

**Water Resources Sustainability Project
(WRS)**

**Pilot Project for Control of Soil Erosion
in the Oued Nakhla Watershed**

**Annual Progress Report
January 1st to December 31st, 1999**

**Deliverable for
United States Agency for International Development**

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December 1999

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Ministry of Environment

United States Agency for International Development (USAID)

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1. Progress in Developing Project Partnerships and Coordination

The Workplan for implementation activities in Oued Nakhla was signed in June of 1999 by the following partners who represent the National Coordinating Committee for the project:

- Moroccan Ministry of the Environment
- Moroccan Ministry of Agriculture
- PREM
- Agency for the Development of Northern provinces
- Tetouan provincial government

The workplan contains agreements for the following work:

- Rehabilitation of irrigation canals in zone 1 (6 km)
- Development of springs and construction of water reservoirs in zone 1 (5 reservoirs)
- Rehabilitation of ravines in zones 2 and 3, and oleander plantings along ravines in zone 1
- Olive tree planting in zones 1, 2, and 3 (50000 trees)
- Construction of cuvettes around olive trees
- Installation of grass strips between olive trees (25 ha)
- Establishment of 15 demonstration trials for wheat, forage, grass, and olives
- Planting 5000 fruit trees along the edges of irrigated terraces
- Purchase and loan farm management equipment to project cooperators
- Improved goat production systems (50 imported Spanish goats)
- Development of beekeeping production systems in zone 4 (100 beehives and equipment)
- Rehabilitation of rangeland and matorral in zones 2, 3, and 4

2. Progress in Developing Village and Farmer Partnerships

PREM consultants Dr. Rachidi and Dr. Mounsif had regular meetings during 1999 with Community Associations in each of the four project zones. In general, they meet twice with the Community Associations before implementation of any project activity, and once afterwards. PREM consultants and personnel also regularly meet with governmental project cooperators at the county and provincial levels.

Farmer participants in PREM project activities in 1999 grew to include an additional 199 cooperators in zones 2 and 3, and 25 cooperators in zone 4. A total of 468 cooperators have now participated in project implementation activities throughout zones 1-4. In addition, discussions concerning cookstoves were held with 98 women in zone 1. Numerous workshops and informal discussions took place during 1999 with villagers.

3. Progress in Education and Training Activity

The Work Center conducted a workshop on construction of cuvettes around olive trees. At

this workshop there were demonstrations showing how wide and deep to make cuvettes, and how to line them with rocks to stabilize the lower edge. The benefits of cuvettes were explained to farmers. These benefits include capture of water to allow better growth of olive trees, collection of soil eroding from upslope cultivated areas, and a well-defined area in which fertilizer can be placed.

At this workshop, it was explained to 22 cooperators that fertilizer would be distributed to cooperators only if they first constructed cuvettes. This was a sufficient incentive for cooperators, as about 70% of the olive trees in zones 2 and 3 had cuvettes constructed around them after the wheat harvest during May and June. In contrast, during 1998 there were fewer cuvettes constructed around olive trees in zone 1 (50% of trees), because the incentive of fertilizer was not linked to construction of cuvettes. Additional training and education is needed in the following years on the importance of maintaining cuvettes, and reforming them after cultivation. This workshop should stress the importance of cuvettes as a basin to hold irrigation water delivered from reservoirs during the summer dry season.

In April a two day formal workshop was held on beekeeping techniques for the 25 cooperators in zone 4. The workshop was led by Dr. Serhane from Agadir. The first day of the workshop focused on methods, while the second day was devoted to practical demonstrations in the field.

In May there was a formal two day workshop on goat production and management techniques. This was led by Dr. Mohamed Mounsiif, an animal scientist from ENA Meknes. Attendees included 18 cooperators from 6 douars, two representatives of the Ministry of Environment, and a representative from the Agence du Nord. Additional workshops are needed next year for the other cooperators, and to deal with practical issues arising after the distribution of goats.

Dr. Mounsiif also led five 2 day workshops during August on rangeland restoration in each of 5 villages throughout zones 2, 3, and 4 of Oued Nakhla. In these workshops villagers were informed about the relationship between a healthy mattoral and grazing quality. Topics discussed included grazing of indigenous plant species, importance of protecting and restoring the mattoral, time required for establishment of newly seeded forage grasses (2 cycles over a year and a half), and the carrying capacity of newly planted areas.

From June 2-5 Dr. Fatima Zahid from ENA Meknes led a workshop to review a survey she conducted of village women in zone 1 (Bettara and Ouadiyine) about preservation of forest resources in Oued Nakhla. The survey included women from 48 families in Bettara and 51 families in Ouadiyine. The findings of this survey were very interesting. Most of the women collected wood from the forest, mattoral, or rangeland for a period of from 4 to 6 hours per day from 5 to 7 days a week. Wood was collected from October to February. Each family usually shared ownership of an oven with as many as 8 other families, and collected from 25 to 60 kg of wood each day. Wood was burned to heat water, cook food or bread, and provide household heat. Small branches and leaves were also fed to animals during the winter. About 90% of the women preferred to have PREM purchase and distribute ovens for cooking bread to each individual woman, rather than collectively owned ovens.

From June 14-16 a workshop on replication of PREM project activities in Oued Nakhla was held in Beni Karrich. Attendees included representatives from the Work Center, the DPA, the DREF, the MOE, the MOA in Rabat, NGOs, and the Dept. Of the Interior. In total the workshop was attended by 50-60 people. Dr. Swift, a PREM consultant, suggested that a handbook for replication of the Oued Nakhla project be produced. The handbook would focus on replication of the participatory approach developed in the WRS project, with chapters on Framing the Erosion Problem, Site Selection Criteria, the Participatory Approach, the Implementation Strategy, and a Case Study on Oued Nakhla to illustrate the project approaches.

Dr. Swift also provided a cursory assessment of the Oued Nakhla project progress. His main observations were that 1) the olive tree planting has been very successful, but dead trees need to be replanted and irrigation needs to be encouraged; 2) Erosion plots are poorly maintained; 3) Indirect interventions have lagged behind schedule, especially those involving women; and 4) Additional effort is needed in local project coordination and management.

Informal training sessions were held on buffer strips.

A workshop on olive tree pruning techniques is planned for next year by Mr. Ain of the Work Center. The demonstration will involve 200 trees in zone 2 planted this year, and an additional 200 trees planted over 20 years ago.

