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Using Indigenous Knowledge in Agricultural Development

D. Michael Warren

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ABSTRACT

The World Bank, like other major development agencies, has been interested in ways to encourage participatory decision-making, strengthen individual and institutional development capacity, and assure the long-term sustainability of development. There is a growing body of evidence describing the positive uses of indigenous knowledge in development projects and many successes in building upon it. The literature shows that by understanding and working with indigenous knowledge and decision-making systems and indigenous organizations, participation, capacity-building, and sustainability all can be enhanced in cost-effective ways.

The belief that indigenous knowledge systems are simple and static is changing fast. Many societies with simple technologies have very complex and sophisticated knowledge about their natural resources. All knowledge systems are dynamic, with elements of both continuity and change. Change is not random, but rather predicated upon conscious efforts by people to define their problems and seek solutions through local experiments and innovation as well as by evaluating technologies developed elsewhere.

This paper reviews three types of project scenarios: projects where local knowledge provided an improved approach to managing natural resources than proposed project technologies, projects that inadvertently ignored indigenous structures, and those projects whose success at meeting their objectives can be linked to the deliberate incorporation of indigenous knowledge components.

The case for using indigenous knowledge in project work is straightforward. Technical solutions to unperceived problems are not readily adopted, new technologies that duplicate indigenous ones are superfluous, and ignoring local approaches to local problems is wasteful.

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INTRODUCTION

The World Bank operates in numerous developing countries that have agricultural and natural-resource management traditions stretching several millennia into the past. Hundreds of ethnic groups in dozens of ecological zones have generated a vast body of indigenous natural-resource management and agricultural knowledge. Collectively they represent a dynamic information base that has supported an immense population by adapting to constantly changing circumstances. These indigenous knowledge systems have been largely ignored in many developing countries (Jiggins 1989; Slikkerveer 1989; Warren 1989a). But we are now beginning to recognize that indigenous knowledge is an important national resource that can facilitate the development process in cost-effective, participatory, and sustainable ways (Vanek 1989; Hansen and Erbaugh 1987).

Indigenous knowledge (IK) is local knowledge--knowledge that is unique to a given culture or society. IK contrasts with the international knowledge system generated by universities, research institutions, and private firms. It is the basis for local-level decision-making in agriculture, health care, food preparation, education, natural-resource management, and a host of other activities in rural communities. Such knowledge is passed down from generation to generation, in many societies by word of mouth. Indigenous knowledge has value not only for the culture in which it evolves, but also for scientists and planners striving to improve conditions in rural localities. Every society has a large body of technical knowledge based on careful observation and use of its natural resources. Every society also has mechanisms through which indigenous knowledge provides the basis for group decision-making and the generation of new knowledge and technologies when current problems and how to cope with them are discussed. And every society has ways to disseminate new information and technologies, whether generated within the society or outside of it (Mundy and Compton 1991).

By recording indigenous knowledge systems (IKSs), they can then be compared and contrasted with the international knowledge system. It is possible to identify beneficial aspects of the IKSs as well as those that could be improved through science-based technologies. The validity and cost-effectiveness of indigenous technologies can be tested scientifically.

Indigenous knowledge is important for many kinds of development activities to be successful. If it has not been recorded, it remains largely inaccessible to development workers. Solutions offered by a development project may fail because they do not fit with the local knowledge. Indigenous knowledge may suggest alternatives. Indigenous technologies used effectively by one society can be used to solve problems faced by another society in a similar agroecosystem located in another part of the world. A blend of approaches and methods from various systems may be appropriate.

The success of a development project often depends on local participation. Familiarity with indigenous knowledge can help change agents understand and communicate with local people, enhancing the possibilities for participatory and sustainable approaches to development. This enables project staff and local people to work as partners in planning and implementing development activities. Although this discussion paper focuses on the role of indigenous knowledge in facilitating the process of development, it is important to stress that the enhanced process will result in improved products of development, such as the higher incomes resulting from increased crop production due to better soil and water conservation resulting from the use of Vetiveria grass.

CASE STUDIES OF INDIGENOUS KNOWLEDGE AND DECISION-MAKING SYSTEMS

There are now hundreds of studies that have recorded indigenous knowledge in many countries. A review of these documents reveals useful insights into how indigenous knowledge and scientific research can benefit from one another. Despite improvements in crop and livestock production technologies, farmers often do not adopt these innovations. Research indicates that the farmers' decisions to reject an innovation are often rational when viewed through the indigenous system. Many farming systems are based on intimate knowledge of soils, vegetation, climate, and pests. They also reflect strategies that allow the farmer to avoid perceived input, output, and marketing risks or uncertainties. Understanding these perceived risks and ways of avoiding them can be an important first step toward fruitful partnerships between development professionals and farmers. Understanding the ways that indigenous knowledge provides the basis for local-level decision-making for both individuals and groups can be very important in development endeavors.

Several types of indigenous knowledge and decision-making that are useful for development are outlined in the next sections.

Mixed Cropping and Forest Gardens

Western visitors to farms and gardens in many parts of the tropical zone find them messy and chaotic. Numerous Euro-American accounts from both the colonial and post-colonial periods express the need to bring order into the local systems. Parallel-row monocropping not only looks neat, but also maximizes short term profits. Its long-term effects, however, are less obvious to farmers who expect to remain on the farm. More than 50 years ago Louis Leakey wrote an account of Kenyan mixed cropping systems as it was seen through the eyes of a Kikuyu farmer. The account clearly depicts the extraordinary production risks and environmental degradation the Kikuyu farmer would face by following the demands of the British agricultural officers to plant monocrop maize (Leakey 1936). Today, many of the international and national agricultural research centers have shown scientifically the utility of these indigenous mixed cropping systems.

Until recently, little scientific attention was given to tropical forest gardens. Ethnobotanists and agroforestry specialists now have analyzed several of these systems. Alcorn (1991) has formulated several ethnobotanical principles based on her research with small-scale farmers:

- Not all wild plants are regarded as weeds. Farmers utilize them for their products and for ecological services they provide;

- Cultivators prefer landscapes with a mosaic of wild and crop biodiversity, native vegetation providing resources for food, medicine, and shelter with minimal energy inputs, crop diversity spreading risk and providing dietary variation;

- Wild plants can be managed to sustain agricultural systems through soil conservation on slopes, regulation of soil fertility, and provision of shade for cropped areas;

- Topographically related variation in wild plant communities is valuable; for instance, seasonally flooded areas receive water-borne organic matter from wild plants, which helps to fertilize crops;

- Experimentation with biological elements (wild plants, new crops, or traditional varieties of current crops from other regions) can improve local systems;

- The conservation of useful, rare plants is a priority goal, achieved through sacred groves and gardens and by individual farmers who take pride in maintaining rare wild plants and rare crop varieties (Alcorn 1991:3-5).

"Many of these systems renew fertility, control erosion, and maintain biodiversity through fallowing" (Alcorn 1991: 11).

Everett's analysis of a Sri Lankan forest garden outlines how farmers carefully plant dozens of species to take advantage of the characteristics of each plant. These are self-sufficient and sustainable systems developed through hundreds of years of observation and experimentation by small-scale farmers.

> "The forest gardens have persisted through centuries of socio-political upheaval and economic change, while the natural forests surrounding them have been felled for timber and to make way for large scale plantation agriculture. Natural forest regeneration on abandoned plantation land is hindered by recurring fire in the dry season. Today, in largely deforested highlands, the villages with their gardens resemble forest islands in a sea of degraded grasslands. The farmers in the traditional villages hold the key to reforestation" (Everett 1991: 1).

<u>Indigenous Technical Knowledge of Tree Management</u>

In a global survey of indigenous knowledge related to the management of trees and tree products, it was discovered that many ethnic groups value trees for reasons not always obvious to Westerners. Trees are used as indicators for soil fertility and seasonal changes, they are used to conserve soil and water and maintain soil fertility, they provide sources of savings and security, and they preserve local animal life. The planning and selection of trees for planting is often tied to a family's consumption, processing, and marketing priorities. Intercropping of trees and annual crops provides many benefits, including the efficient use of space, water, nutrients, and light; the control of weeds, pests, diseases, and erosion; natural fertilization and nutrient recycling; and reduced risks through diversification. In many societies, traditional law and religious taboos ensure that some trees are preserved or used for limited purposes (Mathias-Mundy et al. 1990: 92). And managing home gardens such as those in Java, which contain more than 100 cultivated species, is much more complex than managing a modern agricultural monoculture (National Research Council 1989b: 5).

