EVALUATION REPORT
of the
KORI BANK PROTECTION
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I. BACKGROUND OF THE PROJECT

A. Description of the Project Area

1. Geographical Location: The rocky Air Massif extends from north to south for about 400 kilometers and from east to west about 100-200 kilometers. The mountains are individual rock formations with abrupt peaks and culminating at heights of about 2000 meters. Located on the southern fringes of the Sahara, the Air Mountains form a sort of climatic island of approximately 61,000 square kilometers between the Azaouak and Tenere desert Plains.1

The Bagzane plateau form the southern limit of the Air mountains and constitute an oval shaped plateau approximately 40 km by 20 km oriented in a north-northeasternly direction. The maximum altitude of the Bagzane plateau is 2022 m. The mountain plateau abruptly falls about 700 m in altitude and extends out into a relatively flat transitional plain before joining the vast and sandy Tenere desert plain. There are several major drainage basins with headwaters on the Bagzane plateau and which terminate in the desert plains. The project zone included two such major basins and one smaller sub-basin. These basins were studied by ORSTOM for the duration of the project and their physical characteristics are summarized in Figures 1 and 2.

2. Geological Conditions: The basement rock formations of the Air mountains are metamorphic and magmatic dating from Precambrien or Cambrien periods. Interspersed among the older formations are more recent volcanic rocks. In the southern part of the Air, the volcanic rocks are from the Tertiary and Quaternary periods showing evidence of relative recent activity.

The transitional plains or foothills are characterized by undulating landscapes where hills of outcropping bedrock covered by boulders or blocks alternate with slightly inclined terrains of sub-exposed bedrock with a thin cover of alluvial gravel and sand or flat gravel and sand plains where the bedrock is at greater depths. This landscape is varied by small volcanic formations and by north-south running seasonal waterways (koris) which vary from 50 to several hundred meters in width. These transitional plains range in elevation from approximately 1000 meters near the Bagzane plateau to 700 meters near the Tenere desert plains. The region is underlaid by crystalline basement formations formed by a complex of intensively folded metamorphic rocks (generally gneisses and migmatites) and are traversed and intruded by granites.3 Hydrogeological conditions in the area are
are relatively favorable for the infiltration of surface flows due to the characteristics of the crystalline basement formations, such as a high degree of weathering and decomposition of the uppermost basement rocks, the intrusion of later formations into the older formations and surface depressions which are filled with gravel and coarse sands. However due to the rock lithology and variations in the weathered mantel, porosity and consequently infiltration varies considerably within the region depending on specific geological conditions.

3. Meteorological/hydrological Conditions: Precipitation in the project zone normally falls between July and September and averages about 60 mm annually. Normally, the rain falls in five or six short rains of varying intensity. There is considerable interannual and spatial variation in rainfall.

TABLE I
Annual Rainfall in Three Basins Studied

<table>
<thead>
<tr>
<th>Year</th>
<th>Teloues</th>
<th>Nabarou</th>
<th>Akrereb</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
<td>71 mm</td>
<td>65 mm</td>
<td>65.0 mm</td>
</tr>
<tr>
<td>1976</td>
<td>(50)</td>
<td>(61)</td>
<td>(30)</td>
</tr>
<tr>
<td>1977</td>
<td>118.8</td>
<td>120.8</td>
<td>102.8</td>
</tr>
<tr>
<td>1978</td>
<td>47.9</td>
<td>63.5</td>
<td>48.3</td>
</tr>
<tr>
<td>1979</td>
<td>34.5</td>
<td>43.6</td>
<td>16.8</td>
</tr>
<tr>
<td>Average</td>
<td>65</td>
<td>70.8</td>
<td>52.5</td>
</tr>
</tbody>
</table>

Source: ORSTOM

The higher altitude of the Bagzane Plateau normally attracts greater quantities of rainfall than does the lower plains. ORSTOM's studies over five years show that the average rainfall on the Bagzane plateau at an altitude of approximately 1600 meters was 88.5 mm whereas a station located on the transitional plains at an altitude of 800 meters registered an average of 56 mm over the same time period. Some of the rainfall from the mountains infiltrates through crevices and breaks in the rocks and eventually feeds the underground water table. The largest part of the rainwater, however, runs off the mountains provoking seasonal flooding in the transitional plains before being absorbed by sandy soils or evaporating. The seasonal floods tend to be intense and for a short duration. Most of the "koris" flood for only 3.5 hours and normally only several times per
year. However, the floods have reached maximum flows of 320 m$^3$ per second during the time period studied (3 years). The erosion effect of these intense floods especially on the sandy soils of the transitional plains is considerable. It has been suggested that erosion caused by run off water is increasing and not apparently because of abnormally high rainfall but rather because of the destruction of the vegetation cover, which, slow run off and encourages infiltration.\(^1\)

In general terms, since none of the streams of the region are perennial and water flows are limited to short intense floods, the region is dependent on groundwater resources. These are found at shallow depths in the alluvial soils near the "koris". The local population is familiar with this underflow (infero-flux) and has a long tradition of tapping this resource by digging shallow wells near the sandy beds of the "koris".

4. Vegetation and Soils: In the high plateau regions, rocky colluvial soils predominate and support an extremely sparse growth of annual plants and thorny bushes. The transitional plains are generally covered with sandy soils of poor quality and encrusted, thus producing only limited amounts of natural vegetation.

The "koris" beds themselves, coming under the influence of the seasonal flow of water, consist of various grades of sand with minimal amounts of clay, silt and organic matter. The soils of the banks immediately adjacent to the "koris" continue to be of a sandy nature and tend to be more fertile than soils of the "koris" bed. The better fertility of this soil comes from the higher moisture reserve in the subsoil which cause a greater quantity of vegetative growth. Detritus falling from the foliage becomes ultimately organic matter in the soil augmented by the root systems of annual grasses and plants which grow up quickly and complete their life cycles during the brief rainy season. The difference in organic matter content is clearly visible between the soil of the "koris" bed and the soils of the bank. The bank soils are somewhat darker than the soils in the "koris" bed.

The garden soil is the bank soil described above that has been worked over for long periods of time. It has undergone various influences among which may be categorized the following:

a) Regular irrigation with water carrying fine particles of silt and clay;

   b) Occasional flooding from overflowing "koris";

\(^1\) Conversations with the local populations and project personnel.
water charged with fine silt and clay;

c) Intensive proliferation of the root systems of annual crops. Wheat, millet, barley, tomatoes, etc. - systems which are left behind in the soil to contribute to the stock of organic matter.

d) Organic matter added to the soil surface by sequestering foliage of crops.

e) Organic manures spread on the surface of the soil by the gardener.

f) Regular cultivation and consequent aeration of the upper layers of the soil.

Garden soils are normally more fertile than the uncultivated soils and are rendered so by the gardening process. Both the garden soils and the uncultivated bank soils have a similar origin.

It is quite certain that there is regular removal of soil nutrients by the processes of crop produce removal. However, insofar as the effect of this on fertility is concerned, it must be remembered that fertility is made up of other constituents, such as porosity and amount of aeration and organic matter content.

The natural vegetation in the area is largely restricted to several acacia species, thorny bushes; shrubs and several varieties of short-annual grasses. In the valleys along the "koris", trees are found which throughout the year draw water from the shallow ground water aquifers creating small oases populated with date palms and acacia species. Gardens in these areas produce a variety of crops (such as tomatoes, wheat, barley, corn, vegetables, alfalfa, etc.) when the available soil is properly enriched.

The sparse vegetation is not considered to be a major factor in providing protection against wind and water erosion with the exception of the groves of date palms and acacia in oases which do offer protection against strong winds descending from the Bagzane plateau. These trees help create a favorable microclimate well suited for irrigated gardening.

5. Population/Economy of the Region: The population of the area of Tabelot (Abardek, Teloues and Afassas "koris") is estimated roughly to be 6-7,000 people. The people are predominately Tuareg of Kel Evey origins. The population is traditionally engaged
in gardening, herding, trade caravans and the production of handicrafts. This population is dispersed and rarely live in agglomerations of greater than 500 persons. One general characteristic of this region's population is that it remains fairly fluid and various economic pursuits require the absence of some family members for a considerable amount of time (caravaning for men; goat herding for women).

Of this total population, an estimated 40% of the families, approximately 3000 persons, are predominately engaged in gardening. Most of the gardens are managed as family enterprises but occasionally production units consist of siblings, kinsmen or just friends. On the other hand, most gardening families have members who are engaged in herding and trade caravans. This linkage is mutually beneficial for both gardeners and the caravan traders. A considerable number of gardening families have members who are seasonal migrant workers. Surveys in the project zone indicate that the average gardening family is composed of 7-8 (7.5) persons of which 2-3 (2.3) persons are actively engaged in gardening. Of the remaining family members, usually one or two is engaged in nongardening economic pursuits and the remaining persons tend to be elderly family members and/or young children.

Generally, gardens are worked by the head of the household and one or two of his sons. The adult usually has the task of driving the draft animal which pulls water. The younger sons open and close the water canals and gather hay for the draft animal. For tasks that require more labor such as well construction or repair, neighbors organize themselves, "gaya", to help complete the work.

Traditionally, ownership of a garden is gained by clearing and working the land. Once cleared, the garden remains the property of the one who cleared it, even if not used for several years. Ownership of gardens is usually passed from father to son. Trees are owned independently of the garden in which they may be growing and belong to the person who planted the tree. Trees also are inherited.

Gardens can be rented normally for a cropping season. This occurs most often if the proprietor is absent, elderly or has more than one garden. In such cases, most often the owner of the garden is paid in a percentage of the production of the garden. Rent rates vary considerably depending on the circumstances. Once again, when gardens are rented, the production from the date palm trees is considered distinct from the garden and normally remains entirely for the owner. In the immediate area of Tableot, out of 60 productive gardens, 20% were rented and 80% owned by their current operator. Gardens can be bought and sold, but rarely has this happened.
When gardeners do not have enough family labor to operate the
garden, labor is hired from the community. The persons hired are
usually receiving a portion of their earning in cash, are provided
room and board by the gardener and at the end of the season receive
a small portion of the crop if they worked the entire season.
These employees tend to be young men who have not yet started a
family and are hired for a cropping season.

In the general Tabelot area (including Abardek, Teloues and
Afassas "koris") there are about 475 gardens in production and
an estimated 150 gardens currently abandoned. Numerous reasons
can be cited explaining why these gardens have been abandoned.
The most common reasons given are erosion or that the present owner
does not have sufficient capital to launch his operation. The
most noteworthy investment requirement is a trained and fairly
mature oxen which will require a cash outlay of close to 100,000
FCFA. Less often cited reasons include lack of wells or available
water, fallowing the garden or that the current owner has temporar­
ily left the area. On-site inspection also indicated that some
gardens have probably been abandoned because of their location in
areas of low productivity (i.e., those farthest away from the
seasonal stream bed).