Other workshops are planned on spraying for control of cyclononium oleagum on olives in January, and spraying for insects in June.

The Work Center established several demonstration sites during the months of November and December in each of the four project zones. These demonstrations are of three major types, namely; wheat variety trials, forage variety trials, and grass strip demonstrations.

The wheat variety trials involve all four zones. In zone 1 (near Bettara) there is 0.5 ha of soft white wheat (variety Marchouch) on land from 4 cooperators. In zone 2 (near Ouadiyine) there is 0.5 ha of soft white wheat (variety Kenz) on land from 1 cooperator. In zone 2 (near Azzemour and Bouattou) there is 0.5 ha of soft white wheat (variety Achettar) and 0.5 ha of soft white wheat (variety Marchouch). In zone 4 there is 0.5 ha of soft white wheat (variety Achettar) on land from 1 cooperator. These demonstrations involve seeding rates, fertilizer management practices, and tillage practices that differ from the traditional practices. A 0.25 ha control area with traditional management practices (seeding rate of 200 kg/ha, 100 kg/ha of N-P-K fertilizer (14-28-14), and a cultural sequence involving fertilize-plant-plow) accompanies each of the demonstration plots. In contrast, the improved management involves seeding rates of 300 kg/ha, application of 300 kg/ha of N-P-K fertilizer (14-28-14), and a cultural sequence involving tillage-fertilize-wait 15 days until planting-plow).

Additional demonstration trials involving variation in planting dates of wheat are to be encouraged. Most of the farmers in the watershed begin cultivation of land and planting after several rains, typically during December. Earlier fall planting of wheat (early November) is

very effective at controlling erosion because crops more quickly begin to germinate, grow, and develop root systems that hold the soil. Early planting is dependent on timing of rainfall. Study of long-term climatic records may be useful in determining the optimum time of fall planting based on rainfall probabilities.

The forage demonstration trials involve three 0.5 ha parcels in zones 2, 3, and 4. There were 3 cooperators for these trials. In each trial, a mixture of 40% wheat (variety Drira) and 60% vetch (variety 6235) is planted at a rate of 200 kg/ha seed. Grass provides animals with carbohydrates, while vetch provides protein. Farmers must be taught to collect and store the harvested crop for feeding of their animals during the winter months.

Demonstrations of grass strips between olive trees have been established in zones 1 and 2. In zone 1, 12 cooperators attended an informal educational session on establishment and benefits of grass strips. These demonstrations are each 1 ha in size. A mixture of *dactylis glomerata* and *festuca* has been planted at a rate of 500 kg/ha seed in a band that is roughly 50 cm wide. It is recommended that future trials with grass strips use a wider band of planting, at least 2 m width is desired. About 15 other cooperators have indicated a willingness to participate in grass strip trials on another 15 ha of land, and these lands will be seeded to grass strips in December. Cooperation of all 443 farmers participating in the project could be encouraged if they were provided compensation for the loss of wheat production, and labor to plant the grass seed. Farmers place a higher priority on planting wheat than on planting grass, but both need to be planted at about the same time of year. Also, education is needed on the benefits of grass strips for animal forage.

4. Project Implementation Activities

4.1: Direct Actions

4.1.1: Olive Tree Planting

Villagers in zones 2 and 3 expressed a preference for mixtures of olive, fig, and almond trees on their small plots of land. Their reasoning was that one type of tree might have a poor year, but all three were unlikely to have poor production in a given year. The Work Center, however, wished to have large homogeneous areas planted to single tree species in order to optimize pollination, and simplify the cultural management of these areas in later years. Cooperators could not agree on which areas would be solely devoted to olives, figs, or almonds. As a result, all of the cooperators agreed to plant only olive trees.

PREM consultant Mr. Rachidi took the lead responsibility in organizing the olive tree planting campaign, including training, identifying land parcels to be treated, surveying land parcels, and monitoring success of the tree planting campaign. Approximately 34,000 locations were identified on 240 ha of land in zones 2 and 3 for olive tree plantings. An additional 9,000 locations were also surveyed and planted with olives on 50 ha in zones 2 and 3 in response to a great demand for trees from the villagers. Thus, a total of 43,000 olive trees were planted in zones 2 and 3 on 290 ha of land. Another 10,000 sites were surveyed

on 55 ha in the area of zone 2 adjacent to zone 1 for next years' olive tree plantings. Once the DPA informs PREM that holes have been dug by the cooperators for these trees, PREM will deliver the necessary trees.

As in the previous year, the spacing between trees along the contour was 7 m, and the vertical drop between planted contour lines was 2 m. Due to the irregularity of the terrain and land ownership patterns, this was not possible in all cases. This planting pattern was designed to reduce the horizontal spacing between planted contour lines on steeper slopes (as small as 6 m), and increase the horizontal spacing on flatter slopes (as large as 14 m). This would allow the farmers on the steeper lands, which are very vulnerable to erosion, to eventually phase out cereal production by relying on the income from the olive trees. Locations of trees in adjacent contour lines were offset so that runoff water from the unplanted region on the upper slope would be intercepted by a tree on the lower slope. Difficulties in keeping to a regular system of tree spacing occurred on small irregularly shaped land parcels, especially near ownership boundaries. Trees were kept far enough away from boundaries to prevent disputes between landowners.

During December of 1998 and January of 1999 approximately 43,000 olive trees were planted in zones 2 and 3 on land belonging to 199 cooperators. Since the start of the project, 61,300 olive trees have been distributed to 443 cooperators. The DPA Work Center took the lead in distributing and transporting olive trees and fertilizer. Olive trees of the variety Picholine Marocain were purchased for 8 DH/tree from the Sodea nursery in Meknes. Each farmer counted the number of surveyed tree planting locations on his property, and informed the village committee and the Work Center how many trees were needed.

An informal survey of tree mortality found that roughly 5-10% of the trees planted during the second year of the project had died. This is considered a normal rate of mortality. Mortality is a result of several factors, including improper loss of soil around roots during transport before planting, poor contact between roots and soil after planting, and drought. In contrast, the mortality rate during the first year of the project was 10-15%. This increased rate was a result of drought, lack of cuvettes to store water during summer, and uncontrolled grazing by goats.