The Role of Indigenous Organizations in Decision-Making for Development

Indigenous knowledge provides the basis for local-level decision-making. Most communities have a variety of indigenous organizations through which group decision-making takes place. Frequently these organizations can be invisible to the outsider involved in a development effort. By identifying these organizations and understanding their structures and functions, development projects can determine if it is better to work with and through existing organizations or to develop new ones to help carry out project goals and objectives. Working through existing associations can be important first steps towards participatory decision-making in a development project. Membership in these organizations may be based on a variety of criteria such as kinship, age, gender, or occupation. Among the Akan of Ghana, for example, it is now known that a wide variety of organizations exists within the informal sector. There are, for example, formal associations for both the producers and the sellers of wood carvings, woven cloth, pottery, baskets, handprinted cloth, mats, gold jewelry, beads, and iron implements (Warren and Andrews 1990). Within these groups are individuals regarded as being master artists or producers and those whose opinions about the quality of the goods are recognized and highly valued by the community. The criteria used to evaluate the quality of locally produced items may be profoundly culture bound.

As one might expect, there are strong connections between the associations of sellers and producers. In Techiman, Ghana, it was discovered that the commodity associations in the market played important roles in quality control, price policy, and maintenance of behavioral norms for their members (Warren 1981). When a USAID project designed to facilitate decentralized development planning through the Techiman District Council recognized the importance of market associations and made them partners in setting local-level development priorities, the amount of revenue collected from the Techiman market increased by 422% in two fiscal years. This partnership was instrumental in "changing the nature of the council from an administrative to a developmental one, modifying previous local perception of revenue collection as being only extractive" (Warren and Issachar 1983: 840).

Another example of the use of indigenous organizations in development comes from Thailand. Farmers have developed a well-organized irrigation system in Northern Thailand that is managed by indigenous irrigation associations. Recognizing the experience of these associations, a new project relied on them to define project priorities, which include weir maintenance, desilting of the canals, and equitable water distribution (Plusquellec and Wickham 1988).

There are also examples of projects which might have improved their outcomes by working with local associations. The Mopti Rice Project in Mali ran into the difficulty of maintaining a reliable supply of high-quality high-yielding seeds. This was due to various technical, financial, and management constraints faced by the three national and international agencies involved in the project (Tillier 1982). The project did not consider using indigenous farmers' associations and farmers' experience in seed multiplication techniques. By working with these associations, the project might have increased their capacity to select, produce, and supply seeds locally.

The Management of Common Property Natural Resources

Indigenous decision-making is frequently reflected in the ways in which local communities manage their common property. The term "common property," unfortunately, "has been largely misunderstood and falsely interpreted for the past two-three decades. Common property regimes are not the free-for-all that they have been described to be, but are structured ownership arrangements within which management rules are developed, group size is known and enforced, incentives exist for co-owners to follow the accepted institutional arrangements, and sanctions work to insure compliance. Resource degradation in the developing countries, while incorrectly attributed to 'common property systems' intrinsically, actually originates in the dissolution of local-level institutional arrangements whose very purpose was to give rise to resource use patterns that were sustainable...When local-level institutional arrangements were undermined or destroyed, the erstwhile common property regimes gradually converted into open access in which the rule of capture drove each to get as much as possible before others did. While this has been referred to as the 'tragedy of the commons' it is, in reality, the 'tragedy of open access.' The dissolution of traditional local institutional arrangements has not been followed by the establishment of more effective institutions" (Bromley and Cernea 1989: iii).

Incorporating Farmers' Knowledge in International Rice Research

Since 1986, the International Rice Research Institute has sought to "incorporate farmer perspectives into the development of appropriate rice technologies and have provided farmer-oriented assessments of rice research priorities for collaborative country programs" involving research activities in rainfed lowland and upland rice environments (Fujisaka 1991a: 2). These interdisciplinary FSR-oriented efforts, building upon the positive experiences of the International Potato Center in Peru, begin with priority problems that have been identified by farmers. Agronomic technologies from IRRI that may solve these problems are presented to the farmers, who experiment with them and adopt them if they are found useful. The farmer-adopters themselves are provided forums through which they can discuss their experience with other farmers. The experiences derived from these efforts "suggest that on-farm research can coordinate the contributions of farmers and scientists in the development, adaptation and dissemination of appropriate innovations, and to do so, needs to include:

- understanding existing farmer practices in terms of underlying technical knowledge and as adaptations to local agroecosystems;
- problem identification based in part on such understanding;
- learning from farmers and their problem-solving adaptive experimentation as a starting-point for technology generation;
- substantial participation by farmers having a demonstrated interest in solving the identified problems;
- technology transfer from adapter-adopters to farmers wanting solutions to the problems addressed by the technologies; and

- development of methods by which national programs can implement the same type of technology generation and transfer" (Fujisaka 1991a: 19).

It is clear that "the knowledge of farmers can be used first to identify and prioritize research issues. Such knowledge can then be applied via farmers' participation in the design, testing, and adaptation of appropriate technologies. Finally, such knowledge can be efficiently shared via farmer-to-farmer technology transfer. At the same time, it appears that some of the scientists involved in the cases described have learned from farmers to the point that they have started to reexamine their assumptions about the technology generation and transfer process" (Fujisaka 1991a: 20).

Ethnoveterinary Medicine

Ethnoveterinary medicine includes the indigenous beliefs, knowledge, skills, methods, and practices pertaining to the health care of animals (Mathias-Mundy and McCorkle 1989: 3; McCorkle 1989). Many pastoralists are experts on forage plants and grazing management. The Fulani, for example, can "estimate pasture quality by the soil type, flora, fauna, condition of the vegetation, and impact on the animals" (Mathias-Mundy and McCorkle 1989: 29). And Peruvian pastoralists "rotate animal grazing in high altitude pastures in order to maintain mixed species pastures and thereby assure food for their flocks even during periods of climatic stress" (National Research Council 1989b: 3).

Indigenous Crop Pest Management

There are several recent studies of indigenous crop pest-management systems that do not rely on petrochemical inputs. Plant pathologist David Thurston has documented dozens of indigenous crop-pest management techniques, most of which involve biological interactions. These techniques include "altering plant and crop architecture, biological control, burning, adjusting crop density or depth or time of planting, planting diverse crops, fallowing, flooding, mulching, multiple cropping, planting without tillage, using organic amendments, planting in raised beds, rotation, sanitation, manipulating shade, and tillage" (Thurston 1990a: 98). Biological control also includes the use of natural insecticides, 2,400 plant species having been identified in the control of 800 pest species. Written records indicate the 1,700-year-old use of the yellow citrus ant in China to protect citrus fruits against insect pests (Thurston 1990b: 49).

Paul Richards has described how Yoruba farmers in Nigeria predict and deal with outbreaks of grasshopper pests (Barker, Oguntoyinbo and Richards 1977). Goldman has analyzed the variety of traditional and modern pest control techniques that Kenyan small-scale farmers use to manage postharvest losses (Goldman 1991).

Amish Agriculture in Iowa

In the early 1980s, Iowa experienced a severe drought that drastically reduced production of maize and soy beans by high external-input farmers. Located among these capital-intensive farm enterprises are low external-input farms operated by the Amish, a religious sect that originated several hundred years ago in Switzerland. The Amish use animal traction, crop rotation, and other approaches to agriculture that allowed them to maintain high productivity throughout the drought. Land holdings are kept deliberatively small, energy sources are renewable (wind, horse, human power), mixed cropping and rotations reduce pests and the need for pesticides, livestock manure is used as a fertilizer, and marginal lands are used for pasture (Yoder 1990). Because their costs of production are less than those for conventional Iowa farms, Amish profit margins are greater. "The Amish example, as a community-oriented society, also has implications for projects and researchers at the international level, particularly for research and community development projects in small towns and rural areas. The community as a whole and the interactions which occur in such a setting, not individuals or single households, must be the focus of any undertakings in areas where social organization is based on the group rather than on the individual. Often, international research has not utilized this approach in areas where it is essential" (Yoder 1990: 55).

