13. SUMMARY

This subproject of the Central Tunisia Development Project has been implemented with a high level of performance by the Government of Tunisia (GOT) through the Office of Livestock and Pastures (OEP) of the Ministry of Agriculture (MOA) with the assistance of the contractor, Oregon State University (OSU). The goal of the project is to improve the real income of 3,600 farmers-stockmen in Central Tunisia by development, improvement and sound management of rangelands and sheep flocks. The purpose of the project is to introduce improved rangeland and stockraising management practices among the farmers in Central Tunisia. In order to reach the goal and purpose, the project is designed to introduce and evaluate promising practices through improvement and development of 36,000 hectares of collective and private land spread over 12 sites in the 29 delegations of Central Tunisia. These improvements are to include reseeding of rangelands, fertilization, resting, grazing management systems, establishment of forage reserves, fencing and guarding range, construction of water-retention basins and improvement of flock health and management by vaccination, drenching, dipping, supplemental feeding and introduction of improved breeding stock and modern sheep raising practices.

In order to accomplish these improvements, an important objective is to establish and assist in the development of a range management unit of the OEP. This is to be accomplished by technical assistance, participant training and provision of commodities.

During the first two years of operation covered by this evaluation, the implementation targets have been generally met or exceeded except for the number of hectares under improvement. The original target was based on extensive use of resting (deferment of grazing) to permit the ranges to recover from the effects of long term overgrazing. A detailed plant inventory of the sites to be rested determined that many of the perennial grasses that resting was designed to benefit had been eliminated by cultivation or grazing. The residual vegetation was predominantly non palatable or of poisonous species, thus resting would mainly benefit undesirable species. Because resting can be accomplished quickly on a large scale, the reduction in area suitable for this practice eliminated the possibility of reaching the original target. It has been proposed by the project staff that the original target of 36,000 hectares be reduced to 20,000 hectares. The areas intended for resting were found to have good potential for revegetation in most cases. Revegetation with the seeding of perennials, annuals or planting of shrubs is slower to implement than resting, but substantially increases the grazing potential in a much shorter time span. This would increase the potential project impact on the reduced number of hectares.

14. EVALUATION METHODOLOGY

This is the mid project evaluation scheduled in the subproject paper. It was conducted by a joint US/GOT evaluation team composed of a team leader/range management specialist, a plant materials specialist, an agriculture economist and the Central East Regional Director of OEP. The methodology used was to visit the intervention sites, prospective intervention sites, plant materials nurseries and other locations of project activity. The OSU project technical assistance staff and their counterparts were asked to review their work and answer the questions from the team. This involved nearly two weeks of intensive travel. Discussions were also scheduled with the administrative staff of the counterpart agency, cooperating agencies, the Minister of Agriculture, Governor of Kairouan Governorate, and other relevant GOT officials. The USAID Mission staff including the Mission Director were kept fully briefed by the evaluation team. Because of the strong desire of the administrators of the MOA to have the subproject expanded and the life of project extended, the evaluation focus was directed toward examination of this request. When the team had determined this was justified based on their evaluation and were satisfied this had the support of both the Minister of Agriculture and the USAID Mission Director, the primary evaluation effort was directed toward developing an amended project paper which reflected the recommendations of the team and was acceptable to the project, other GOT and USAID Mission staffs.

15. EXTERNAL FACTORS

The project has not been significantly affected by external factors even though the GOT has been financially pressed by a drought and the generalk worldwide depressed economic conditions during the period in which the project has been operational.

16. INPUTS

The overall input delivery by both the GOT and OSU has been timely and appropriate. Limited modifications have been made in the scheduled inputs to better reflect the needs identified through project implementation. The short term training of technicians at OSU was initiated very soon after signing of the contract. Ten participants have been provided practical field training in Oregon for six weeks (five each year in 1982 and 1983). Four additional trainees are preparing to depart. The original long term participant trainees were scheduled for M.S. degrees. This was changed so that half (5) were scheduled for M.S. programs and the other five were selected from two-year certificate holders with three years of practical experience and place in programs in the U.S. to provide two years additional technical skills development and a B.S. degree.

The type and total person months of technical assistance have not been changed, but the duration has been modified slightly by reducing one year of TA in sheep production and adding it to plant materials. This reflects the early availability of Tunisian staff capable of handling the sheep production requirements and the need for additional effort in the identification and seed multiplication for plant materials. The provision for TDY consultants has been timely and appropri ate to project needs as has the TA staff.

The assignment of GOT counterparts has in general been timely and adequate. The usual problems are being encountered where once the counterparts have demonstrated their capability they are sent off for participant training. This results in discontinuities and interception in project needs. This will remain a problem until all scheduled training is completed.

The provision of heavy equipment services, the construction of water-retention basins and veterinary services by other units and organizations has encountered some scheduling difficulties, but has been generally satisfactory.

The deliveries of commodities by both the contractor and the GOT, although satisfactory for primary needs, have experienced some unnecessary delays and commodity needs identified in the implementation process were not adequately foreseen. This has included the need for all weather, high clearance vehicles for use during the rainy season, adequate spare parts for drills and other imported impliments and some long delays in custom clearance through inadequate handling of customs documentation requirements.

17. OUTPUTS

Because the project has been operative less than two years, many of the anticipated outputs are yet to be realized. However, the measurable outputs to date are quite impressive and generally exceed targets substantially with the exception of number of hectares rested. This is due to a deliberate change mandated by a detailed plant inventory that indicated a major reseeding effort was necessary and would be more productive than a resting and rotational grazing program. Although the various interventions have had mixed success, this has been due in part to the experimental nature of the interventions under conditions in Central Tunisia, but more directly to serious drought conditions particularly in 1983-84. In spite of these difficulties the success rate has been more than satisfactory. The experience gained in the first two years makes the potential for major progress in the future quite high. This has been the basis for the GOT to request that AID increase the resources and life of project.

The outputs in the first two years are summarized in the project activity report for 1983. These included operations on

six sites in two provinces that involved interventions that represented 3,735 hectares. In addition, extensive seed collections were made of local plant species with range potential which were tested at five locations along with plant materials imported from the USA, Australia, Kenya and various Near East locations. This represented approximately 150 new species of local and introduced material that included grasses, legumes and shrubs.

In addition to range interventions, forage feed reserves of shrubs were established. In 1983 alone, 62 hectares were planted which included planting of 60,840 acacia shrubs, 30 hectares of spineless cactus and 42 kilometers of thorned cactus for live fencing. Carob trees were planted to provide future shade for sheep flocks. This amounted to 18,013 trees. In addition, plantings were made of atriplex for protein feed reserves.

The cumulative totals for the two years of project operation cinluded 501 beneficiaries. The interventions on their behalf included 2,530 hectares reseeded to perennials, 434 hectares to annuals, 68 hectares in live feed reserves, 617 hectares rested. The total interventions covered 3,735 has.

To compensate farmers for lost use of their rangelands during the improvement phase, supplemental feed was distributed at half price based on a formula for lost grazing. So far 150 performance tested rams have been distributed in the flock improvement program and veterinary services have been provided to 1871 stockmen. These involved vaccination, drenching and dipping which reach a total of 29,659 sheep.

A total of seven water retention basins have been constructed. Extension campaigns have been undertaken with both current farmer participants and potential p@rticipants. This is a continuing activity. Ten short term participant trainees have completed training in the USA. Four additional short term and three M.S. level participants are preparing for departure. This means that in all ten degree level participants will have started their training.

18. PURPOSE

The project purpose as stated in the project paper is to introduce improved rangeland management and stockraising practices among the farmers of Central Tunisia. As outlined in the ouputs of the project so far this purpose is being met and in general has exceeded expectations.

19. GOAL/SUBGOAL

The stated goal in the project paper is to improve the quality of life and real incomes of the poor majority in the target area. The number of beneficiaries reached and the quantity and quality of services delivered so far are very encouraging in relation to reaching the project goal.

20. BENEFICIARIES

The project is directed at both those that are dependent on collective grazing areas as well as those dependent on and privately held grazing areas. Eighty percent must have holdings of less than twenty hectares. So far these criteria have been met. In addition to the poor majority, the beneficiaries have also included female farmer-stock raisers who are functioning as heads of households. Thus the project is impacting on the priority targets for AID assistance.

21. UNPLANNED EFFECTS

There have been no real unplanned effects other than the changes mandated by the amount of rangeland that had been plowed and cropped as marginal farm land. This is due to efforts to gain access to land under the current process of land title establishment: Those that farm land have the possibility of gaining title. This has caused much land to be farmed that is not suitable and in the long term could create serious erosion problems. This has had a direct influence on project activities.