Farmers are extremely pleased with the olive tree planting program. They understand that when these trees begin producing olives, the household income of project cooperators has the potential to increase significantly. Cooperators in each zone have requested that the project provide a few collective olive oil extraction units to process the olive crop.

4.1.2: Protection of Olive Tree Plantations With Guards:

Grazing by goats has been largely controlled during the second year of the project. This was achieved by hiring four guards at 700 DH/month to protect trees from animal grazing. Trees in most areas of zones 1, 2, and 3 are quite healthy. A visual survey of olive tree plantings during a field trip in December showed that there is considerable wheat residue remaining on lands where olive trees were planted, indicating that animals have not grazed these lands since harvest. In contrast, land without olive trees has very little crop residue.

One major problem with animal grazing of olive trees planted during 1999 has occurred in zone 2 near the road between Beni Karrich and Beni Hassan. A man with cows and goats living next to the road has no land on which to graze them, and has not benefitted from the olive tree planting program. During the day he grazes his animals in the matorral far above the lands planted to olive trees. During the night he allegedly sends his wife or son to graze the animals in olive tree plantations downslope of the road. The guard responsible for controlling the area in question does not work at night. At least three project cooperators have complained three or four times about losses of their olive trees due to animal grazing by this man. There is clear evidence of olive trees with upper branches eaten away, and footprints of cows in the cuvettes around these trees. Two of the cooperators claim to have lost 200 olive trees each, another man claims to have lost 31 trees. The latter has filed a lawsuit in the local court asking for 8000 DH in damages. The court is processing claims against this man, but the cooperators are very angry about the damages and long-term losses they will incur. If the man is found guilty he could be assessed a fine for damages, if he cannot pay his animals may be confiscated, and he may be sent to jail. Needless to say, the cooperators in this area are very unhappy. PREM should write letters to the Ministries of Agriculture and Environment asking for their support of a legal resolution in favor of the cooperators whose trees have been damaged.

4.1.3: Development of Supplemental Irrigation Water Sources for Olive Tree Plantings:

Damages by drought during the summer have largely been ameliorated in zone 1 after construction of 7 water reservoirs by PREM contractor Mr. Brahim Hilali. Each reservoir has a water storage capacity of 10 cubic meters. The water is supplied by springs, which have been developed and improved by PREM project contractors. Springs are lined by rocks and have a concrete receptacle on the ground from which water is piped by gravity to each reservoir. Springs should be further improved by covering them to prevent evaporation, deposition of sediment, and contamination with animal feces and urine. Reservoirs are constructed with a concrete base and are enclosed by sheet metal, there is a pipe to prevent overflowing of the reservoir. Rocks should be placed below the point where this pipe discharges to prevent soil erosion. Each reservoir also has an outlet pipe with a faucet to control flow of water into a receptacle. The receptacle can then be taken to the field and used to irrigate each tree. Villagers also collect water for household uses. Plans to develop a ground water well in zone 1 were abandoned when it was learned that there is no ground water table available.

4.1.4: Construction of Cuvettes Around Planted Olive Trees:

After the Work Center held a workshop on construction of cuvettes, cooperators built cuvettes around roughly 70% of the olive trees in zones 2 and 3, and around 50% of the trees in zone 1. Visual inspection of these cuvettes showed that the perimeters were generally in good shape, although most of the basins have filled in with fine sediment eroded from upslope cultivated lands.

4.1.5: Application of Fertilizer to Olive Tree Plantings:

Fertilizer for olive trees was applied to olive trees in zones 2 and 3 during the second week of December. Twenty one tons of ammonium sulfate (21% nitrogen) were trucked to strategic points along the main highway by Work Center personnel and distributed to cooperators. Demonstrations for applying fertilizer in olive tree cuvettes were made in tree basins along the highway. As fertilizer was taken by cooperators, laborers hired by PREM went with cooperators to immediately apply the fertilizer to cuvettes. Fertilizer was applied at a rate of 0.5 kg per tree. Cooperators complained that the type of fertilizer provided was not correct. They wanted the N-P-K blend product rather than the single product (termed salt), rather than the complete blend. It was not, however, possible to apply the complete blend during December.

4.1.6: Improved Access to Agricultural Management Tools:

Dryland agricultural lands in Oued Nakhla are managed using traditional methods, including wooden plows pulled by animal traction. Modern tools are generally not available for routine practices such as spraying of herbicides and insecticides, pruning trees, sawing or chopping wood, or plowing. In recognition of excellent cooperation with project activities (construction of cuvettes and irrigation of trees), 10 cooperators in Oued Nakhla were each provided a hand sprayer.

The Work Center has started to make available modern agricultural tools for loan to cooperators. PREM purchased 2 motorized sprayers, 50 hand sprayers, 50 pruning shears, 50 saws, and 5 axes for loan to cooperators through the Work Center. PREM is in the process of purchasing 50 iron plows, each weighing 14 kg. The Work Center has held an informal workshop with 12 farmers in zone 1 on the proper use of iron plows, and will hold workshops on the proper use of each tool in all zones during the upcoming year.

4.1.7: Stabilization of Ravines

Mr. Brahim El-Hilali was hired by PREM to stabilize 5 ravines with a total length of 1.5 km in zone 1. Construction of a combination of check dams and gabions was completed in December of 1998 and January of 1999. Inspection of the check dams and gabions showed that they were well designed and constructed. Most check dams and gabions had trapped a significant amount of fine to coarse debris from water flowing through the ravines after heavy rainstorms. In several cases, the area immediately upslope of gabions is completely full of stones washed downstream by heavy flows of water. This visual evidence shows that ravines are an important source of sediment to the river.

Some problems were observed with the rehabilitation of ravines. The major problem is that oleanders were not planted along the sideslopes of the ravines. Ravines are experiencing severe slumping of these sideslopes, which is filling in the catchment behind gabions. It is very important to stabilize sideslopes of ravines with oleanders to prevent slumping. This slumping has diminished the effectiveness of gabions in capturing sediment and dissipating

the energy of water flows. In contrast, ravines in zones 2 and 3 are largely vegetated, and no instances of severe bank erosion were observed even though there are no check dams or gabions in those zones.

Less serious problems with ravines include holes that have developed along the contact zones between a few gabions or check dams and the surrounding soil. These holes must be repaired, otherwise water will flow under the gabions or check dams and cause serious erosion.

