Nepal (the Resource Conservation and Utilization project and Rapti) initially strengthened district-level panchayats, or councils. Results were negligible, mainly because panchayats tended to concentrate on central and local political interests, not user interests.

Over time, however, central planning and management of conservation programs shifted to a more participatory, bottom-up system that involved farmers, local user groups, and indigenous institutions. NGOs in particular were found to be more effective than government agencies, partly because they targeted a specific area and provided services to that area for a relatively long period. Both Rapti and the Resource Conservation and Utilization project (RCUP) also provided training in a wide range of agroforestry and sustainable agriculture practices for line department staff and project beneficiaries.

Policy Environment

The fourth strategic intervention typically associated with successful sustainable agriculture programs concerns the economic policy environment.

Although the policy environment in the Gambia improved dramatically in general during the 1980s, partly as a result of USAID assistance, economic policies appeared to have had little effect, either positive or negative, on the sustainable agriculture program. That is, the success of the program seemed to be independent of the economic policy environment. This is probably because rice is a subsistence crop in the Gambia, and incremental rice production made possible by the saltwater intrusion dikes was consumed locally, by the farmers who grew them, and not sold at market.

In Mali, USAID encouraged policy reforms to reduce the role of the public sector (including the large parastatal, Opération Haute Vallée du Niger) and liberalize markets. For example, USAID helped reduce fertilizer subsidies. That increased the price of chemical fertilizers and provided an incentive to use organic fertilizers instead. Organic fertilizers are both cheaper and more environmentally friendly than chemical alternatives. Market forces were more important to project success in Mali than in the Gambia. Adoption of sustainable agriculture practices would not have been profitable unless markets were liberalized and price controls removed.

Jamaica presents yet another variation. In the Gambia, economic policy had little effect because rice was produced for domestic consumption. But in Jamaica, economic policy was important. Perennial trees were planted under the Hillside Agriculture project, and coffee and cocoa were sold on the international market. Policy reforms begun in Jamaica in the mid-1980s promoted economic liberalization, including currency devaluation, and made production for export attractive. This, together with market deregulation, helped create a policy environment in which farmers who invest in traditional export crops, such as perennial trees, have the opportunity to increase their profits.

Furthermore, since the early 1990s, the government of Jamaica has given environmental issues increased attention. For example, it has elevated environmental concerns to cabinet status and published a national environmental action plan. But before the mid-1980s (when IRDP was implemented), the emphasis was on ensuring jobs for members of the political party in power. This was not conducive to supporting environmental programs and other development activities.

In the Philippines, the government's first priority was to ensure enough rice for the country. Because rice is not an upland crop, government policy toward upland farming was basically one of benign neglect. Therefore, upland farmers, more so than rice farmers, had to be convinced they could profit from adopting new practices. This meant they needed secure access to land for a long enough period of time to make change worthwhile. USAID helped the government implement a program offering "certificates of stewardship," under which individual farmers, community organizations, and small firms gained 25-year rights to public land in designated upland areas. All who adopted conservation practices designed for upland farming systems were eligible to participate. As a result, many farmers switched from slash-and-burn cultivation to hedgerow cultivation (SALT).

In Nepal, responsibility for soil and water conservation was diffused among several government ministries and departments. In addition, government policy did not, until recently, stress the importance of natural resource management. RCUP's contract approach to conservation proved unsuccessful, partly because it failed to engender a sense of ownership and commitment among local residents. In contrast, experience with the Rapti project provided the basis for developing a national policy of integrated watershed management. The Ministry of Forests and Soil Conservation adopted the Rapti model for implementation throughout the country. The new policy gave legal status to user groups so they would protect and manage community forests on public lands.

Table 1 summarizes these findings for each of the four interventions.