22. LESSONS LEARNED

The primary lesson learned is that the farmer-holders at the lowest end of the resource scale are both unable and, as a result, unwilling to risk changes required for improved range and livestock management. As a result, the project target that 80% of participants must be in the limited resource category may be too high for full project impact in relation to potential, since reaching this target may require inclusion of those unable to benefit.

Another lesson learned is that it is very difficult to organize private holders, and they cannot be effectively organized for communal grazing of private holdings, especially if they are not part of a close farming group.

SPECIAL COMMENTS

This project has been an outstanding example of where a university contractor has fielded a very competent team of well trained staff that have been able to forge a highly productive team relationship with very competent counterparts at the early career level. As a result the team effort has produced high morale and productivity levels leading to a rapid payoff. Because of this, a high priority has been placed by the GOT and USAID in making full capitalization through adding resources and time to the subproject.

The primary recommendations of the evaluation team are that the subproject be extended an additional three years with added technical assistance provided in the areas of revegetation, grazing management and seed production. This will permit

adequate guidance for increasing the amount of rangeland reseeded with a minimum target of 2,000 hectares per year. To accomplish this, it is recommended that a 150 hectare seed production farm be established. In order to optimize use of the improved range and to maximize flock utilization without causing range deterioration, grazing trials are recommended to determine grazing optimization curves for the major vegetation types. These trials will also provide excellent demonstrations for farmer extension efforts.

To institutionalize the capacity to maintain the range improvement program after completion of the project, expansion of the participant training program is recommended along with additional commodities needed to implement the expanded level of activity. These are fully detailed in a draft project paper supplement prepared by the evaluation team.

CENTRAL TUNISIA RURAL DEVELOPMENT

RANGE DEVELOPMENT SUBPROJECT

EVALUATION REPORT

AND

DRAFT PROJECT PAPER AMENDMENT*

(PROJECT NO. 664-0312.8)

*This draft PP amendment was prepared by an outside evaluation team and does not necessarily represent the views of USAID/Tunis nor the GOT.

July 1984

Project Goal and Purpose:

This is a subproject of the Central Tunisia Rural Development Project which has the overall GOAL to improve the quality of rural life and real income of the poor majority in the area. The subproject is directed more specifically at the farmer-livestock producers. The PURPOSE of this subproject has not changed and is to introduce improved rangeland management and stockraising practices among the livestock producers of Central Tunsia.

Project Description:

1. Problem statement: Demographic growth in Central Tunisia during the past thirty years has resulted in major increases in livestock inventories, particularly sheep numbers, which have expanded from about 635,000 head in 1950 to over two million head by 1980. This increase has been acompanied by replacement of the large nomadic herds that historically have grazed the area, with small flocks that tend to be poorly managed. The small flocks comprise a part of the mixed farming system that is practiced by the farmer-livestock raisers who have made the transition from nomadic herder to sedentary farmer. The settling of the nomadic population, along with popylation increases, have caused intensified pressure on available land with the result that large amounts of marginal land have been plowed and planted to barley and other crops, and lands unsuited to any type of cultivation have been excessively overgrazed. The result has been a low level of animal nutrition, which is exacerbated by varying annual and interseasonal rainfall. Consequently the production of the individual and the national flocks is extremely low. This is true both in terms of lambing rates and carcass weights. Because of the low offtake, livestock producers tend to keep greater numbers of animals each year in order to maintain a certain level of income.

The high rate of crop failures, due to inadequate and inconsistent rainfall, has resulted in much of the marginal cropland reverting back to grazing use. Returning these lands to grazing has not been accompanied by revegetation, therevfore leaving only residual plants, comprised largely of annual weedy species, of low palatability and forage production potential, and frequently including a high percentage of poisonous plants.

Failure to revegetate the marginal croplands, that are generally left fallow or abandoned from cropping altogether, results from the lack of knowledge about vegetation potentials, and unavailability of seed, equipment and technical advice on revegetation and follow-up management.

Appropriate management practices on non-cropped rangelands are also lacking due to the type of tenure arrangements, lack of knowledge and failure of users to control access to common grazing lands necessary to permit their proper use and improvement. The result of these failures has been low productivity of both the rangelands and small ruminant flocks. This reduces the income potential of large areas of a scarce land resource and creates severe erosion problems from overgrazing and farming of marginal lands.

2. Proposed solution - The Project Role: In recognition of this problem, the GOT has included the development of rangeland improvement and management capability as part of its program for the development of Central Tunisia. This subproject was implemented in 1982 by the Office of Livestock and Pastures (OEP), a parastatal under the Ministry of Agriculture (MOA). OEP has established a range management unit (RMU) that is directly responsible for the project.

Technical assistance is provided through a host country contract with Oregon State University (OSU). During the first two years of the project, a variety of activities were carried out. Initially a socio-economic survey was conducted to gain information about the proposed beneficiaries and to obtain a better estimate of livestock numbers on the sites on which interventions were planned. A range survey was also carried out on the sites selected for initial interventions. These initial sites included both an area of common grazing land and one composed of privately held land. On collective lands a range management committee of users was organized with the help of local leaders. Based on the plant species analysis from the range survey it was determined that emphasis needed to be shifted from resting rangelands to promote their recovery, followed by rotational grazing on these lands, to revegetation as the primary interventions leading to range improvement. This requires changes from the initial target of 36,000 hectares to be improved on twelve sites, to a reduction to 20,000 hectares to be improved. Revegetation is an intervention much more difficult and time consuming to implement than resting, and is more expensive to undertake.

Successful revegetation with adapted species of perennials and annuals, followed by proper management, will provide much higher range production in a shorter time frame than resting, unless the area rested has a high initial population of desirable range plant species. Based on the experience gained in the initial two years, in which 2,530 hectares were seeded to perennials, 434 hectares to annuals, and 68 hectares to shrubs and thornless cactus for live forage reserves, the potential impact and economics of the project appear very favorable

Other interventions included distribution of 150 performance tested improved rams, vaccination and treatment for endo and ecto parasites of 29,659 sheep for 871 stockmen, planting 18,013 carob trees for flock shade, planting 42 kilometers of cactus fence and construction of 7 water retention basins.

Besides revegetation, 617 hectares of range was rested. Other interventions tested included scarification with locally fabricated pipe harrows to enhance recovery of rested land. To compensate farmers for lost grazing during the period of range improvement, supplemental feed was provided with a 50% subsidy. A limited amount of oat and vetch seed was distributed to encourage participants to produce hay as a supplement.

A thorough mid-project review by a combined external and GOT evaluation team concluded that the project had made significant progress and offered excellent potential for reaching its goal and purpose. The change in emphasis from resting ranges to revegetation will require additional time and resources to ahieve the potential impact. As a result, the mid-project review recommended extending the life of the project two years and increasing the resources to provide for the establishment of a seed production farm to initially provide seed for revegetation of 2,000 hectares of rangeland per year by the project, and to act as a foundation seed farm for private seed producers who could provide seed to farmers adopting the iomproved range and livestock management practices demonstrated by the project. In addition, greater emphasis is needed to develop grazing optimization data through grazing trials that are necessary for establishing proper grazing management of the range once it is improved.

In order to provide the required services and advice to farmers and stockmen after the completion of the project, additional participant training was deemed necessary. The

development of the seed farm, increased vegetation activities, and conducting the grazing trials, requires additions in technical assistance and commodities. This amended project paper provides for these needs.

3. Time Phasing: This project is both an institution building project and a development project. The institution building activities are the development of the RMU in the OEP. This is being done through participant training and technical assistance. This amendment will give expanded scope by the addition of a seed production function to the OEP to provide both foundation seed and supplies for the project reseeding needs of species identified in the plant materials testing program. The increased emphasis on revegetation, in addition to the management and extension functions, will require longer and different types of technical assistance and added types of participant training. This amendment will extend the LOP to September 1989 and cover the increased costs. All of the ten original long term participant trainees are now assigned to studies abroad. Identification of the additional long term trainees added will require early attention once this amendment is approved. Because of the long lead time required, the development of the seed farm and ordering the necessary commodities needs highest priority. Grazing trials recommended will be based on both revegetation interventions already carried out and on future interventions. They should receive early planning to ensure adequate information as they will form the basis for development of grazing utilization management plans. Unless unexpected delays occur, the time frame proposed should permit the project to acomplish its objectives.