Ravines in zones 2 and 3 were surveyed to identify sites suitable for installation of gabions and check dams. It was found that ravines in zones 2 and 3 were heavily vegetated, and did not require additional structural rehabilitation.

4.2: Indirect Actions

4.2.1: Improvement of Goat Breeding Stock:

The importation of improved goat breeding stock (Morciano) from Spain was seriously delayed by an epidemic. After Spain controlled the outbreak of disease in their goats an agreement was signed in September between Morocco and Spain to allow the resumption of goat imports.

The epidemic seriously depleted the number of goats available for importation. Although the project desired 50 male goats for improved breeding stock, only 25 were available. Additional efforts are needed to acquire 25 more goats from Spain. During November 25 male goats were imported and sent to a goat farmer named Mr. El-Biarri who lives in the M'diq area. These goats were supposed to be quarantined, and kept in isolation from other goats until it could be assured that the imported goats were free of disease. In reality, the goats are mixed with other goats imported from Spain that the farmer owns, and are breeding with them.

Blood tests were taken of the imported goats to test for arthritis, encephalitis, and viral diseases. The results of these tests should be known in late December. If they are free of disease, the goats can then be distributed to each of 25 cooperators already identified in Oued Nakhla by the DPA. Each of these cooperators has at least 25 goats already. Cooperators were identified following a survey of goat herd numbers and size in Oued Nakhla by Dr. Mounsif. All goats in the Oued Nakhla watershed were immunized by the DPA during June and December to prevent the spread of disease from unimproved to improved goats.

Dr. Mounsif has expressed some concern over the feeding of imported goats. The goats were seen eating straw, which has very low nutritional value. No evidence was seen that the goats were being fed nutritional concentrate. The farmer claims that the goats are being properly fed with salt, straw, forage, and concentrate. Project PREM should not distribute goats in Oued Nakhla unless their weight is at least 30 kg.

4.2.3: Development of Beekeeping Production System:

Agence du Nord purchased 100 beehives for distribution in zone 4, where the mattoral is in very good condition for producing nectar needed by bees. They also purchased two sets of beekeeping equipment for use by a collective of 25 cooperators who manage the beekeeping operations. This equipment includes protective suits, knives, collectors, smokers, extractors, vats, and tubs. Defective metal in the extractors has caused a delay in delivery of the extractors. Only one of the beehives has ceased to function due to diseased bees. The other 99 beehives are thriving.

The Work Center and DPA identified 25 cooperators who were willing to work together in managing the beekeeping operations. A workshop on beekeeping techniques was held in April by Dr. Serhane from Agadir to show cooperators how to identify bee diseases, and proper methods for raising bees, maintaining hives and collecting honey. A total of 21 cooperators attended the two day workshop.

4.2.3: Rehabilitation of Rangeland and Degraded Mattoral

Plans for widespread rehabilitation of public rangeland and degraded mattoral (an initial target for 60 ha of land in zone 1) were seriously delayed due to social attitudes towards public grazing land. After reseeding rangeland and degraded mattoral it is necessary to protect these lands from grazing for a period of roughly one and a half years. Some of the villagers will not agree to protect the reseeded public mattoral for the necessary time period. Many villagers are willing to avoid grazing for this period, but unless everyone abides by the agreement, the reseeding project on public mattoral lands cannot be successful.

Even if the public lands cannot be seeded with forage species for improved animal grazing, they can be planted with trees to stabilize the soil and provide villagers with additional sources of income. The DPA has verbally promised to provide 8000 carob and 16000 acacia trees for planting in the degraded mattoral of zones 2, 3, and 4.

Reseeding of private mattoral lands appears to be a promising endeavor. Several cooperators approached PREM consultants with a desire to have their private grazing rangeland planted with improved grass forages. In November, 12.5 ha of private rangeland in zone 2 (near Azzemour) was seeded at a rate of 5 kg/ha festuca and 3 kg/ha of glomerus dactyla. Another 5 ha (in two parcels of 2 and 3 ha) will be seeded within the next month. The land was plowed prior to seeding, and was fertilized with 50 kh/ha of 14-28-14 N-P-K fertilizer afterwards. Grass forage has already germinated and is showing good growth. These areas will be protected from grazing for the next year and a half.

There are an additional 55 ha (three parcels of 15, 25, and 15 ha) of private land that could be seeded with grass forage in zone 2. Also there is roughly 40 ha of private land in zone 3 that could also be restored. PREM should provide the labor to reseed these lands, after the cooperators prepare the land for seeding by tillage.

4.2.4: Development of Irrigated Fruit Tree Production:

A meeting was held with 32 farmers in zone 1 to determine their level of interest in obtaining fruit trees. Most of the farmers had limited interest, with a preference for only 600 apples, peaches, nectarines, and quince expressed at the meeting. The DPA believes there will be greater interest in fruit tree plantations on irrigated terraces in zone 3 (near Achekrade), and has identified 12-20 ha of land for fruit tree plantings. This area has a larger quantity of irrigated terraces than any other zone. The DPA believes cooperators will be satisfied with apples (Golden Delicious and Starking Delicious), pears (William Bovey and Passe Crassence), prunes (Golden Japan and Stanley), and quince (Champion). A total of 5000 trees (1000 each of apples, pears, prunes, and quince) have been purchased by PREM for planting along the contour to stabilize edges of irrigated terraces in zone 3. Planting should take place in the first three months of 2000.

4.2.5: Rehabilitation of Irrigation Systems

No additional work was conducted in 1999 on rehabilitation of irrigation systems in zone 1 because of the great expenses involved. The DPA is considering an RFP for rehabilitation of irrigation canals in zone 3, in coordination with the anticipated planting of 5000 fruit trees in zone 3. The Agence du Nord is considering an RFP for rehabilitation of irrigation canals in zone 2.

5. Progress in Monitoring Erosion Losses

PREM consultant Muhammad Tayya and Peace Corps volunteer Jennifer are responsible for data collection and analysis from erosion plot studies. There are four general types of land cover on 14 erosion plots, namely; dryland cultivation, olive trees, matorral, and forest. Treatments on the cultivated plots include fallow, plowed fallow, wheat, legume, and forage grass. Treatments on the olive tree plots include olive trees, olive trees with cuvettes, and olive trees with cuvettes and grass strips. Treatments on the matorral plots include two plots each of dense versus degraded matorral. The remaining two plots are forested.