Table 1. Degree to Which Sustainable Agriculture Interventions Were Successful, by Country

Country	Intervention	Successful?
Technological Change		
the Gambia	saltwater intrusion dikes; water retention dams	yes
	contour plowing; grass waterways; bench terraces	somewhat
Mali	rock lines	yes
	stabling livestock; using manure pits	somewhat
Jamaica	concrete bench terraces	no
	perennial tree crops; improved practices	yes
Philippines	agroforestry hedgerow farming	yes
Nepal	composting; stall feeding; reforestation	somewhat
Education and Awareness		
the Gambia	word of mouth; farm visits	yes
	posters; exhibits; radio broadcasts	no
Mali	top-down, one-way extension messages	somewhat
Jamaica	extension service; parastatals; local management committees	somewhat
	posters	no
Philippines	word of mouth; farm visits; training workshops	yes
Nepal	village-level meetings; plays; role playing; site visits	somewhat
Institution Building		
the Gambia	Soil and Water Management Unit supported for 13 years; competent advisers provided; trainees returned to good jobs; link between participation and benefits emphasized	yes
Mali	village-level organizations emphasized	somewhat
Jamaica	technical assistance to Ministry of Agriculture; local management committees created; participation–benefits link not emphasized	somewhat
Philippines	training centers and farmer associations created; farmers and extension agents trained; NGOs strengthened; community participation emphasized	yes
Nepal	initial emphasis on district-level organizations; later on NGOs and local user groups; training was provided	somewhat
Policy Environment		
the Gambia	none, but economic policy reforms had already been introduced by other USAID programs	neutral
Mali	policy reforms reduced the role of the public sector, increased market liberalization, and reduced the fertilizer subsidy	yes
Jamaica	none, but economic liberalization and deregulation helped create a policy environment conducive to export-crop production	yes
Philippines	certificates of stewardship ensured secure access to land	yes
Nepal	legal status was given to user groups to protect and encourage good management of forests on public lands	somewhat

4 Program Impact

THE AGENCY'S PROGRAMS in sustainable agriculture have generally been positive and resulted in significant benefits. However, socioeconomic impacts were easier to document than environmental impacts. In fact, none of the sustainable agriculture programs had been designed to measure biophysical or environmental impacts stemming from adoption of improved practices. This was partly because most USAID projects operated within a relatively short time frame, whereas most environmental programs by their very nature require a relatively long period to demonstrate results. Consequently, the evaluation teams relied on secondary data and proxy indicators to assess environmental impact.

The findings reported below were based on personal observations, interviews with farmers and program implementers, and previously conducted studies that usually did not examine the actual impact of the program. Although some programs (the Gambia, for example) carried out studies to measure progress (using indicators such as area affected by conservation technologies relative to total farmland, and economic benefits of conservation technologies relative to their costs), most did not. As a result, evaluation teams had to assume 1) sustainable agriculture programs had positive impacts when most farmers in project areas adopted improved conservation practices on at least some of their fields and 2) these practices were well known to have significant economic and environmental benefits.

Socioeconomic Impact

In the Gambia the economic impact of the soil and water conservation program was impressive. Within one or two seasons, average rice yields increased by 108 percent, from 1.3 tons per hectare to 2.7 tons. In one village, women confirmed to the evaluation team that they were able to harvest from one plot what they typically had harvested from three plots before the saltwater intrusion dike was constructed. And in another village, rice was harvested on plots that had not been cultivated for more than a decade. In upland areas, too, construction of contour berms and antierosion measures resulted in increased production of corn, millet, peanuts, and sorghum.

Increased production contributed to increased incomes and improved food security. For example, increased water retention made possible by conservation infrastructure allowed women to grow vegetables during the dry season following the rice harvest, providing a new source of cash income. Both men and women repeatedly pointed out that saltwater intrusion dikes allowed families to eat for months without purchasing rice or other foodstuffs, and that money saved could be used to meet other needs.

There were social benefits as well. For example, conservation infrastructure effectively ended flooding in Njawara. And women, who were primary beneficiaries of the new income-earning activities, regained control over subsistence production in their traditional fields.

In Mali, millet and grain sorghum yields increased by at least 10 percent in fields where rock lines had been constructed. Even though labor costs in building the rock lines were significant, the internal rate of return to investing in the technology was estimated at 45–95 percent, depending on the method used to transport rocks.