4. Target Areas: In addition to the sites included in the original paper, additional sites will be considered to the north of the present locations. The boundaries of the intervention area are set by those of the overall Central Tunisia Rural Development Project. However, as farmers take on the responsibility for range improvement, the Project will need to be flexible in determining the area receiving technical advice. It may be necessary to utilize higher rainfall sites for certain seed production functions to insure adequate supplies that are outside present project boundaries. As range improvement is needed in several parts of the country, responding to farmers demands should be considered in terms of the need for livestock forage and erosion control purposes rather than strictly political boundaries.

5. Beneficiaries: The primary beneficiaries of the project will be the livestock producers who reside within the boundaries of the Central Tunisia Rural Development Project. Initially this will cover about 2500 farm families. That number should rapidly begin to expand by the end of the project financing, to where at least 15,000 to 25,000 families will be primary beneficiaries within twenty years. Secondary benefits will be gained through more reliable and expanded supplies of meat and wool in the country, reduction of soil erosion and water runoff, reduced rural to urban migration, and expansion of service industries that will accompany increases in income.

6. Project Outputs: The primary outpouts will be a Range Management Unit of the OEP with adequatly trained staff capable of sustaining a range management program in Central Tunisia that can revegetate and oversee management of 2,000 hectares of range improvement accomplished annually, provide the seed and planting stock to sustain this annual increment of improvement, and provide foundation seed and technical advice for private seed multiplication that should develop to fill demand on private holdings as a result of project demonstration and extention activities. In addition, the RMU will oversee and provide advisory functions on range and livestock management, supply supplemental feed during periods of intervention that reduces grazing, arrange for veterinary services, improved breeding stock and other services required for improvement of the range livestock producers. Applied research activities will be conducted to test new plant materials and technical innovations that become available.

7. Project Inputs: To be determined by USAID/Tunis, GOT Ministry of Agriculture and project staff.

8. Administrative/Management Responsibilities:

a. Project Organization and Management.

This amendment makes a slight change in organizational responsibility. The RMU has operational responsibility for the project under the OEP. The contractor operates under a host country contract in an advisory capacity. A coordinating committee comprised of the various participating and collaborating agency administrators reviews programs, progress and resolves inter-agency problems. The

Central Tunisia Development Authority (CTDA) will no longer have coordination and evaluation responsibilities. Those responsibilities will be handled by the coordinating committee and the MOA.

b. Administration.

(1) GOT

As already outlined the OEP is the counterpart agency. The direct administrative responsibility has been assigned to the director of the Range Management Unit.

(2) Contractor

The OSU contractor operations are advisory in nature, but include collaborative operational assignments designated by the Director of the RMU, as appropriate. The administrative responsibility for all four OSU subprojects has been assigned in-country to one of the OSU resident advisors to facilitate coordination and consolidation of services. Day-to-day responsibility for OSU staff and technical requirements has been assigned to the senior resident advisor for each subproject. The contractor is also responsible, in collaboration with the RMU, for procurement of U.S. originating commodities.

(3) AID

The USAID agricultural officer in Tunis has responsibility for AID oversight, monitoring and evaluation requirements. In the event that this office is terminated in Tunis, responsibilities would have to shift to Washington, with possible support from the regional Near East Offices in Rabat and Aman. This should pose no serious problems, as the Ministry of Agriculture in Tunis has considerable experience in handling USAID projects, including host country contracting for services. Likewise, the contractor has experience in operating with the the MOA, and has already demonstrated its ability to handle the existing contracts, including procurement and shipping of commodities.

10. Statutory Checklist:

All statutory criteria have been met. (To be verified by USAID/Tunis)

RECOMMENDATIONS:

That the extension of the Tunisian Range Management Subproject No. 664-0312.8 be approved and additional funds in the amount of $3.0 million be added. It is further recommended that the Project Assistance Completion Date (PACD) be extended an additional 36 months to September 30, 1989.

PROJECT RATIONALE AND DESCRIPTION

A. Background:

1. General.

The Range Management Subproject was funded under the comprehensive Central Tunisia Development Project (664-0312), as an amendment to that project dated June 5, 1981. As a subproject, Range Management had as a purpose to introduce improved rangeland management and stockraising practices among Central Tunisia's farmers. A scheduled evaluation held in May of 1984 concluded that the project was making very good progress toward achieving the project's purpose. Range improvement techniques were being systematically developed, and almost 4,000 hectares had already received range improvement interventions. Most targets were being met, and generally planned implementation was according to schedule. In the area of livestock management, the evaluation team felt that, although work was progressing, these techniques were still a long way from being introduced to area farmers.

The two main sub-elements of the project purpose were to test and adapt a technology for range improvement in Central Tunisia and to develop an institutional capability within the OEP of the Ministry of Agriculture to support and carry out range improvement in the area. The evaluation team felt that both of these sub-elements were being successfully developed. There was a strong recommendation that the project continue, and hopefully expand its efforts in these areas.

The evaluation recommended that an extension of the project be granted so that 3 additional years of work could be done. One reason for thie recommendation was that the original technical design emphasized deferred grazing or

resting of land as the major technical intervention. The project staff has found that more active interventions such as reseeding were required on large portions of the rangeland. This has required testing and adapting a wider range of interventions for range improvement on a much larger scale than was originally proposed. The evaluation concurred with the project staff in their decision, and therefore proposed an additional two years for developping appropriate techniques for range improvement, testing and evaluating those techniques, and extending them to area livestock producers.

Additionally, the evaluation and redesign team, in discussions with project staff, AID officials, and GOT officials, proposed that efforts be made to insure that the project would be capable of expanding, and that the range improvement efforts could be sustained over time. This requires that in addition to continuing the planned efforts of the project, some additional emphasis needed to be placed on insuring the long-range impacts of the project work. Most notably will be an effort to induce livestock producers to increasingly assume responsibility for rangeland improvement.

During the next five years, an increased emphasis will also have to be placed on improved livestock management, the relationship of the livestock to the range, and the techniques of improved livestock-range management will have to be extended to livestock producers on the improved range sites.

This proposed amendment to the Range Management Project, therefore, is a continuation of a project that has been under implementation for the past two years. It will extend the project two years in time, and strengthen and expand its efforts, which have already been determined to be successful.

2. The Project Area.

The central portion of Tunisia is much less developed, more sparcely populated and has considerably lower average income levels than the northern portion of the country. The southern portion of Tunisia includes part of the Sahara and the nearly vacant areas on the fringe. It is largely uninhabitated outside of a few oases. The central zone is largely dryland cropping and semi-arid rangelands interspersed with irrigation perimeters from either catchments or tube wells. Many of these are small farmer irrigation of limited portions of their small holdings from hand dug wells or use of natural springs. Many of these have been developed or improved under the Small Holder Irrigation subproject of the CTRD.

The dryland mixed farming system served by this project covers a rainfall zone that is primarilly under 400 mm of annual precipitation and most of which is 300 mm or less.

Most of the farm holdings are less than 20 hectares. Nearly all farmers raise livestock as part of the system, mainly sheep. Generally flocks are under fifty head and average about twenty-five. Sheep are a major source of farm income, particularly for those farmers without any irrigation. Where small scale irrigation is available, vegetables, fruit crops and forages, such as alfalfa, are raised as cash crops with all residues fed to livestock. These small farmers also crop dryland with barley as the primary crop and durum wheat on the better soils. These provide stubble and straw residues for sheep feed, and will be grazed when moisture is inadequate for grain development. These fields will be fallowed after the grain crop, primarilly by allowing the fields to grow up in weeds and volunteer grain which is used for grazing. On deeper soils, tree and vine crops, primarilly olives, almonds and grapes are raised. Some dryland vegetables and food legumes are also produced.

The non-tillable and marginal lands are used as either privately held or communal grazing land. The sheep are dependent on a combination of feed resources that include the grazing land, fallow crop land, stubble fields, crop residues and supplementation from hay, cultivated forages and concentrate based on barley grain as the locally produced component.

In the past, much of this region was communal range land that was used by migratory tribes that held large bands of sheep and goats and travelled long distances during annual migration that followed feed sources. As these migrants settled, nearly all tillable land was plowed in efforts to privatize holdings by each family. Livestock numbers have nearly quadrupled in the past thirty years while areas of rangeland have steadilly decreased. This has put increasing burdens on farm land to support the flocks and increased importation of hay, straw and concentrate feeds have been required to sustain animal numbers. This has been made economically viable by rapid rises in the market demand and price of sheep and goats during the period of rapid economic growth resulting from the oil boom and high levels of employment for migrant labor in Europe. The economics are less attractive today, where conditions have now changed, and livestock prices have stabilized or declined. Much of the land plowed has proven to be sub-marginal and abandoned for cropping, but not revegetated for grazing.

