Designing a natural resource management strategy for poor farmers in marginal environments

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The challenges of a pro-poor natural resources management (NRM) strategy

For the most part, resource-poor farmers gained very little from the processes of development and technology transfer of the Green Revolution (Pearse, 1980). Many analysts of the Green Revolution have pointed out that the new technologies were not scale-neutral. The farmers with the larger and better-endowed lands gained the most, whereas farmers with fewer resources often lost, and income disparities were often accentuated (Shiva, 1991). Not only were technologies inappropriate for poor farmers, but peasants were excluded from access to credit, information, technical support and other services that would have helped them use and adapt these new inputs. Although subsequent studies have shown that the spread of high-yielding varieties among small farmers occurred in Green Revolution areas where they had access to irrigation and subsidized agrochemicals, disparities remain (Lipton and Longhurst, 1989). Moreover, in the most intensively cropped lands there are observable trends of yield declines (i.e. rice-wheat systems in India and rice under continuous cropping in the Philippines), linked to the cumulative effect of environmental degradation, partly caused by the use of high-input technologies (Pingali et al., 1997). New approaches to enhance productivity in such high-potential areas will have to depart in significant ways from the Green Revolution, emphasizing resource-conserving technologies (i.e. incorporation of legumes in rotation schemes) that enhance the sustainability of agroecosystems In many countryside areas, intensified social differentiation and concentration of wealth have set in.

Perhaps even more significant is that the areas characterized by traditional agriculture remain poorly served by the transfer-of-technology approach, due to its bias in favor of modern scientific knowledge and its neglect of local participation and traditional knowledge Lappe et al., 1998). The historical challenge of the international agricultural community is therefore to refocus its efforts on marginalized farmers and agroecosystems and assume responsibility for the welfare of their agriculture (Table 1). The private sector and advanced research institutions have little interest in targeting such groups as they do not represent significant markets.

In order to benefit the poor more directly, an NRM approach must be applicable under the highly heterogeneous and diverse conditions in which smallholders live, it must be environmentally sustainable and based on the use of local and indigenous resources (Table 2). The emphasis must be on improving whole farming systems at the field or watershed level rather than specific commodities. Technological generation must be demand driven which means that research priorities must be based on the socio-economic and environmental needs and circumstances of resource-poor farmers (Blauert and Zadek, 1998).

The urgent need to combat rural poverty and to conserve and regenerate the deteriorated resource base of small farms requires an active search for new kinds of agricultural research and resource management strategies. NGOs have long argued that a sustainable agricultural development strategy that is environmentally enhancing must be based on agroecological principles and on a more participatory approach for technology development and dissemination (Altieri et al., 1998). Focused attention to the linkages between agriculture and natural resource management will help greatly in solving the problems of poverty, food insecurity and environmental degradation.

To be of benefit to the rural poor, agricultural research and development should operate on the basis of a "bottom-up" approach, using and building upon the resources already available: local people, their knowledge and their autochthonous natural resources. It must also seriously take into consideration, through participatory approaches, the needs, aspirations and circumstances of smallholders (Richards, 1995).

Table 1. Goals of an NRM Strategy for Poor Farmers

- Poverty alleviation
- Food security and self reliance
- Ecological management of productive resources
- Empowerment of rural communities
- Establishment of supportive policies

Table 2. Technological requirements of resource-poor farmers

Innovation Characteristics Important to Poor Farmers	Criteria for Developing Technology for Poor Farmers
■ Input saving and cost reducing ■ Risk reducing ■ Expanding toward marginal-fragile lands ■ Congruent with peasant farming systems ■ Nutrition, health and environment improving	■ Based on indigenous knowledge or rationale ■ Economically viable, accessible and based on local resources ■ Environmentally sound, socially and culturally sensitive ■ Risk averse, adapted to farmer circumstances ■ Enhance total farm productivity and stability

Defining the target population of a pro-poor NRM strategy

Although estimates of the number and location of resource-poor farmers vary considerably, it is estimated that about 1.9 to 2.2 billion people remain directly or indirectly untouched by modern agricultural technology. In Latin America, the rural population is projected to remain stable at 125 million until the year 2000, but over 61% of this population is poor and is expected to increase. The projections for Africa are even more dramatic. The majority of the rural poor (about 370 million of the poorest) live in areas that are resource-poor, highly heterogeneous and risk prone. Their agricultural systems are small scale, complex and diverse. The worst poverty is often located in arid or semi-arid zones, and in mountains and hills that are ecologically vulnerable (Conway, 1997). These areas are remote from services and roads and agricultural productivity is often low on a crop by crop basis, although total farm output can be significant. Such resource-poor farmers and their complex systems pose special research challenges and demand appropriate technologies (Netting, 1993).