In Jamaica, economic effects were substantial. Coffee production increased from less than the national average (about 20 boxes an acre) to almost 30 boxes an acre. Likewise, cocoa production increased from 8–10 boxes to about 30 boxes an acre. Another analysis concluded that after four years, coffee production increased by 21 percent and cocoa production increased by 45 percent. In large part, these yield increases were due to increased availability of external inputs (principally fertilizers and pesticides) and improved practices recommended by the Hillside Agriculture project. The extent to which increased production translated into increased income varied, depending largely on world market prices for coffee and cocoa and the foreign exchange rate.

The Hillside Agriculture project also had an important social impact. Perennial trees provide an annual source of income over a long period, 15 to 20 years. Therefore, the social security of the beneficiaries of the program has improved in direct relation to the number of perennial trees planted and resuscitated. This was important because the beneficiaries (both men and women) are generally older than the population at large (the average age of Jamaican farmers is 55).

In the Philippines, too, the soil conservation program has had positive results. Despite the space taken up by hedgerows under sloping agricultural lands technology, net production per unit of land has steadily increased on newly terraced land, eventually to levels obtained before erosion began. And yields were much greater than those obtained under slash-and-burn cultivation of comparably degraded lands in other parts of the Philippines.

After several years of cultivation, farmers implementing SALT realized yield increases estimated at 300 percent. Increased yields allowed farmers to satisfy their subsistence needs on less land, and the "extra" land could then be used for planting fruit, vegetables, and other cash crops. As a result, net income of farmers who switched from slash-and-burn cultivation to hedgerow cultivation typically increased by $400 per hectare.

Even though SALT required more labor, the return to the technology was 25 percent greater than with traditional slash-and-burn cultivation. And when additional economic benefits are taken into account (for example, potential for livestock production and crop diversification), economic incentives for adopting SALT are even greater.

In Nepal, improved water management has enabled farmers to double- or triple-crop their fields, resulting in a doubling or tripling of yields. Increased yields has permitted farmers to shift from subsistence crops to cash crops and other market-oriented enterprises, which has contributed to increased incomes. Additional income has permitted increased savings and investment at both the household and community levels. At the community level, savings have been pooled and invested in infrastructure such as public buildings and elementary schools.

Reforestation activities have also contributed to improved household welfare. For example, the time women used to spend collecting grass, fodder, and fuelwood can, thanks to reforestation, be devoted to other activities. Time saved can be substantial: one study found that hill women in deforested areas of Nepal spend, on average, 2½ hours daily on foraging.

Environmental Impact

Saltwater intrusion dikes and water retention dams introduced in the Gambia have had a significant positive environmental impact for lowland rice farmers. The effect is most dramatic where salinization made fields impossible to cultivate, and dikes and dams reversed this situation. In all, the saltwater intrusion dikes and water retention dams protect critical portions of 15 percent of the lowland rice-growing areas of the country. Benefits of conservation structures introduced to upland farmers are less striking. The structures help reduce soil erosion and flooding on about only 1 percent of upland farming areas.

Of the three conservation technologies reviewed by the evaluation team in Mali, installation of rock lines in farmers' fields has had the greatest environmental impact. Rock lines have resulted in decreased soil surface erosion, increased water retention, improved soil buildup, and increased crop yields in areas adjacent to the rock line. Although quantitative data on results were limited to the number of meters of rock lines actually installed, assumptions about positive effects of the technology were based on results in other Sahelian countries with conditions similar to those found in Mali.

In Jamaica perennial trees were planted on steep hillsides susceptible to soil erosion. More than one million coffee and cocoa trees were planted, and more than two million trees were resuscitated on nearly 7,000 acres. The initiative has reached more than 9,500 beneficiaries. In addition, the Hillside Agriculture project introduced structures to control soil erosion, including more than 38 miles of ditches, 1,000 gully plugs, more than 16 miles of grass barriers, 26 miles of wooden barriers, and nearly 3,500 plant basins. It is clear these interventions have helped reduce soil losses on highly erodible steep lands, but, as in Mali, there are no direct measures of reduced erosion.