3. <u>Relationship of Program Objectives:</u>

a. Government of Tunisia

The GOT has placed a high priority on the improvement in the

income for the rural population in Central Tunisia, which is an area of predominantly small, limited resources farmers and landless laborers. Most of these small holders obtain a substantial or major portion of their farm income from small ruminants, mainly sheep. One of the favored elements in the Tunisian diet is meat of sheep. The per capita consumption has been increasing more rapidly than production. Increasing the productivity of sheep flocks through improved range and livestock management will help both producer and consumer. In addition, range improvement will reduce soil erosion and excessive water runoff and stream flooding and siltation. This subproject is therefore fully in accord with GOT priorities.

b. AID Priorities

AID's present orientation in Tunisia is to reduce its activities as the country reaches an economic level that places it considerably above the level of most AID recipient countries. Efforts in agriculture, during a period of phase-down, are being restricted to the area of Central Tunisia. As noted previously, this area has more disadvantaged people than the northern part of the country. Although urban development and private business and industry development now are considered of higher priority in AID's Tunisia program, a certain level of effort was considered important in the development of Central Tunisia. In addition to the need to help meet Tunisia's food requirements, helping to increase the incomes of Central Tunisia's farmers helps to remove some of the pressure on rural to urban migration which can exacerbate the efforts to improve uban conditions. AID's entire Central Tunisian Rural Development Project has been undertaken in an effort to aid the GOT in producing food, raising incomes and stimulating balanced growth.

c. Other Activities in Related Areas.

Two additional CTRD subprojects have direct relationship to this subproject. The Dryland Farming Systems Research Subproject is examining improved practices to increase the dryland yields of wheat and barley that form a major part of the annual feed calendar. In addition, they are doing research on hay, forage and pulse crops that are important potential improvements on the croplands of beneficiaries for use as livestock feed. The Extension Subproject is developing a core of specialists, several of which could provide in-service training and technical support to the RMU. In addition, the Subproject of Small Holder Irrigation is moving into improved on-farm water management. Many of the beneficiaries of the Range Management Project have some irrigated resources or use grazing on irrigated lands at some season. All these subprojects need to interact and provide exchange of information and technical assistance as appropriate. Since they are all being provided technical assistance by the same contractor, technical cross-fertili-

zation should be possible.

The World Food Program has been providing food-for-work commodities to project beneficiaries on land that is rested. They also support planting cactus for feed reserves in the region. This cactus program may become a large scale donor assisted effort in the future.

The Near East Bureau is working with various international agencies, the S&T Bureau and recipient governments to improve the exchange of information and biological materials and to coordinate in-service training where appropriate. This is focused on dryland agriculture and includes the activities covered by this subproject. Every effort should be made by the subproject to both take advantage of these network activities and contribute to them. There are closely related AID financed projects in Morocco and Portugal, and one is in the project design phase in Jordan. Every effort should be made to interact with them.

B. Detailed Project Description:

1. Project Purpose

The purpose of this subproject amendment remains the same as presented in the original subproject PP, that is, to introduce improved rangeland management and stock raising practices among the farmers in Central Tunisia.

2. Project Outputs

Anticipated project outputs as stated in the original subproject PP are adequate to achieve the purpose and progress toward that purpose appears satisfactory. However, in order to assure the creation of a sustained program of diffusing the techniques among Central Tunisia's farmers, and thereby progress toward the long range economic and social goal, a reinforcement of existing outpiuts and adding further outputs seems advisable. Therefore, the outputs have been revised and somewhat restated.

(a.) Proven economically feasible technology for rangeland and forage improvement.

The original subproject design intended to obtain improved rangeland primarilly through the development of 12 pilot sites covering approximately 36,000 hectares of land. Various techniques would be used on these sites to achieve that improvement, with the largest emphasis placed on resting and deferred grazing. The Project staff found that a greater emphasis had to be placed on other techniques such as reseeding, revegetation, mechanical treatment, etc. However, these techniques had to be adapted to the situation in Central Tunisia.

Consequently, this amendment puts more empahsis on developing and adapting technology for rangeland improvement so that the chances of successful improvement can increase and costs can be minimized. A target will be to obtain a 50% chance of sucessful intervention through 1985, a 60% chance through 1987, a 70% chance in 1988, a 75% chance in 1989-1991, and an 85% chance thereafter.

The Project will continue to work on:

-screening of plant materials, and
-testing methods of land preparation and reseeding/revegetation,

and will increase emphasis on:

-measuring the economics of the interventions;
-grazing management to determine appropriate utilization of range and production levels through grazing trials; and
-development of socially acceptable grazing systems.

The assumptions are that this improvement can be obtained in a cost-effective manner and that the present technology can be improved upon, at least for most sites.

(b.) A Project Unit that can undertake range and forage improvement on approxamately 3,000 hectares per year, and provide technical assistance to farmers and extension services.

This output was previously contained under outputs for trained field staff, trained backstop staff, pilot units and land treatment. Operating in conjunction with output (a) above, the objective is to intervene on large areas under actual range conditions or on cereal cropping areas to increase the available forage. The operations should be conducted over several years and several different sites to demonstrate to the farmers the benefits of the technology. At the same time the staff will be trained under field conditions, thereby increasing their technical expertise that will be required for sustained efforts in range and fodder improvements.

It is assumed that concentrating the training and development of the unit, while targeting a smaller surface area, will improve the prospects for long range expansion of project efforts. It is also assumed that the unit can shift the responsibility for improvement of forage production to the farmers, thereby decreasing its direct intervention role and increasing its technical advisory role. A test of these assumptions will be the target of 100 farmers undertaking improvements by the end of the project with technical assistance form the

project.

(c.) A management unit for the Introduction of Improved sheep management to Central Tunisia's farmers.

This output was previously part of the pilot unit output, and increased meat production and specialized feeding outputs. The project found it necessary to establish a separate activity to work with sheep production. Considering that one of the major ways in which producer incomes will be increased will be through the increased expansion of meat and wool production, and a major share of this expansion will be through improved livestock management, a more important empahsis on livestock management is advised. This output therefore will combine the previously more disperate elements of sheep husbandry under one output, and increase both the focus and extent of those activities in the Project. The activities of the sheep unit will continue, namely:

-distribution of hay and concentrates;
-organizing and assisting with animal health campaigns;
-genetic improvement through the distribution of improved rams; and
-creep feeding domonstrations with area farmers.

The project has timed the distribution of feed to correspond to the breeding and lambing seasons, thereby hoping to improve lambing rates and lamb survivability and growth. As data is gathered on the benefits of this activity, as well as the creep feeding and animal health interventions, convincing farmers of these benefits will become the main task. Therefore an extension system in sheep husbandry will have to be developed. Through the grazing trials that are recommended, information should be collected on meat production, breeding and lambing rates and general animal health. In addition overall feed, nutrition and management calendars are needed. A comparison of traditional management practices with those recommended by the livestock services and demonstrated in actual farm conditions should give the basis for improved husbandry practices to be extended.

This Output should therefore add:

-analysis of comparative production data;
-economic analysis of management and feeding practices;
-general herd management comparative data analysis;
-an anlysis of the social problems of sheep management improvements; and
-a sheep husbandry extension system.

(d.) A Seed Production System.

This output is added, in this amendment, to the original

project design. This has been done for several reasons:

- The heavier emphasis on reseeding has drastically increased seed requirements and costs. Already, almost $150,000 have been spent on seed. To meet the projected level of 2000 hectares reseeded each year, from 10,000 (@ 5kgs./ha/) to 24,000 (@ 12 kgs/ha.) of seed will be needed each year. Seed costs have ranged from 2 dinars to 4.5 dinars/ kg plus shipping. Thus costs will be at least $60,000/year and could reach $144,000/year.

- Local plant materials have been screened that are very promising and could be more adaptable to local conditions. These need to be multiplied.

- An expanding range management program will require a low cost source of seed, in increasing quantities. The original targets of 12,000 new hectares per year after the end of project funding would require up to 144,000 kgs. of seed.

- Foreign sources cannot always be relied upon to supply the quantities and types of seed needed.

- A foreign exchange saving of $.5 million may be possible.

A seed farm will be built which will have an initial minimum capacity of producing 10,000 kgs. of seed annually. A seed cleaning and treatment capacity will also be established to handle the farm's production. This will meet much of the project's needs.