During the life of the project several surveys were conducted
by the Agadez Department Agriculture Service personnel in the project
zone primarily to determine the surface area planted to certain crops,
the size of families working the garden and some indication of
their well-being and production needs. These statistics were
reviewed by the Departmental Agriculture Service. Based on avail­
able statistics and the completed analysis the following indicative
conclusions are advanced.

1. The gardens, double cropped and occasionally triple
cropped per year, will provide the gardening family a good part
of their annual food needs and in addition about 250,000 - 260,000
FCFA in cash from the sale of garden products. This would give the
typical gardening family a cash per capita income of about 35,000
FCFA or roughly $160 originating from the family garden. Actual
profit to the family would of course be considerably less after
deducting production costs such as purchases and maintenance of
draft animals, well reparation, fertilizers, seeds, temporary labor,
etc. This income is usually augmented by other sources of income
of the family, such as income from livestock commerce and handicrafts.

2. Cereals, primarily wheat and corn, account for approxi­
mately three quarters of the production of the gardens and have a
much lower cash value per hectare than legumes (garlic and onions) or vegetables (tomatoes and potatoes). Such a production pattern probably reflects the isolated conditions of the project zone and the difficulties encountered in proper storage and transportation of legumes and vegetables and the uncertainty of being able to purchase basic food grains when needed.

3. Most of the gardens are cropped twice a year, however, some gardeners do crop their gardens a third time if adequate water and fertilizers are available. The cold dry, season crop is grown between November and March. Wheat tends to be the major crop and is used as both a food and cash crop. The other crops grown during this crop cycle (potatoes, tomatoes, onions and garlic) are primarily cash crops. The second crop is produced during the rainy season. Major crops produced during this cropping cycle are corn and millet with lesser amount of the garden producing vegetables for sale or family consumption. The area planted during the rainy season cropping cycle tends to be slightly larger than the area planted during the cold dry season. Both cropping cycles are dependent on irrigation.

4. Gardeners' allocation of their land resources to various crops is surprisingly homogeneous within the area and doesn't appear to vary significantly on the basis of wealth, size of garden; nor the availability of water. Some variation was noted between general localities in the Air region but given the fact that the data was generated some times in different years and other by different data collectors such variation may or may not be significant.

5. The statistics would indicate that a considerably larger amount of land could be put into production each year. The typical garden in the Tabelot region averages slightly less than one hectare in total area (9,800 sq. meters). The survey data also indicates that rarely does the gardener actually cultivate over a third of his available garden in any one crop season. Secondly, a large number of abandoned gardens were noted in the various surveys. Yet contrary to what one might expect, little in-migration is evident.

6. While gardening in the Air mountains can not be viewed as a lucrative enterprise, our analysis and observations indicate that it can provide an adequate standard of living. Rarely does one find an established gardener leaving this work for a salaried job in an urban area or at the mines. People leaving the area tend to be young and/or not having a garden. Several cases were observed where individuals worked at a salaried job long enough to obtain adequate capital to launch a gardening operation. Once adequate capital was accumulated they returned to gardening. This would seemingly indicate that the returns on gardening are at least
approximately equivalent to the SMIG or expected returns to unskilled labor at the minimum wage level. It should be noted however that in the cases observed where a wage earner returned to gardening, a plot of land was available from his family.

7. Finally, the lack of temporary or seasonal farm labor appears to be developing as a constraint to the levels of production in the gardens. Obviously, gardeners cannot pay competitive salaries with various types of construction companies and the mining operations. As a result, the normally available pool of adult male garden laborers has ceased to exist as these individuals seek employment elsewhere. A second factor restricting the availability of labor is the increased emphasis on educational opportunities. Children attending the region's one boarding school are not available to help their fathers or elder brothers working in the gardens. 2

B. Drought Relief Activities and CWS Activities

Although geographically isolated, the area of Tabelot has been exposed to considerable external developmental influences. The primary school in Tabelot was founded in the late forties and has continuously functioned although not always at full capacity. In the mid-1960's a government dispensary was established in Tabelot to provide health services and health education to the rural population. During the drought in the early seventies, the population in the Tabelot region was classified as priority "at-risk" and needed emergency food and supplies were provided. Shortly thereafter, Church World Service and the Nigerien Agricultural Service Fruit Tree Section provided assistance to the community to combat aphids attacking the date-bearing palm trees of the region. This limited activity entitled "Operation Ladybug" evolved into the two-phased Air Oasis project. The Air Oasis project continued the plant protection/research program using predatory insects and local methods of ecological control; assisted in improving agricultural productivity by introducing low cost and simple well construction, garden production techniques and an agricultural credit program; and, assisted in the development of a marketing and supply system serving the gardeners of the area. During the second phase of the Air Oasis project, the "kori" bank protection project was added to these ongoing activities.

C. Development and Implementation Strategies

As development activities in the Tabelot area have evolved over the past five years, development strategies or modalities used in Tabelot have also changed and have been examined at least twice by persons independent of the project.

2 There is one school in Tabelot for the Tabelot and Afassas areas and a second school in the Abardek area.
The first independent inquiry compared development approaches used on small scale projects in similar regions of the Agadez department in the mid-seventies shortly after the ravages of the drought. The author, Morel, concluded that essentially two approaches were being followed: "one type of project is based essentially on finding technical solutions, (and) mobilizing considerable funds and materials. The second type of project is based primarily on human interests and appeals to modest sources of finance. The latter strategy tends to be implemented by young idealistic volunteers". CWS project was considered to be of the first typology. Morel concluded that technically oriented projects (Type 1) tend not to adequately take into consideration the human element and often propose technical solutions that are beyond the means of the local population. The second type of projects tend to focus on implementing activities that while being compatible with the implementation capabilities of the local population are not technically appropriate to solve the problems of the zone.

Morel noted that the local population of the Air has traditionally exhibited a high capacity for adaptation and innovation. Projects in this region should build and reinforce this local capacity, rather than relying heavily on external initiatives and solutions.

Lastly, Morel also questioned whether projects using non-indigenous technologies would continue once external assistance withdrew, especially considering the general isolation of the area and the limited resources available from the departmental-level technical services.

The second analysis of the development strategy employed at Tabelot is contained in an assessment and comparative analysis of the development impact of Private Voluntary Organizations (PVOs) in Kenya and Niger. This study assessed several implementation strategies used by various PVOs, the impact on target populations of development activities undertaken by the PVOs and finally some tentative conclusions regarding the level of impact normally associated with the various PVO implementation strategies.

For Tabelot, the study noted that during the first phase of the Air Oasis project (1974-6) the project adhered to an implementation strategy with considerable technical assistance and a high PVO involvement in defining and directing project activities. In redesigning Phase Two of the same project, Church World Service reduced its role to promote greater interaction between government service technicians and the local population. The strategy followed for the Phase II Air Oasis Project was one of providing low profile support to a


project that depends on small groups at the local level to carry out activities and make key decisions. The "kori" bank protection project reflects the early type of implementation strategy similar to the approach used in Phase I of the Air Oasis project with a high level of PVO involvement.

For the assessment of project impact, the PVO study primarily considered the following factors: a) direct monetized benefits to the local population from the project, b) overall benefit to cost ratio, c) likelihood and organizational capabilities in place to keep the project functional after external assistance is withdrawn, and d) likelihood for spontaneous replication of the project activities in surrounding or similar areas or continued innovation among original project beneficiaries.

The Air Oasis project rated a moderate overall impact and in relation to the other PVO projects in Niger rated relatively high.

The Kori Bank Protection project was not included in the study and assessment of PVO activities. Were the same type of assessment of impact to be performed on the Kori Bank Protection project, the overall project impact would most likely be lower than the Oasis Air project given a less favorable benefit/cost ratio.

Perhaps most importantly, the study of the PVOs identified several characteristics common to those projects generally having a high project impact on the target population. These characteristics are reprinted below and were taken into account in a general manner in the discussion of the project's impact (Section III of this report).

- Identification of a technology that is immediately applicable under local constraints, with a direct return to those who adopt it;

- An explicit effort to gain the widest possible commitment to the proposed intervention from prospective users, before it is introduced on a broad scale;

- A deliberate attempt to draw on local capacities for self-help, whether latent or already firmly established;

- A policy of working through the formal administrative structure and the indigenous system of authority, in order to maximize access to the population of intended beneficiaries; and

- A demonstrated capacity to modify project content, dropping those interventions that do not take root, as implementation proceeds.
The purpose of the preceding sections is to present a description of the project's environment both in physical terms as well as in development and attitudinal terms. In essence, what was started as a primarily humanitarian emergency assistance activity has developed into a small medium-term development program. That has become increasing diversified when viewed as a whole. The "kori" bank protection project should be seen as one element of such a program.

D. Conditions Giving Rise to the Design of Kori Bank Protection Project.

The request for the Kori Bank Protection project originated about mid-way through the Phase I Air Oasis project. Early reports done by the Air Oasis project noted the erosion problem but neither the project personnel nor the local population defined this as a problem to be addressed. Several factors probably contributed to focusing on the problem of damage caused by erosion. Firstly, damage from erosion apparently increased during and immediately after the drought because of the loss of ground cover which formerly acted to aid in absorption of run-off water, and to break some of the force of the floods. Secondly, as cement wells were installed in gardens, the value of the garden appreciated considerably and the gardener was keen on protecting his investment. Thirdly, some of the labor force used to implement erosion control projects in other areas of the Air mountains were drawn from the Tabelot area returned home and told people of efforts being taken in neighboring areas to address the problem of erosion.

The design of the erosion control project was difficult because of the lack of hydrological information giving sound indications of the force of the seasonal floods which the protecting structure must withstand. Secondly, indigenous erosion control measures were judged inadequate even by the local population. This required then, a new technology be used which must also be adapted to local conditions.

In general, the available erosion-control technology was developed for areas of greater productivity. Replication of these technologies without some adaptation would prove more costly than would be economically justifiable. The project designers felt that available technologies need experimentation and adaptation specifically to determine modifications that would reduce construction and installation costs and still provide adequate protection against erosion.

