Mexico - Mixteca Region (Oaxaca) – Fighting Desertification with Community Reforestation and Sustainable Agriculture

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The region known as La Mixteca northeast of the City of Oaxaca looks like a desert, though in the past it was covered with forest. The desolate landscape and desertification process are the result of generations of bad land-use practices. The causes that converted forests into wastelands are many and complex. Some say the tradition of overexploiting natural resources extends back to the days of the Aztecs, who demanded heavy tribute from the local Mixtec population. During the centuries of Spanish colonization, the construction of massive missions required large amounts of lumber, and goats were introduced into an already degraded landscape. The region became a corridor for driving goats to market, and excessive grazing prevented the recovery of forests that were logged for railroad ties, cleared for agriculture expansion, or (mainly oaks) cut for firewood and charcoal – the primary fuel in the region's rural communities to this day.

Centuries of degradation were exacerbated during the second half of the Twentieth Century by the Mexican government's agrarian policy and Green Revolution technology. Government policies offered credit only to cultivate monoculture cash crops, driving the ancient and ecologically sustainable milpa system into virtual extinction. Monocultures exhausted the soil and exposed it to erosion. The Green Revolution brought chemical fertilizers, which boosted crop yields, but the benefits were short-lived. Soil erosion and degradation continued, compelling farmers to use ever-increasing amounts of fertilizers. Depleted soils and high fertilizer costs forced farmers to abandon their fields, extending their agriculture into newly clear-cut lands. Deforestation and erosion accelerated, and today the region suffers one of the highest rates of erosion on the planet. It is one of the poorest regions in Mexico, unable to produce enough to feed itself, and has one of the nation's highest rates of emigration.

Deforestation and erosion make the Mixtec Highland look like a desert

The Solutions

But recently this region received international attention for doing things right. In 2008, Jesús León Santos and the Center for Integral Farmer Development (CEDICAM) received the Goldman Environmental Prize for their work on reforestation, soil conservation, and sustainable agriculture.

Their story begins in the early 1980s, when a group of Guatemalan refugees fleeing from that country's civil war settled in Mexico's Mixteca region with assistance from the American nonprofit organization World Neighbors. Disturbed by the erosion and desertification, the Guatemalans began sharing their soil conservation and sustainable agriculture techniques with the local population, aided by the Mexican nonprofit organization CETAMEX (Mexican Center for Appropriate Technologies).

Alfonso López López, a farmer and current president of CEDICAM, recalls how his father would berate him for "wasting time with those Guatemalans," and how he had to run off on his motorcycle to attend their workshops. But it was these foreigners who set in motion the process of restoring soil and forests by sharing their experience. In the beginning it wasn't an easy sell.

One of the first successes was persuading a few farmers to plant their beans in rows, rather than broadcasting the seeds at random. With yields as much as five times better than that of friends and neighbors, they soon convinced their communities that what the Guatemalans offered was no waste of time. In 1988 the catholic parish of Nochixtlán got involved and supported these efforts by offering office space. Parish religious educators, mostly female, promoted nutrition and health education in rural communities

alongside CETAMEX staff. Years later, two of these women would go on to become CEDICAM's first female employees.

When problems surfaced after several years between the workers and leadership at CETAMEX, World Neighbors sponsored the formation of a new farmer-led organization. Under the leadership of Jesús León Santos, these farmers pooled their savings and purchased a plot of land just outside Nochixtlán which would become their headquarters, allowing them to move out of the parish offices and achieve greater autonomy. By 1997 the transition was complete, and the farmers had created CEDICAM, an organization to call their own. CEDICAM expanded its work along three axes:

- reforestation and soil conservation;
- sustainable agriculture;
- nutrition and health.