The capacity to clean seed will be about 3 to 4 times what is believed will be produced on the farm. This will allow treatment of seed produced by contract growers through seed production contracting, which the project will try to develop. Eventually, the seed production will move to the private sector, and the seed farm will produce only parent material.

It is assumed that economical production of local seed material can be done through private channels to meet future range reseeding needs.

3. <u>Project Inputs:</u>

The original subproject PP estimated input costs as 1.815 million dinars for the GOT ($4.0 million) and $2.6 million for USAID. AID's contribution covered the costs of technical assistance ($1.337), long and short term training ($640,000), evaluation ($40,000), and commodities ($582,500).

Although the Project as presently being implemented can be

successfully completed under the present level of funding and the present time frame, it is the opinion of the evaluation/redesign team that additional inputs and extended time would be extremely cost effective. This proposed amendment, therefore, recommends two levels of additional funding, subject to availability of funds. The first level would transfer $1.5 million of existing funds from other subprojects of the Parent Project and would require no new obligations. It would increase AID's funding to $4.1 million. The second level would require an additional $1.5 million in new obligations. In each level of funding the GOT budget committments would be 2 million dinar increments. Amendment level one would, therefore, increase overall costs by $4.5 million. Amendment level two would increase those costs by $9.0 million, and is strongly recommended if those funds become available.

In the first level of funding, the USAID contribution would go to the establishment of the seed production capability ($737,000), increased technical assistance and some commodities to range improvement tecnology ($302.000), long and short-term training ($342,000), inflation ($47,000), and contingencies ($67,000).

The Tunisian Government would contribute the land for the seed farm, operations cost of the project, commodities and personnel.

The increased funds would permit extending activities for two years, increasing the emphasis on rangeland improvement technology, improving grazing management, strengthening the Project Technical Unit, and the development of a seed production system. The two year extension would also increase the shift to private sector involvement, particularly the physical and financial contribution of participating farmers and seed producers.

As noted, the project review and redesign team strongly recommends that an additional level of funding be approved. This level would add $1.5 million in U.S. contributions and 2.0 million dinars in GOT contributions. The U.S. contributions would cover 87 PMs of long and short term TA, 10 PYs of long term training, and approximately $400,000 in commodities. Tunisian contributions would cover increased personnel, increased operations costs, and additional commodities.

This additional funding level would permit a faster and more comprehensive testing and development or range and forage improvement technology, and an increase in acreage improved. It would allow an increased emphasis on animal production and management, and movement toward development of livestock extension capabilities. Most importantly it would increase the pace toward private farmer involvement and greatly increase the likelihood of attaining desired adoption rates.

III. Project Analysis:

A. Cost Estimate and Financial Plan

AID's major inputs into this project amendment, under funding increment one, are the provision of long and short-term technical assistance, long and short-term training for Tunisian participants, and commodities for range improvement and seed production and treatment which are not available in Tunisia. U.S. local currency costs are a total of $97,600, which is for the purchase of some items ofequipment for the seed center.

The GOT contributions to this project are estimated at 65% , and only project expenses that would be incurred "with" the project have been considered, i.e. additional GOT expenses. These include all operations costs of the project, including feed sold to participating livestock producers at 1/2 of regular price as payment for lost production on rangelands deferred from grazing during range improvement. These operations costs are estimated at an additional $1,414,000 over the original budget in this amendment. Project personnel increases due to this amendment are estimated at $675,000, training costs at $48,000, construction costs at $169,000, and commodities at $863,000.

The AID contribution to the original subproject was estimated at $2.6 million. A host country contract with Oregon State University was negotiated to provide the U.S. funded inputs. Of an original $2,457,000 contract, it is estimated that $1,495,516 remained as of April 1, 1984. Table III.A.1. gives the cost breakdown of that contract.

The GOT originally made total committments to the Project of $3.0 million. Of this, aproximately $1.5 million have not been expended. Both U.S. and GOT unexpended commitments would be used in this amended project. Additional funds of U.S. $1.5 million and GOT dinar 2.0 million (aprox. $3.0 m) would be committed. Those additional funds are summarized in Table III.A.2. below.

TABLE III A.1

RANGE MANAGEMENT PROJECT 644-0312-8

USAID FUNDED CONTRACT FOR IMPLEMENTATION

	Personnel	DPE	Travel	Allowances	Other Direct	Participant Training	Commodities	Indirect Cost	Total
Contract Amount	$550,000	$144,000	$152,000	$130,000	$103,000	$640,000	$454,000	$284,000	$2,457,000
Estimated Expenditure Through March '83	77,797	14,842	47,256	14,354	23,303	20,117	198,596	81,081	477,646
Voucher 15 July '83	8,256	2,253	6,770	1,774	744	18,034	20,302	16,064	74,197
16	9,476	2,302	1,051	2,557	2,637	12,647	17,669	13,427	61,766
17	9,529	2,270	0	3,089	2,743	5,316	6,917	7,583	37,447
18	8,782	2,211	2,575	1,687	739	3,396	1,331	5,070	25,791
19	9,083	2,255	1,002	870	322	7,013	322	5,228	26,095
20	8,911	2,405	0	2,959	1,178	2,290	787	4,334	22,864
Vouchers Total	54,037	13,696	11,398	12,936	8,363	48,696	47,328	51,706	248,160
Estimated Through Dec. '83	162,408	36,747	65,446	33,421	33,585	77,826	276,683	151,289	837,405
Annual Cost -- 4	27,018	6,848	5,699	6,468	4,181	24,348	23,664	25,853	124,079
Estimated Cost Through March '84	189,426	43,595	71,145	39,889	37,766	102,174	300,347	177,142	961,484
Estimated Balance March '84	360,574	100,405	80,855	90,111	65,234	537,826	153,653	106,858	1,495,516

Table III.A.2.
Summary Cost Estimate and Financial Plan
($000 U.S.)

Category	AID FX	AID LC	GOT FX	GOT LC	TOTAL FX	TOTAL LC
T.A.	480				480	
GOT Personnel				675		675
Training	342			48	342	48
Commodities	462	97.5		863	462	960.5
Construction				161		161
Other				1414		1414
Contingency	67				67	
Inflation	47				47	
TOTAL	1398	97.5		3161	1398	3258.5

Estimated incremental funding due to this amendment, under level one funding, is provided in Table III.A.3., by source and use of currency and by fiscal year.

TABLE III A.3

INCREMENTAL BUDGET ESTIMATE, BY SOURCE AND USE, AND BY FISCAL YEAR (IN THOUSAND U.S. DOLLARS)

	FY 1984				FY 1985				FY 1986				FY 1987				FY 1988				FY 1989				TOTAL PROJECT			
	U.S.		GOT		U.S.		GOT		U.S.		GOT		U.S.		GOT		U.S.		GOT		U.S.		GOT		U.S.		GOT	
	FX	LC	FX	LC	FX	LC	FX	LC	FX	LC	FX	LC	FX	LC	FX	LC	FX	LC	FX	LC	FX	LC	FX	LC	FX	LC	FX	LC
Personnel																												
U.S. L/T					180.0				240.0				60.0												480.0			
U.S. S/T																												
Total U.S.					180.0				240.0				60.0												480.0			
Division				40.0				127.0				127.0				127.0				127.0				127.0				675.0
Total Personnel				40.0	180.0			127.0	240.0			127.0				127.0				127.0				127.0	480.0			675.0
Training																												
U.S. L/T					66.0				126.0				60.0												252.0			
U.S. S/T					30.0				30.0				30.0												90.0			
Total U.S.					96.0				156.0				90.0												342.0			
GOT							19.0				14.0					13.0												46.0
Total Training					96.0		19.0		156.0		14.0		90.0			13.0									342.0			46.0
Commodities																												
Seed Production		97.5		123.0	400.0																				400.0	97.5		123.0
Range	62.0			40.0				200.0				200.0				300.0									62.0			740.0
Total Commodities	62.0	97.5		163.0	400.0			200.0				200.0				300.0									462.0	97.5		863.0
Other																												
Food/Veterinarian				50.0				120.0				150.0				150.0				150.0				150.0				770.0
Operating				10.0				125.0				125.0				125.0				125.0				125.0				635.0
Total Other				60.0				254.0				275.0				275.0				275.0				275.0				1414.0
Construction				161.0																								161.0
SUBTOTAL	62.0	97.5		424.0	576.0			600.0	396.0			616.0	150.0			717.0				402.0				402.0	1284.0	97.5		3161.0
Contingency					30.0				17.0																67.0			
SUBTOTAL	62.0	97.5		424.0	726.0				413.0			616.0	150.0			717.0				402.0				402.0	1351.0			
Inflation					17.0				15.5				13.9												47.0			
TOTAL PROJECT	62.0	97.5		424.0	743.0			600.0	428.5			616.0	163.9			717.0				402.0				402.0	1398.0	97.5		3161.0

The budget projections for level two funding, $1.5 million increment, or $3.0 million for the additional amended budget, are given in Table III.A.4. below:

TABLE III.A.4.