After considering a variety of proposals and options, the project designers finally decided to experiment with erosion control
measures that could be implemented by the local population with
some technical oversight. It was stressed that the project was
experimental and recognized that the force of the water might
destroy or damage the types of structures being implemented. The
project was designed to try an array of technical possibilities and
study the hydrology of the region. This experience would then
guide future planners on the most appropriate types of protection
to be used. Several secondary considerations were also agreed upon.
First, as this was an experimental project to be executed under considerable
amounts of uncertainty, it was decided to hire workers rather
than request local participation without compensation. In addition,
it was believed that the lack of capital as contributed to the
abandoning of gardens and to the decreasing productivity of the
area. By paying salaries to local workers, it was hoped that some
gardeners lacking capital to put their gardens into production could.acquire sufficient resources to restart their gardens. Finally,
in order to better accomplish the above mentioned considerations and
to familiarize the local population with new construction technologies
that would enable them to maintain the structures, it was decided to
try to use, to the maximum extent possible, work crews hired from
the existing population at Tabelot instead of bringing in laborers
hired from outside the project zone.

As this project differed considerably from the proposals
put forth by the Agadez representative of the Rural Engineering
Service (Genie Rural), and as a consequence contained a higher degree
of risk of failure, it was decided to use the same project management
structure as for the Air Oasis project (joint Agricultural Service/CWS) rather than incorporate Genie Rural directly in the management
of the project. It was understood and agreed upon that the Genie
Rural would act as a consultant to project implementors.
II. COMPARISON OF PLANNED ACTIVITY WITH THAT REALIZED.

A. Purpose.

The purpose of this activity was to identify cost effective means of implanting vegetative and rock structures capable of protecting and stabilizing kori bank gardens.

B. Outputs.

To achieve this objective five project outputs were defined which, if each output was accomplished, would have assured (at least in principle) that the project purpose was attained. These project outputs are listed below and compared with what was actually accomplished.

Output #1: Planned: A set of implementation and construction recommendations which provide specific information on: a) an array of protection structures treating light to severe erosion; b) detailed recommendation for planting and maintaining vegetative erosion control; c) recommendations for transporting and processing rock used in the construction of the erosion control structures.

Output #1: Actual: This evaluation constitutes the only formal set of recommendations developed by the project. As such, it lacks some of the details that would be helpful in designing and implementing future projects of this sort.

Output #2: Planned: Approximately 5000 meters of landscaping with vegetative covering; 1500 meters of dry rockwork; and 1000 meters of rock and gabion work. The planned construction would provide protection for approximately 85 hectares of which about half was established gardens and 10 hectares on which was located public facilities (well, mosque, school and dispensary).

Output #2: Achieved:

- 1000 meters of sloped and planted embankment (of which only about a third or fourth is still growing).
- 630 meters of dumped or loosely placed rock,
- 1135 meters of fitted or layered rock work,
- 1765 meters of dry rock work,
- 1020 meters of rock filled gabion work. (See Annex 1 for more detailed descriptions, drawings and construction costs).
In comparing maps to the actual work accomplished it would appear that a minimum of 85 hectares are protected by the construction works of the project. Thirty existing gardens benefit from the project financed construction and four or five gardens are being started in areas now protected. Thus the evaluation teams estimated that close to 40 hectares of gardens have been protected. The public facilities were protected as planned. Comments: a) it should be clearly noted that the effectiveness of the protection afforded by the project cannot presently be determined because of the low level of rainfall received after the construction work was completed. Some of the works were completed prior to the 1979 rainy season but only very minor flows occurred that year. The works completed after the 1979 rainy seasons have yet to go through a rainy season.

The shortfall in the amount of sloped and planted embankment (only 20% of the amount planned) was due to implementation difficulties encountered in realizing the type of work planned. Watering and protecting the young vegetation proved more difficult and costly than originally planned. Difficulties encountered in the maintenance of young plants was partially due to the low levels of rainfall received in 1978 and 1979. Secondly, after two successive years of poor rainfall, grasses used in the vegetative protection became difficult to find in the immediate area of Tabelot. Thirdly, the bottom of the sloped and planted embankments were eroded by fairly light rains and flooding. Thus in light of (1) a reduced natural supply of vegetation suitable for transplanting on the erosion-control structures; (2) the higher than expected maintenance requirements; and (3), the relative instability of this type of work when compared to rock structures, emphasis in project implementation was shifted to rockwork construction.

The proposed lengths of both rockwork and gabion bank protection were surpassed, due primarily to the competence of the construction crew, its supervision and the availability of gabions from other sources for use on the project.

It should also be noted that several of the proposed work sites were modified or changed completely as the identification of planned work sites in the activity paper was not always clear. The map of the project area contained in the project document did not correspond well to the actual topography of the zone and thus some locations were modified during the implementation of the project. One site was also changed at the request of the villagers.

Assessment of Output #2:

Several types of proto-typical bank protection structures were to be evaluated by this project. The lack of significant rains and hence, no heavy flooding in the area during the last two years prevented a decisive evaluation of the various types of work. However, construction experience and costs, on-site inspection, and stream bed erosion patterns led to several particular, if not definitive conclusions.
Vegetative bank protection (sloping and planting saplings and grasses) proved most disappointing both in execution and effectiveness. Close supervision was initially necessary to assure proper planting and spacing. With below average rainfall in the area since 1978, grasses suitable for transplanting were not immediately available and finally had to be transported by vehicle from areas up to 10 kilometers away from the construction site. Due to the paucity of rainfall, permeable and sloping soils, and high evaporation rates, constant and heavy watering was necessary for the transplanted vegetation. The benefitting gardeners could not be held responsible for this twice daily, time consuming and painstaking watering given the limitations of their water supply and available time. Finally, a 20-man crew was employed full-time at a considerable cost, to water the 1000 m. of new vegetation, and this was barely adequate due to rapid evaporation and percolation. Only those grasses and saplings transplanted by chance immediately prior to rains appear to have flourished and their survival throughout the approaching dry season is questionable. Protection against the goat herds in the area was also necessary; especially considering that the vegetation was planted on unstable slopes. The protective fencing constructed of tunafia (Calotropis procera) had to be replaced occasionally as it was easily washed away by light flooding.

The grasses, shrubs and small trees planted by the project have not provided the degree of erosion control anticipated by the project designers. Light flooding in 1979 caused some erosion of the lower portions of the newly sloped and planted embankments. Much of this erosion is due to the fact that the root structures of the vegetation used by the project has a much slower growth and maturation rate than anticipated by the project planners. This slow growth rate is common to most indigenous species which have adapted to limited moisture availability. The growth rate was reduced further by poor rains over the past two years, a condition which is not infrequent. While the evaluation team believes that vegetative protection remains a conceptually sound method of providing the degree of erosion control desired, its slow growth rate will require considerable care and temporary protection while it is taking root. It would appear that relying on vegetative cover alone to provide erosion control has limited applicability in the project zone. Most areas will require additional protection to reinforce vegetative protection, especially in the early years of plant development and additionally, in times of severe flooding.

The effectiveness of the bank protection provided by various types of rockwork is more difficult to ascertain without the trial of heavy, flash flooding. Of the configurations tried, loosely-placed rock piles, usually formed by a dumping rocks directly from the truck, represents the lowest cost or level of investment (Approximately $10 per meter depending on size. See Fig B3 in the Annex). These piles, however, appear too unstable to afford any but the most cursory protection. Rocks are easily scattered by people and animals and have no cohesive structure to resist flood forces.
An increased level of investment is represented by layered and/or fitted rockwork, either in the form of small dikes or revetments. Three configurations of this type were built. First, at site "A" a large dike was constructed with fitted boulders infilled with smaller rock as shown in Fig A1 and A2 in the Annex. The cost was $70 per meter due both to its size and a ramp constructed for passage of the main road. A second, much smaller dike was built entirely of fitted and layered heavy boulders to protect an island at Site E at a cost of only $20 per meter. Finally, along a meter-high eroded bank at Site F, a fitted and layered rock revetment was built at a cost of approximately $25 per meter. All of these fitted rock works appeared surprisingly stable and were not affected by the passage of animals or people. In fact, the first large dike has not been affected after several months of heavy, if infrequent vehicle movement. Furthermore, this type of rockwork can be executed rapidly and correctly by local masons increasing the probability of maintenance and replication. The solidity of these works, however, depends on several characteristics: uniform and solid rock, 2:1 side slopes, earthen backfill, a maximum impact angle of 30 degrees with the current and a minimum foundation depth of 50 cm. Following these criteria, fitted rock work should provide adequate bank protection during all but the most exceptional floods. The cost of fitted rock work depends considerably on the availability of suitable rock near the worksite. Even on this small project, it was necessary towards the end of the project to transport rock over a distance of 10 kms. The quality of rock is much less important in construction using gabions or loosely placed or dumped rock.

The greatest costs were incurred by configurations of rock-filled gabions. These were composed of large, 1.5 M³ wire cages laid and tied upon, or next to one another and filled with randomly sized rocks. The configurations tried varied in size and cost from a small dike of single gabions with loose rock foundations at Site F costing $35 per meter, to a large jetty of multiple-layered gabions with large foundations at Site C at $185 per meter (See Figs B1-2, C1-2, D1-2 and F1 1-2 in the Annex ). Without doubt, all of these rock-filled gabion configurations are the most stable and cohesive form of bank protection constructed by the project. If anything, many of the configurations appear overbuilt for the banks they protect.

Obviously, the level of investment, and hence, certainty, in bank protection should be justified by the value of the land which is protected. However, the foreign manufacture and high cost of gabions skew their cost-effectiveness and negate their local replicability. Since simpler rock work appears structurally adequate for most bank protection, the use of gabions should be limited to the protection of major roadways, buildings or agricultural works or to the construction of dams, barriers or jetties which bear the full force of flood waters. The difficulty in obtaining quality masonry work in such regions (due to lack of water, high cement costs, transportation and storage difficulties and poor mortar work) enhances the value of gabion construction for water management works.
As mentioned earlier, the identification of work sites along the "koris" was difficult. Sites could be selected more reasonably and precisely with aerial photographs or photomaps. Such photographs are available from ORSTOM/Niger at a scale of 1:10,000 and can be enlarged to a smaller scale as needed (ex. 1:2,500). This would enable more accurate site selection as well as determination of areas to be protected. Even photographs or snapshots taken from a small plane during an overflight would be useful to avoid guesswork, misinterpretation and poor placement. In fact, aerial photos taken each year would indicate changes and tendencies in "koris" flow patterns; certainly a worthwhile supplemental investment.

Output #3: Planned: The activity would provide experience and on-the-job training for the managerial and supervisory field staff of the project. The project anticipated upgrading the skills of seven persons; 6 work site supervisors and one accountant/administrative assistant.