Adoption rates of SALT in the Philippines have varied considerably, depending on the particular site. At most sites visited by the evaluation team, the technology has resulted in increased terrace formation and soil stabilization—clear environmental benefits.

The evaluation team in Nepal did not gather much quantitative data to evaluate environmental impact. However, the team did observe farmers using multipurpose trees and fodder grasses and legumes to stabilize slopes and provide animal fodder. At the time of the visit, community-based groups were practicing afforestation to increase overall vegetative cover and protect land surrounding springs and irrigation canals. In addition, some farmers were using manure obtained from stall-feeding livestock to improve soil fertility. The practice has a direct environmental impact.

5 Program Performance

USAID PROGRAMS are designed to be effective, efficient, sustainable, and replicable; and CDIE evaluations examine the extent to which USAID programs satisfy these objectives. This synthesis is no exception.

Program Effectiveness

Generally speaking, a program is effective if it reaches the population it intends to benefit and if the results are those anticipated and desired in the design of the activity.

The soil and water conservation activities supported by USAID in the Gambia were effective on both counts. This was due in large measure to 1) selection of comparatively simple, low-cost, and easy-to-maintain technologies; 2) direct and readily apparent linkage between the problem (reduced productivity due to saltwater intrusion) and the proposed solution (construction of saltwater intrusion dikes); 3) ability to demonstrate significant, short-term benefits to those participating in the activity; and 4) willingness of community members to redistribute reclaimed lands brought into production equitably.

From 1983–84 to 1992–93, 1,611 hectares of lowland ricelands were rehabilitated, and soil conservation measures were applied to 1,920 hectares of upland area. As a result, 140 villages and 30,000 people were positively affected. Women, the rice growers in the Gambia, were principal beneficiaries.

The 2 percent of Mali that is arable was targeted under USAID's sustainable agriculture program. From 1989 through 1992, 1,711 meters of rock lines and 19,740 meters of dikes were constructed. In addition, since the program was premised on the belief literacy was essential to project success, more than 500 literacy centers were established—65 percent for men, 20 percent for women, and the remainder for mixed-sex groups. Beyond that, there was no targeting of persons or groups. Soil conservation practices have generally not been adopted, except by farmer demonstrators. And the results of the literacy program appear minimal. In fact, the problem of agricultural unsustainability, which received much attention in the 1970s during a major drought, has worsened since then as a result of continued rainfall shortages, population pressures, deforestation, and poor cultivation practices.

Although the majority of hillside farms in Jamaica are small (70 percent are less than 5 acres; 95 percent, under 10) the Hillside Agriculture project did not attempt specifically to reach the smallest or poorest farmers. On the contrary, it attempted to reach those who had secure land tenure, had a dedicated attitude toward farming, and were young (in a country where the average age of farmers is 55). All participants (more than 9,500), regardless of income level or farm size (which averaged two thirds of an acre), received the same benefits: enough seedlings and fertilizer to cover not more than one acre of land. Neither the husband nor the wife benefited more than the other; additional income generated under the project was treated as family income and shared between the two.

Sustainable agriculture projects in the Philippines targeted one of the poorest regions of the country, where people for the most part had been overlooked by government programs. The technology introduced, SALT, required limited financial resources and was available to any farmer with land to cultivate. In addition, the program generated benefits for neighboring farmers and landless residents, who were hired to help establish and later prune hedgerows. The program also generated public benefits, such as reduced flood risk, not targeted to specific groups.

In Nepal, women and disadvantaged groups have a predominant role in decisions related to agricultural production and resource use. It was logical, therefore, to target these groups as the primary project beneficiaries. Many formed user groups (equitably represented by gender, caste, and ethnicity) in the course of implementing and managing the conservation activities. In the Pereni subwatershed, for example, farmers increased irrigated area to 180 hectares from 45 hectares over a four-year period and also rehabilitated eroded soils.