INDIGENOUS KNOWLEDGE AND DEVELOPMENT PROJECTS

There is growing interest by developing nations and donor agencies in understanding the role indigenous knowledge can play in making development projects more effective and efficient (see several examples in Franke and Chasin 1980; Bheenick et al. 1989; Verhelst 1990; Barborak and Green 1987; Hoskins 1984). Niamir has recently compiled a list of pastoral projects and programs that have included indigenous knowledge components (Niamir 1990: 90-94). Titilola and

Dommen have analyzed the costs and benefits of adding indigenous knowledge components to development projects (Titilola 1990; Dommen 1988 and 1989). Others have addressed the potential role of indigenous knowledge in international agricultural research (Cashman 1989), in forest management (Poffenberger, ed. 1990), in gender issues and development (Norem et al. 1989), in sustainable approaches to agriculture and development (Ascher and Healy 1990; Jodha 1990; Warren 1991a and 1991b; Warren and Cashman 1988), and in the agricultural research and extension process (Butler and Waud 1990; Cernea et al. 1985; Denning 1985; den Biggelaar 1991; Röling and Engel 1989; Moris 1991; Fairhead 1990). Working with and through indigenous organizations for development has been addressed by Cook and Grut (1989), Messerschmidt (1991), Rau (1991), Groenfeldt (1991), and Uphoff (1985).

The recognition of the utility of indigenous knowledge in development efforts by donor agencies and national and international agricultural research institutes has been greatly enhanced by the addition of a growing number of social scientists to these agencies over the past two decades. Experience with Farming Systems Research and Extension (FSR/E) projects as well as the Training and Visit Extension System (T&V) has provided further evidence of the importance of understanding and building upon existing farmers' knowledge and decision-making processes (Rajasekaran and Warren 1991; Rajasekaran, Warren and Babu 1991). World Bank social scientists have advocated the importance of these social dimensions to farming in both FSR/E and T&V (see Cernea et al. 1985).

The FSR/E perspective, for example, "recognizes that local farmers know a great deal more about their own situation and needs than does anyone else, and that these exigencies can and should form the basis of local development projects in the sector" (Collinson 1985: 84). Social scientists have been actively involved in identifying the socio-economic aspects of farmers' problems to complement the biological research efforts at the member institutes of the Consultative Group of International Agricultural Research Centers (CGIAR). The growing number of examples includes CIMMYT (Collinson 1985), CIAT (Ashby 1987; Ashby et al. 1990), CIP (Rhoades 1987; Rhoades and Booth 1982), ISNAR (Biggs 1988), and IRRI (Fujisaka 1991a, 1991b).

Other international development agencies also are exploring ways in which indigenous knowledge can facilitate project efforts. Social scientists working with the USAID Small Ruminant Collaborative Research Support Program (CRSP) have been successful in combining both folk and scientific approaches to animal-health problems (McCorkle 1989). Canada's International

Development Research Centre (IDRC) has been particularly supportive of projects incorporating indigenous knowledge (Matlon et al. 1984) as has the Overseas Development Institute in London (see, e.g., Box 1987; Farrington and Martin 1987; and Rhoades 1987). The Information Centre for Low-External-Input and Sustainable Agriculture (ILEIA) in The Netherlands and the Center for Indigenous Knowledge for Agriculture and Rural Development (CIKARD) in the USA have played very important roles in establishing global networks of development professionals involved in projects building upon indigenous knowledge. A growing number of developing country governments are recognizing that their indigenous knowledge systems are national resources that can facilitate development efforts within the country. Examples include Nigeria (Phillips 1989; Titilola et al. 1989), Indonesia (Padmanagara 1985), and Zambia (Kean et al. 1990).

This section surveys the role of IK in three types of project situations: projects where indigenous knowledge provided an improved approach to managing natural resources than proposed project technologies, projects that inadvertently ignored indigenous structures, and those projects whose success in attaining project objectives can be linked to the deliberate incorporation of indigenous knowledge components.

Cases where local knowledge provided an improved approach to managing natural resources than proposed project technologies

SR52 Hybrid Maize in Zambia

Many small-scale producers in Zambia have been reluctant to adopt SR52 hybrid maize, a high-yielding variety developed in Zimbabwe. Zambian Ministry of Agriculture planners and extension workers viewed SR52 as one means of achieving food self-sufficiency in Zambia, and considerable effort has been made to convince farmers to adopt this variety. The rate of sustained adoption by small-scale farmers has been disappointing. Ministry planners discussed this problem with small-scale farmers at an mphala, an indigenous village-level problem-solving organization for the Chewa-speaking people of Eastern Zambia. This meeting revealed a lengthy list of production and marketing risks that the farmers had identified, leading them not to adopt. The planners learned that the quality of the SR52 seed was often inadequate, leading to low germination rates. The variety requires chemical fertilizer, which in turn necessitates credit. In many parts of Zambia, a majority of the small-scale farmers are women, who find it very difficult to acquire credit. The variety requires a new and more complex management system, but the extension service was unable to provide timely support. Farmers discovered that the hybrid was more susceptible to drought and attack by weevils, and stored less well in the indigenous grain storage structures than the locally adapted open-pollenated varieties. Because the hybrid maize could be sold only through the official government marketing agency, farmers were limited to the official prices and found it could take a lengthy period before they received their money. This indigenous risk analysis by small-scale farmers resulted in Ministry policy changes. It was decided to divert some of the funds away from research on hybrid maize and towards a breeding program to address constraints that farmers identified in their open-pollenated varieties. The program to improve open-pollenated varieties has been very successful, with several improved varieties achieving sustained high adoption rates (Warren 1989b).

Traditional Rainfed Irrigation Project, Chad

The Government of Chad has seen "irrigation as a means of meeting its national objective of food self sufficiency. Farmers, on the other hand, have usually sought to include irrigation in a mixed survival strategy, blending recession, flood or small-scale localized opportunities with rainfed farming and livestock or off-farm work depending on local circumstances" (World Bank 1989: 26). A financial and economic rate of return analysis indicated that cultivation of rice, wheat and sorghum is most economically viable under the traditional rainfed irrigation system. Four models were examined: (1) water control based only on pumping with a diesel engine; (2) controlled flooding based on gravity, permitting partial water control; (3) improved rainfed agriculture based on bottomland cultivation; and (4) traditional rainfed irrigation, which accounts for 90% of the rice production in Chad. "The relatively greater profitability of the improved, traditional polders is confirmed by the economic analysis which showed that cereals cultivation, particularly wheat and sorghum, had an acceptable ERR for the traditional polder whereas it was negative for the modern polder" (World Bank 1989: 25). "Government and donors have tended to assume that farmers were interested in irrigated agriculture and failed to develop an understanding of how irrigation fits into the farmers' economic strategy" (World Bank 1989: 26). "Cultivation of traditional cereals on the traditional polders is economically viable, whereas this is not the case for the modern polders. Government and donors need to seriously re-examine the decision to invest heavily in modern polders on Lake Chad which are extremely costly in terms of both investment and operating costs" (World Bank 1989: 28).

Rice Irrigation Project in Timbuktu, Mali

Three rice production models were analyzed by Rajasekaran: (1) flood irrigation, an indigenous approach; (2) transplanted rice cultivation based on modern pump irrigation technology; and (3) a proposed system combining elements of the indigenous and modern systems based on supplementary irrigation (Rajasekaran 1990). The indigenous approach involves rice grown on floodplains of the Niger River in northern Mali. Small earthen dikes are constructed by the villagers using sandbags, twisted branches and thorn bushes. At the beginning of the river flooding, these structures function to control submersion of the rice plants and, once the flood recedes, they serve to retain water.

Small-scale pump irrigation projects were first introduced in 1984. Water is pumped directly from the river into earthen channels constructed manually by the villagers through a Food for Work Program sponsored by the United Nations Capital Development Fund and the United Nations Development Programme.

The proposed system would supplement the indigenous approach with pump irrigation during the initial stages of rice growth at a cost four times less than that for the modern pump irrigation projects.