Output #3: Actual: The construction work as implemented was organized somewhat differently than originally planned. This change modified the types of on-the-job training actually received by project staff. The overall number of persons who learned new job skills or gained additional experience from the project exceeds slightly what was originally planned. The evaluation team considers that the following individuals have received the opportunity to learn new job related skills or have existing skills considerably improved.

<table>
<thead>
<tr>
<th>Job Title</th>
<th>Number of Persons</th>
<th>Type of Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction Crew</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foremen</td>
<td>2</td>
<td>Organization and management of construction operations</td>
</tr>
<tr>
<td>Foremen assistants</td>
<td>2</td>
<td>&quot;</td>
</tr>
<tr>
<td>Masons</td>
<td>5</td>
<td>Masonary construction skills</td>
</tr>
<tr>
<td>Accountant</td>
<td>1</td>
<td>Project management and accounting skills</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>10</strong></td>
<td></td>
</tr>
</tbody>
</table>

Assessment of Output #3: Management/Supervisory skills development.

1. Foremen and assistants:

The selection of construction crew foremen was based on the suggestions of the local population and was primarily a function of
their general leadership capabilities and social position rather than any consideration of technical knowledge or capabilities. Both foremen were about 50 years of age, considerably older than what would normally be expected. Both foremen were long standing and respected members in the local community: one was a gardener and the second was engaged in livestock and small commercial pursuits. Although lacking any previous experience in either construction or the management of work crews, both foremen proved capable of organizing and managing their crews in an exemplary manner. The responsibilities exercised by the foremen were:

a) Recruited and when necessary dismissed workers.

b) Supervised recording of hours worked, calculation and payment of salaries and mediated any labor concerns.

c) Organized work crews and allocated manpower to specific tasks.

d) After reviewing work to be completed and specifications for such work with the project engineer, the foremen supervised all work performed by work crews.

e) Supervised distribution and collection of tools and project equipment used by the work crews.

f) Directed and supervised the use of the trucks (except for fuel).

The two foremen were assisted by two assistants. The assistants were younger men who were literate and kept written records. The assistants generally assisted the foremen in carrying out all of the above assignments.

The two foremen apparently overcame the lack of technical training and experience for this work by exhibiting a high degree of motivation. During short absences of the project's technical staff, the foremen continued the work based on instructions and their own judgement. Most of the time, their judgement and decisions were sound although in several instances some of the completed work required modification or replacement. The foremen themselves felt that with good plans and detailed explanations of the types of work desired, they could continue the types of construction done by the project. Their technical capabilities appear to be limited to continuing work once adequate preparation has been done. They do not have the technical capability to do basic surveying and sighting. The organizational and managerial skills of the
foremen are of a sufficiently broad scope that they could be applied to different types of activities. These organizational skills were applied to road construction, rock and gabion construction, landscaping and tree and grass planting and maintenance. The foremen's technical and administrative skills seem best used when limited to managing work crews of 30-35 persons.

The foremen's organizational and managerial skills were however proven only in situations where there is a monetary compensation to the workers and where the workers are essentially of the same ethnic group. The absence of either or both of these factors may create organizational and managerial problems that surpass the local foremen's capabilities. The project engineer also felt that the two foremen were perfectly capable of continuing similar types of construction with initially close supervision and then bi-weekly supervision.

The younger assistants, while knowledgeable of the requirements of the job, probably do not have the maturity or respect in the eyes of the workers to replace the foremen. They do appear capable of reducing the considerable work load placed on the foremen and in time may develop into competent leaders in their right. The importance that the local society places on age and experience should not be overlooked in organizing activities to be implemented by the local population.

2. Masons:

The project hired four masons throughout the duration of the project. At the beginning of the project, two of the four masons were experienced masons coming from a similar type of project at Timia. These experienced masons provided on-the-job training for several workers from Tabelot. The four masons terminating the project were all from Tabelot or the immediately surrounding area. The responsibilities of the masons as cited by themselves are:

a) Supervised the digging of trenches for the rock and gabion construction.

b) Supervised the placement of rocks and gabions while keeping the works level and in a straight line.

c) Inspected completed works with the foremen to insure that the desired construction specifications (height, width, size and type of rock used, alignment and leveling) were met.
d) Determined the quantity and quality of rock needed for specific types of construction and supervise the stockpiling of rock needed for construction purposes.

e) Supervised several mason's helper's and other workers.

f) One of the four masons acted as head mason and in addition to the above responsibilities, he supervised the work of the three other masons and provided any training needed by other masons or mason's helpers.

Technically speaking, the skills required by the masons were fairly rudimentary. The most difficult task was keeping the base of the constructed works level. The project engineer would take site readings delineating the tops of the structure and would set up a series of leveling stakes. The foreman and masons then took over using a string level to keep the works correct. A second technical skill essential for this work is selecting the proper type and size of rock and its correct placement in the protecting wall.

The evaluation team tried to compare the apparent skills of these masons with those working on different types of construction projects in the Agadez Department and generally concluded that their skills are as good as, if not better, than higher paid masons working elsewhere. However, the Tabelot masons do not have experience in using cement binding in the construction. Their comparative advantage is in their ability of leveling and aligning their construction works. In total, six masons have their skills developed or enhanced through the implementation of this project. Four of the six remain in Tabelot while two have returned to near by Timia. Several of the four remaining at Tabelot will probably continue to work as masons if such jobs are available in the Agadez Department.

3. Project Accountant:

The project hired one accountant/administrative assistant to keep the projects' financial records and assist the project managers perform the routine administrative work required by the project. While the individual hired has for this job, carried out his responsibilities in an acceptable manner and in doing so has acquired several years of additional professional experience, it isn't apparent that the individual's skills were significantly improved or expanded.

The evaluation team noted that it would have been beneficial for the project to develop closer working relationships
between the project and the Agadez Subdivision office of Genie Rural. It should be understood that Genie Rural was somewhat reluctant to participate in the project given its experimental nature and the consequent risk of failure. Secondly, GR had budgetary constraints and limited personnel to participate fully in the implementation of the project. Expatriate personnel of the GR office in Agadez (a Peace Corp volunteer) did, however, complete detailed topographical maps of the Telouss kori and participated in the ORSTOM hydrological studies. It is the evaluation team's opinion that an opportunity for very valuable practical experience was lost by not having a closer working relationship between the Nigerien staff of GR and the project.

Output #4: Planned: The project would develop a semi-skilled labor force capable of undertaking similar types of erosion control programs. A labor force of approximately 100 persons was planned.

Output #4: Actual: The labor force hired by the project never exceeded 105 persons anytime during the project. However, because of the sporadic arrival of certain project commodities (gabions) and immutable deadline for certain project activities (tree and grass planting), work crews were often changed and given new tasks. Thus the majority of the labor force hired by the project has participated in all of the activities dealing with erosion control funded by the project.

Assessment of Output #4:

When the project was designed, the local population recognized that erosion was a critical problem confronting the region's gardeners. The local population knew of experiments in other parts of the Air Mountains (Timia and Iferouane) where measures were taken to decrease the erosion, protect eroding gardens and increase water infiltration. While knowledgeable of these experiments, the local population had little understanding of the construction technologies that may be applicable to the erosion problems they themselves were facing. Now people living in the area have had actual experience in constructing various types of erosion control devices and are aware of some of the basic principals involved in erosion control. How this newly acquired knowledge is used depends on the resources available to the local population and their own motivation to protect their gardens. It is unlikely that significant new erosion control devices will be started by the local population with no outside assistance. Erosion control within their means (vegetation with summary piled rocks) has not provided encouraging results to date. The more complex structures require financial, technical and logistical means beyond what is available in the village. The technical capacity to repair
works damaged by occasional flooding does, however exist locally. It, of course, remains to be seen whether this capacity will actually be used to repair the works without any outside assistance.

Output #5: Planned: The project anticipated that the hydrological research component of this activity would determine the volume and velocity of the seasonal runoff in the Telouess basin and contribute to determining annual recharge of groundwater.

Output #5: Actual: ORSTOM has studied rainfall and seasonal runoff for three rainy seasons. The 1977 rainy season produced floods with flows in excess of 300 m³/second. The 1978 and 1979 rains produced very minor flows. The ORSTOM studies to date have tended to concentrate more on rainfall and seasonal runoff and less on the basin's groundwater recharge as was specified in their contracts.

Assessment of Output #5: The purpose of the hydrological studies was 1) to determine the volume and velocity of runoff in the Teloues Basin and 2) to contribute to a determination of annual groundwater recharge. The study was conducted during the wet seasons of 1977, 1978, and 1979 and involved several ORSTOM technicians who monitored approximately 30 raingauges, 3 limnographic stations and supporting equipment on the Teloues drainage basin as well as the Nabarou and Akrereb basins which drain into the Teloues.

Although the results for 1979 are not yet available, reports for the preceding two years have been submitted to the AID mission. These reports contain the following information:

- Physical and Hydrological characteristics of the basins including areas, altitudes and rainfall and runoff patterns;

- Total volume of water carried by each "kori" and a comparison with the volume of rainfall received in their respective basins;

- Water or flood flows and their duration in each "kori" for each major rainstorm.

Unfortunately, 1978 and 1979 were years of poor rainfall in the area. Annual rainfall in 1978 was 2 to 3 times less than that in 1977, and the annual rainfall in 1979 was again less than that of 1978. Therefore, although comparison of each year's results yield a better understanding of the hydrological system in each basin, only the results of the 1977 study are significant for maximum or flash flood flows in the "koris". In spite of the minimal rainfall, the reports also provide an indication of the basin's groundwater recharge capabilities. These, however, have not been
Several pertinent conclusions which can be drawn from the reports are as follows:

- Heavy rains of approximately 30 to 40 mm will provoke flash flooding with peak flows on the order of 300 m³/s in the Teloues and Akrereb "koris" and 160 m³/s in the Nabarou, rising in one hour or less.

- "Kori" flows account for a maximum of only 10% of the total rainfall volume in the larger basins, Teloues and Nabarou, which extend onto the Bagzane Plateau indicating that a considerable amount of water (on the order of 10,000, 000 M³ during a year of light rains) is stored in the plateau.

- Larger proportionate amounts of outflow through the Akrereb "kori" of up to 37% indicate considerable water loss by sheet runoff on the lowland plains.

- Basin and flood rate comparisons combined with on-site inspections indicate that flash flooding in the Nabarou is modulated by flow constricting upstream topography. These conclusions are consistent with those reported in 1975 by M. Schroder, a hydrogeologist under contract with Church World Service.