Table 3. Some features of peasant farming systems and poor rural households

Characteristics of Poor Small-Holders	Constraints to which Poor Farmers Are Exposed
■ Meager holdings or access to land ■ Little or no capital ■ Few off-farm employment opportunities ■ Income strategies are varied and complex ■ Complex and diverse farming systems in fragile environments	■ Heterogeneous and erratic environments ■ Market failures ■ Institutional gaps ■ Public good biases ■ Low access to land and other resources ■ Inappropriate technologies

In the case of Latin America, despite the increasing industrialization of agriculture, the great majority of the farmers are peasants, or small producers, who still farm the valleys and slopes of rural landscapes with traditional and subsistence methods. Peasant production units reached about 16 million in the late 1980s occupying close to 160 million hectares, involving 75 million people representing almost two thirds of the Latin America's total rural population (Ortega l986).

Despite economic and biophysical constraints, the contribution of peasant agriculture to the general food supply in the region is significant. In the l980s it reached approximately 41 percent of the agricultural output for domestic consumption, and is responsible for producing at the regional level 51 percent of the maize, 77 percent of the beans, and 61 percent of the potatoes (Table 4).

Table 4. Estimated Arable Land and Population on Steep Slopes of Selected Latin American Countries and Their Contribution to Total Agricultural Output.[1]

Country	Arable Land (%)	Agricultural Population (%)	Percent Contribution to Agricultural Output (Including Coffee)	Contribution to Country's Total Agricultural Production Corn (%)	Potato (%)
Ecuador	25	40	33	50	70
Colombia	25	50	26	50	70
Peru	25	50	21	20	50
Guatemala	75	65	25	50	75
El Salvador	75	50	18	50	-
Honduras	80	20	19	40	100
Haiti	80	65	30	70	70
Dominican Republic	80	30	31	40	50

[1]Modified after Posner and McPherson (1982).

In Brazil, small peasant producers control about 33 percent of the area sown to maize, 61 percent of that under beans, and 64 percent of that planted to cassava. In Ecuador the peasant sector occupies more than 50 percent of the area devoted to food crops such as maize, beans, barley and okra. In Mexico, peasants occupy at least 70 percent of the area assigned to maize and 60 percent of the area under beans (Ortega, 1986).

Most peasant systems are productive despite their low use of chemical inputs. Generally, agricultural labor has a high return per unit of input. The energy return to labor expended in a typical highland Mayan maize farm is high enough to ensure continuation of the present system. To work a hectare of land, which normally yields 4,230,692 calories requires some 395 hours; thus, an hour's labor produces about 10,700 calories. A family of three adults and seven children eat about 4,830,000 calories of maize per year, thus current systems provide food security for a typical family of 5 or 7 people (Gladwin and Truman, 1989).

Also in these systems, favorable rates of return between inputs and outputs in energy terms are realized. On Mexican hillsides, maize yields in hand-labor dependent swidden systems are about 1940 kg/ha, exhibiting an output/input ratio of 11:1. In Guatemala, similar systems yield about 1066 kg/ha of maize, with an energy efficiency ratio of 4.84. Yield per seed planted vary from 130-200. When animal traction is utilized, yields do not necessarily increase but the energy efficiency drops to values ranging from 3.11-4.34. When fertilizers and other agrochemicals are utilized yields can increase to levels of 5-7 t/ha, but energy ratios are highly inefficient (less than 2.5). In addition, most peasants are poor and generally cannot afford such inputs unless agrochemicals are subsidized (Netting, 1993).