Data collected from the erosion plots in 1998-99 have not yet been fully analysed. Preliminary analysis of eroded sediment from the cultivated and olive tree plots showed nearly negligible erosion (<41 kg/ha) regardless of treatment during the period from January to May. In contrast, erosion data from 1997-98 showed rates of erosion averaging 2334 kg/ha on cultivated plots, from 303-440 kg/ha on matorral plots, and 192 kg/ha on forested plots. It is unclear why the erosion data collected are so poor for 1998-99. Perhaps the collection tanks at the bottom of each plot are leaking, the plot borders (especially at the corners) are allowing sediment to escape, or the samples are improperly collected from tanks (e.g. without adequate stirring). The source of this problem should be identified. It is recommended that Jennifer visit the cultivated and olive tree erosion plots during an intense rainstorm to observe whether or not the collection system is operating properly.

Ravines are a significant source of sediment in zone 1. Many of the gabions and check dams are completely filled with large stones and sediment, thus reducing the operating efficiency

of these structures. The source of this debris is slumping banks along the ravines. It is very important to stabilize these banks with oleander or acacia plants during 2000. After stabilization of the banks, the stones and debris behind gabions and check dams should be cleaned out.

Many cuvettes around olive trees in zones 1-3 are typically filled with fine sediment which has been transported in runoff from upslope cultivated areas during the last year. Given a typical cuvette with a radius of 30 cm and a depth of 15 cm, each cuvette could hold 0.04 cubic meters of soil. With a soil bulk density of 1400 kg/cubic meters, each cuvette holds roughly 60 kg of soil. Assuming an olive tree planting density of 180 (immature) trees per ha, these cuvettes would hold nearly 11 tons of soil. This is very consistent with project proposal estimates of 18 tons of soil loss prevented per ha for mature olive tree plantings with cuvettes. Of course, once the olive trees mature, the mature tree canopy will provide even greater reductions in erosion than the immature tree canopy as the energy of falling raindrops is attenuated.

Alternatively, assuming that 65% of the 61300 immature olive trees planted during the first two years of the project had cuvettes with 60 kg of soil, the cuvettes would hold 2365 tons of soil. Further study of the trapping efficiency of cuvettes should be conducted by Jennifer during the next year. This can be achieved by placing marked wood or metal measuring pins in reconstructed cuvettes to measure the depth of sediment accumulated during the year.

6. Progress Towards Indicators of Project Success in 1999

The pilot project has generally been on target with respect to indicators of progress identified in the 1999 Workplan (see Table 1).

Among the salient accomplishments of PREM and its project partners in 1999 are the following:

- Signed Project Workplan with Ministries of Environment and Agriculture, Agency for Development of the North, and the Tetouan Provincial Government.
- Added 224 village cooperators to project implementation activities, and initiated discussions with 98 women concerning cookstoves in zone 1.
- Conducted workshops covering 7 topics relating to project implementation activities. These topics included construction of cuvettes, beekeeping, goat production, rangeland restoration, cookstoves, and replication of project activities.
- Established 8 demonstration trials in four project zones concerning wheat, forage, and grass strips. These demonstrations address issues such as seeding rate, variety performance, fertilizer management, and tillage management.
- Planted 43000 olive trees on 290 ha of cultivated dryland in zones 2 and 3.

- Constructed cuvettes around 70% of the trees in zones 2 and 3, and 50% of the trees in zone 1.
- Protected newly planted olive trees using 4 paid guards.
- Developed 7 reservoirs to irrigate olive trees in zone 1 during the summer drought.
- Applied 0.5 kg ammonium sulfate fertilizer to 43000 olive trees in zones 2 and 3.
- Purchased modern agricultural management tools for spraying, pruning, sawing, cutting, and plowing olive trees. These tools will be loaned to project cooperators.
- Stabilized 1.5 km of ravines in zone 1 using a combination of check dams and gabions.
- Imported 25 Spanish goats for distribution to 25 cooperators in zones 1-3.
- Provided 100 beehives and several complete sets of beekeeping equipment to 25 cooperators in zone 4.
- Reseeded 12.5 ha of degraded matorral in zone 2 with grass forage.
- Reduced erosion on dryland olive tree plantings by an estimated 11 tons/ha, or 2365 tons for the entire planted area.

Table 1: Indicators of Project Success		
Indicator	Target	Actual Quantity
ü Sign Workplan Agreement with Project Partners	1	1
ü Number of Contracts Signed with Farmer Cooperators	-	224
ü Olive Tree Plantings	240 ha	290 ha
ü Cuvette Construction	390 ha	440 ha
ü Hire Guards for Trees	-	4
ü Irrigation Reservoirs	3	7
ü Grass Strips Between Trees	170 ha	2 ha
ü Reduced Erosion	25-49%	15-20%
ü Number of farmers and families trained in conservation techniques	-	138++

Table 1: Indicators of Project Success		
Indicator	Target	Actual Quantity
ü Number of workshops and training sessions	6	7
ü Stabilization of ravines	1.5 km	1.5 km
ü Planting of ravines	1.5 km	0 km
ü Purchase Spanish Goats	20	25
ü Improved Farm Equipment	8	165
ü Beekeeping Operations	100	100
ü Rehabilitate Mattoral	32 ha	12.5 ha
ü Survey Irrigation Canals	zone 2	-

7. Recommendations for 2000 Workplan

As noted above, the project has achieved good success in its second full year of activity. Several recommendations are given below to improve the project even further. The 2000 Workplan presented in the following section is consistent with these recommendations.

- Improve tracking of project progress against the workplan on a semi-annual or quarterly basis. PREM project leaders and consultants should identify and correct shortcomings at an early stage, rather than at the end of each year. Presently, consultants perform specific tasks, but implementation of direct and indirect actions, and training activities are not always consistent with the scope of activities in the workplan.
- Improve partnership and communication between the PREM team, the National Coordination Committee, and the Local Implementation Committee by holding quarterly meetings to facilitate communication and coordination of all project activities.
- The DPA Work Center personnel should fully participate in project activities taking place in the watershed. They should be a part of every project activity which occurs in the watershed. The Provincial DPA personnel should be closely involved in decisions concerning project implementation activities.
- Project partners and participants already agree on the objectives of the project (reduced erosion, soil sustainability, water conservation, and improved farmer profitability). Project participants need to communicate with one another for the purposes of agreeing on specific project activities to be implemented, and who is responsible for their implementation.
- Initiate activities that involve the education of women and reduce their consumption of wood collected in the matorral.
- Encourage the re-construction of cuvettes around all planted trees in zones 1, 2, and 3. Cuvettes are destroyed after cultivation of dryland for wheat plantings. Cuvettes need to be reconstructed immediately after planting wheat, not after harvest of wheat. Workshops should be organized to educate villagers in the importance of cuvettes for long-term productivity of trees, and train them in techniques for re-constructing them.
- Continue to protect planted trees from grazing with guards.
- Establish grass buffer strips along the contour between planted trees in zones 1, 2, and 3.
- Develop additional sources of water for trees during summer in zones 2 and 3.
- Plant oleanders and acacias in ravines of zone 1. Slumping ravine banks are producing significant quantities of sediment.