Facilities of the Center for Integral Farmer Development (CEDICAM) in Nochixtlán, Oaxaca

Sustainable Agriculture

Food self-sufficiency has been CEDICAM's central theme. The Mixteca region imports much of its food, but the communities in which CEDICAM is active have been able to improve their crop yields enough to move beyond subsistence to producing a surplus and creating a market for locally grown produce. This has been achieved by:

- reviving the traditional milpa farming system;
- composting and using “green manures” as organic fertilizers;
- reducing dependence on chemical pesticides;
- selecting seeds to improve local varieties of corn;
- marketing their crops as “organic.”

The traditional milpa farming system is a polyculture with several complimentary crops mixed together in the same field. The most basic arrangement is squash, corn, and beans. The corn begins to grow just as the squash dies off. The beans use corn stalks as poles and peak just as the corn stalks are drying out. Many other crops can be included: for example, chilies, sweet potatoes, tomatillo, and chayote. This crop mixture helps conserve soil fertility; it is less vulnerable to pests that can wreak havoc in monocultures; and it provides a more balanced diet for the farmer’s family. In addition to milpa farming, greenhouses have been built to grow vegetables, allowing families to sell their excess produce on the market.

Most plowing in this impoverished region is still done with oxen. CEDICAM promotes what is known locally as “Egyptian” plowing, which consists of opening the soil without turning it over. Egyptian plowing, which is particularly adapted to semi-arid landscapes, reduces soil erosion and conserves soil moisture by decreasing water evaporation from the soil.

A comprehensive waste management program has been developed to produce organic fertilizers. Before, animal manure was underutilized because livestock were simply tethered in fields to drop their manure there. By penning livestock into hard-floor corrals, manure could be concentrated and composted to provide higher quality fertilizer.

The bokashi technique, first developed in Japan, has been adapted successfully to local conditions and produces high quality compost in just 2-3 weeks. The keys to bokashi are inoculation with high-performance yeast and bacteria to ferment the waste and addition of sugars to augment the fermentation, generating high temperatures that accelerate the process even further.

Worm-composting has also been introduced successfully, particularly among women who use it primarily in greenhouses and family gardens. In addition to using the compost, the “juice” from worm-composting is collected in discarded plastic bottles for later use to fertilize individual plants. Farmers overcome the expense of investing in worms by borrowing a kilogram of fresh worms from CEDICAM and returning worms a year later.

Jesús León Santos (founder of CEDICAM) and his daughter Diana with the compost at their farm

More recently CEDICAM has begun promoting the use of "green manures," grain and legume crops that are worked into the soil as natural fertilizers. Crops grown for green manure include peas, fava beans, mustard, wheat, and barley. A weed locally called "white clover" (*trébol blanco*) can be grown on even the poorest soils because it uses symbiotic bacteria to fix nitrogen from the atmosphere. It provides a way to improve the soil fertility in fields with crops by applying green manure produced on soils that are not fit for agriculture. At first farmers had trouble incorporating the green manure into the soil, as they could not afford heavy machinery for tilling and their traditional oxen-plows could not handle the job. Lawnmowers and weed-whackers now do the job, and the trimmings are simply left to decompose on the ground. This ground cover also helps preserve soil moisture.

All these improvements have allowed farmers to reduce and even eliminate their use of chemical fertilizers. They have achieved similar success along the pesticide front. Extracts from Mexican marigold, common rue, chili and garlic, as well as soap solutions, are used to repel pests. A soil fungus (Beauveria bassiana), which is pathogenic to insects, has also been recruited as a biological agent to fight insect pests. Spores can be applied to crops as either a solution or powder, though care must be taken not to treat flowers visited by pollinating insects. These natural methods have enabled farmers to cut back and even eliminate the use of chemical pesticides, allowing them to market their produce as "organic."

Another important feature of sustainable farming is proper seed selection, particularly for corn. The communities served by CEDICAM have been very successful. Mexico is the birthplace of corn, and Oaxaca is home to dozens of local varieties of different colors, shapes, sizes, and uses. CEDICAM has been

instrumental in teaching farmers how to continually improve yields by selecting for the best seeds. Plants are chosen from the center of the field, and not the edges, to avoid genetic contamination from nearby plots. Selection criteria include:

- plant resistance with regard to drought, freezing, lodging, storage, pests, and disease;
- productivity (number of ears, ear size, kernel size);
- final use (eat fresh, make corn meal, or feed animals).