In many areas of the region, traditional farmers have developed and/or inherited complex farming systems, adapted to the local conditions, that have helped them to sustainably manage harsh environments and to meet their subsistence needs, without depending on mechanization, chemical fertilizers, pesticides or other technologies of modern agricultural science (Denevan, 1995).

The persistence of more than three million hectares under traditional agriculture in the form of raised fields, terraces, polycultures, agroforestry systems, etc., document a successful indigenous agricultural strategy and comprises a tribute to the "creativity" of peasants throughout Latin America (Wilken, 1997). These microcosms of traditional agriculture offer promising models for other areas as they promote biodiversity, thrive without agrochemicals, and sustain year-round yields. An example are the chinampas in Mexico which according to Sanders (l957) in the mid 1950s exhibited maize yields of 3.5 to 6.3 tones per hectare . At the same time, these were the highest long-term yields achieved anywhere in Mexico. In comparison, average maize yields in the United States in 1955 were 2.6 tones per hectare, and did not pass the 4 tones per hectare mark until 1965 . Sanders (1957) estimated that that each hectare of chinampa could produce enough food for 15 to 20persons per year at modern subsistence levels. Recent research has indicated that each chinampero can work about three quarters of a hectare of chinampa per year (Jimenez-Osornio and del Amo 1986), meaning that each farmer can support 12 to 15 people.

Agroecology as a fundamental scientific basis for NRM

For years several NGOs in the developing world have been promoting agroecologically-based NRM approaches. Agroecology provides a methodological framework for understanding the nature of farming systems and the principles by which they function. It is the science that provides ecological principles for the design and management of sustainable and resource-conserving agricultural systems—offering several advantages for the development of farmer-friendly technologies. First, agroecology relies on indigenous farming knowledge and selected modern technologies to manage diversity, incorporate biological principles and resources into farming systems, and intensify agricultural production. Second, it offers the only practical way to restore agricultural lands that have been degraded by conventional agronomic practices. Third, it provides for an environmentally sound and affordable way for smallholders to intensify production in marginal areas. Finally, it has the potential to reverse the anti-peasant bias of strategies that emphasize purchased inputs as opposed to the assets that small farmers already possess, such as their low opportunity costs of labor. Ecological concepts are utilized to favor natural processes and biological interactions that optimize synergies so that diversified farms are able to sponsor their own soil fertility, crop protection and productivity. By assembling crops, animals, trees, soils and other factors in spatial/temporal diversified schemes, several processes are optimized. Such processes are crucial in determining the sustainability of agricultural systems (Altieri, 1995).

Table 5. Agoecosystem processes optimized through the use of agroecological technologies

- Organic matter accumulation and nutrient cycling
- Soil biological activity
- Natural control mechanisms (disease suppression, biocontrol of insects, weed interference)
- Resource conservation and regeneration (soil, water, germplasm, etc.)
- General enhancement of agrobiodiversity

Agroecology takes greater advantage of natural processes and beneficial on-farm interactions in order to reduce off-farm input use and to improve the efficiency of farming systems. Technologies emphasized tend to enhance the functional biodiversity of agroecosystems as well as the conservation of existing on-farm resources. As shown in table 6 promoted technologies are multi-functional as their adoption usually means favorable changes in various components of the farming systems at the same time (Gliessman, 1998).

Table 6. Selected examples of multifunctional agroecological technologies

- Cover crops, green manures and mulching
- Intercropping
- Rotations
- Organic soil fertilization
- Agroforestry (including social forestry)
- Crop-livestock integrated system (including aquaculture)

For example, cover crops function as an “ecological turntable” which activates and influences key processes and components of the agroecosystem: the complex of beneficial fauna, soil biology, weed suppression, nutrient cycling, etc. Similarly the incorporation of green manures not only provides nutrients, but also increases soil organic matter and hence water retentive capacity, further reducing susceptibility to erosion.

Many of the above are proven and promising agroecological technologies that can be integrated to enhance the sustainability of farming systems. Throughout the developing world, farmer groups in collaboration with NGOs are implementing at the local level hundreds of local agroecologically-based initiatives. Many of theses experiences demonstrate the feasibility of stabilizing yields, regenerating and conserving soils and water, preserving agrobiodiversity and enhancing food security, all based on agroecological technologies and locally available resources (Pretty, 1995).