The *gross margin per kilogram of paddy after labor remuneration* (in FCFA) is as follows: (1) indigenous flood irrigation system - 50.3; (2) modern pump irrigation system - 58.5; (3) proposed system combining elements of the indigenous and the modern systems - 73.8. The modern system has a margin lower than the proposed combined system due to greater production costs and frequent pump breakdowns. This analysis indicates the potential cost-effectiveness of building upon and strengthening an indigenous system.

Waru waru in Peru and Bolivia

Several recent projects have demonstrated the utility of investigating complex irrigation systems that have fallen into disuse because of social conflict and warfare. The remains of the extensive system of raised beds (waru waru) found on the high plateau around Lake Titicaca in Peru and Bolivia have been ignored for many generations since they fell into disuse during the Incan occupation at the beginning of the fifteenth century. The Canadian International Development

Agency and Canada's International Development Research Centre have initiated efforts to reconstruct the raised beds with their irrigation channels. In 1985, two hectares of rehabilitated raised fields served for microclimatic and soil-management studies. It was discovered that this ancient pre-Incan system had many advantages over dryland potato production. The advantages include improved moisture control and soil fertility, production of fish in the channels around the beds, and a temperature several degrees warmer than in open fields, allowing a longer growing period before the first frost. The influence of the raised bed technology was also evaluated in terms of crop yields. It was found that the crops produced on the raised beds without fertilization "produce yields quite comparable to and in many cases larger than the ones obtained by the peasants under more favorable climatic conditions" (Tapia and Banegas 1990: 96). "The reutilization of the raised-field technology not only will help support the growing populations of the towns and cities of the altiplano, where many comuneros have had to migrate in search of a livelihood, but will also help to preserve the fields for the future. At present there are several institutions and communities involved in intensive work to rehabilitate the camellones, putting in use an ancient technology in a country like Peru that badly needs to increase its local food production" (Tapia and Banegas 1990: 97).

Neem Biopesticides in Niger

A team of entomologists and social scientists from Niger and the University of Minnesota has stimulated exchange of indigenous knowledge on neem products through a USAID-funded project. The seeds and leaves of the neem tree (Azadirachta indica) have been used for their insecticidal properties in India for hundreds of years. "Traditional uses of neem included protection of clothing, books, and stored grain by layering with leaves and incorporation of the leaves in making earthen storages. The earliest scientific research on neem was almost entirely on stored-product insects. The use of neem to protect standing crops is a very recent development. It has been observed that neem trees are essentially immune to attack by the desert locust. Locusts confined on neem trees die of starvation without feeding. However, attempts to protect crop plants with sprays made from neem leaves met little success. In the 1950s, it was discovered that highest concentrations of biologically active constituents in neem occur in the seed kernel. Using this information, Indian scientists successfully protected standing crops against invading locusts in 1962 by spraying with a 0.1% neem kernel suspension. Subsequent research has demonstrated the efficacy of neem extracts against more than 120 species of insects and that list is being extended rapidly...Neem-based insecticides appear to be exceptionally safe in terms of human exposure or environmental effects. Indeed, medicinal properties were attributed to neem from the earliest of

Sanskrit medical writings" (Radcliffe et al. 1991: 30). Given the prevalence of the neem tree in Niger, and the periodic problems small-scale farmers face with locusts, it was decided to present this botanical insecticide as an alternative pest control method that was effective, safe, and required minimal capital inputs. This had been tried successfully in Togo in another project implemented 1982-85. Although the project analyses are still ongoing in Niger, it is apparent that farmers there are now using neem products instead of imported chemicals (Radcliffe et al. 1991). Two important lessons can be learned from this case study. It is possible to test scientifically the validity and cost-effectiveness of an indigenous technology, and it is also possible to transfer the technology to similar agroecosystems in other parts of the world.

<u>Agroforestry Research Project in Kenya</u>

The International Council for Research in Agroforestry (ICRAF) and Wageningen University established an on-farm agroforestry research project in the Machakos District of Kenya in 1981. In 1983 a team of social and ecological scientists expanded the project beyond alley cropping field trials to include community-wide activities. The team "soon confronted problems rooted in the gender division of rights, responsibilities and knowledge at household and community level" (Rocheleau 1991: 9). It became apparent that the project had not involved women in either the planning stages or testing of new technologies. Efforts were then made to understand the gender differences in indigenous agroforestry knowledge, the structure of indigenous women's reciprocal work groups and mutual aid associations, and the experimentation of women in soil management. It was discovered that women had particularly important survival knowledge and skills used in response to the drought and famine of 1985. Based on this new understanding of gender differences in local knowledge and organizational structures, an improved action research program was established that utilized both men and women and facilitated the sharing of agroforestry knowledge and use of wild plants as sources of food, fodder, and medicine.

<u>CTTA in Niger</u>

A USAID-funded project implemented in Niger by the Academy for Educational Development discovered that farmers experiment and exchange research results, operating completely outside the national agricultural system. "There is incontrovertible evidence that, drawing upon their own resources, African farmers have always been and continue to be great agricultural innovators and experimenters. Sahelian farmers in particular must constantly cope with rapid climatological changes in order to survive. To do so, they require a continuing supply of locally adapted technologies. The assumption behind the Niger study was that farmers are dynamic actors in the process of meeting this need. Indeed, there is some evidence that producers' propensity to experiment and innovate is greater in highly diversified and/or stressed environments where extension is poor or non-existent. Much can therefore be learned from farmers. The Nigerian Sahel served as a natural laboratory in which to observe and analyze their adaptive, adoptive, and communicative behavior" (McCorkle and McClure 1991: 6).

Twenty mini-case studies emerged from the CTTA research activity, documenting Nigerian experimentation with, adaptation, and adoption or rejection of new agricultural technologies. "In each case, the communicative routes by which knowledge of the new item or practice had been acquired were also traced. With the notable exception of rejected technologies (two cases), in the overwhelming majority of cases, the formal RD&E system in Niger had played little or no direct role in these indigenous processes" (McCorkle and McClure 1991: 7). A major outcome of the research was the "documentation of local communication resources presently used for transfer of agricultural information and technology among farmers themselves, again with little or no direct support from the formal extension service" (McCorkle and McClure 1991: 7).

"The case studies include examples of successful experimentation and/or innovation in food and tree crops, irrigation and other water harvesting techniques, gardening, field and seed preparation, fertilization, livestock nutrition, rodent and weed control, natural resource management, food storage, food processing, and market products and outlets. In sum, the cases span all four domains of agriculture: production, distribution, transformation, and consumption. In the course of compiling the case studies, farmers were observed to manipulate such research-related concepts and techniques as the functional equivalent of a (necessarily oral) literature review before mounting field trials, split plots and trial replications, experimental versus non-experimental variables, cost/benefit and risk assessments, team-like analyses of results, and hypothesis generation for future research" (McCorkle and McClure 1991: 8). One of the examples of farmers' experimentation was the control of striga (witchweed), a parasitic plant that chokes staple cereal crops at root. "Through on-farm varietal testing, Nigerian producers are systematically selecting for short-cycle millets that can reach sufficient maturity by the peak time of striga attacks so that grain formation is little impaired. This approach is designed to complement another, longstanding indigenous strategy against striga wherein sesame is sown in the same seed pocket along with the food grain. The sesame works as a 'trap crop' to divert the striga's attacks" (McCorkle and McClure 1991: 9).

Cases where development projects inadvertently ignored or overrode local technologies or resource management patterns

Hindu Water Temples and Rice Production in Bali

Anthropologist Stephen Lansing and ecologist James Kremer have studied the role of the Hindu temples on the island of Bali in controlling the flow of water resources for 37 rivers from the highest elevation down through thousands of rice farms to sea level. A computer simulation based on the indigenous knowledge, decision-making and organizational structures involved in this rice production system shows that the system of temples and priests operates as a management system to optimize the use of water resources, maintain soil fertility despite several rice crops per year, and control the spread of insect pests. This thousand-year-old system operated with minimal chemical inputs. Recently a $54 million project was introduced in Bali to modernize irrigated rice production. Despite documentation provided by Lansing and Kremer, the project officials were not convinced of the role of the water temples in rice production, and proceeded to introduce new management systems with high chemical inputs. The result has been a dramatic decline in the eel, frog, and fish populations in the rice paddies; an increase in rice pests; a decline in rice production and soil fertility; and considerable confusion over water rights. Officials now recognize that the rice production system has been managed by the network of temples and their priests (Lansing and Kremer 1991).