Program Efficiency

Program efficiency assesses benefits in relation to costs. For a program to be efficient, benefits must, at a minimum, equal the return that could be earned on alternative investments elsewhere in the economy.

Economic analysis of the soil and water conservation program in the Gambia showed that during the 13-year project period the benefit–cost ratio was 0.76 to 1. Benefits were less than costs, indicating the project was not economically viable over that time period. According to the analysis, the break-even year would be 2006. At that point, benefits would just equal costs, for a benefit–cost ratio of 1:1.

When the analysis excluded the 13-year donor phase of the project, treating costs incurred then as sunk costs, and instead included only the 14-year period ending in 2006 (the break-even year), the benefit–cost ratio was 5.18 to 1. This means that each dollar expended on the soil and water conservation program would return more than $5, which, from the government's point of view, is very attractive.

In Mali no attempt was made to assess the economic efficiency of the two USAID projects, Haute Vallée du Niger I and Haute Vallée du Niger II. Analyses show, however, that construction of rock lines to reduce soil erosion and restore soil quality was financially viable from the farmers' point of view, depending on the means used to transport the rocks. To construct 100 meters of rock lines took 40 days of labor using headloads, 21 days using carts, and 10 days using trucks. If the rocks were transported by truck, construction of rock lines had a high internal rate of return. But when the more rudimentary modes of transport were used, the rate declined.

In Jamaica the Hillside Agriculture project was judged economically feasible in 1987 when the project was designed. The internal rate of return was estimated at 9–22 percent, depending on assumptions concerning rates of adoption, commodity prices (mainly of coffee and cocoa), wage rates, and yield increases. But yield increases for coffee had been overestimated by a factor of 2, at least. When internal rates of return were recalculated under the assumption coffee yields were half those assumed in the 1987 analysis, estimated rates of return ranged from 6 to 18 percent, and estimated project benefits were cut almost in half.

SALT had not spread sufficiently in the Philippines to cover the costs of the Farming Systems Development project and the Rainfed Resources Development project. As of

1993, only about 2,000 hectares were being cultivated with the use of SALT—out of 9.5 million hectares of public uplands where the technology could be applied. Assuming benefits of the hedgerow technology were $400 per hectare, a total of 41,250 hectares would have to be put under SALT cultivation to cover the costs of the projects. But $400 per hectare is a conservative estimate. If other benefits (reduced flooding, more stable watersheds, improved opportunity to grow cash crops) were included in the analysis, fewer than 41,250 hectares would have to be cultivated using SALT in order to cover project costs.

The evaluation team in Nepal did not estimate the economic efficiency of soil and water conservation programs implemented under the Resource Conservation and Utilization project and Rapti I. Nonetheless, the team concluded the program was not efficient, mainly because it depended on large-scale, costly engineering works. Also, it used a top-down approach to introduce the technologies without involving beneficiaries, and technologies were not widely adopted. Since the infrastructure is now in place and the user-oriented approach is being used, the natural resource component of Rapti II is likely to be more efficient than Rapti I.

Sustainability and Replicability

A final issue is whether the soil and water conservation programs were sustained after USAID assistance ended.

USAID's soil conservation work in the Gambia is both sustainable and replicable. Farmers realized good returns on their labor investments, and there is solid evidence they are maintaining their dams and barriers, even extending them where possible. The staff of the Soil and Water Management Unit, the main institution strengthened by USAID, has the technical capability to continue to design the saltwater dikes and water retention dams that have had such positive results. To do this, however, the unit will need continued funding from the Gambian government or donors. Although soil salinization problems are generally site-specific, the technologies applied in the Gambia can be replicated elsewhere, such as in neighboring Senegal, where conditions are similar.