The application of agroecology to improve the productivity of small farming systems

While it may be argued that peasant agriculture generally lacks the potential of producing meaningful marketable surplus, it does ensure food security. Many scientists wrongly believe that traditional systems do not produce more because hand tools and draft animals put a ceiling on productivity. Productivity may be low but the causes appear to be more social, not technical. When the subsistence farmer succeeds in providing food, there is no pressure to innovate or to enhance yields (Toledo et al., 1995). Nevertheless, agroecological field projects show that traditional crop and animal combinations can often be adapted to increase productivity when the biological structuring of the farm is improved and labor and local resources are efficiently used (Altieri, 1995). In fact, most agroecological technologies promoted by NGOs can improve traditional agricultural yields increasing output per area of marginal land from some 400-600 kg/ha to 2000-2500 kg/ha. enhancing also the general agrobiodiversity and its associated positive effects on food security and environmental integrity (Table 7). Some projects emphasizing green manures and other organic management techniques can increase maize yields from 1-1.5 t/ha (a typical highland peasant yield) to 3-4 t/ha. Polycultures produce more combined yield in a given area than could be obtained from monocultures of the component species. Most traditional or NGO promoted polycultures exhibit LER values greater than 1.5. Moreover, yield variability of cereal/legume polycultures are much lower than for monocultures of the components (Francis, 1986).

In general, data shows that over time agroecological systems exhibit more stable levels of total production per unit area than high-input systems; produce economically favorable rates of return; provide a return to labor and other inputs sufficient for a livelihood acceptable to small farmers and their families; and ensure soil protection and conservation as well as enhance biodiversity (Pretty, 1997).

For a region like Latin America which is considered to be 52.2 percent self-reliant on major food crops as it produces enough food to satisfy the needs of its population, agroecological approaches that can double yields of the existing 16 million peasant units can safely increase the output of peasant agriculture for domestic consumption to acceptable levels well into the future. To address hunger and malnutrition, however, it is not only necessary to produce more food, but this must be available for those who need it most. Land redistribution is also a key prerequisite in order for peasants to have access to acceptable land and thus perform their role in securing regional self-reliance.

A methodological framework for designing NRM strategies

In order for the NRM guiding principles to translate into management options appropriate to poor farmers, methodological mechanisms must be in place so that technologies reach poor farmers and the goals of sustainable development are achieved.

Such methodological mechanisms include:

- Confronting the site specificity of NRM
- Effective partnerships which include farmer organizations
- Participatory research and development methods

- Empowerment of local communities in defining research agendas
- Scaling-up of successful local sustainable agriculture initiatives
- Development of indicators of sustainable NRM.

Importance of site specificity in NRM

The high variability of ecological processes and their interactions with heterogeneous social, cultural, political, and economic factors generate local systems which are exceptionally unique. When the heterogeneity of the rural poor is considered, the inappropriateness of technological recipes or blueprints becomes obvious. The only way that the specificity of local systems--from regions to watersheds and all the way down to a farmer’s field--can be taken into account is through site-specific NRM (Beets, 1990). This does not mean however, that technologies adapted to specific agroecological conditions may not be applicable at ecologically and socially homologous larger scales.

NRM site-specificity requires an exceptionally large body of knowledge that no single research institution can generate and manage on its own. This is one reason why the inclusion of local communities at all stages of projects (design, experimentation, technology development, evaluation, dissemination, etc.) is a key element in successful rural development. The inventive self-reliance of rural populations is a resource that must be urgently and effectively mobilized DeWalt, 1994).

Participatory research and development approaches

A key methodological theme that cuts across NRM is how to best integrate the various social actors involved in the process of generation and diffusion of innovations. Much has been said about the potential role of farmer knowledge and experimentation as a critical link in the research process, but there are very few practical examples.

Most development programs that placed the interests of small-scale farmers high on their agenda, fell short in their expectations as they failed to seriously address popular participation. The implication here however is not for researchers to promote participatory approaches so that farmers put to better use already made or new “technological packets”. The few existing examples of generation and diffusion of “farmer friendly” technologies suggest that full participation of farmers is essential to the development and dissemination of sustainable agriculture methods and technologies. In such cases horizontal and equitable interaction among actors replaces top-down relations, and promoted initiatives are responsive to farmer needs and ideas (Thrupp, 1996). In fact, farmer knowledge is melded with current scientific knowledge.