Agro-Forestry Projects in West Africa

Hoskins analyzed agro-forestry projects in several West African nations that had conflicted with indigenous natural-resource management systems. In Burkina Faso, for example, government officials and forestry advisers selected a site described by project directors as "useless bushland." They proceeded to clear off the brush and trees to plant straight rows of exotic fuelwood species. "Neither the project designers nor the foresters had realized that this useless-looking brushland fallow was actually a part of a delicately balanced indigenous agro-forestry system" (Hoskins 1984: 46). Although local women assisted their husbands in the grain fields and maintained their own gardens, they relied on this tract of land for a wide variety of forest products including shea nuts used for cooking oil; various leaves and seeds used in nutritional sauces; grasses and barks for weaving and dyeing mats and baskets; leaves, pods, and roots for home remedies; dead branches and sticks for cooking fuel; and baobab fruits. They also used the area to browse their goats on shrubs and bushes. "This project plantation later was burnt and residents believed the fire started because local traditional land-use rights were overridden by leaders and project managers. Residents had lost access to needed forest products essential in their indigenous agro-forestry system" (Hoskins 1984: 46). This example indicates the importance of understanding gender differences in indigenous natural resource management systems.

"A large part of the subsistence needs of West African farming and herding families is provided by secondary and tertiary tree products from trees growing in fields, fallow, or pasture lands. These products are so essential that their potential loss, with the accompanying risk if a monoculture fails, form the major reasons why extension agents have found such resistance to the introduction of 'modern' agriculture and forestry. Even agro-forestry techniques, which sound good on paper, must be applied with an understanding of the specific locale" (Hoskins 1984: 47).

"Designers and implementers of agro-forestry activities in West Africa have a good resource in the indigenous agro-forestry activities which still exist in many traditional societies. Various aspects of the indigenous systems are almost always strained and some may be dysfunctional. However, the rewards given by the systems already in place will be used by local residents to measure the desirability of any new idea. A new technology can readily succeed when it offers a better all-round return to the rural family than the technologies they are already using. However, only when benefits and shortfalls of the current system are understood can one be sure to address real questions, offering solutions with confidence that the 'advanced' ideas, though perhaps marvelous on paper, are not irrelevant in the real world" (Hoskins 1984: 49-50).

Off-Farm Indigenous Technologies and Innovations

Although most work in the area of indigenous knowledge has involved agriculture, several new studies explore how indigenous research and development in the informal industrial sector could be included in technical assistance programs and national development plans. Thomasson (1991) has shown that the Kpelle artisanal steelmaking technology, although nearly moribund today, is capable of producing agricultural implements of far better quality than those being imported. Iron ore available to Kpelle blacksmiths is high in titanium and chromium, allowing the production of hoes and cutlass blades that have a high tensile strength and are resistant to rusting.

Instead of encouraging this local industry, Liberia undermined it through the large-scale importation of hoes of inferior quality.

The Intermediate Technology Development Group analyzed 17 off-farm innovations in 14 developing countries. It identified numerous indigenous technologies that have been ignored by national planning units and international development agencies (Gamser, Appleton, and Carter 1990; Gamser and Appleton 1991). Sierra Leone, for example, has relied on rock salt imports from Senegal. Although the government of Sierra Leone has supported projects funded by several donor agencies to introduce solar salt extraction operations, all of these have been expensive failures. Meanwhile, local artisans continue to provide over 40% of the national salt demand through indigenous salt filtration techniques. Not only is this salt-from-silt technology very clever and cost effective, it is a technology that could be transferred to many other developing countries at very low cost.

Among the other off-farm innovations analyzed are a variety of cassava processing machines used for grating, dewatering, sieving, and frying, all designed and produced by small-scale Nigerian artisans. In Tanzania, 60% of the country's coffee produced by small-scale growers is pulped using locally made machines. In Kerala State of India, artisan fisherman are using local techniques to restore shallow water reef formations essential for maintaining fish populations.

<u>Water-Harvesting Projects in the Sahel</u>

Many water-harvesting projects in the Sahel have not been based on indigenous techniques used for many generations to conserve soil and water (Reij et al. 1988). Several examples of these techniques are now documented and being used in a variety of projects. Mossi farmers in Burkina Faso construct rock bunds and stone terraces. The Dogon of Mali construct a basin system in their fields that is effective in conserving rainfall. The Hausa in Niger's Ader Doutchi Maggia use rock bunds and construct small weirs using sticks, grain stalks, and earth to divert water over their fields. Farmers in the Yatenga Region of Burkina Faso use a water harvesting technique called zay. The zay are holes 5-15 cm in depth and 10-30 cm in diameter, into which manure and grasses mixed with earth are placed. The zay conserve runoff, which is slowed down by rock bunds. This system is used by the farmers to rehabilitate degraded, barren and crusted soils (Reij et al. 1988: 47).

Rice Farming in Senegambia

Attempts to boost rice production in the Senegambia have relied on pump-irrigation projects that have resulted in unforeseen adverse socio-economic and ecological consequences. Recent research on the indigenous soil and water management systems in the region indicates considerable gender differences in the indigenous rice production knowledge systems. Among the Mandinka, for example, women controlled traditional rice production in six micro-environmental zones. Rice being produced in the new pump-irrigation systems has come under the control of men, resulting in intrahousehold conflicts (Carney 1991: 5). "The social tensions emerging with Gambian river basin development have resulted in the under-utilization or abandonment of irrigated perimeters" suggesting that "pump-irrigation schemes are unlikely to provide a sustainable approach to regional food security" (Carney 1991: 5). Rice cultivation in the Senegambia region dates back three thousand years, during which time "farmers have fine-tuned rice cultivation to a range of agroecological zones with differing edaphic properties and moisture regimes" (Carney 1991: 2). Development efforts that would build upon this indigenous knowledge base are now being discussed.

Terrace Farming in Yemen

Yemen has had a tradition of both dryland subsistence agriculture on highland terraces and seasonal flood irrigation farming along the major wadis. These farming systems have existed for several thousand years, and much of the indigenous agricultural knowledge still survives. Many of the mountain slopes were transformed into dryland terraces at least a thousand years ago. Recent efforts by a variety of multilateral and bilateral donor projects to modernize agriculture in Yemen have ignored this extensive system of dryland terraces. Development efforts have centered on the introduction of tubewell irrigation in the coastal zone and valleys of the central highlands. As a result of the greatly expanded number of tubewells the limited groundwater is being mined with dramatic drawdowns on the water table. "The extensive system of dryland terraces, representing the vast majority of Yemen's agricultural land, has simply been written off as too marginal and too dependent on household labor. Virtually no effort has been made through government programs to improve or at least stabilize existing terraces" (Varisco 1991: 3). The highland terrace system is in a state of decline due to abandonment, which, if not reversed soon, could create a major environmental crisis. This situation has been aggravated by the national drain of male labor, with a third of the male workforce migrating and working in other countries. Much of the subsistence farming has fallen on the shoulders of women, who have abandoned the more distant and marginal terraces. The influx of cash remittances and availability of cheap grains has made it less expensive to buy imported wheat than to grow it on subsistence plots. A 1989 biological diversity study in Yemen related the extent of the environmental degradation to the decline of the traditional terrace systems that has already resulted in major sheet and wadi erosion (Varisco 1991).

Cases where projects deliberately worked with and through indigenous concepts and social systems

Primary Health Training for Indigenous Healers

Many developing countries struggle to stretch Ministry of Health budgets to ensure equitable and appropriate levels of medical care for their largely rural populations. In Ghana, for example, about 85% of the health budget supports secondary and tertiary health facilities in large urban centers. The remaining 15% is insufficient to serve the 75% of the Ghanaian population living in 46,000 small towns and villages. Moreover, 82% of the physicians in public service live and work in the main cities.