ESTIMATED BUDGET FOR LEVEL TWO, INCREMENTAL FUNDING
$1.5 MILLION U.S.AID

Technical Assistance:		
3 PY Additional		$ 360,000
1 PY Extension for seed production		$ 120,000
1 PY Extension for range/livestock		$ 120,000
27 PM of short term TA		
Economics	(6PM)	$ 60,000
Livestock	(9PM)	$ 90,000
Farm Machinery	(9PM)	$ 90,000
Seed Production	(3PM)	$ 30,000
TOTAL TECHNICAL ASSISTANCE		$ 870,000
TRAINING		
Long Term		
2 Ph.D.		$ 150,000
4 M.Sc.		$ 80,000
TOTAL TRAINING		$ 230,000
COMMODITIES, RANGE		$ 400,000
TOTAL		$1.500,000

B. IMPLEMENTATION PLAN

This amended sub-project will continue to be implemented by the OEP through its Range Management Unit. It is recommended that the U.S. funded inputs, including technical assistance and commodities, be supplied through an amended host-country contract with Oregon State University. This is logical as OSU will continue to supply T.A. and other inputs under their existing contract. That contract will continue for another two years. As OSU is knowledgeable about the project, has experience in range management in a similar climatic zone, and is aware of sources of appropriate commodities that need to be purchased, it is logical to amend their contract to include the inputs to be supplied under both the existing and amended project agreements.

The evaluation team noted that the implementation schedule of the original PP was generally on target. It appears that the progress under the project will continue to follow that schedule for those elements of the project that were contained in the original document. Because the seed production system is a substantially new addition to the original project, a separate implementation schedule is suggested for that operation.

IMPLEMENTATION SCHEDULE; SEED PRODUCTION SYSTEM

July 1, 1984	Project Approval
	Find land for seed farm (Project staff)
	Order seed farm commodities (Project staff-OSU)
	Design seed farm and seed center facilities (Use short-term consultant with Project staff)
	Order seed farm supplies from U.S. (Consultant specifications, OSU procure)
	Begin recruitment for seed production advisor (OSU)
September 1, 1984	Hire seed production advisor (OSU-MOA)
November 1, 1984	Order local farm supplies for spring (Project staff)
	Order farm commodities from Tunisia sources (project staff)

January 1, 1985	Seed production advisor on board
	Seed farm acquistion completed, make arrangements for seed farm and seed center design and construction if needed (Advisor and Project staff)
	Appoint interim Tunisian seed farm manager (OEP)
	Seed farm equipment arrives
February-May 1985	Clean seed production fields and grounds, prepare for fall seeding (Farm staff)
June 1, 1985	Begin needed construction for seed farm and seed center (Farm staff - GR)
	Appoint an interim Tunisian seed center manager (OEP)
	Order U.S. seed center commodities (these can be ordered earlier if seed center building is ready sooner) (OSU)
Summer 1985	Install and test irrigation system (Farm staff - Gov't irrigation office)
Fall 1985	Plant seed production fields of grasses and legumes needed by Project
May 1986	Tunisian seed production specialist (M.Sc.) returns from U.S. and begins supervising seed farm and seed center. Interim Tunisians continue as farm manager and seed center manager under supervision of seed production specialist.
May-June 1986	Harvest seed
July-August 1986	Clean seed
Fall 1986	Plant seed fields

C. PARTICIPANT TRAINING

Under the existing project 10 participants for long term training and 14 for short term training have been funded be AID. This has been done through a contract with OSU. As this arrangement has proven satisfactory and cost effective it is recommended that the arrangement be extended to include training under this amendment.

Seven long-term (4 B.S. and 3 M.S., 14 PY) participants and 15 short-term (45 PM) participants will be funded under this amendment. These will be selected be the MOA/OEP with consultation from the RMU and the technical advisors. The GOT will cover transport costs for all participants. The scheduling is given below:

SCHEDULING OF PARTICIPANT TRAINEES

Long-Term

3 persons are scheduled to depart for long-term training in June of 1984 under existing budget committments.

4 persons are planned to receive B.S. level training. This will require two years of training each, with 2 people scheduled to depart in 1985, and 2 people in 1986. Areas of study are:

Range science with minors in;

agricultural mechanics
agronomy
seed production
range utilization

3 persons are scheduled for M.S. level degrees, requiring two years each. Two would be scheduled for 1985 and one in 1986. They would study range science with minors in ;

seed production
range improvement
range management and utilization

5 persons per year will go for short term training in 1985, 1986, and 1987.

Schedule For Long-Term Participants
(10 original, 7 proposed)

	1983	1984	1985	1986	1987	1988
Depart	1MS 2BS	4MS 3BS	2MS 2BS	1MS 2BS		
Return			1MS 2BS	4MS 3BS	2MS 2BS	1MS 2BS

D. SOCIAL ANALYSIS:

The social analysis undertaken for the original subproject PP remains basically the same. the proposed amendment makes no major changes that would affect the social systems as analyzed in the PP. In the review, the team found that the project staff was required to make some slight modifications from the original design relative to social factors. Those are discussed below.

1. Social Organization:

The PP called for establishing management committees on private and collective lands to manage grazing of improved ranges. In the case of collective lands this has been followed. In the case of private rangelands, that is, privately held lands in larger grazing areas, this has not been done. In most cases, these lands are held within kin groups, and a formal committee is neither desired nor needed.

2. Grazing Management:

The PP assumed that management of the grazing would be done by determining the appropriate number of animal units to be grazed on the perimeters and allocating to owners or collective members the number of animals each member could graze. This has not worked for two main reasons. First, herders complain that splitting their flocks between the perimeters and other feed sources requires engaging additional shepherds, problems in breeding and lambing seasons and other feed and water problems. Secondly, herders worry that other members may not respect the numbers and will therefore gain more from the improved range. The project staff, feeling that it is too difficult to police numbers, resolved the problem by letting all the sheep of the members graze, controlling utilization by the dates of opening and closing the range. Thus sheep grazing days are set according to the available fodder and the actual days for grazing are determined by the sheep owned by the members. This appears to be an acceptable solution.

3. Risk Behavior:

As noted in the original PP social analysis, risk behavior will, to a large extent, determine the adoption rate of the proposed technology. With a larger emphasis being placed on range reseeding and the associated higher cost, the problem of risk behavior is even more important. Because of this, the review team proposed concentrating more effort on determining the probability of success of revegetation, finding ways to reduce the cost of revegetation interventions, and determining more precisely, through grazing trials, the actual benefits. Because of the climatic variations, this data should be collected for at least five years, so success and benefit probabilities can be included in financial analysis.

A major ingredient in convincing farmers that the new practices

should be adopted will be to lower the risk associated with the unfamiliar practices. This means that the project will have to prove to the satisfaction of itself and the farmers that the techniques have a good chance to succeed.

4. Prestige, Saving and Herd Size:

A key assumption linking goal and purpose is that "improved range management and stock raising practices will improve the quality of the sheep flocks which in turn will increase the market price of animals and contribute to higher productivity." Implicit in the economic analysis is that more and larger lambs can be produced with fewer ewes, so that lower numbers of animals need to be kept on the range. The PP argued that these assumptions would hold, and the investment was viable because:

(1) Stock raisers would respond to the price incentives

(2) There would be a mulitplier effect from the pilot sites

(3) Rotational grazing and reduced herd sizes would continue after the project ended.

At this point in the project it is not evident that improved range management and stock raising practices will improve the quality of the flocks. Not enough experience with grazing on the improved pastures has bee done to make these determinations. One danger is that improved range will increase fodder and cause herders to keep more sheep, thus contributing to increasing numbers and low productivity. Improved husbandry practices such as creep feeding, flushing, health and nutrition may not be seen by herders as contributing to better herds. A major unstated assumption, but implicit in the economic analysis, is that better range and husbandry practices will increase the production (weight and numbers of lambs) of both ewes and hectares.

There is little doubt that the improvements can produce those results. However, there may be other factors such as prestige in the number of animals owned that will offset any gains made in pasture improvement, improved flock health, etc.