- Increase the number of education and training activities on the project. Demonstration and training sessions on cuvettes, erosion control, buffer strips, apiculture, goat management, timing of planting, and best management practices for rainfed agricultural production are the highest priorities.
- Continue to implement indirect actions outlined in the Workplan, and fully integrate NGOs into the project. A sub-contract for indirect actions involving cookstoves should be developed, and a meeting should be organized of NGOs to be involved with indirect actions, particularly regarding high efficiency cookstoves, rehabilitation of irrigation canals, planting of fruit trees, apiculture, goat breeding, and improvement of the matorral.
- Improve the efficiency of collection and analysis of data from the erosion plots, which has been hampered by a lack of quality labor and maintenance problems.
- Initiate a series of field trips for project cooperators and DPA technicians to sites within Morocco and Spain where successful activities on olive, goat, and bee production, and on erosion control practices in dryland and matorral, and on reduced wood consumption can be demonstrated.

8. Workplan for 2000

The Workplan for 2000 has been modified to account for progress made on the project during 1999. The Workplan includes the following activities:

1. Project Partnership Coordination
2. Implementation of Direct Actions
3. Implementation of Indirect Actions
4. Education and Training
5. Project Monitoring and Reporting

A timetable for project activities is given below (Table 2).

8.1: Project Partner Coordination

8.1.1: Contractual Relationships

Regular meetings are required among project partners and various project committees to track project progress, plan and coordinate project implementation activities, and solve problems that may arise. The National Coordinating Committee and the Local Implementation Committee should meet quarterly, at the least. A sub-contract should be signed by January or February with the DPA and other PREM partners to execute all of the direct actions listed in Table 1. PREM team members should organize meetings with Moroccan Agencies and NGOs who will be involved with implementation of the indirect project actions and sign sub-contracts with them to implement indirect actions. These include the Agency for the Development of Northern Provinces, the Asociacion Tetouani de Iniciativas Sociolaborales (ATIL), the Instituto de Promocion y Apoyo al Desarrollo

(IPADE), and the Association pour la Protection de l'Environnement et le Developpement de la Wilaya de Tetouan (APET).

8.1.2: Formation of Women's Educational Association in Zone 1

Women spend considerable time and effort collecting wood in the matorral regions for cooking, heating water, and feeding animals during the winter. Stoves used to burn wood are very inefficient, thus leading to increased degradation of the matorral. Improved efficiency cookstoves in the ATTC project have been shown to reduce the consumption of wood by 38%, and reduce the time women spend collecting wood by 375 hours annually. The PREM project should work with consultant Fatima Zahid to develop a Women's Educational Association in Zone 1. This Association would discuss issues related to reduced wood collection and improved efficiency cookstoves. The Association would develop a plan for utilizing improved cookstoves in Zone 1.

8.2: Implementation of Direct Actions

8.2.1: Olive Tree Plantations

Olive trees with cuvettes were planted in 1998 and 1999 on 440 ha in zones 1, 2, and 3. In the process of planting wheat, these cuvettes were destroyed by cultivation. Cuvettes are to be re-constructed on all of this land around trees in 2000. It is very important that this re-construction take place early in the rainy season, rather than after harvest, to enhance the collection of water and sediment by the cuvettes.

An additional 20000 olive trees should be planted in zones 1-3 during 2000. These trees are an extension of project activities stimulated by greater than expected villager desires for olive trees. Some of these trees should be used to replace dead trees from plantings in previous years.

Buffer strips consisting of grass forage (dactylis) should be installed along the contour line between planted fruit trees in zones 1, 2, and 3. The areas targeted for this activity in 1999 are 75, 25, and 70 ha, respectively, in zones 1, 2, and 3. The buffer strips should be at least 2 m, and preferably 3 m wide. These areas will be protected from grazing for at least one and a half years. Farmers should be compensated for the loss of wheat production that these strips cause. Since grass planting coincides with planting of wheat, PREM and its partners should hire laborers to seed the grass strips after farmers have tilled the land.

Guards should continue to protect the planted olive trees and buffer strips in zones 1, 2, and 3 from grazing. During the fall and early winter, villagers should be provided with fodder for their animals, to alleviate the lack of grazing land associated with olive tree plantations. PREM and its partners should actively support the cause of villagers whose trees have been illegally eaten by animals.

Water resources will be developed in zones 2 and 3 to assist villagers in irrigating newly planted olive trees. DPA will execute the development of these resources. At least 9 new

reservoirs should be constructed during the spring and early summer before dry weather causes water stress in olive trees.

8.2.2: Stabilization of Ravines

Five ravines stabilized by Brahim El Hilali in zone 1 during 1999 are to be stabilized further by planting oleanders and acacias along the banks. Stabilization will involve planting at least three rows of plants during the spring along the ravine banks between gabions and check dams. During the summer and fall, gabions and check dams that have filled with rocks and stones should be cleaned out by laborers hired by PREM.

8.2.3: Rehabilitation of Irrigation Canals

The DPA wishes to plant 5000 fruit trees along the contours on irrigated terraces in zone 3 during 2000. Irrigation canal delivery systems are very inefficient, leading to the possibility that insufficient water will be available to water the trees during the summer dry period. The DPA should issue a Request For Proposals to survey the irrigation canals in zone 3, and rehabilitate the portions with the greatest losses of water. Matching funds should be obtained to assist in funding this project.