In addition to examining the technical aspects of the hydrological study, the evaluation also considered the utility of this type of study in relation to the information needs of project design and implementation. It should be noted that the viewpoints of the team differed somewhat on this point. The teams considerations are noted below:

a) It was agreed that the type of study conducted provides very useful information in understanding the environment of the project zone and contributes to a better understanding of the impact of the Air range in the desert environment. This information will be useful for longer term development programs for the general region.

b) Rainfall in the project zone varies greatly in respect to both time and place. Studies undertaken to find "average" conditions in this environment must be long term efforts, will be costly and even then, the concept of "average" has little practical meaning in such an environment. Given the cost of such studies and compared with the overall cost of the project and the present or envisioned types of erosion control works, it is difficult to justify
the continuation of gathering rainfall and surface flow data.

c) On the other hand, studies to date have provided some order of magnitude of potential surface flows which the constructed works must withstand. What presently is lacking is some indication of the water forces that the different types of structures can actually withstand. We assume that floods of the magnitude of those registered in 1977 would destroy the vegetative protection and that the gabion structures would be able to withstand such forces. However we have no empirical data to support such assumptions concerning the strength of the completed works. As a consequence, recommendations made from experience to date by this project may be misleading.

d) Water resources are extremely important in the project zone and all future development programs must take into account the limitation of this resource. To better understand the potential of the project zone, a considerably greater amount of information is needed on groundwater flows, quality and recharge.

e) Such studies as these are crucial for the long term development of this desertic region. These studies will also be rather long term efforts. It is essential to have direct participation by Nigeriens in such studies.

C. Project Inputs:

In order to realize the planned outputs and subsequently achieve the project objective, certain inputs or contributions were made for this project. Substantial contributions to the project were made by the following organizations or agencies. As is frequently the case, not all the required inputs were originally planned and certain inputs were received from sources not identified in the design of the project.

<table>
<thead>
<tr>
<th>Organization or Agency</th>
<th>Type of Assistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prefecture of Agadez</td>
<td>Assistance in project management</td>
</tr>
<tr>
<td>Departmental Agricultural Service</td>
<td>Project management</td>
</tr>
<tr>
<td>Departmental Service of Water &amp; Forestry</td>
<td>Consultation and Nursery Facilities at Tabelot</td>
</tr>
<tr>
<td>Genie Rural Agadez Subdivision</td>
<td>Consultation and participation of GR/Peace Corps volunteer, vehicle and equipment,</td>
</tr>
</tbody>
</table>
Departmental Service of Plan | Consultation
---|---
World Food Program | Food stuffs as partial compensation for work crews; construction materials (gabions)
Church World Service | Project management and construction materials (gabions)
Oasis Air Project | Project vehicles, equipment and infrastructure
INRAN | Housing for technical assistance at project site
Organization of Dutch Volunteers | Technical Assistance
Agency for International Development | Consultation and Financial Assistance
Government of Niger | Financial Assistance (counterpart funds)

Below are listed the project inputs furnished to the project primarily by AID first as planned, secondly as delivered and lastly brief comments which the evaluation team made which may be helpful in future projects of this sort.

**Planned Input #1**: Gabion cages of 1m x 1m x 2m: dimensions sufficient for 1000 meters of construction work.

**Actually Delivered**: 1000 gabion cages size 6 ft x 3 ft x 3 ft and 100 gabion cages size 12 ft x 3 ft x 1 1/2 ft. The gabions were ordered by Church World Service in April 1978 from Terra Aqua Company of Reno, Nevada. The gabions were shipped from Nevada in June 1978 and arrived in Lome, Togo in September/October 1978. The gabions arrived in Niamey in early May 1979 and then arrived at their final destination of Tabelot in June 1979. Other project experience has indicated that 12 months delay between the time the commodities were ordered and the date that they were delivered in Niamey is to be expected. The first 800 meters of gabions used by the project were provided by UNDP/WFP from existing stocks in Agadez.

**Planned Input #2**: Trees were to be planted in nurseries and local gardens and once they reached an appropriate size they were to be transplanted to the work sites.
Actually Delivered: Trees were planted in the project nursery and transplanted and maintained by paid workers, given the unanticipated difficulties in this operation. Secondly, the rate of growth of the species selected, (*Salvadora persica*), proved much slower than anticipated.

**Planned Input #3:** Cash portion for a total labor force of 1000 man-months of salaries for 100 workers for 10 months. Food stuffs to supplement cash income was to be provided by the World Food Program.

*Actually Delivered:* The project paid the cash portion of salaries for a labor force of 1196 man months. Supplementary foodstuffs were provided as planned by the World Food Program, when available. On several occasions, food stuffs were not available and a supplementary cash payment was made to the workers from project funds. The monthly employment of laborers is shown below.

TABLE II

<table>
<thead>
<tr>
<th>Workers Employed by the Project</th>
<th>1978</th>
<th>1979</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>106</td>
<td>100</td>
</tr>
<tr>
<td>Feb</td>
<td>104</td>
<td>104</td>
</tr>
<tr>
<td>Mar</td>
<td>102</td>
<td>104</td>
</tr>
<tr>
<td>Apr</td>
<td>88</td>
<td>81</td>
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<tr>
<td>May</td>
<td>49</td>
<td>96</td>
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<td>Jun</td>
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<tr>
<td>Jul</td>
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<tr>
<td>Aug</td>
<td>47</td>
<td>47</td>
</tr>
<tr>
<td>Sep</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>Oct</td>
<td>68</td>
<td>68</td>
</tr>
<tr>
<td>Nov</td>
<td>88</td>
<td>88</td>
</tr>
<tr>
<td>Dec</td>
<td>105</td>
<td>105</td>
</tr>
</tbody>
</table>

(1196 man months)\(^1\)

(141 man months)\(^2\)

\(^1\) Initial AID project funds depleted at this time.

\(^2\) Workers paid from USAID/GON counterpart funds.
Planned Input #4: Services of mid-level supervisory staff and skilled workers. Project management personnel will be provided by the Government of Niger and Church World Service. Periodic technical consultants will be provided by the government's technical services represented in Agadez.

Actually Delivered:

<table>
<thead>
<tr>
<th>Personnel</th>
<th>Source of Funding or Manpower</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 work crew foremen and 2 assistants (65 man months)</td>
<td>Project (AID)</td>
</tr>
<tr>
<td>6 masons (68 man months)</td>
<td>Project (AID)</td>
</tr>
<tr>
<td>Co-Project manager: Agriculture Service (22 months)</td>
<td>Government of Niger (Agriculture Service)</td>
</tr>
<tr>
<td>Co-Project Manager: CWS (16 months)</td>
<td>Church World Service</td>
</tr>
<tr>
<td>Project Engineer (11 months)</td>
<td>Organization of Dutch Volunteers</td>
</tr>
<tr>
<td>Consultants (2 months)</td>
<td>Government of Niger (GR and Water/Forestry Service)</td>
</tr>
<tr>
<td>Surveyor (6 months)</td>
<td>Peace Corps/Genie Rural</td>
</tr>
</tbody>
</table>

Planned Input #5: One six ton dump truck (est. cost - $30,000 or FCFA 7,350,000).

Actually Delivered: One Berliet L-64 Benne delivered May 1978 with spare tire and tools. Actual cost: FCFA 7,815,000 or $35,156,000

Note: difference in price is due primarily in changes in $/FCFA exchange rate between date when the project was designed and date truck purchased.

Planned Input #6: ORSTOM hydrological study for the 1978 rainy season.

Actually Delivered: Although the field work has been completed, ORSTOM has not distributed the final report for the 1978 campaign. Final payment on ORSTOM contract pending receipt of this final report.

The evaluation team feels that a high degree of the project's planned inputs have been received and in a quality and quantity deemed appropriate. Several general comments follow:
a) The quantity and level of technical expertise was underestimated by the project designers. The original project document indicated that the project would rely on the project management staff (CWS-Agricultural Service) implementation team with consultation occasionally from Genie Rural. The project noted the need for more technically qualified personnel to assist in the implementation of the project and subsequently requested the services of a Dutch volunteer who in this case was a civil engineer. This input was probably vital to the project, as the earlier work completed before the arrival of the Dutch volunteer is considerably inferior to work completed after his arrival.

b) The quality of gabions procured from the United States is superior to that furnished by UNDP/WFP and prices are about equal. Thus, there's some advantage in using U.S. manufactured gabions. However, the delays in procurement and delivery are long and most likely this cannot be substantially reduced. If American manufactured gabions are expected to be used in any future work, they must be ordered at least twelve months prior to the date construction is expected to begin.

c) If vegetative cover is used in future erosion control projects, several aspects need to be given greater consideration, such as:

1) Slow growth rate of most of the native vegetation in the area. This will require that plants be started in nurseries long before being transplanted to the worksites.

2) Given the constraints on water resources and on the time that local gardeners have available to assist in maintaining these plants, it will most likely be necessary for the project to develop a well to supply water and take the responsibility for watering and maintaining the transplanted vegetation until the plants are well established. This will probably entail some type of mechanization, either an animal drawn system or a vehicle mounted distribution tank.

3) Some type of protection must be afforded to the young transplanted vegetation against destruction by the village goat herds.

d) Topographical maps were prepared as an input to the project to assist in designing erosion control structures. Such maps require a considerable amount of time to develop and on a large scale are probably not feasible. A more cost effective manner of acquiring such information would be to use enlarged existing aerial photographs, coupled with topographical studies only in areas of considerable erosion. Taking aerial photos annually of the koris would also indicate changes and tendencies in "kori" flow and erosion patterns.
KORI BANK PROTECTION AID—PROJECT

Statement of Budget and Actual Expenditures

<table>
<thead>
<tr>
<th>Budget Category</th>
<th>USAID Project Budget</th>
<th></th>
<th>Disbursements May 1980</th>
<th>Unexpended Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>original</td>
<td>Revised (6-1979)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personnel</td>
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<td>$67,404</td>
<td>$74,497</td>
<td>$(-7,093)</td>
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<tr>
<td>Truck</td>
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<td>35,157</td>
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<tr>
<td>Material (tools)</td>
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<td>36,821</td>
<td>36,188</td>
<td>633</td>
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<tr>
<td>Gasoline</td>
<td>8,500</td>
<td>11,870</td>
<td>15,587</td>
<td>(-3,717)</td>
</tr>
<tr>
<td>Hydrological Studies</td>
<td>17,000</td>
<td>22,327</td>
<td>13,998</td>
<td>8,329 *</td>
</tr>
<tr>
<td>Contingencies</td>
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<td>3,421</td>
<td>1,380</td>
<td>2,041</td>
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<tr>
<td><strong>TOTAL</strong></td>
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<td><strong>$177,000</strong></td>
<td><strong>$176,807</strong></td>
<td><strong>$193</strong></td>
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</table>

GON-USAID Counterpart Funds

(in FCFA)

<table>
<thead>
<tr>
<th>Budget Category</th>
<th>as of 1/1980</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personnel</td>
<td>3,085,321</td>
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<tr>
<td>Material (tools)</td>
<td>26,000</td>
</tr>
<tr>
<td>Gasoline</td>
<td>1,763,558</td>
</tr>
<tr>
<td>Contingencies</td>
<td>128,370</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>5,000,000</strong></td>
</tr>
</tbody>
</table>

Source: USAID/Niger

* Final payment of FCFA 1,750,000 (est. $8,330) remains outstanding.
III. ASSESSMENT OF PROJECT IMPACT.