Similarly, the rock line technology introduced by USAID in Mali to conserve soil moisture can be successfully extended to other areas with similar soils, slopes, cropping patterns, and rainfall—within Mali and in other Sahelian countries. The positive returns to labor invested in building rock lines make it a financially sustainable technology for most farmers. It may not, however, be institutionally sustainable at the village level. Conservation structures should be installed to cover fairly large areas, usually most of the sloping fields of the watershed. This requires village-level organizations. The capacity to organize farmers, therefore, is a key determinant of whether or not the technology is replicated.

Improved soil conservation techniques used in Jamaica have been applied in many countries. The practices work well and are replicable under similar soil, climate, and cropping conditions. However, long-term sustainability of these practices in Jamaica is questionable. This is not because they require a large investment—they do not. Rather it is because farmers require institutions to supply services (such as credit), inputs (such as seedlings and fertilizer), and markets. In Jamaica, these institutions at the local level tend to function poorly.

The hedgerow technology, SALT, developed in the Philippines can work well in many countries, particularly where steep slopes and acid, infertile soils are being converted from forest to cropland. Moreover, farm-level economics makes SALT profitable. The technology is replicable as long as there are viable institutions, such as an extension service, to introduce it and train farmers in its use. In the

Philippines, NGOs were one of the most important institutions to perform this function. But NGOs may not operate in or have resources to extend SALT to all areas of the country.

The CDIE evaluators noted that upland farm management systems need an ''economic engine'' for sustainability and spread. Sloping agricultural lands technology succeeds best where farmers and local communities have linked it to profitable cash enterprises such as growing fruit trees or raising livestock. Where not integrated with cash enterprises, SALT has often been abandoned.

The techniques introduced in Nepal are simple and require no large investments or complicated training programs. They are replicable both within the country and in other countries. In fact, all the technologies used in Nepal are routinely applied elsewhere.

6 Management Recommendations

FOUR MANAGEMENT RECOMMENDATIONS emerge from this synthesis. Two are based on experiences and lessons learned in all five countries evaluated. The other two are based on evidence found in only three or four of the countries.

1. Economic benefits. Introduce conservation technologies that yield significant economic (as well as environmental) benefits in a relatively short time.

- In the Gambia, rice production doubled and sometimes tripled—in one year—in areas where saltwater intrusion dikes were constructed. Because the benefits from contour berms were typically less immediate and less appreciable, adoption of this technology was less widespread.
- In Mali economic benefits resulted from adjusting policies that had discouraged adoption of sustainable agricultural technologies by keeping the price of chemical fertilizers lower than that of more environmentally friendly organic fertilizers.
- In Jamaica farmers received immediate economic benefits (free seedlings, fertilizer, and technical advice), more than compensating for the three or four years it took for seedlings to produce coffee or cocoa. Resuscitation of existing trees almost doubled yields within two years.
- In the Philippines farmers abandoned the sloping agricultural lands technology if it was not linked with a profitable cash enterprise.
- In Nepal conservation practices linked to increased rural incomes were more likely to be adopted than those that were not.

2. Simple technology. Introduce conservation technologies that a) are easy to maintain, b) place minimal demands on labor, c) require few changes in existing practices, and d) are simple and relatively inexpensive.

- In the Gambia saltwater intrusion dikes satisfied most of these criteria.
- In Mali rock lines and other conservation structures were simple and relatively inexpensive, as was organic fertilizer recycling; all these measures complemented existing practices.
- In Jamaica perennial tree crops planted under the Hillside Agriculture project were familiar to farmers, and improved practices were simple to adopt (although additional labor requirements sometimes were a problem). In contrast, conservation technologies promoted under the In-

tegrated Rural Development project were complex, expensive, and unfamiliar to farmers, and they required changes in existing practices.

- In the Philippines SALT was not a simple technology, but it worked, because systematic training (including farmer-to-farmer training) ensured that farmers adopted the technology without committing errors that could lead to poor results.

3. Local institutions. Support and strengthen local institutions and organizations that supply inputs, technical advice, and markets to help ensure the sustainability of conservation programs.