It will be essential to monitor the position of herders and develop means of changing attitudes if the assumptions stated are to hold. If they do not hold, the GOT may have to take more direct action, such as through quotas, taxation or user fees, to control animal numbers in order to get the benefits of improved practices. However, it would be hoped that the practices themselves, possibly coupled with intensive demonstrations and training sessions could produce the desired results.

To help determine how herder attitudes are formed, as well as how management decisions are currently made, monitoring of herder behavior will be necessary. This can be partially accomplished through the presently employed social questionaires, as well as

direct observation. A key to the acceptance by farmers will be (in addition to reducing the risk mentioned above), more demonstrations and extension work. The review team feels that, if funds are avaiable, this work should be considerably expanded beyond that included at present or in the proposed amendment under the first level of funding.

E. Technical Analysis:

1. Technology for Rangeland Improvement:

a. Site Selection and Analysis:

The original project paper requires that a rangeland management plan be implemented to improve existing vegetation with respect to composition of forage species andtotal forage production. Sites for enacting the interventions were to be selected in such a fashion as to represent the main types of rangeland tenure patterns in the area. The main recommended intervention was the useof deferred rotation to provide flexible grazing management that would promote animal weight gains and optimal vegetation growth. Fencing, water development, surface treatments and seeding were to be employed as appropriate for the environmental and social situation at each site.

Site selection andanalysis was conducted by the Central Tunisia Range Project staff as part of the range management planning process. Analysis of site capability and constraints allowed project staff to select range management practices that would meet management objectives for each site. Sites for interventions were selected to represent collectively owned and privately owned perimeters. In every case a primary criteria for inclusion in the project was prior resolution of land titling issues.

The original project plan called for the division of management sub-units at collective sites and the development of rangeland committees of participating farmers that would work with the OEP technicians in implementing the program and governing the use of rangelands under their jurisdiction. On perimeters where private ownership is the norm, participating farmers would be organized into groups to facilitate the transfer of technical information.

The management units were divided into sub-units, and a range committee was organized on collective lands at El Brikate. Range committees on collective lands were partially successful in giving the farmers input into interventions. Range committees of private landowners were unnecessary as the farmers' extended family was already cooperatively grazing on their private lands. On collective and private lands farmer interest in range improvements, especially reseeding, has been good.

Based on range site capabilities and constraints, appropriate combinations of range seeding, shrub transplanting, fertilization, grazing management, water developemnt, rest,

ripping, scarification, and other improvement practices were selected and implemented on the sub-units.

The project should continue to analyse each project site and apply interventions that are appropriate to the environmentaland social conditions at the site. Site descriptions should be recorded as part of a written management plan and intervention sucesses (and failures) should be monitored and documented throughout the project to provide a record for use by future range managers in the area. These records should document productivity improvement by management practice and site so that an accurate assessment of economic feasibility by practice and site can be completed during the final years of the project.

The original project plan called for initial interventions on 2 range perimeters totalling 5000 hectares of rangeland and to progress to 12 perimeters and 36,000 hectares by the end of the subproject. This target assumed use of extensive range management practices such as grazing management and rest. Although these techniques have been employed, range reeeding has proven a faster and more certain means of range rehabilitation in many areas, but it requires more intensive inputs. These intensive practices must progress at a deliberate and measured paceto determine which practicesare most successful on a variety of sites over several years. Consequently the project should concentrate on doing a high quality job on fewer hectares with a better chance of success rather than intervene on 36,000 hectares and go too fast to do a good job and increase the risk of seeding failure. The project has actually intervened on 3 perimeters with a total of approximately 3700 hectares as of May 1984.

b. Land Preparation and Seeding Techniques:

Because of the heavy emphasis the project design placed on deferred rotation, project inputs for large scale range reseeding were limited. In addition, as range reseeding appears to have been included in the design more as an exceptional intervention, or an applied research and testing effort, than as a major intervention, the stress on adaptive techniques was limited. During implementation this was judged to be a flaw in the design, and the emphasis shifted to range reseeding in many cases. However, this has meant a scaling down of total surface treated. The investment costs per hectare have also risen, requiring greater forage production to cover costs and a need to reduce associated risks. Consequently the project began to try different seeding techniques, monitor results of various techniques on different sites, and develop equipment for seeding that could be locally manufactured and were low-cost.

With advice from Tunisian and U.S. range specialists the project staff began large scale seeding using plant materials such as *Agropyron desertorum*, *A. cristatum*, *A. elongatum*, *Dactylis glomerata*, *Medicago spp*, and *Hedysarum coronarium*. At the same time they began to test other plant materials.

Large scale seedings in conjunction with other interventions such as fertilization, ripping, scarification, water development, fencing, grazing management and cactus and shrub plantings have been tried on numerous sites with a favorable precipitation year in 1982-83 and an unfavorable (no autumn rain) year in 1983-84. Developing seeding techniques has been a key effort of the project. Using broadcast and drill methods in combination with various surface treatments, the Project has demonstrated the importance of time of seeding, depth of seeding and general care during seeding. this has given a clear idea of the appropriate seeding methods for various soil conditions from deep sandy soils to shallow rocky surfaces. The project has succeeded in intervening on 2700 hectares and tested various seeding methods and materials. Most of the seedings have been sucessful and experience has been gained from failures as well as successes. There have been successes in establishing perennial grasses, annual legumes and shrubs along with increased understanding of what interventions are most appropriate for the range sites on which there were interventions.

The project should continue to analyse sites and test new techniques and plant materials on these sites as management experience in Central Tunisia increases.

Range seeding should be conducted on numerous sites during at least 5 years so that seeding success on Central Tunisia's important range sites can be assessed over several weather years. Conducting improvements, especially seeding, over several years will help to spread the risk of periodic seeding failure due to weather conditions. The seedings will be monitored to determine the subsequent survival and productivity of the seeded annual and perennial forages. Surface treatment, seeding method, time of seeding, fertilization, and other seeding and land preparation techniques should be assessed simultaneously. Fertilizer trials and soil and plant tissue testing would indicate fertilizer needs during and after seeding. Inoculation demonstrations should be conducted using available Rhizobium. Legume seed inoculation is good insurance and decreases the risk of legume seeding failure. A special effort should be made to develop seeding and other improvement techniques that can be implemented by the farmers with minimal investment and maximum chance of success. Direct seeding of shrubs should be further tested so that the cost of shrub establishment can be reduced. Proper grazing management techniques during and after seeding establishment should be determined. the results of this testing and monitoring program will be used to develop range reseeding recommendations and to show which sites can be successfully reseeded and which should be improved by other means. An extension program of field days and demonstrations will now be instituted to get the farmers involved in the project so they can begin to see the potential for range improvement on their own farms. This is a prerequisite to implementation of range improvement by the farmers.

c. Plant Materials Screening:

The original project paper suggested that the long-term plant materials testing program of perennial grasses and legumes from northern and central Tunisia, started by OEP in cooperation with CTDA, INRAT, INAT, Cereals Institute, and Le Kef Institute in 1980, be continued by the range project. the project has placed 230 cultivars into the testing program at each major site at El Brikate, Sbiba, El Alaa, Gafsa and Mezzouni. Observation and seed increase plots have also been established at El Grine and Doumis. Seed tested in the adaptability trials were obtained from commercial and government plant material inventories and testing programs in the U.S., Australia, Kenya and Syria. Several native plant materials were collected throughout Tunisia by Range Project staff. The most promising Tunisian plant materials identified by the project as of 1984 include: several annual Medicagos, Argylobium unifloum, Hedysarum carnosum, H. coronorium, H. spinosissimum, Dactylis glomerata and Oryzopsis milliacea. Although imported plant materials were used in the early large scale seedings of perennial grasses, the native annual legumes and perennial grasses may be better adapted. Some of the perennials and and annuals now being imported into Tunisia originated in North Africa, but were selected and increased in U.S. or Australian testing programs.

Project efforts in plant materials testing should be continued The project has several promising plant materials and others may become apparent with continued screening. The project should make additional contacts with other Mediterranean plant material sources such as Morocco and Australia. The Australians have several medics and grasses that have not yet been obtained and entered into the testing program. Each plant material should be screened in a 5 year testing program so that various weather years will be experienced. After the initial screening, promising plant materials should be placed in larger standard plots and tested at several locations over several (5) years so that responses to numerous sites and weather years can be determined. Greater use should be made of California Agronomy and Range science extension and experiment station staff as they have many years of Mediterranean plant materials and seeding technique experience.