A. General

The evaluation team’s original intent was to use the methodologies contained in the forementioned DAI study to assess the impact of this project. However given the tentative nature of the conclusions that can be drawn now, the team decided to simply describe the impacts which have been observed during the course of this evaluation. A more realistic impact assessment can be done later which can build upon considerations set forth in this evaluation. Secondly, the evaluation team believes it would be more appropriate to evaluate the impact of the totality of development activities that have been implemented in the region rather than a single component.

B. Observed Impacts:

Some evidence of the impact which these erosion-control structures have had on the region’s gardeners is apparent. It is already obvious that gardeners perceive the construction of the protection structures as lessening one of the constraints to the expansion and productivity of the zone’s garden economy. Many of those gardeners whose gardens have benefited from the construction of mechanical protection structures have made conscious decisions, based on a sense of greater security, to increase investments and the cultivated surfaces of their gardens. A sampling of some individual cases revealed some of the changes that have been instituted by area gardeners as a result of project inputs.

The evaluation team visited four or five new gardens in the area protected by erosion control structures. In each of these cases the garden had been abandoned for the last several years. The gardens were abandoned for a variety of reasons but in all cases loss of productive land or trees due to erosion was part of the reasons given as to why the gardeners had abandoned the area. The returning gardeners interviewed indicated that the principal reason for their reopening abandoned parcels was the erosion control afforded by the project. When questioned further the gardeners admitted several other factors contributed to their decision to return such

\[1\] Difference in number is due to one case where two brothers are reopening an abandoned garden. It was not clear whether it represents one large garden worked communally by brothers or two gardens farmed individually.

\[2\] The length of time that the garden had been abandoned varies considerably. In one case the garden had not been cultivated for about twenty years. The other cases involved considerably less time.
as: a ready supply of labor, an agricultural input delivery system supplying fertilizers and improved seeds, and a readily accessible market/transportation system. Regardless of the motives, the most productive land protected by the erosion control structures is now in production. Several abandoned gardens still exist in the vicinity of the protective structures but they tend to be the gardens the furthest away from the "kori" and consequently have poor soils and limited water resources. In at least one case, it would appear that the owner was concerned about his claim to an abandoned garden being respected given the fact that public funds had been used to protect the area.

It should also be noted that in all the cases studied the garden plot was put back into production by its owner or his immediate family.

Several other gardeners indicated that once convinced of the effectiveness of the erosion control structures they were prepared to make considerable investments in terms of both time and money to increase their garden's productivity. One gardener already convinced of the stability to the erosion control structures has abandoned a safer although marginal garden in favor of one situated on what has been considered until now, a very vulnerable island. Opening this garden required the construction of a well, related infrastructure, and considerable effort and costs to increase the fertility of the sandy soil. If the protection provided by the project holds up, the gardener stands to make a considerable return on his investment given the larger size of the garden, more dependable water resources and better soils. Numerous other gardeners in the area expressed their desire to have bank protection in areas of considerable erosion near their gardens. At time, the request was based on the perceived need to expand the area being cultivated in order to permit young family members to establish gardens having good soil and abundant water resources. If the heads of the families could not ensure younger family members of a means of livelihood, young men would most likely migrate out of the area.

The evaluation team visited several gardens along the same "kori" but outside the area where this project was operating. It was observed that several gardeners have on their own initiative, loosely piled rocks along the edges of their gardens threatened by erosion. Several other gardeners requested to use or to rent the project truck to haul rocks to the edge of their gardens. While the durability of such structures is somewhat questionable, the existence of such initiatives certainly attests to the felt-need for conservation/protection structures and the commitment of the local gardeners to obtain such protection.
In several instances, gardeners working in protected areas, were observed to put under cultivation those areas within their gardens that are closest to the "kori" bank. While potentially the most susceptible to flooding and erosion, these areas are covered with alluvial soils having higher production possibilities than soils located some distance away from the "kori". The direction of this garden expansion is opposite from the retrenching exercise that characterizes those gardens threatened by flooding and which do not have adequate protection systems. When facing erosion, gardeners are normally obliged to move further away from the "kori" onto hard, marginally productive land where water resources most often scarce. Protection systems seem to be offering the possibility of returning to fertile soils.

It appears that an unusually important number of date palm shoots have been planted in gardens alongside the "kori" in the Tabelot vicinity. This concentration may be due in part to past CWS project activities, or to current INRAN activities in the area which assist in the distribution of such shoots. It seems, however, that at least a part of the current enthusiasm for planting and caring for date palm shoots can be attributed to the security of the protection provided by this project. Date palms grow well in sandy soils and thus grow best on the sand banks of the "kori". This, of course, is the soil that is most prone to severe erosion. Floods destroy a considerable number of these precariously located trees annually. An erosion control program coupled with planting new palm shoots represents an important means of increasing incomes derived from the gardens.

The project was designed with several secondary objectives in mind. One such secondary objective was to offer long and short term employment in the region in order to reduce migration to urban areas. It was felt that if additional land could be made available, young men not having ownership or the right to use land would then have the option of starting a garden instead of migrating to urban areas in search of a job. Secondly, by paying salaries, aspiring gardeners who lacked sufficient capital to launch a garden operation, could acquire the needed capital by working on the project as a laborer. Thirdly, by using the local population and organizing them into work groups, organization skills would be created which at least would ensure the structures were maintained and repaired and perhaps new structures would be eventually built, independent of the project.

In respect to the first objective of creating a local option to out-migration, it should first be noted that the economic incentive to leave the region is much stronger now than when the project was designed, and the number of young persons leaving the region is
is greater now than several years ago due to the labor force re-
quired by the various mining operation and road construction projects.
The project did, however, manage to keep its labor force intact pri-
marily because of the workers preference to work near home. The
project did draw a small number of workers from immediately sur-
rounding regions (one worker came from a herding family in the Tenere
desert and several came from families living on the Bagzane Plateau.)
At least one of these in-migrating workers, now that the project
is completed, has made inquiries into the possibility of remaining
in Tabelot, working one of the unused gardens, and eventually
settling down in the area. As noted before, the project has also
prompted the return of several absentee gardeners and/or land
owners. On the other hand, it should be noted that no new land
appears to have been made available to young men who didn't have
title to land personally or through family claims. The questions
of employment opportunities for non-land owning families, abandoned
gardens and new lands are very sensitive issues which the evaluation
team did not feel appropriate to discuss at length with the Tabelot
population.

Throughout the life of this project, approximately 16 million
francs CFA ($75,000) or roughly 40% of the project's cash outlay
was paid out in the form of salaries and other compensations to
local workers. If a worker stayed with the project throughout its
duration (as approximately 40 workers did), the worker would have
received payments totalling approximately 200,000 FCFA between May
1978, and December 1979, plus food stuffs. Cash incomes of this
level is a fairly new experience for the Tabelot area. This influx,
of money had certain repercussions. It would appear from talking
with workmen, supervisors and villagers that a considerable part of
the money was invested in their own economic livelihood or that of
their family. One worker wisely saved his earnings until he had
sufficient capital to make the down payment on a draft animal, the
necessary well improvements and an adequate supply of food grains to
get him and two workers through the first cropping season on his
new garden. A second worker saved money and purchased a sewing
machine which he used then as a supplemental, and now as a main
source of income. Many workers purchased goats and sheep for their
families' herds. Other workers purchased draft animals and fertilizer
for their families' gardens. Most of the individuals consulted felt
that very little of the money paid to workers went for non-essential
consumption items - tea, and sugar, of course being considered
"essential". It was also noted that the number of marriages transacted
in the area increased notably.
While it is undeniable that paying salaries increased some consumption spending in the area. (The village cooperative store changed working hours to be able to accommodate the project's work force), the evaluation team observed little evidence of ostentatious consumption and did observe numerous cases amongst workers interviewed who did make wise and sound investments. Thus, the team concludes that the project had the intended effect of generating capital investment and savings in the local economy.

The organizational skills among the residents in the Tabelot region are considerable, and have been made evident on several occasions. Within the Oasis Air project, gardeners organized themselves into well digging crews and have carried on the work after the project was terminated. In the "kori" bank protection project, the quantity and quality of the work accomplished would seem to indicate that the execution of similar works could be done by local work crews with biweekly supervision. The local population, understanding the importance of the marketing/transportation system to their local economy, has not only constructed a 150 kilometer road, but offered to organize themselves to maintain the road if the state can provide for transporting the repair crews along rather desolate stretches of the road. Despite some comments by local people on the decline of community spirit as exhibited by fewer "gaya" exercises and an increase of individualism, the community appears perfectly capable and motivated to organize itself to undertake development activities which it feels are needed.
IV. PRESENTATION OF PROJECT FINDINGS AND RECOMMENDATIONS.

The purpose of this project was to identify cost effective means of implanting vegetation and rock structures capable of protecting and stabilizing "kori" bank gardens. With the important reservation that the structures need testing against severe floods, the project evaluation team believes that, to a large degree, the purpose of the project has been achieved. The project has shown several types of erosion control structures which can be constructed and approximate costs of construction several erosion control structures. The principle conclusions which the evaluation teams feels can be drawn from the project are as follows:

A. General Conclusion and Recommendations.

1. Erosion is a major constraint to be addressed if the productivity of the gardens is to be increased. Harris's topographical study of the Teloues indicated approximately seven kilometers of protection/erosion control was needed to treat moderate to heavy erosion in areas currently in production along the forty kilometers of the "kori" studied. In addition to the Teloues "kori", the south eastern part of the Air mountains contain two other major drainage systems, the Abardek and Afassas basins, plus several minor affluents.