Selected seeds are planted separately, and a second round of selection is made looking for the largest and healthiest ears (i.e., no insect or disease damage) and at least 12 rows of kernels in straight rows. In this way each farm is a living laboratory in which varieties adapted to varied conditions of weather, soil, and cultural preference are constantly being improved. With proper selection and care, these local varieties are as productive as imported hybrid seeds. Discarded plastic bottles are used to store selected seeds, allowing farmers to have their own seed bank and keep it safe from vermin. These varieties are then shared and traded in informal networks of markets and fairs.

Maize seed storage

All these advancements have been achieved through a comprehensive training program called “Farmer to Farmer,” which aims to lead by example and convince with results. From the very beginning CEDICAM decided to be a farmers’ organization. Agronomists and other “experts” were deliberately excluded due to prior negative experiences with government officials.

Working horizontally and sharing in the work, farmers are persuaded to dedicate a section of their land to

the new techniques, so that before-and-after comparisons can be made. Inspired by higher yields, savings, and improved livelihoods, the most successful farmers are recruited into sharing their experiences with their neighbors. These efforts are carried out by two types of workers: promoters and facilitators. Promoters have model plots of their own and participate in meetings, workshops, and training sessions. Facilitators help identify promoters, offer logistic support for meetings and workshops, and seek out and create educational materials. In this way CEDICAM leads by example, through its constant presence in communities, sharing in the hardships as well as the rewards. It has a permanent presence in 12 farming villages and more informal arrangements with another 30 communities.

Soil Conservation

But as impressive as these achievements have been, what has really brought international attention has been CEDICAM's struggle against soil erosion, which has developed along two fronts – soil conservation and reforestation.

The construction of containment ditches along contours on the hillsides is one of the most visible and effective projects. The ditches have a double function: retaining water and prevent soil erosion. They capture rainwater as it flows down a hill, channeling the water through the soil to supply crops downhill from each ditch. The ditches keep topsoil from washing away because they reduce the flow of water down the hills, and because soil loosened by rain is trapped in a ditch. Construction of these ditches is an enormous undertaking, requiring an immense quantity of manual labor.

Each meter-long section of a 60 cm wide x 60 cm deep ditch can recover up to 360 liters when it rains. Dozens of kilometers of ditches are built every year, and so far the total is hundreds of kilometers. Contour ditches are laid out with a device first introduced by the Guatemalans and known as the "A". It consists of two long wooden poles forming an A-frame that is used to mark out the contours. Initially the ditches were dug by hand, relying on the indigenous tradition of community service known locally as tequio, in which all members of the community are expected to participate.

The success of the containment ditches was quickly evident in the recovery of previously dry springs and streams, and even in the birth of brand new springs. Now the federal government, through the National Forestry Commission (CONAFOR), has adopted this technique and taken over the construction of containment ditches with heavy machinery. The success of this project has inspired CEDICAM to implement other water management projects, such as the construction of rainwater cisterns to supply water to their greenhouses.

Contour ditch system for capturing rainwater and soil on a slope in Telantongo, Oaxaca

Reforestation

Even more impressive has been the reforestation project. While many of CEDICAM's other projects had immediate and obvious benefits, reforestation is a longer-term investment that requires more faith. When they first began, there was much resistance because trees take years to grow. It was not easy to convince people to invest their work in something that might never benefit them directly. Some were willing to plant fruit trees but not other kinds of trees. At first, the few people who were persuaded planted only one or two trees, maybe five. With time, the ready availability of limbs for firewood was key in convincing the populace that non-fruit trees were also worth planting.

