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Use of Live Fences of Nopal (*Opuntia*) and Associated Crops to Rehabilitate and Protect Sloping Land in Loja, Ecuador

A live fences project in Ecuador sought to associate the idea of environmental recovery, characterized by an agro-ecological focus, with a perspective on social and economic development. Cultivation of the Opuntia *cactus and the cochineal insect (*Dactylopus coccus*), environmentally and culturally adapted to the region, permitted the recovery of several degraded areas and generated income for rural dwellers, especially during periods of drought. Among the most important project impacts were: recovery of traditional knowledge, cultural values, ancestral skills, and inveterate attachment to communal properties; determination of the ecotones of the cactus for production of cochineal, fruits, forage, and live barriers; recovery of areas eroded by overexploitation and inadequate management; increased sensitivity among political leaders regarding the problems of desertification and the need to support a second phase of the project; decision-making by community-based organizations; and commitment of the community to the activities of the project, based on agreements between authorities, academia, and the community. In 1999, the project was honored with the "Saving the Drylands" Award given by the United Nations Environment Programme (UNEP) at Recife, Brazil, during the Third Conference of Parties (COP 3) of the Convention to Combat Desertification (CCD).*

FIGURE 1 The project includes planting of opuntia among native, drought-resistant trees that can provide fuelwood. (Photo courtesy of UNEP)

Applying ancestral skills in a coastal Andean area

The Province of Loja is located in a mountainous coastal region in southern Ecuador, bordering on northern Peru. It covers 10,793 km^2, equivalent to 4% of the country's land area. Altitudes vary from 140 to 400 m, with temperatures ranging between 0 and 22°C and annual rainfall between 380 and 774 mm. Soil fertility is low and water content deficient; only 26% (280,000 ha) of the area is suited for agriculture and 40% for livestock, with similar restrictions. The remaining 35% resembles deforested soils—very fragile and vulnerable and unsuitable for economic activities other than conservation.

The project was implemented by the Department of Agricultural Sciences, National University of Loja, Ecuador. The project philosophy was based on the use and exploitation of ancestral skills and the centennial tradition of planting and harvesting of opuntia and cochineal crops. A site accessible to local farmers was selected for the experimental phase with 2 criteria: suitability for healthy and vigorous growth and longevity (about 30 years) of plants that would serve as barriers; and exhibition of an ecotype highly receptive to cochineal productivity, as this was identified as one of the main future sources of income, including fruit and forage production.

The opuntia was planted in burrows that follow contour lines. The project promoted the practice of leaving existing native *faique* bush vegetation between the opuntia burrows for exploitation as a source of firewood (Figures 1, 2). Numerous outputs were expected:

- Rehabilitation of degraded hillsides through cultivation of opuntia as fences or barriers in association with other crops.