The existing farmer-to-farmer networks and methods of communication have proven invaluable in the spreading of ideas and innovations. In turn, these participatory arrangements strengthen and empower local farmer and community organizations, and furthers learning and adoption of alternatives (Selener et al., 1997).

Partnerships and intercultural dialogue

The site-specific nature of sustainable NRM strategy places farmers, herders, fishermen, and other rural people in a central position. They are the ones with the greatest knowledge of local conditions and needs. Working with farmer organizations, NGOs, and other civil society groups, international centers can provide some of the tools that will help these groups determine the way in which natural resources are better managed. Thus, the scientists must develop site-specific NRM strategies in partnership with NGOs and the rural communities they set out to help.

These partnerships will require mutual respect, a common language, a new appreciation of indigenous knowledge and new methodologies. This is an area in which anthropologists and social scientists have much to contribute. They can help biophysical scientists develop truly participatory methodologies and increase their appreciation and understanding of local knowledge and conditions. Local knowledge is in fact considered so valuable that it should in itself become an important topic of research.

Often these kinds of partnerships require a complete re-training of scientists. For example, the language ordinarily used by scientific researchers is usually incomprehensible to peasant farmers. Conversely, traditional and agroecological concepts and terminology are not understood by scientists. Here again, cultural anthropologists could help develop a language common to both researchers and community members.

Scaling up of successful local initiatives

Many initiatives promoting agroecologically based NRM have crystallized at the local level, positively impacting a few rural communities in terms of food security, environmental preservation and income generation. In order to extrapolate to a more regional level the full benefits of such sustainable agriculture initiatives, the scaling up of successful local projects is a key requirement. This remains however a major research and methodological challenge and there are no recipes on how to proceed with scaling up. It is known that in order for these efforts to be expanded, major changes need to take place in the areas of institutional partnerships, agricultural policies, research agendas and educational processes (Blauert and Zadeck, 1998).

A possible approach would be to provide through new institutional partnerships, additional methodological or technical ingredients to existing cases that have already reached a certain level of success. This would complement the efforts of local NGOs and communities who are already involved in NRM field work, carrying out networking activities, and engaged in advocacy work to influence research direction and/or policies that will benefit resource-poor farmers.

Linking NRM and rural development

Although appropriate NRM strategies are key to improving the livelihoods of poor farming communities, effective social organization, empowerment of communities, access to land, and enabling policies are also crucial for an NRM strategy to significantly impact poor farmers of the developing world.

Empowerment of rural communities

Because rural communities are affected by factors which are in constant flux and because NRM projects have a finite life, it is crucial that the process by which new NRM strategies are developed, enhance the ability of rural communities to innovate, to respond to new challenges, and to influence the policies which affect them. This is yet another reason for including members of rural communities in the research process.

The benefits gained from NRM research and development include both the end-product--i.e., new strategies and technology to sustainably manage natural resources--and the process used to arrive at the end-product. By using an empowering methodology, members of rural communities, such as women's groups and indigenous peoples learn not only the technical tools for sustainable NRM but also gain much needed political power and recognition that will ensure enduring results. This process makes use of a methodology in which rural people participate in setting research agendas. For example, members of the communities could be included on the boards of international research centers. Farmers, herders, and fishermen should also determine goals and design of research agendas of such centers and be involved in carrying out and evaluation of projects. This can be achieved using approaches such as farmer-to-farmer training, farmer-led research, “land-to-lab extension”, and multi-directional technology dissemination instead of one-way technology transfer from lab to land. The ability of rural communities to innovate and to respond to new challenges will then be enhanced and will continue beyond the time period of projects.