Having no prior experience with raising trees, CEDICAM had to proceed by trial and error, and there were some missteps along the way. At the beginning, eucalyptus and ironwood seedlings provided by government nurseries proved inadequate to the soils and climate of the Mixteca. Following CETAMEX founder Angel Roldán's advice, farmers started looking for species indigenous to the region and settled on a pine (Pinus oaxacana) known locally as *ocote*, and an alder known locally as *elite* (Alnus acuminata). The group visited several existing nurseries to learn proper techniques before establishing its own nursery, which now produces over 30,000 seedlings per year. CEDICAM estimates over 4 million trees have been planted so far.

The indigenous pines and alders grow quickly. The alder is particularly impressive because it fixes nitrogen from the atmosphere and thrives on even the poorest soils. It is excellent at improving the soils, since its

leaf fall deposits so much nitrogen-rich organic matter on the ground. In a grove of 20-year-old alders, we were able to dig 20-30 cm deep in black moist earth, while only a few meters away outside the grove there was nothing but bare rock.

Gerry Marten **checks out a 20-year-old elite (Alnus acuminata) grove. Note the bare ground in the background outside the grove.**

Left: Soil formed from the litter beneath an alder tree (Alnus acuminata)
Right: Eroded soil a few meters outside the alder grove

Because these trees grow so quickly, limbs can be cut for firewood without damaging the trees. This was perhaps the most convincing aspect of the reforestation project for the local people, since previously they had to spend a lot of time traveling ever-increasing distances in search of retreating firewood sources. Now these communities have a sustainable source of firewood close at hand, making it unnecessary to cut many trees in the rest of the landscape. To reduce firewood demand, CEDICAM has also worked to promote the adoption of efficient, wood-saving stoves, which also improve the health of families by burning cleaner and

reducing smoke inhalation in the kitchen (see the Patsari Stove story).

For reforestation to be successful, it was necessary to exclude goats from reforested areas, a move that was not welcomed by the owners of goat herds. But with the aid of prior experience, the necessary zoning was agreed upon, and goats have slowly been replaced with sheep, whose grazing is a bit more selective and less destructive.

A limitation of these fast-growing trees is that they tend to have short lives. The first trees, which were planted in the mid 1980s, are starting to die out. This suggests a need to diversify the reforestation with slow-growing species as well. The good news is that the fast-growing trees are now seen in places where none were planted, suggesting that nature has begun to take over their propagation. Although reforestation will be a long process, these first steps have been successful enough to encourage people to carry the reforestation further.

Social Impact

CEDICAM projects have also improved the status of women. At first women were not even allowed in the farmers' organizational and training workshops, but now women are prominent in all CEDICAM activities, including community organizing and technical assistance to farmers in the field. The change has been due in part to pressure by international donors interested in gender equality, but it was really more of a response to the realities of these communities, where high levels of emigration, particularly among young men, have forced women to take on a broader role in economic activities.

These communities have also seen changes in the way they organize and regulate land use. Communal lands in Mexico are usually divided into family plots for individual use. Common areas not suited for agriculture are used for grazing, firewood collection, and charcoal production. The common areas are particularly vulnerable to Tragedy-of-the-Commons in the absence of strict rules for their use, and one of the first side-effects of CEDICAM's work has been the emergence of zoning and land-use rules in communities where a free-for-all attitude had previously been the norm. Rules are decided at community assemblies. Examples include prohibiting the harvest of oaks for charcoal production, banning grazing from reforested areas, and imposing heavy fines on offenders.

The Lessons

A conspicuous feature of the turnabout from decline to restoration has been the conversion of vicious cycles into virtuous cycles. Although the causes of environmental decline in the Mixteca are complex, we can identify the introduction of goat-herding into an already fragile ecosystem as the "negative tipping point" that set decline in motion. It was overgrazing by goats that interrupted nature's regenerative powers, starting a vicious cycle in which goats degraded the land, the land was incapable of supporting other uses, goat herding increased, and the land was degraded even more. The government's agrarian policy and the

use of chemical fertilizers were responses to the crisis of erosion, land degradation, and deforestation, but they proved counterproductive in the long run.