- In the Gambia, USAID stayed the course by supporting the Soil and Water Management Unit for 13 years. Unless there is continued budgetary support, though, the unit's ability to provide technical advice at the local level will be limited.

- In Mali the Mission supported village-level organizations and institutions that linked farmers with improved technology and the inputs they needed to apply that technology.

- In Jamaica long-term sustainability of the conservation activities is questionable, largely because government institutions that supply inputs, technical advice, and markets lack the budget and the staff to do so efficiently; NGOs, however, are filling the gap in some locations.

- The same is true in the Philippines, where local NGOs and farmer organizations provide technical advice and inputs and will continue to do so as long as they are adequately funded.

- In Nepal local organizations and community participation helped keep the natural resource management programs in operation.

4. Secure tenure. Support soil and water conservation programs only when intended beneficiaries have secure access to land.

- In the Gambia, community members redistributed reclaimed land equitably to those who worked to construct and maintain the saltwater intrusion dams.

- In Jamaica secure land tenure, one criterion used to select farmer beneficiaries, was especially important to make sure farmers would reap the benefits of planting and maintaining perennial tree crops long into the future.

- In the Philippines certificates of stewardship provided individual farmers, community organizations, and small firms 25-year rights to public land in designated upland areas. Farmers who did not own land received the landowner's assurance of at least medium-term access to the land.

Appendix

Evaluation Methodology

THIS ASSESSMENT IS BASED on five country case studies. The countries were selected from among those identified in a desk study commissioned by CDIE (CDIE 1992): two in Africa (the Gambia and Mali), two in Asia (the Philippines and Nepal), and one in Latin America and the Caribbean (Jamaica).

Assessment teams conducted fieldwork in each country. Each team had three or four members, including a leader (typically an economist), an agricultural specialist (generally an agronomist or natural resource specialist), and a social scientist (usually an anthropologist). In four of the five countries (all except Jamaica) the teams assessed USAID-funded activities in forestry as well as sustainable agriculture. These four teams included a forestry expert. In some countries (the Gambia, for example), translators, enumerators, and research assistants served on the teams. Fieldwork began in the Philippines in July 1993 and ended in Jamaica in June 1994. The teams spent about four weeks in each country.

A uniform analytical framework was used to assess the impact of USAID sustainable agriculture programs. This ensured comparability among the five studies and aided synthesis of findings. The analytical framework specified two kinds of impacts, environmental and socioeconomic. It also identified four factors or strategic interventions most likely to contribute to or explain program impact: introducing new conservation technologies and practices, promoting environmental education and awareness, strengthening local and national institutions, and ensuring an appropriate policy environment.

The teams relied on three main sources of information: 1) Documentation available in Washington and the USAID Mission in each country. Program and project evaluations as well as analytical work concerning the interface between soil and water conservation on the one hand and agricultural production on the other were especially important. 2) Key informant interviews with people familiar with USAID-supported activities in sustainable agriculture. These people typically included government officials and representatives of donor agencies and NGOs. 3) Site visits where USAID-supported activities had been implemented.

The four strategic interventions served as the organizing principle for developing survey instruments and topical guides. These were used to conduct key informant interviews, record descriptive information at each site visited, and gather data on biophysical and socioeconomic impact. They were designed to provide a structure in which to conduct the interviews; they were not designed to elicit quantitative information that could be statistically analyzed across villages or farmers.

Sites visited by each team were selected against criteria that would ensure, among other things, geographical balance within the country, so that no greater or lesser weight was given to known success stories. It was usually possible to visit sites where USAID funding had ended (as distinct from projects still under way), that is, where long-term impact of the projects could be assessed.

The number of sites visited by teams varied, depending in part on logistical considerations. In the Gambia, for example, 10 sites were visited over a six-day period. Each site visit required about 2½ hours. In contrast, the Jamaica team conducted 28 field interviews at 11 sites, primarily with individual farmers. Each farmer interview required one to two hours. Because of the settlement pattern, there were no group (or village) interviews in Jamaica as there had been in the Gambia, but rather individual farmer interviews.

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