In June 1979, the Primary Health Training for Indigenous Healers (PRHETIH) Project was inaugurated in Techiman District in the Brong-Ahafo Region with support provided by the Peace Corps, a Canadian NGO, and the Ministry of Health. Recognizing that various types of indigenous healers live in virtually every small town and village in Ghana, it was decided to enlist them as allies of the Ministry. Weaknesses within the indigenous therapeutic systems were identified with the help of the indigenous healers themselves and a 14-week training program was designed with their cooperation. During 1979-83 more than 120 indigenous healers completed this training. The project has now spread to other districts in Ghana.

The most important impact of PRHETIH has been the dramatic decline in the outpatient load carried by the district hospital (Holy Family Hospital). Despite a very limited professional staff (including one to three physicians), the number of outpatient visits increased steadily from 40,000 in 1965 to 120,000 in 1980. This was followed by decreases to 77,000 in 1984 and 65,000 in 1985. Although a large portion of this decrease has been due to the establishment of 10 health centers and 24 community clinics in Techiman District, informal surveys indicate a considerable increase in the case load carried by the indigenous healers whose skills in primary health care were improved through the PRHETIH training sessions. The drop of 55,000 outpatient visits for the district hospital over a five-year period has enormous implications for health policy and planning. With more minor ailments being handled adequately in the rural areas by indigenous healers and health centers, the district hospital can provide more quality care for the serious health cases. The fact that indigenous healers are private sector specialists and not paid through the Ministry of Health has cost implications for Ministry of Health planning. An evaluation of this project is expected to begin soon with Dutch aid assistance (Warren et al. 1982; Warren 1989c). Meanwhile, the project has served as a model for other projects funded by USAID in Swaziland and Nigeria (Warren and Green 1991), and for possible new approaches to rural health delivery by WHO (Green et al. 1989) and by the European Community in Mozambique.

Vetiveria Use for Soil Erosion and Moisture Control in India

Vetti ver is the Tamil name for vetiver (Vetiveria zizanioides), a grass species which is highly resistant to insects and disease and has been used as a hedge plant to conserve soil and moisture for at least 200 years in the hilly areas of Tamilnadu (The World Bank 1990: v). After the World Bank-aided Kabbalanala Watershed Development Project in Karnataka, India, introduced the use of Vetiveria in 1987, it was discovered that farmers had used the grass extensively in many other parts of India for soil and water conservation and cattle fodder. Volatile oils extracted from the roots have long been used as a base for perfumes (Subramanya and Sastry 1989?). Immigrants from south India have also carried vetiver and the knowledge of its uses to Africa, the Caribbean, and Fiji as early as the turn of this century. It has recently been used successfully as a vegetative mechanism to control soil erosion and for moisture conservation in IBRD-funded activities in several countries in Asia, Africa, and South America, including China, India, Nepal, Philippines, Sri Lanka, Madagascar, Nigeria, and Zimbabwe (see the World Bank's Vetiver Newsletter).

World Bank studies indicate the superior cost-effectiveness of this vegetative approach over engineered systems of soil conservation. "Investment costs for bunding (contour or graded banks), bench terracing and associated waterway construction typically exceeds US$500 per hectare. Annual maintenance requirements are also substantial, and are often neglected leading to failure of the investment. The establishment of vetiver grass hedgerows, in similar circumstances, can be accomplished for less than US$30 per hectare. Considering the benefits of moisture conservation and soil productivity loss prevented, the internal rate of return (IRR) for vetiver hedgerow establishment in India approaches 95%. Even with generous assumptions, engineering treatments showed IRRs of approximately 35%" (Smyle and Magrath 1990: 6).

Rainfall and nutrient losses can be reduced to negligible levels through the use of Vetiveria. Being cheap to establish, it can help increase standards of living in rainfed areas by reducing the effects of drought, increasing the slope for safe crop production, protecting irrigation systems from silt problems, and increasing yields through improved moisture conservation (Greenfield 1989: 5).

Acceptance and maintenance rates by farmers in project areas has been very high. Farmers recognize the following advantages of vetiver: the loss of land due to the use of vetiver is minimal, it functions like a bund, is a source of fodder, withstands grazing or burning, does not exhibit invasive behavior, competition with adjacent crops is minimal, hedgerows persist for many years without maintenance, is easily and inexpensively propagated, is a perennial, and checks water velocity and soil loss (Smyle and Magrath 1990).

Like the neem tree pesticide project in Niger, this is another example of the scientific and development community recognizing the value of an indigenous technology that has been field tested by local people, the World Bank providing the mechanisms to make it available to other parts of the world.

The Niger River Fisheries Project

The Niger River Fisheries Project began in 1983 with FAO staffing and UNDP funding. The Peace Corps and USAID also have been involved. "Niger fishermen have profound knowledge of river ecology that once served as the basis for their management of the fisheries. Project personnel solicited details of this knowledge and organization from senior fishermen, complemented by information from biological, fish capture and socio-economic surveys. They subsequently presented propositions for future management based on the resulting synthesis of scientific and local knowledge. Fishermen and fisheries agents debated the justifications, means of application, and effects of each management approach in a series of public meetings. This was a significant departure from the former practice of fisheries service. Fishermen responded quickly with interest in revitalizing local practices based on a respect of their knowledge, in collaboration with government technical services. Project results suggest this approach is a genuine foundation for long-term development by and for local populations" (Price 1991: 1-2).

The French colonial government had radically altered the traditional approaches to fishing on the Niger River. "Given an emphasis on European management models based on external information, the staff ignored local authority and knowledge. The Niger government fisheries staff that inherited this administration at independence followed their predecessors' disregard for the fishermen's knowledge" (Price 1991: 3). During the dialogue between project staff and fishermen, fishermen presented their perspectives on the decrease in the quantity and quality of fish being captured. These involved ecological and human factors such as the dramatic decline in the average annual water flow, increased population pressure along the Niger River, and the impact of new technologies such as nets with small mesh size.

The indigenous fishermen associations have continued to actively coordinate their activities with the fisheries service as part of the project management plan. These have included management and regulatory activities based upon indigenous knowledge such as the reëstablishment of traditional fishing sanctuaries restricted or forbidden for fishing and a ban on small mesh nets and on capture of immature fish. An improvement in the fish population and a revitalization of the small-scale fishing industry is expected to result from these efforts.

Soil Regeneration Project in Rwanda

The German Agency for Technical Cooperation has funded a soil regeneration project in Rwanda that has worked with and built upon local skills and knowledge to reduce deforestation and soil erosion. The Nyabisindu project has also developed new technologies that build upon traditional agricultural practices. "Researchers and other staff started with methods based on local skills and resources and focused on using the whole-farm system for recycling nutrients. The value of mulches, animal and green manures, erosion control, and raised beds were already known to many Rwandan smallholders" (Sands 1987: 35). In central and southern Rwanda, for example, "a traditional, extensive fallow system has been gradually transformed into an intensive farming system that utilizes every parcel of land in this hilly country. Techniques used include hillside terracing, valley floor fishponds or raised gardens, composting, mulching, living fences, hedgerows, woodlots, fodder banks, and intercropping of trees, crops and livestock" (Cook and Grut 1989: 27). Among the principles found useful in this project are the following:

- "Use adaptable technologies that build on traditional practices;
- involve farmers in the design, implementation, management, and evaluation of the program;
- coordinate program with existing governmental activities; and
- use technologies that can be taught" by one farmer to another (Sands 1987: 48-49.