We can identify the Guatemalan refugees – and more specifically their advice on farming and soil conservation methods and the support by World Neighbors and CETAMEX – as the positive tipping point, the "EcoTipping Point," which set in motion a gradual process of environmental restoration and agricultural recovery. Demonstrating that bean yields could be improved dramatically by planting in rows was the first step towards food self-sufficiency. This inspired farmers to embark on soil conservation measures (e.g., contour ditches) and tree planting, which reversed the vicious cycle of land degradation. The vicious cycle was transformed into a "virtuous cycle" in which the social and environmental forces that had driven decline were driving restoration. Further success gave people the experience and confidence to undertake additional actions to further improve their waste management, their soils, their landscape, their diet, and their quality of life.

How did CEDICAM communities actually manage to achieve this? What were the ingredients for their success? Their story displays the same key ingredients for success that are prominent in other EcoTipping Point success stories:

Outside stimulation and facilitation. A success story typically begins when people from outside a community stimulate activate a shared community awareness about its problems – how the situation is changing and what seems to be responsible – and provide fresh ideas for possible actions to deal with it. The Guatemalan refugees showed the Mixtec farmers a different way of doing things, encouraging the farmers to confront their problems. While CEDICAM's accomplishments have come primarily from the human and financial resources of the people in the region, organizational and financial assistance at key points along the way – from nonprofit organizations such as Bread for the World, Catholic Relief Services, Maryknoll, and the Rotary Club International – have also made a difference.

Strong local democratic institutions and enduring commitment of local leadership. The experience of Oaxaca's Mixteca region shows how lasting results can come from below, from the grassroots of society. They have not been imposed by government policies, but rather achieved through the self-evaluation, creativity, broad-based decisions, and manpower of an independent community making the best of its own resources. The strength of democratic institutions in the indigenous communities of the Mixteca region has allowed them to embark on projects that are conceived and supported by the same people who must implement them. The traditional tequio community service system is a particularly noteworthy expression of this communal democracy. Building on the vitality of strong community participation, CEDICAM's success has come from decades of commitment and hard work by Jesús León Santos and his colleagues.

Coadaption between social system and ecosystem. Success depends on technology appropriate to the local environment and the corresponding social organization for putting the technology effectively into use. Environmental and social gains proceed together. In addition to the tequio, which was so readily

adapted to rescuing the landscape and reviving traditional agriculture, we find in CEDICAM communities other social institutions that evolved with the project. One is the "Farmer to Farmer" methodology which seeks to train neighbors by treating them as equals. This approach contrasts with government strategies which often seek to impose solutions from above, solutions that not only fail but often are counterproductive. Another important social adaptation has been the change in the role of women and how women's work is valued. With regards to ecosystem adaptation, the land has responded positively to reforestation and changes in agricultural methods. Higher crop yields are the most obvious ecosystem response, but soil fertility is also enhanced where crops are mixed and rotated.

"Letting nature do the work". Micro-managing the environment is beyond human capacity. Effective problem solving utilizes nature's healing powers for restoration. In the Mixteca region, trees are starting to grow where they were never planted. Springs and rivers that had dried up have come back to life .CEDICAM's production of natural fertilizers reduced the need for chemical fertilizers, allowing nature to maintain soil fertility. The milpa system is environmentally sustainable because its multi-species polyculture is a mimic of nature.

Transforming waste into resources. What appears to be "waste" – such as degraded land, abandoned buildings, garbage, or marginalized people – is mobilized and transformed into valued social or material capital. Because the Mixteca region is so poor, CEDICAM has had no choice but to make the fullest use of any available resources. It has recycled agricultural and other wastes into compost to improve the soils. Refugees are by definition unwanted in their homeland. They are in a way "discarded people", which in this case were valued and appreciated in their adoptive land.