Policy

Many of the causes of poverty and environmental degradation have their roots in policies which affect the price of agricultural products and access to good land (Lappe et al., 1998). If, for example, a rural community is poor because of a history and policies which have forced it into cultivating marginal land, does it make sense to develop ways in which this inherently less productive and fragile land might be improved? Or would it make more sense to promote land reform to eliminate some of the causes of poverty? This is the dilemma facing many scientists. Even though the mandate of international research centers is not in the realm of policy formulation, such centers can nevertheless, within the limits of their abilities, bring the “voice” of poor farmers to relevant international fora and attempt to influence the policy-making process. For example, when conducting participatory programs, national and international decision-makers should be included in the process. This would ensure that policy makers are at least kept informed on the evolving situation in rural communities (Thrupp, 1996).

Some policy issues which affect the price of agricultural goods and access to land directly affect the goals of poverty alleviation and sustainable management of natural resources. This is why it is important for scientists to support efforts aimed at obtaining fair prices for raw agricultural products, land redistribution, and ending trade liberalization, at least in the case of staple foods, which are crucial to food security.

Self-sufficiency

Before the rural poor in marginal areas can be expected to be a part of and compete with powerful and fluctuating global forces, they must build up a minimum level of local self-sufficiency. This prevents them from sinking to levels at which their food security is threatened.

The kinds of technologies developed should therefore emphasize as a prerequisite food self-sufficiency and independence from outside resources (Reinjtes et al., 1992). Research can help develop these kinds of technologies by using existing production systems as a starting point while reinforcing the innovative characteristics of these local systems.

Similarly, at the level of economics, local agricultural production should gain some independence from global market prices of agricultural goods. This can be done by encouraging local circuits of production and consumption or by linking farmers to export markets mediated by organizations involved in fair-trade schemes.

Conclusions

Several conclusions can be drawn from the above analysis:

1. Improving the management of natural resources is not only linked to the alleviation of poverty but it is also essential to achieving sustainable productivity increases in traditional and ecologically vulnerable areas (Browder, 1989). For this to happen, the proposed NRM strategy, however, has to deliberately target the poor, and not only aim at increasing production and conserving natural resources, but to create employment, provide access to local inputs and output markets (Table 8).

2. Researchers and rural development practitioners will need to translate general ecological principles and natural resource management concepts into practical advice directly relevant to the needs and circumstances of small-holders.

3. The new pro-poor technological agenda must incorporate agroecological perspectives. A focus on resource conserving technologies, that uses labor efficiently, and on diversified farming systems based on natural ecosystem processes will be essential. Technological solutions will be location specific and information intensive rather than capital intensive. The many existing examples of traditional and NGO-led methods of natural resource management provide opportunities to explore the potential of combining local farmer knowledge and skills with those of external agents to develop and/or adapt appropriate farming techniques.

4. Any serious attempt at developing sustainable agricultural technologies must bring to bear local knowledge and skills on the research process. Particular emphasis must be given to involving farmers directly in the formulation of the research agenda and on their active

participation in the process of technological innovation and dissemination. The focus should be in strengthening local research and problem-solving capacities. Organizing local people around NRM projects that make effective use of traditional skills and knowledge provides a launching pad for additional learning and organizing, thus improving prospects for community empowerment and self-reliant development.

5. A pro-poor NRM strategy should include delineating an agenda for policy formulation that facilitates participatory natural resource management practice based on both farmer-based traditional innovations and selected external inputs when appropriate (Table 9). The strengthening of local institutional capacity and widening access of farmers to support services that facilitate use of technologies will be critical. There is also need to increase rural incomes through interventions other than enhancing yields, such as complementary marketing and processing activities. To design and implement such an agenda, cooperation among governments, international agencies, NGOs, committed members of the private sector, and the technical and scientific communities will be required.

Table 8. Elements and contributions of an appropriate NRM strategy

■ Contribute to greater environmental preservation ■ Enhance production and household food security ■ Provide on and off-farm employment ■ Provision of local inputs and marketing opportunities	■ Promotion of resource-conserving multifunctional technologies ■ Participatory approaches for community involvement and empowerment ■ Institutional partnerships ■ Effective and supportive policies

Table 9.Requirements of a pro-poor NRM strategy

■ Use of agroecological technologies that optimize biological processes ■ Minimize use of external inputs ■ Minimize tradeoffs between productivity, sustainability and equity ■ Farmer participation and partnerships ■ Enabling policies

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