Indigenous Agricultural Knowledge and Extension in Southern Sudan

A twelve-year extension project operated by a non-governmental organization among the Moru of southern Sudan was based on indigenous natural-resource and agricultural knowledge. This experience has convinced the project staff "that the values and priorities of a subsistence society are rational responses to the environment in which they are located, being based on generations of experience and accumulated knowledge, solving problems, some of which the formal sector has yet to address. The details of the agricultural system and how it relates to the wild environment point to the need for a different extension approach, which accepts that the indigenous knowledge is a valuable resource that can be used in directed change, and that the society is open to change that relates to its values and priorities of production" (Sharland 1991: 1). The main approach used in this project was two-way communication between the senior extension staff and their field staff and the field staff and farmers. "This was greatly facilitated by the extension staff all being practicing traditional farmers themselves, having personal experience of both the indigenous knowledge and practical constraints of the farmers. A major tool used in developing solutions was the monthly meetings in which all field staff reported on problems encountered, and solutions were discussed in relation to both formal science and indigenous knowledge and practices" (Sharland 1991: 2). The Moru knowledge "proved an invaluable resource for developing extension recommendations in Mundri District" (Sharland 1991: 4). The following lessons have emerged from the establishment of a formal extension service working with and through indigenous agricultural knowledge:

- "studying indigenous knowledge can increase the effectiveness of communication in two major ways: by targeting the right section of the population and by using the proper vernacular terms in relation to explanations rooted in the formal knowledge sector;

- understanding indigenous knowledge and perceptions can point to important ideas and practices that are necessary for subsistence, but are often overlooked by formal science, and can help in gaining understanding of farmers' perspectives;

- the major concerns of the farmers are often highlighted through understanding the indigenous knowledge;

- factors in a new technology or idea that are of interest to farmers beyond the primary reason for introduction are often useful leads and can be identified and used in the extension effort;

- indigenous knowledge also can be used to understand where a recommendation from formal knowledge may not be possible and compromise is needed;

- technology already known and used in one context can be shared for use in another;

- existing knowledge that has stood the test of time often needs adapting for changing conditions in the same field and area; traditional experimental procedures may be slow in effecting this adaptation; extension can sometimes help the adaptation process when the indigenous knowledge is understood;

- existing practices that are beneficial, but may be lost in a changing world, can be reinforced by the formal scientific sector by giving them backing that can relate to the growing schooled population;

- existing practices may become harmful under new conditions of a changing situation; understanding indigenous knowledge can help point to these;

- solutions from outside are sometimes needed for problems that have been identified from within under changing conditions, but for which there is little understanding yet" (Sharland 1991).

Indigenous Knowledge and Potato Production

Scientists from the International Potato Center discovered that small-scale potato farmers in Nepal, Kenya, and Peru had independently developed a diffused light technique that reduced the sprouting of stored potatoes. This technique was tested scientifically at CIP, where it provided the basis for the farmer-back-to-farmer paradigm proposed by Rhoades and Booth (1982). This technique has now been disseminated through the International Potato Center's international extension projects to potato farmers in many other countries (Rhoades 1989: 5-6).

MAKING RURAL PEOPLE PARTNERS IN RESEARCH AND DEVELOPMENT

Robert Chambers (1985, 1989), Paul Richards (1985, 1986), Anil Gupta (1991), Robert Rhoades (1987, 1989), and many others have depicted the creativity and innovativeness of farmers and other rural people as they react to changing conditions, demands, and constraints. Rhoades and Bebbington have identified three types of farmer experimentation: experiments based on pure curiosity and problem-solving and adaptation experiments (Rhoades and Bebbington 1991: 1).

As experimenters, these individuals operate and base their decisions on indigenous knowledge systems. But very little effort has been made to record these systems, to understand the variability in the systems according to gender, age, class or caste, and occupational role, and to explain how they form the basis for local reactions to new problems they face as a result of rapid population growth, intensified farming, environmental degradation, and other changes. It is clear from the case studies just reviewed that farmers and other rural people have much knowledge to offer the national and international agricultural enterprise. Rural persons are clearly aware of the weaknesses that may exist in their knowledge base at a given point in time. It also is obvious that indigenous agricultural knowledge can be shared from one part of the world to another, as shown by the neem biopesticide and vetiver grass project experiences.

Although most examples of the innovativeness of farmers have come from studies in developing countries, recent attention has been directed to the historical and contemporary dimensions of farmer innovativeness in Great Britain and the United States. Jules Pretty (1991) has carefully reconstructed how the innovative technologies developed through British farmer experimentation were extended to other farmers through tours, farmer groups, open days, and publications, resulting in a fourfold increase in crop and livestock production during the two-century period before the establishment of a Ministry of Agriculture, research stations, and an extension service in Great Britain. The recognition of the importance of farmers in technology generation and farmer-to-farmer extension declined dramatically after the first agricultural experiment station was established in 1843 in Great Britain.

A growing interest in sustainable agricultural systems in the United States has resulted in the recognition of the formal and informal experimentation being conducted by farmers who are actively seeking means to reduce their costs of production. The attention of agronomy researchers at Iowa State University has recently been drawn to the research efforts of Richard and Sharon Thompson, two of the leaders of the Practical Farmers of Iowa organization. Operating a diversified farm in eastern Boone County, the Thompsons have as many as 200 field research plots on their farm, which they open to the public for field days. The Thompsons have experimented with crop rotations, ridge tillage, and species diversity to reduce the incidence of crop pests, tested the effectiveness of various cover crops to reduce soil erosion, and tried various combinations of municipal sludge and animal and green manure, along with crop rotations, to maintain soil fertility (National Research Council 1989a). The Thompsons represent an example of a new indigenous agricultural knowledge system reflected in a farming enterprise that is sustainable (Thompson, Thompson and Exner 1990; Warren 1991b).

We need to recognize indigenous knowledge and decision-making systems as important national resources that have been ignored, neglected, and sometimes maligned (Warren 1989a; Rajasekaran, Warren and Babu 1991). "If modern development is to succeed, it needs to match the adaptability of its indigenous counterpart. This is not to say that indigenous resource use systems should simply be adopted by modern colonists, but it does imply that the indigenous strategy of conservation and sustainable exploitation is an essential principle for modern development. Implicit in this view is acknowledgement of the complex and sophisticated nature of indigenous exploitation and of the fact that indigenous knowledge itself constitutes a valuable resource" (Eden 1990: 84-85).

African professionals have recently advocated the need to pay attention to indigenous knowledge systems. Thomas Odhiambo, for example, has stated that "The knowledge, skills and survival strategies of farmers operating with low levels of external inputs have often been ignored or even eroded by outsiders promoting 'modern' agricultural technology. However, with increasing awareness of the limitations and hazards of conventional agriculture, a growing number of scientists have begun to recognize indigenous knowledge as a major untapped resource for developing sustainable agriculture. Local practices offer joining points for developing ways of increasing the productivity and sustainability of local resources. Indigenous knowledge can reveal missing ecological keys which may help scientists develop alternative agricultural technologies less dependent on non-renewable resources (e.g., fossil energy) and environmentally damaging inputs (e.g., chemical pesticides) than conventional technologies" (Odhiambo 1990: 3).

Oluwayomi Atte has presented indigenous knowledge as the key to local-level development. "In the face of dwindling resources available to African countries, and noting that even the richest and most benevolent governments cannot provide all the needs of the people, it has been suggested that indigenous local knowledge, and the technical expertise developed there from, can become vital tools in planning for rural development" (Atte 1989: 1). Given the fact that rural people "have intimate knowledge of environmental processes and make rational resource management decisions based on such knowledge," development agencies should consider the "strategy of enhancing the utilization of local resources by using, and improving upon, the knowledge and technical expertise of rural people to bring about local self-reliance and development in Africa" (Atte 1989: 1). Atte provides a thorough literature survey of African knowledge of soils, vegetation, climate, crop pests, veterinary medicine, and indigenous engineering skills.

Recent publications by The World Bank reflect the appreciation of the cost-effective role indigenous knowledge systems can play in the development process. "Considering local knowledge and present production systems can pay off by saving time and preventing a waste of resources in project development and implementation"..."The point to note is that project planners and managers from the outside need to be aware of the indigenous knowledge of different local groups and to learn from them. This will often involve more time than planners have devoted to such understanding in the past" (Gregersen et al. 1989: 120).

Although rural communities have detailed knowledge of their own ecosystems, they may not have access to the knowledge available in other indigenous systems as well as in the international scientific knowledge system. "Science therefore has very important contributions to make to local adaptations, through identifying the ecological functions of the various components of ecosystems and the way new and improved agro-ecosystems can be designed for specific localities. Science can help mobilize traditional knowledge through: preparing guidelines on methods for obtaining, assessing, and presenting traditional conservation knowledge; preparing an inventory of traditional knowledge systems, highlighting those aspects that can contribute to conservation and development, and giving special attention to traditional knowledge systems in danger of being lost; documenting the role of women in resource utilization in traditional societies and ensuring that knowledge held by women is given appropriate recognition; and translating traditional means of conservation--sacred groves, community responsibility, taboos, etc.--into forms useful to development planners and managers of biological resources" (McNeely et al. 1990: 114).