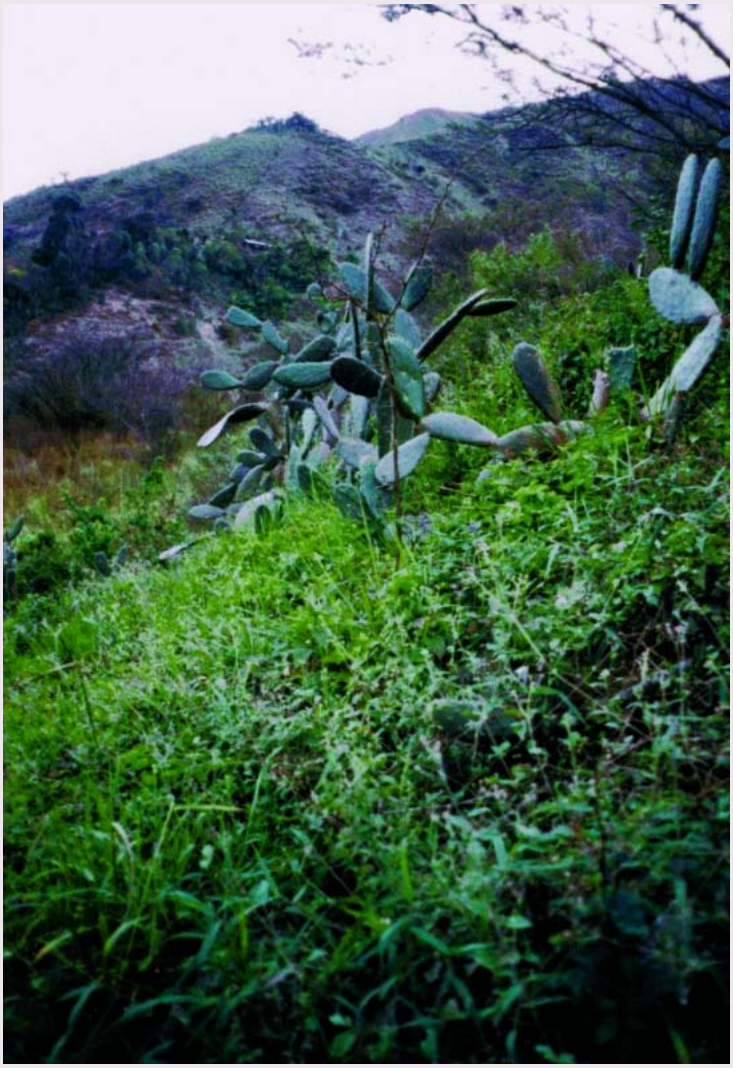

FIGURE 2 To prevent further land degradation and increase agro-ecological benefits, opuntia is planted in burrows following contour lines. (Photo courtesy of UNEP)

- An increase in production and agricultural productivity through improved soil fertility.
- Increased income for farmers, particularly during drought, from sales of the edible opuntia fruits and cochineal—important elements in food processing and dye, the value of which has increased considerably in the international market in the past few years.
- Appropriation of useful skills in the search for alternative livelihoods in Loja, with the aim of promoting a new economic climate and sustainable development.

Implementation through alliances and rural mobilization

The project strategy had 2 main components: alliances with the different groups in the regional community; and the involvement of producers in the utilization of the technology.

One group of alliances with various institutions helped to make the proposal viable. These alliances facilitated the incorporation of different social actors in the implementation of the project, including the communal, academic, political, and governmental sectors. For instance, technical schools and nongovernmental organizations (NGOs) present in the region adopted the technology as part of their educational curriculum, teaching students to implement pilot areas on their respective campuses. NGOs, on the other hand, spread the project concept, taking advantage of their strong links with the community. Another important institution in the alliance was the Church, which was instrumental in diffusing the technology among farmers, whereas the alliance formed with the Ecuadorian army resulted in their helping farmers to plant opuntia in many localities close to soldiers' camps, despite border conflicts.

Farmers were also involved through direct mobilization and participation. The project implementer, the National University of Loja, visited the entire province, identifying the characteristics of the productive systems and the environmental conditions of individual and communal properties and opuntia with the farmers. Farmers met periodically to discuss their problems and other important matters.

Striving for sustainability

The lessons of the project are of interest in terms of sustainable development because they demonstrate the long-term social and economic strategic importance of conservation and rehabilitation of soils in the region:

- *Environmental sustainability.* The project area provides evidence of the feasibility of producing opuntia and cochineal species on very steep slopes, varying from 30 to 58%, a significant fact in the battle against desertification.
  Initial data showed that soil rehabilitation was directly related to improved levels of humidity and water retention capacity. If this is confirmed in the long term, the technology will broaden the ability of the farmers to manage opun-

FIGURE 3 A farmer on his land, showing the Opuntia burrows technology, which is perfectly adapted to dry conditions and improves the productivity of traditional crops such as the maize visible in the background. (Photo courtesy of UNEP)

tia together with other crops. The technology diffused by the project seems well adapted to existing environmental conditions and has proven to be a good ecological alternative in strengthening agro-ecological practices. In the last phases of the project, as part of its strategy of replicability, economic value was assigned to native species and an "agro-ecological model" adopted as the starting point for environmental sustainability.

- *Economic sustainability.* There are no economic data to evaluate the results of the project. However, it can be inferred from interviews and observations that levels of uncertainty with regard to generation of income have diminished. The project has elements of efficiency (use of resources with reduced environmental impact) and impartiality (attention to current and future generations of farmers).
- *Sociocultural sustainability.* The project respects traditions and ancestral skills, including a demonstration that innovation is possible by rediscovering the potential of an agro-ecological model compatible with community culture and values. The new aspect of sociocultural sustainability has to do with the capacity of the people to control their lives and maintain community identity.
- *Political–institutional sustainability.* The dimension of sustainability reflects interinstitutional coordination and alliances between groups with a common vision of an agro-ecological project. This process is just beginning. Although it will take many years to show its real potential, the first steps have been taken. Replicability is a question of time and perseverance.