Rapid results. Quick "payback" from a community's efforts helps to mobilize commitment to the effort. Once positive results begin cascading through a community and the environment, normal social, economic, and political processes reinforce the benefits from there. For farmers in the Mixteca region, higher yields from planting beans in rows brought tangible benefits to farmers within a matter of months, conveying a message that they could improve their lives with prudent experimentation. The construction of contour containment ditches on the hillsides also had rapid and dramatic consequences, when dry springs were brought back to life. The benefits from reforestation were slower, but enthusiasm for reforestation grew when people realized they no longer had to travel long distances in search of firewood.

Powerful symbols. Symbols can help to consolidate community action. Food self-sufficiency can be considered a powerful symbol in the Mixteca experience because it summarizes precisely the reason why these changes began and continue to happen. Greater agricultural yields have not only improved the family diet, they have improved the local economy. Food self-sufficiency has become a source of pride, as agricultural renewal offers new opportunities for youth who previously had no choice but to move away from the region to find work. Perhaps most important are symbols of cultural transformation that gave hope and pride to communities that knew only despair in the past. In a land that "didn't even grow thorns," Jesús León Santos called our attention to the birdsongs, telling us there were none when he was young. To

us this is the perfect symbol of the region's renewal.

Overcoming social obstacles. Today's complex society can present numerous obstacles to positive change. The Mixteca experience offers examples of how such obstacles were overcome.

- The tequio community service system surmounted a problem so common elsewhere – that people "don't have time" to contribute to the social and environmental commons.
- CEDICAM has overcome obstacles that arise when people feel threatened by dramatic change. For example, when reforestation efforts began, it was necessary to satisfy goat herders who objected to exclusion from areas with tree seedlings.
- There have been risks of entanglement with political and religious divisions in the state of Oaxaca, but CEDICAM's neutral policy has kept it out of those conflicts.
- The autonomy and relative simplicity of the region's indigenous communities has enabled them to proceed with what makes sense, independent of widespread and often crippling dysfunction in the mainstream society.
- Self-sufficiency has gone hand-in-hand with autonomy. Although external financial support has been significant, CEDICAM is basically a group of peasants who are transforming their communities and giving the nation, and the world, an example of how to get things done without depending heavily on outside resources.

Social and ecological diversity. Greater diversity offers more choices and more opportunities that some of the choices will be good ones.

- By accepting the Guatemalans and following their example, the Mixtec communities increased their social diversity.
- CEDICAM has worked with government agencies and collaborated with universities in Mexico and abroad.
- The women in indigenous communities evolved a greater diversity of roles.

All these experiences have expanded the social universe and diversity of choices in the Mixteca.

Social and ecological memory. Drawing upon the past can be a particularly significant source of diversity. Although some of the techniques employed by CEDICAM are introduced, many are not new. They are traditional practices that have stood the test of time. They were lost, and now they are being recovered. Though the landscape of the Mixteca region appears to be a wasteland, it is capable of producing food and growing forests with proper care. This productive capacity had not been lost as much as it had been forgotten, and it is now being "remembered" with proper attention. By reviving the traditional milpa the diversity of crops that had been lost to monoculture has been restored. As for reforestation, native trees reflected an evolutionary memory that provided the right species for local conditions after initial efforts with exotic species were unsuccessful.

Building resilience. Resilience is the ability to withstand unexpected surprises that threaten to make things worse. It is essential for locking in the gains from social and environmental restoration. The key to resilience is adaptability. The founders of CEDICAM began to forge a culture of resilience when they responded to the departure of CETAMEX by forming their own organization. Since then, they have crafted their strategy to nurture resilience at every step of the way. Crop diversification increases food security, as do soil conservation measures. The high rate of emigration, particularly among young men, could have stifled efforts for positive change, but women have filled the void created by this lack of manpower." Success breeds success." The community's organization, experience, and confidence have strengthened its capacity for adaptation, innovation, and respond effectively to future threats. With their dedication, intelligence, and generosity, the people of the Mixteca region should continue to provide an inspiring example for many years to come.

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