Many indigenous systems can be improved. If this were not so, farmers would not continue to experiment! If we can understand both the indigenous system and what the international knowledge system might have to offer it, we can enter an era where the international agricultural research system works together with the millions of small-scale farmer innovators on this globe.

ESTABLISHING A GLOBAL SYSTEM FOR INDIGENOUS KNOWLEDGE

Some 3,000 development professionals and institutions in 124 countries are now linked by an international network operating through CIKARD, the Center for Indigenous Knowledge for Agriculture and Rural Development. CIKARD was established in 1987 at Iowa State University. It is designed to strengthen the capacity of domestic and international development agencies to improve agricultural production and the quality of life in rural areas in cost-effective and sustainable ways. CIKARD focuses on understanding, recording, preserving, and using the indigenous knowledge of farmers and rural people around the globe, and on making this knowledge available to development professionals and scientists. It coordinates its global networking efforts with other centers such as the Information Centre for Low-External-Input and Sustainable Agriculture (ILEIA) in the Netherlands.

CIKARD is facilitating a decentralized approach to recording and utilizing indigenous-knowledge systems through a growing network of regional and national indigenous knowledge resource centers. The Leiden Ethnosystems and Development Program (LEAD), established in 1988 at Leiden University in the Netherlands, is working closely with CIKARD to produce CIKARD News and a variety of monographs dealing with indigenous knowledge. It also is supporting development activities based on indigenous knowledge in Kenya, Indonesia, and several West African nations.

In 1989, agreements were made to establish regional centers in both Africa and Asia. The African Resource Centre for Indigenous Knowledge (ARCIK) has been established at the Nigerian Institute of Social and Economic Research in Ibadan. The Regional Program for the Promotion of Indigenous Knowledge in Asia (REPPIKA) is housed at the International Institute of Rural Reconstruction in the Philippines. A sub-regional Latin American center was established in 1990 at the Postgraduate College in Chapingo, Mexico. Each regional center will have a documentation unit, a training and consultancy unit, and a research unit. Negotiations are under way for the establishment of sub-regional centers for the Andean nations and for East Africa.

Staff within the regional and sub-regional centers will be trained to facilitate the establishment of national indigenous-knowledge resource centers within that geographical region. A Nigerian national center has already been established. Plans are being made to establish other national centers in Costa Rica, Venezuela, Colombia, Peru, and Bolivia. Regional staff will help their counterparts at the national centers run training workshops to introduce the methodologies for recording indigenous knowledge systems into the educational institutions within the country. Recorded systems will be systematically stored, catalogued, and made available to extension and other development workers.

The global response to CIKARD has been very positive. It is apparent that numerous development workers and agencies feel that an understanding of indigenous knowledge systems can facilitate the current efforts of international development donor agencies. The examples provided in this paper indicate clearly how small-scale and resource-limited farmers and other rural persons use indigenous strategies to deal with a wide range of risks and uncertainties.

A joint enterprise between farmers and agricultural researchers can help us to understand the priority physical, biological, environmental, and socio-economic constraints that farmers face. Specific strategies that deal successfully with particular risks can be shared with farmers elsewhere struggling with similar problems. Developing a world-wide indigenous knowledge exchange system through CIKARD and the emerging global network of regional and national indigenous knowledge resource centers can help the flow of information on location-specific, crop-specific, indigenous risk-aversion strategies in a cost-effective manner.

INDIGENOUS KNOWLEDGE AND THE WORLD BANK

The World Bank, as well as numerous other development agencies, has been actively seeking ways of ensuring participatory decision-making, strengthening development capacity at the individual and institutional levels, and assuring long-term sustainability of the development process. The growing body of development experience indicates that by understanding and working with and through indigenous knowledge and organizational structures, participation, capacity-building, and sustainability can all be enhanced in cost-effective ways. There are several key areas where the World Bank can take a leading role in promoting use of indigenous knowledge for development. These include support to systematically record and preserve indigenous knowledge for development efforts at national resource centers, provide training opportunities to incorporate indigenous knowledge components into educational institutions, conduct participatory research on indigenous knowledge systems, and establish systems for global networking and electronic exchange of indigenous knowledge. These suggestions are discussed in more detail next.

Biodiversity and Indigenous Knowledge

The World Bank and the CGIAR system are embarking on a growing number of activities involving biodiversity and natural resource management. These activities can be greatly strengthened through indigenous knowledge components. Indigenous knowledge is the basis for local-level management of natural resources and biodiversity. Efforts by the CGIAR system to collect and maintain germplasm banks need to be complemented with equal efforts to record the human knowledge accumulated over many generations about the uses of this plant material. Many of these knowledge systems are at great risk.

It is possible to preserve only a small proportion of the world's genetic resources in ex situ germplasm banks. The vast majority of useful and potentially useful species must be preserved in situ. Understanding how local people manage their environment is vital to maintaining the rich diversity of plants and animals in that environment. The World Bank could support these types of activities through the network of indigenous knowledge resource centers.

Global Network of Indigenous Knowledge Resource Centers

There is a critical need to analyze national educational policy and identify public policy initiatives that would allow indigenous knowledge components to be added into the curricula for secondary schools, universities, and extension training institutes. The World Bank could support training programs for the introduction of IK methodologies to national research, extension, and educational institutes.

Support must be provided to the growing international network of regional and national indigenous knowledge resource centers. In some developing countries this support could come in part through debt-swap resources. It may be possible to establish mutually supporting linkages between various CGIAR centers and indigenous-knowledge resource centers. For instance, the African Resource Centre for Indigenous Knowledge at the Nigerian Institute of Social and Economic Research is very near IITA, with which it maintains many professional ties. The Regional Program for the Promotion of Indigenous Knowledge in Asia is located at the International Institute of Rural Reconstruction, which has a memorandum of understanding with IRRI. The new center in Mexico is housed at the Postgraduate College at Chapingo, which has a long relationship with CIMMYT. Centers under consideration in Peru and Colombia could be linked with CIAT and CIP. Many other linkages could emerge over time.

Identifying priority problems for small-scale farmers within agroecological zones could help set international and national agricultural research center research agendas that would be more meaningful at the local level. World Bank and CGIAR support for these centers would be mutually beneficial and help strengthen the capacity of national institutes to add indigenous knowledge components to FSR/E and Training and Visit extension system programs.

Research on Indigenous Knowledge Systems

The Bank should consider supporting efforts to improve field methodologies for recording indigenous knowledge and decision-making systems and for comparing these with the international knowledge system. It should support research on the impact of constraints on indigenous knowledge systems and their adaptability to rapid population growth, environmental degradation, and policies promoting high-external-input monocropping and cash cropping. This could include studies of indigenous strategies for managing renewable natural resources in a variety of constraining circumstances, such as change from extensive to intensive agriculture, movement to marginal lands, and deforestation and desertification due to population pressure. Of particular interest is variability in indigenous knowledge systems due to gender, class and caste, and ethnicity.

Under what conditions is indigenous knowledge generated, diffused, and adopted at the local and regional levels? What happens in normal and in stress-related conditions, in normal and abnormal years? What are the seasonal dimensions? Is local experimentation enhanced in dependency and resource-deprived conditions or where resources are within the control of local people? How can indigenous agricultural knowledge be better integrated into FSR/E activities and the Training and Visit extension system? How can indigenous knowledge components be added into socio-economic soundness analyses for project identification and design exercises? What is the potential role of indigenous communications channels for the extension process?

Other research should be conducted on the use of regional and national indigenous knowledge resource centers to facilitate the transfer of indigenous knowledge and innovations from one ecological zone to a similar zone in a different part of the world. Research in these areas would strengthen Bank-supported efforts involving FSR/E, Training and Visit extension programs, and natural-resource management projects.

Global Networking for Indigenous Knowledge and Development

World Bank support should be provided for both global and national networking efforts related to the use of indigenous knowledge in development. Global networking is currently done through mechanisms such as CIKARD News published by the Center for Indigenous Knowledge for Agriculture and Rural Development and ILEIA Newsletter published by the Information Centre for Low-External-Input and Sustainable Agriculture. Regional and national indigenous knowledge resource centers are considering the establishment of localized newsletters. Directories of development professionals experienced in the use of indigenous knowledge in development and of indigenous organizations involved in development should be compiled at the national and global levels.

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