8.3: Implementation of Indirect Actions

8.3.1: Improved Management of the Mattoral Zone

Social attitudes towards grazing of public mattoral currently prevent the widespread sowing of forage grasses in mattoral zones as envisioned in the project proposal and 1999 workplan. PREM should hire a sociologist familiar with agricultural land use and rangeland issues to meet with villagers concerning the issue of forage grasses in public mattoral zones. Perhaps the sociologist can develop a set of procedures for reseeding a portion of the public mattoral with forage grasses that are socially acceptable to all villagers.

If a set of socially acceptable procedures for reseeding public mattoral with forage grasses can be developed, then fescue (*Festuca elatior* L.) should be planted on 32 ha of the public mattoral in whatever zone is amenable to this process. Sowing should occur during the autumn at a rate of 15-20 kg/ha, and a depth of 2-3 cm. Newly germinated grass will be protected from grazing for a period of one and a half years.

Roughly 8000 carob and 16000 acacia tree seedlings provided by the DREF from the Sodea nursery should be planted on 660 ha of public mattoral in zones 1-4. Planting density will be approximately 36 trees/ha (20 m spacing between trees). No surveying is necessary to identify planting zone locations. These trees are not likely to be destroyed by direct animal grazing. Educational sessions should be conducted with villagers to stress the importance of not using newly planted trees for firewood or animal feed.

8.3.2: Improved Management of Private Rangeland

Forage grasses should be planted on 55 ha of private rangeland in zone 2 and 40 ha in zone 3. Seeding would be at a rate of 15-20 kg/ha, and at a depth of 2-3 cm during the months of November through February. Agreements should be signed with cooperators to protect these areas from grazing for a year and a half. Cooperators should be taught to harvest the forage grasses and store them until animal feed is needed during the winter months or during drought.

8.3.3: Improved Goat Production

Roughly 25 farmers in zones 1-3 having more than 25 goats each will be provided with a recently imported healthy Spanish male goat weighing at least 30 kg for improved breeding. A contract will be signed with the participants stating that the males from crossbreeding will be sold when they reach puberty to avoid excessive herd size. Non-improved male goats in the herds should be castrated.

Roughly 25 additional Spanish goats should be imported and quarantined until blood tests show that they are healthy. These goats should be fed a balanced diet consisting of forages, composite nutritional feed, and straw until they are ready to be distributed in Oued Nakhla. Roughly 25 farmers in zones 1-3 having less than 25 goats each will be provided with one of these improved goats.

8.3.4: Improved Fruit Tree Production on Irrigated Terraces

Farmers in zone 3 will be surveyed to determine what types of fruit trees they wish to plant along the contour on their irrigated terraces. The DPA will provide roughly 5000 fruit trees for planting on irrigated terraces in zone 3 during the period from November to March.

8.3.5: Improved Efficiency Cookstoves

If the Women's Education Association in zone 1 agrees, four improved efficiency collective cookstoves should be provided to key cooperators in zone 1. A micro-credit should be provided to each cooperator to initiate a program of collective bread baking. In this program, a collective of women would be formed for each cookstove. Each woman in the collective would have shared responsibilities for bringing wood to fuel the cookstove. One woman would be responsible for baking the bread, and selling it to cooperators at a reasonable price.

The main problem with cooperative cookstoves is that they are not the action preferred by women in the villages. They prefer to each have their own cookstove. If this solution is desired by the Women's Association, the main difficulty will be in deciding who receives an improved efficiency cookstove. The cost of the individual cookstoves is much less than the cost of collective cookstoves, so it will be possible to distribute up to 50 individual cookstoves, depending on financing arrangements with the Agence du Nord.

8.3.6: Cooperative Olive Oil Extraction Units

Project cooperators with olive tree plantations have requested that PREM investigate the possibility of providing them with several collectively operated units for extracting olive oil.

The price of such units should be investigated, and if reasonable, the project should provide cooperators in zones 1-3 with 5 units (1 in zone 1, and 2 each in zones 2 and 3).

8.4: Education and Training

8.4.1: Workshops on Installing and Maintaining Grass Buffer Strips

PREM consultants and the DPA Work Center personnel should instruct farmer participants in zones 1, 2, and 3 on benefits of buffer strips, and methods for their installation and maintenance. A demonstration of these installation techniques will be included.

8.4.2: Workshops on Re-Constructing Cuvettes

PREM consultants and the DPA Work Center personnel should instruct farmer participants in zones 1, 2, and 3 on the importance of cuvettes for collection and storage of water, and methods for their re-construction and maintenance after tillage. It is very important to re-construct cuvettes soon after tillage and wheat planting, rather than after harvest of wheat. A demonstration of these construction techniques will be included.

8.4.3: Workshop on Erosion/Water Storage/Crop Productivity Relationships

PREM consultants should instruct farmer participants in zones 1, 2, and 3 on the relationships between erosion control, improved water storage in cuvettes, and productivity of fruit trees and rainfed cultivated crops. This workshop should stress the economic benefits to farmers of controlling erosion and conserving water. The DPA Work Center should plant some demonstration plots on badly eroded and weakly eroded soil in close proximity to one another to demonstrate the reductions in yield which are associated with erosion and lack of cuvettes. This workshop could be held in conjunction with the workshop on cuvettes.

8.4.4: Workshops on Goat Productivity Management

PREM consultants, and DPA Tetouan or DPA Work Center personnel should instruct farmer participants in zones 1-3 on the proper techniques for improving goat productivity. These include benefits of improved breeding stock, avoiding cross-breeding, culling the herd, optimizing live weight rather than total number of animals, caring for young goats, disease identification and management, rotational grazing, and storage of fodder.

8.4.5: Workshops on Bee Management

PREM consultants, the Agency for Development of the Northern Provinces, the DPA Work Center in Beni Karrich, and NGOs selected to assist the project in beekeeping should instruct zone 4 participants in improved beekeeping techniques. These include feeding techniques,

inspecting and cleaning hives, breeding, multiplication of colonies, swarming, harvesting, and equipment operating procedures, maintenance, and repair,

8.4.6: Workshops on Farm Equipment Use Techniques

The DPA Work Center should instruct farmer participants in zone 1 on proper methods for using, maintaining, and repairing metal plows, sprayers, and threshing machines. Special emphasis is needed on timing of plowing and contour plowing. Plowing so that the soil furrow is thrown down the hill should be minimized, otherwise long-term soil erosion losses by tillage will be significant. Care should be taken to avoid abusive uses in the matorral of the new pruning shears, saws, and axes.