Given agricultural resources of the region, development of the zone will require further intensification of production. Further intensification of the production of the gardens will only be possible if gardeners make additional capital investments in their gardens. Typically such investments are additional improved wells, draft animals, more efficient irrigation systems, fertilizers, and fruit trees, etc.

Such improvements are costly and gardeners will not make the needed investments if erosion is threatening to destroy his garden. The gardener will also probably not make the investments to improve his garden unless he has access to urban markets when he can sell his fresh cash crops such as potatoes, garlic, etc. Given the number of improvements made on gardens now protected from erosion, we believe that gardeners are willing to make considerable investments to improve the productivity of their gardens if erosion is controlled.

2. Erosion control projects in the region will be fairly expensive to implement and will have an especially high cost per beneficiary. Prior calculations have indicated that in order to show a credible positive cost/benefit ratio the bank protection structures constructed should not exceed a per garden cost of $3000 - 4000. Most of the construction types tested by this project fit within that limit. However investments of that level which only have one garden or one gardener's family as a beneficiary may be
hard to justify given other investment opportunities in Niger. From an economic point of view at least, erosion control projects should be coupled with agricultural extension and cooperative development which will assist gardeners realize a larger part of their production potential.

3. During the course of the evaluation, several additional and related problems were raised which have a considerable impact on increasing the productivity of the gardens.

a) Water resources are scarce in the region and certainly will impose some limit on the future development of the region. In anticipation of such an eventuality, it would seem beneficial to have more information on groundwater flows, quality and annual recharge.

During the early years of the project, 1977-8, the Tabelot area seemed to have adequate water resources to permit an increase in the area in production and perhaps in the population of the zone. Two years of poor rainfall has reduced substantially the water resources in the area and today it appears inadequate for the existing gardens. Thus, the evaluation team, knowing the considerable variation which exists in the zone's annual rainfall would question the earlier conclusion of the possibility of expanding the area under cultivation in this zone. In this context, it would be interesting to survey the gardens in production in March 1980 to see if the two previous years of poor rainfall made a significant change in either the area cultivated in the percentage active to abandoned gardens.

b) Ground water availability is dependent on highly variable annual rainfall. Some areas of the project zone seem to have more stable water tables. During the duration of this project, certain gardens have been abandoned because of the lack of water following two years of mediocre rainfall. Since the rainfall of the area is known to be highly variable, it would seem prudent to try to concentrate the rather expensive erosion control construction in areas proven to have abundant and more stable groundwater resources. Failure to take groundwater conditions into account in locating sites to be protected may result in considerable investments in areas which can only be cultivated intermittently or in the years of abundant rainfall.

c) Costly soil conservation and erosion control programs are may be justified if the constraining factor of production is the lack of land resources. The number of abandoned gardens in the project zone appears surprisingly high and has raised some questions concerning the actual availability of land.
The question of land availability appears to be linked to the land tenure system in the region as well as to the existing natural resource base. The existing tenure system is a sensitive issue and not within the scope of this evaluation. It is, however, a subject that should be given serious consideration before larger scale projects of this nature are begun.

d) A considerable number of gardeners seem to lack the necessary means of starting their own productive garden or of substantially increasing its productivity. Surveys indicate that the most frequently cited reasons for gardens being abandoned is that gardeners lack a draft animal or a well. While the evaluation team feels that the responses of the surveys tend to oversimplify the problem of abandoned gardens, the team also recognizes the legitimate need for a credit program in the region. The annual production on a number of existing gardens could be improved by a credit program. There appears to be a number of younger men who because they lack the necessary resources are forced to seek employment elsewhere.

B. Specific Conclusions and Recommendations.

1. Water Management and Erosion Control Programs.

   a) With the exception of Site A, little effort was made in this project to test structures intended to direct or slow the flow of water. The structures built were intended primarily to protect the existing stream banks with little or no interference with the natural flow, force or channel of the water. In the design of future projects consideration should be given to a limited number of structures designed to direct the flow of water and to reduce its force. Structures intended to reduce the force of the floods should be located in the up-stream portions of the drainage basin and on small tributaries in order to reduce the strength requirements of the works to be constructed. Small check dams of this nature would also serve to increase the recharge of the aquifer.

   b) The use of aerial photographs is recommended to identify sites for the placement of such structures.

2. Types of erosion control structures:

   a) Based on the information and experience to date, it is recommended to use layered and fitted rockwork as the predominant type of "kori" bank protection following these construction criteria:
1) Earth backfills;
2) Deep "kori" side foundations;
3) 2 to 1 minimum side slopes, and,
4) Current impact angles of less than 30 degrees.

The application of this recommendation is dependent on the severity of the erosion and the availability of appropriate types of rocks.

b) The use of rock-filled gabions should be limited to areas of extreme erosion, the protection of areas having a very high value, or as barriers, jetties, groins or dams exposed to full flood forces.

c) The use of trees, shrubs and grasses should primarily be limited to use in areas of erosion, stabilized concurrently by physical works, or areas with light erosion.

3. Project Implementation.

a) The evaluation team believes it would have been highly desirable to have Genie Rural's Agadez subdivision play a considerably greater role in the implementation of the project. The team also commends the project recruitment of an engineer to assist in execution. The results of the project appear to be considerably enhanced by this advisor's technical capabilities. Future projects should include the Genie Rural as an integral part of the project's management structure, with the assistance of a technical advisor.

b) Both the quantity and the quality of the construction work accomplished by locally formed work crews would seem to indicate that in future projects the execution of similar work could be assigned to such work crews provided, that clear and simple engineering plans were explained to the foremen and that the work crews were monitored by a qualified supervisor on a bi-weekly basis.

c) Given the delays encountered in procuring U.S. manufactured commodities (gabions), orders must be placed a year in advance of the projected start-up date of the construction work. This in turn will require that the minimum duration of a similar project using American manufactured gabions would be three years if not longer. Utilizing local work crews will also require a longer implementation timeframe as the pool of available labor is limited.
d) The evaluation team believes the hydrological studies funded by the project have been beneficial to the implementation, and will continue to be useful in evaluating the results of the project and any future project planning exercise. It is noted, however, that certain modifications could make the studies of greater value. The evaluation team suggests that if the studies are continued, efforts be made to assign Nigerien staff to participate in such studies. As most of the time required for the study comes during the time when students are on vacation, such participation would appear to be an extremely useful field experience for GR's future staff now in training. Secondly, the evaluation team suggests that greater emphasis in the studies be placed on determining ground water availability, utilization rates and the rates of recharge. Thirdly, it is recommended that if hydrological studies are continued in the Tabelot area, the contractor be requested to assess damage to the structures constructed caused by flooding. Assessments of the damage should be made after each major flood with a summary of the structure performance at the end of the season.
BIBLIOGRAPHY


Office Allemand de la Cooperation, Technique, S.A.R.L., "Rapport d'Etude socio-economique sur Iferouane et Timia", par G. Spttler, University de Freiburg a Breisgan, RFA.


ANNEX I

Sketches and detailed descriptions of erosion control structures implanted by the project.

- Map of Teloues Basin
- Map of Tabelot Construction Site
- Description of works constructed
- Sketches of works constructed
## ANNEX I
### LISTING OF BANK PROTECTION WORKS

<table>
<thead>
<tr>
<th>SITE</th>
<th>LENGTH</th>
<th>WORK</th>
<th>COST</th>
<th>CHANGES IN DESIGN</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>385 M.</td>
<td>Fitted rocks w/infill of loose rock w/ramp Figs. A1 and A2</td>
<td>$70/M</td>
<td>Length increased 135M to protect downstream bank. Road ramp added.</td>
</tr>
<tr>
<td>B</td>
<td>300 M</td>
<td>Double gabions w/o foundation Fig B1</td>
<td>$90/M</td>
<td>Gabions instead of rockwork to protect village</td>
</tr>
<tr>
<td></td>
<td>.50 M</td>
<td>Single gabions, rock covered w/o foundation Fig B2</td>
<td>$40/M</td>
<td>Gabions instead of rockwork to protect village</td>
</tr>
<tr>
<td></td>
<td>630 M</td>
<td>Loosely piled rocks Fig B3</td>
<td>$10/M</td>
<td>No change</td>
</tr>
<tr>
<td>C</td>
<td>20 M</td>
<td>Single gabions w/rock foundation Fig C1</td>
<td>$45/M</td>
<td>Vegetation replaced by a large jetty to channel flow through village and to protect well</td>
</tr>
<tr>
<td></td>
<td>20 M</td>
<td>Multiple gabions w/rock foundation $185/M Fig C2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>220 M</td>
<td>Double gabions w/rock foundation Fig D1</td>
<td>$85/M</td>
<td>Vegetation not planted (500M)</td>
</tr>
<tr>
<td></td>
<td>325 M</td>
<td>Single gabions w/rock foundation Fig D2</td>
<td>$60/M</td>
<td>No change</td>
</tr>
<tr>
<td>E</td>
<td>700 M</td>
<td>Sloping and planting Fig E1</td>
<td>$20/M</td>
<td>Additional 1300 M of vegetation discontinued</td>
</tr>
<tr>
<td>E1</td>
<td>700 M</td>
<td>Fitted and layered rock Fig. E1 1</td>
<td>$20/M</td>
<td>Site changed due to village demands and time constraints</td>
</tr>
<tr>
<td></td>
<td>300 M</td>
<td>Sloping and planting w/loose rock protection</td>
<td>$25/M</td>
<td>Site changed due to villager demands and time constraints</td>
</tr>
<tr>
<td>F1</td>
<td>25 M</td>
<td>Rock covered single gabions w/rock foundation Fig F1 1</td>
<td>$40/M</td>
<td>Site F not located and alternate Site F1 chosen</td>
</tr>
<tr>
<td></td>
<td>60 M</td>
<td>Single gabions w/rock foundation Fig. F1 2</td>
<td>$35/M</td>
<td>Site F not located and alternate Site F1 chosen</td>
</tr>
</tbody>
</table>
### Site Information

<table>
<thead>
<tr>
<th>Site Length</th>
<th>Work Description</th>
<th>Work Location</th>
<th>Changes in Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 M</td>
<td>Fitted rock revetment Fig. F1 3</td>
<td>$25/M</td>
<td>Site F not located and alternate Site F1 chosen</td>
</tr>
</tbody>
</table>

**Note:** Costs do not include dump truck amortization or repair. Total cost with inland transportation of one 6 foot gabion = $42.44
ANNEX II

Summary results of production survey carried out in 1977 and 1979 by Agadez Agricultural Service.