Commitment to project objectives and proposals

Decisions based on project proposals, and doubts or questions from farmers, establish the scope of commitments through a mechanism of agreements between communal authorities and public organizations that support the project. Signature of such agreements is preceded by ample discussion within communal organizations. This procedure has the advantage of clearly defining commitments and distribution of responsibilities.

The agreements imply an acknowledgment of the objectives and the resources available to the parties in facing problems caused by eroded soils and steep slopes. They also imply the participation of communal institutions in a joint program of promotion and production of opuntia as well as cochineal and land conservation and determine the contribution of different parties.

Enhancing social capital

Strengthening social institutions

The project has used 2 soil resource-related social institutions to promote its objectives. One is communal properties, whose ownership and resources are shared by all members of the community. Another is inherited family properties, localized generally in the neighborhood of the communal properties. The project has succeeded in calling attention to farmers and their forms of ancestral organization by initially studying the production systems of each local community and environmental conditions. Some community groups participate in the project as a direct effect of the demonstration zones promoted by professionals and university students, whereas others establish planting of opuntia and cochineal on existing farmlands, supported by other initiatives.

Social cohesiveness stems from the communal custom of meeting on the first Sunday of every month to discuss problems, with the aim of organizing shifts for the use of water and the management of other common resources. Community authorities have used this opportunity to replicate the messages of the project. This has increased interest among rural families in adopting project proposals.

At least 10 communities participated in the cultivation of opuntia and cochineal crops within the framework of the project, and around 50 others were interested. Community organizations and local NGOs predict a greater impact as the influence of the project reaches more than 1000 farmers. The combination of activities including demonstration sites,

undergraduate theses, meetings, field days, visits to community properties, and publications has raised awareness among certain sectors of the regional community and promoted the diffusion of the technology. Synergy between the actions of community organizations, the university, NGOs, and the Provincial Council has been achieved.

Community benefits

Communities already perceive project benefits, and those that participate in other initiatives influenced by the agro-ecological perspective and the proposed technology have better control over their lives. For example, farmers expressed their satisfaction with the extra income received from the cochineal, the retention of soil in the opuntia plantations, and fruit consumption as part of the family diet. Above all, farmers noted that the project recognizes the value of ancestral skills and practices. Opuntia and cochineal are part of the cultural patrimony of these peoples (Figure 3). Their use strengthens self-esteem among older members of the community and represents an opportunity to keep younger members from abandoning the region. The possibility of income throughout the year increases levels of certainty about the future of the family, decreases anxiety during lengthy droughts, and could eventually reduce emigration.

Aside from empowerment, communities perceived the following project benefits as important contributions to their lives:

- The opportunity to obtain opuntia seeds (suckers) for annual increase of density on each farm.
- Laboratory support for the improvement of soils, which retain a greater percentage of potassium, phosphorus, and nitrogen as a result of cultivation of opuntia. The productivity of other crops such as maize has also improved.
- The recycling of organic residues as fertilizer for opuntia, especially manure from goats, *cuye* (guinea pig), chickens, cows, and pigs.
- A greater awareness of the importance of vegetation, especially those few trees and shrubs that withstand the long droughts and furnish firewood.
- The participation of government agencies in financing field work days on a national scale.

Communities also attribute some general benefits to the project, directly or indirectly:

- The technological possibility to reduce the impact of desertification in a high-risk region.
- Updated information on the diversity of productive systems and arid ecosystems that characterize the region.
- A change in credit systems by including loans for planting opuntia and harvesting cochineal.
- The participation of women's organizations in the production of opuntia and cochineal in a communal society traditionally organized around men.
- Increased applications for technical assistance and information.
- Greater interest among undergraduate students at the University of Loja in research on various issues related to project objectives.
- Greater dissemination of the project approach among different organizations.

Conclusions

This project has demonstrated that it is possible, with scarce financial resources and the efforts of many years of agro-ecological research, to increase awareness of responsibility for survival strategies among diverse social actors, and, in the long term, among the poorest population groups. It is gradually becoming sustainable in environmental, economic, sociocultural, and political terms.

The dissemination of a technology in the context of a local development model is closely connected to its simplicity, cultural adaptability, and a low level of investment. The process of dissemination and replicability cannot require external institutional or financial instruments, at least not in the case of traditional populations. Future plans could include initiating a databank on specific productive systems in the region and their environmental conditions.

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