8.4.7: Workshops on Disease and Pest Control in Olive Trees

The DPA Work Center should hold two workshops in each of zones 1-3 on identification and control of diseases and pests in olive trees. The workshops will also describe proper methods for spraying chemicals, including personal safety and environmental protection.

8.4.8: Demonstration Trials on Wheat, Forage, and Olives

The DPA Work Center has already established demonstration trials in zones 1-4 to illustrate proper management techniques for wheat, forage, and grass strips. Demonstrations typically involve trials with various types of tillage, fertilizer management, and varieties of crop in comparison with typical farmer practices. Farmers should be taken to demonstration sites near harvest time to see the improvements in crop yield using good management practices.

It is highly recommended that additional wheat management trials be established from October through December of next year to illustrate the benefits of early seeding (improved production and reduced erosion).

Additional trials will be established for olive tree management practices. These trials should stress fertilizer management, pest and disease management, pruning, and the use of cuvettes for improved water uptake.

8.4.9: Field Trips for Project Cooperators and Technicians

As the project progresses, several technical questions will undoubtedly arise concerning olive trees, fruit trees, forages, goats, bees, and erosion control. A program for updating the knowledge of project cooperators and Work Center technicians is needed. One aspect of this program should involve field trips to sites where improved management techniques can be demonstrated. Examples of sites within Morocco where new information can be learned would include visits to ENA Meknes and Hassan IAV extension centers, visits to Bellotta, and visits to olive tree, fruit tree, goat and beekeeping projects. Work Center technicians could also visit University Extension demonstration sites in southern Europe, including Spain and Italy.

8.4.10: Workshops and Field Trips on Fuel Usage and Improved Efficiency Cookstoves

The Women's Educational Association in zone 1, as well as other women from zones 2-4 should visit sites in Morocco where they can learn more about improved efficiency cookstoves. Examples include the Near East Foundation work in southern Morocco, and the GIF RIF project. In addition, women should discuss the impacts of their cooking practices on health of the matorial region, and on wood cutting activities. Women should be taught responsible wood cutting practices, and should not abuse the new pruning shears, saws, and axes loaned by the Work Center.

8.5: Project Monitoring and Report Writing

8.5.1: Soil Erosion Plot Monitoring Data

PREM consultant Dr. Tayaa has established 14 soil erosion plots to estimate the impacts of project activities on soil loss. These plots should be visited by Peace Corps volunteer Jennifer during a heavy rainstorm to determine whether they are functioning properly. Leaks in the erosion plots which cause erosion rates to be underestimated should be repaired. Additional collection tanks may be needed at the corners of each tank if sediment is washing over the corners during heavy rainstorms. Alternatively, the height of metal borders can be raised to prevent overflow. Measurements of soil permeability should be made on each erosion plot using either undisturbed cores, or in-situ double ring infiltrometer methods. These data are needed to estimate soil erodibility.

8.5.2: Improved Estimates of Erosion Prediction Parameters

Data from erosion plots should be analyzed using standard procedures to obtain improved estimates of the rainfall erosivity factor (R), soil erodibility factor (K), and cropping system factor (C). These improved parameter estimates are needed to estimate the impacts of project activities on soil erosion.

8.5.3: Geographic Information System (GIS) Data Coverages

The soils and terrain in the Oued Nakhla watershed are heterogeneous. Estimating reductions in erosion from project activities is subject to uncertainties caused by this heterogeneity. The survey information used to identify locations for fruit tree plantations in zones 1, 2, and 3 should be developed into a three dimensional topographic datalayer for Oued Nakhla by PREM consultants Dr. Bouabid, Dr. Rachidi, Dr. Tayya and Dr. Naimi. This datalayer should be combined with existing datalayers for land use and soil properties using a GIS. The slope length and steepness of the terrain should be computed as an additional datalayer. These GIS datalayers, in conjunction with data from the erosion plots, can be used to obtain accurate estimates of project impacts on erosion.

8.5.4: Monitoring Impacts of Cuvettes, Buffer Strips, and Check Dams

Peace Corps volunteer Jennifer should collect data to quantify the amount of sediment retained in cuvettes, buffer strips, and check dams installed by the project. Metal pins or rods with graduated marks for measurement of depth should be placed in several (50) cuvettes, buffer strips, and check dams across zones 1-3 to facilitate quantification of sediment trapped by each action. These pins should be installed at the start of the rainy season, and observed monthly to determine rates of sediment accumulation.

8.5.5: Estimating Project Impacts on Reductions in Soil Erosion

A meeting of PREM project consultants should be convened to discuss progress towards estimating project impacts on reductions in soil erosion. This meeting will address erosion plot data, improved erosion prediction parameter estimates, GIS datalayer coverages, and quantification of sediment trapped by cuvettes, buffer strips, and check dams. An analysis of these data will be conducted for a preliminary estimate of project impacts towards indicators.

Peace Corps volunteer Jennifer should conduct detailed surveys to measure the number of cuvettes constructed, the number of dead trees, and the number of grass buffer strips established.

8.5.6: Quarterly and Annual Reporting of Progress

PREM team members and consultants will make quarterly and annual reports on project progress to USAID. Indicators of project success are provided in Table 3.

Table 3: Pilot Project Indicators of Success

Year Three	<ul style="list-style-type: none"> ü Track number of meetings of Coordinating and Implementation Committees ü Track number of Community Association Meetings ü Track number of sub-contracts signed with DPA and NGOs ü Track number of Women’s Education Association Meetings ü Track number of cuvettes installed ü Track area of land with buffer strips installed ü Track length of ravines stabilized with oleanders ü Track number of guards hired ü Track number of water sources developed ü Track hectares of matorral and rangeland improved ü Track number of goats provided ü Track number of cookstoves provided ü Track number of cooperative olive oil extraction units provided ü Track number of fruit trees planted on irrigated terraces ü Track length of irrigation canals rehabilitated ü Track number of improved farm equipment provided ü Track number of farmers and families trained in improved management techniques ü Track number of workshops and training sessions held ü Integration (map registration) of soils, land use, topography, and hydrology coverages with GIS ü Improved parameters for the Wischmeier equation using data from erosion plot experiments and other data ü Installation of erosion pins in cropland, ravines, and matorral ü Estimate reduction in erosion from project actions ü Quarterly and annual reports of progress
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