- Table II-1 Partial Summary of Data Collected on May - September Cropping Cycle in Tabelot Zone
- Table II-2 Partial Summary of Information Gathered on November - March Cropping Cycle in Tabelot Zone
- Table II-3 Comparison of Average Allocation of Garden Plots to Different Crops According to Selected Social and Economic Groupings and Locations
TABLE II-1
PARTIAL SUMMARY OF DATA COLLECTED ON MAY - SEPTEMBER CROPPING CYCLE IN TABELOT ZONE

<table>
<thead>
<tr>
<th>&quot;Kori&quot; Basin</th>
<th>Sample Size</th>
<th>Total Surface Area Under Cultivation</th>
<th>Corn (ha)</th>
<th>Millet (ha)</th>
<th>Sorghum (ha)</th>
<th>Potatoes (ha)</th>
<th>Alfalfa (ha)</th>
<th>Malohiya ¹ (ha)</th>
<th>Okra ¹ (ha)</th>
<th>Squash ¹ (ha)</th>
<th>Tomatoes (ha)</th>
<th>Peppers (ha)</th>
<th>Other (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tabelot</td>
<td>(22)</td>
<td>15.2 hectares (3416)</td>
<td>54310 (73)</td>
<td>6418 (09)</td>
<td>325 (00)</td>
<td>6796 (09)</td>
<td>1070 (01)</td>
<td>1680 (02)</td>
<td>375 (00)</td>
<td>510 (01)</td>
<td>200 (00)</td>
<td>1740 (02)</td>
<td>-</td>
</tr>
<tr>
<td>Nabrun</td>
<td>(50)</td>
<td>16.5 hectares (3328)</td>
<td>76857 (46)</td>
<td>70119 (42)</td>
<td>-</td>
<td>16344 (10)</td>
<td>-</td>
<td>2122 (01)</td>
<td>-</td>
<td>205 (00)</td>
<td>200 (00)</td>
<td>550 (00)</td>
<td>-</td>
</tr>
<tr>
<td>Telouen</td>
<td>(42)</td>
<td>12.8 hectares (127840)</td>
<td>63070 (50)</td>
<td>52060 (41)</td>
<td>-</td>
<td>8990 (07)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3720 (03)</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: Data taken from Agadez Agriculture Service Survey

¹Crop grown for household consumption.
### TABLE II-2

**PARTIAl SUMMARY OF INFORMATION GATHERED ON NOVEMBER-MARCH CROPPING CYCLE IN TABELOT ZONE**

<table>
<thead>
<tr>
<th>&quot;Kori&quot; Basin</th>
<th>Number of Active Gardens</th>
<th>Number of Abandoned Gardens</th>
<th>Number of Owner/Operators (%)</th>
<th>Renters (%)</th>
<th>Total Surface Area Under Cultivation</th>
<th>Wheat (ha (%))</th>
<th>Potatoes (ha (%))</th>
<th>Tomatoes (ha (%))</th>
<th>Garlic (ha (%))</th>
<th>Onions (ha (%))</th>
<th>Other (ha (%))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tabelot</td>
<td>62</td>
<td>30</td>
<td>46 (80)</td>
<td>14 (20)</td>
<td>15.1 hectares (2560火)</td>
<td>11.5 (76)</td>
<td>0.4 (3)</td>
<td>1.1 (7)</td>
<td>1.2 (8)</td>
<td>0.9 (6)</td>
<td>0.2 (1)</td>
</tr>
<tr>
<td>Teloues</td>
<td>47</td>
<td>28</td>
<td>?</td>
<td>?</td>
<td>14.3 hectares (3040火)</td>
<td>10.9 (76)</td>
<td>0.7 (5)</td>
<td>1.3 (9)</td>
<td>0.4 (3)</td>
<td>1.0 (7)</td>
<td>-</td>
</tr>
<tr>
<td>Barghot</td>
<td>15</td>
<td>9</td>
<td>11 (73)</td>
<td>4 (27)</td>
<td>3.4 hectares (2210火)</td>
<td>2.6 (76)</td>
<td>0.1 (3)</td>
<td>0.4 (12)</td>
<td>0.1 (3)</td>
<td>0.1 (3)</td>
<td>0.1 (3)</td>
</tr>
<tr>
<td>Algouma</td>
<td>40</td>
<td>5</td>
<td>21 (53)</td>
<td>19 (47)</td>
<td>15.0 hectares (3510火)</td>
<td>12.0 (80)</td>
<td>0.6 (4)</td>
<td>1.4 (9)</td>
<td>0.6 (4)</td>
<td>0.5 (3)</td>
<td>-</td>
</tr>
<tr>
<td>Ebey</td>
<td>37</td>
<td>8</td>
<td>31 (84)</td>
<td>6 (16)</td>
<td>9.0 hectares (2950火)</td>
<td>6.4 (71)</td>
<td>0.4 (4)</td>
<td>1.1 (12)</td>
<td>0.5 (6)</td>
<td>0.5 (6)</td>
<td>0.1 (1)</td>
</tr>
<tr>
<td>Ilyalen</td>
<td>26</td>
<td>20</td>
<td>17 (65)</td>
<td>9 (35)</td>
<td>15.0 hectares (3660火)</td>
<td>5.9 (66)</td>
<td>0.4 (4)</td>
<td>1.0 (11)</td>
<td>0.8 (9)</td>
<td>0.7 (8)</td>
<td>0.2 (2)</td>
</tr>
<tr>
<td>Nabaran,</td>
<td>51</td>
<td>23</td>
<td>33 (65)</td>
<td>18 (35)</td>
<td>15.3 hectares (2925火)</td>
<td>11.3 (74)</td>
<td>0.5 (3)</td>
<td>1.5 (10)</td>
<td>0.9 (6)</td>
<td>0.8 (5)</td>
<td>0.3 (2)</td>
</tr>
<tr>
<td>Tehintibizgin</td>
<td>35</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>11.4 hectares (3750火)</td>
<td>8.1 (71)</td>
<td>0.6 (5)</td>
<td>0.6 (5)</td>
<td>0.4 (4)</td>
<td>0.7 (6)</td>
<td>1.0 (9)</td>
</tr>
<tr>
<td>(79)</td>
<td>23</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>28.0/9.0 hectares (3915火)</td>
<td>6.5 (23/72)</td>
<td>1.3 (5/14)</td>
<td>0.3 (1/3)</td>
<td>0.2 (1/2)</td>
<td>0.4 (1/4)</td>
<td>0.4 (1/4)</td>
</tr>
<tr>
<td>(77)</td>
<td>68</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>8.0 hectares (3070火)</td>
<td>5.9 (74)</td>
<td>0.8 (10)</td>
<td>0.2 (3)</td>
<td>0.1 (1)</td>
<td>0.4 (5)</td>
<td>0.6 (8)</td>
</tr>
<tr>
<td>Biri</td>
<td>26</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>14.5 hectares (3020火)</td>
<td>9.8 (68)</td>
<td>1.2 (8)</td>
<td>0.8 (6)</td>
<td>0.7 (5)</td>
<td>0.7 (5)</td>
<td>1.3 (9)</td>
</tr>
<tr>
<td>Eadaao</td>
<td>48</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>14.5 hectares (3020火)</td>
<td>9.8 (68)</td>
<td>1.2 (8)</td>
<td>0.8 (6)</td>
<td>0.7 (5)</td>
<td>0.7 (5)</td>
<td>1.3 (9)</td>
</tr>
<tr>
<td>Abardak</td>
<td>70</td>
<td>7</td>
<td>50 (70)</td>
<td>20 (30)</td>
<td>16.5 hectares (2500火)</td>
<td>10.0 (61)</td>
<td>0.6 (4)</td>
<td>2.2 (13)</td>
<td>1.5 (9)</td>
<td>1.8 (11)</td>
<td>0.5 (3)</td>
</tr>
</tbody>
</table>

1. Average area per garden in square meters.

2. This particular portion of the study measured the total area of the garden as well as that portion of the garden actually cultivated. Based on this figure as well as other limited surveys and observations, it seems correct to estimate that during the cold dry season, gardeners usually plant about one third of the area of the garden to crops. Most often they have indicated that water available from the wells for irrigation will not permit a larger percentage of their garden to be planted.
## COMPARISON OF AVERAGE ALLOCATION OF GARDEN PLOTS TO DIFFERENT CROPS ACCORDING TO SELECTED SOCIAL AND ECONOMIC GROUPINGS AND LOCATIONS

(Survey: Agadez Agricultural Service Feb. 1979)

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>Total Average Area Cultivated per Garden (M²) (100%)</th>
<th>AVERAGE AREA PLANTED TO DIFFERENT CROPS (M) AND PERCENTAGE OF AVERAGE AREA CULTIVATED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Total sample average for the Tabelot region (62 gardens)</td>
<td>2542</td>
<td>1917 (75)</td>
</tr>
<tr>
<td>2. Variable group representing gardeners having assured sources of income apart from their garden. (5 gardeners)</td>
<td>2775</td>
<td>2175 (78)</td>
</tr>
<tr>
<td>3. Variable group representing gardeners considered &quot;wealthy&quot; (8 gardeners)</td>
<td>2599</td>
<td>2046 (79)</td>
</tr>
<tr>
<td>4. Variable group representing gardeners considered &quot;poor&quot; (8 gardeners)</td>
<td>2539</td>
<td>2043 (80)</td>
</tr>
<tr>
<td>5. Variable group of gardeners cultivating an area greater than 3500 sq. meters. (8 gardeners)</td>
<td>4200</td>
<td>3280 (78)</td>
</tr>
<tr>
<td>6. Variable group of gardeners cultivating an area between 1900 sq. meters and 1000 sq. meters. (8 gardeners)</td>
<td>1470</td>
<td>1470 (75)</td>
</tr>
<tr>
<td>7. Variable group of gardeners considered to have abundant water resources in their gardens. (8 gardeners)</td>
<td>3125</td>
<td>2465 (79)</td>
</tr>
<tr>
<td>8. Variable group of gardeners considered to have poor water resources in their gardens. (8 gardeners)</td>
<td>2200</td>
<td>1690 (77)</td>
</tr>
<tr>
<td>9. Averages from gardens located at Timia 1975-6. (12 gardeners)</td>
<td>3096</td>
<td>2581 (84)</td>
</tr>
<tr>
<td>10. Averages from gardens located at Abardek 1979. (66 gardeners)</td>
<td>2500</td>
<td>1515 (60)</td>
</tr>
<tr>
<td>11. Averages from gardens located at Afassas (Birni) 1979. (26 gardeners)</td>
<td>3070</td>
<td>2495 (81)</td>
</tr>
</tbody>
</table>

Source: Agadez Agricultural Service