2. Seed Production and Multiplication:

Seed production and multiplication was not part of the original project design. However, with the shift in emphasis to more reseeding, and the successful seeding demonstrations by the project it is clear that the project must develop a seed production capability. The plant materials team has begun to increase seed on a limited scale, producing 2000 kgs. of seed of the more promising species in 1984. To meet projected seed requirements of a minimum of 10,000 kgs. per year at present costs for imported seed would require $60,000 per year. By the end of the project a seed farm of 100 - 125 hectares could

easily supply the seed requirements of the project.

The seed farm should be comprised of 100 hectares of dryfarmed cropland and 10 to 25 hectares that can be irrigated. the seed farm should supply project seed requirements throughout the life of the project and it should develop the capabilityto produce foundation seed of those forages that will be recommended for seeding in Central Tunisia. The seed farm should develop and extend seed production techniques to farmers so that they can produce seedto support the reseeding of Tunisian rangelands by farmers on private and collective lands.

The seed farm will have to develop appropriate techniques for dryland and irrigated production of range forage seeds. Weed control techniques must be developed, demonstrated and extended. Concepts of seed field isolation and rouging of atypical plants must be demonstrated to guarantee the maintence of pure cultivar lines. Plant selection should not attempt to remove the phenotypic variation exhibited by the annual legumes, as heterogeneity is an important mechnaism for surviving in the variable environment and multiple sites characteristic of a Mediterranean climate.

The project should begin to contract seed production to farmers early in the project. This will demonstrate the potential for private sector seed production and give plenty of time to work out problems through an extension seed production program. The project has already harvested seed from a private farm, dividing the quantity of harvested seed with the farmer.

As the project develops its seed production and processing capability, it should develop a cooperative relationship with GRAFOUPAST, a government seed processing, marketing, importing and distribution organization partially owned by OEP. Although it is not producing rangeland grass seed now, eventually GRAFOUPAST, or a similar organization , must take over large scale seed processing to meet range forage seed demands.

Seed from the seed farm will be made available free of charge in the first year or two to encourage private range reseeding. Eventually this should progress through a subsidy phase where the seed price is equivelent to that of subsidized seed grain or the variable cost of forage seed production. Eventually the seed price should be determined by market supply and demand forces of free enterprise. Progress through these phases will depend on the project's ability to prove the benefits and economics of range improvement to the farmers through an effective extension demonstration program.

3. Seed Production Capability:

To develop the needed seed production capability the project will require a seed farm, a seed processing plant, a seed production specialist U.S. advisor, and long-term seed production training for a Tunisian. The seed farm should have a minimum capacity of 10,000 kgs. of seed per year. At 100 kg. of seed produced per

hectare (below average weather year), the farm should be 100 ha. of good nonirrigated farmland. An additional 10-25 ha. of irrigated land would increase the certainty of a yearly crop and increase productive capacity. Ten thousand kg. of seed is adequate to seed 2000 ha. of range annually. As farmers begin to seed their own land this additional demand should be met by contracting seed production with farmers.

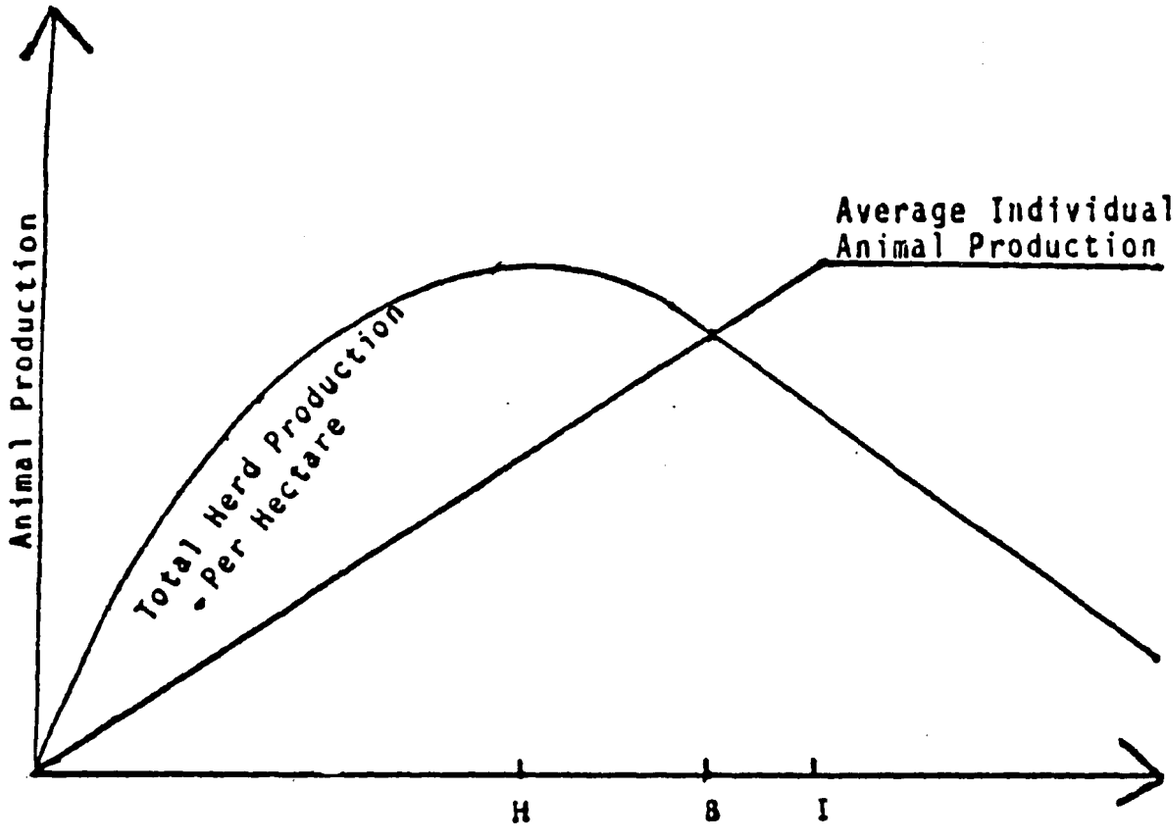
A seed processing plant capable of processing a minimum of 10,000 kg. of seed in 2 months (July and August) will be needed to meet minimum project needs. As farmer demand for seed is generated, the seed processing plant must be able to process more than 10,000 kg. of seed. A 30,000 kg. processing capacity in 2 months should meet project needs. If greater demand is created during the project, arrangements for seed processing and distribution should be made with GRAFCUPAST or a similar organization.

A seed production specialist trained in agronomy and farm management with experience in seed production and processing would act as an advisor for 2 years during which the seed farm and processing plant would be brought to full capacity. The U.S. advisor would work closely with his Tunisian counterpart so that a local management capacity for the seed farm and processing plant would be developed by the end of two years. The Tunisian manager should have a B.S. degree, with training in agronomy, farm management and agricultural mechanics. One participant trainee presently studying seed production would be a likely candidate to assign to the seed production unit.

4. Rangeland Utilization and Management:

a. Livestock-Vegetation Relationship

Once rangelands have been improved it is extremely important to Learn how to graze them without again reducing their ability to produce. Learning to use these ranges most effectively requires understanding the animal-vegetation relationship. This means knowing how the sheep respond tothe quantity and quality of vegetation available to them and how that vegetation responds to the time and intensity of grazing. The animal-vegetation relationship can best be shown by developing livestock production optimization curves for the important vegetation types. In cases where forage quality changes drastically, one set of curves may be required for the growing season and another set for the dormant season. Each set of curves is developed to show average individual animal production and total herd production per hectare plotted over the quantity of vegetation remaining after grazing (Figure 1).



Kg/Ha - Kilograms per hectare of vegetation remaining ungrazed

Figure 1 - Livestock Production Curves

The quantity of forage available for grazing increases from left to right. At the point where the average individual production is zero, there has been so little feed available that the animal only maintains itself and produces nothing. As more feed becomes available to the individual animal, its production increases until point I is reached. This is where the quantity of feed is enough to give maximum individual animal production. Having more vegetation than this amount available to the animal will not increase production.

The principle of individual animal production was understood centuries ago. An old Icelandic farm rule says, "If you reduce the number of animals on your farm and those that remain put on weight then you had too many animals for your farm."

Where the production of the individual animal is zero, the total herd production per hectare is also zero. Total herd production per hectare increases as more feed is available and it increases more rapidly than individual animal production. Maximum total herd production per hectare is reached at point H.

The range manager adjusts the quantity of feed available to his animals by adjusting livestock numbers. In order to move from left to right on the production curves, total animal numbers are reduced to make more feed available to the remaining individuals. After reaching point H, further reduction in animal numbers to

allow for more feed to the remaining individuals results in reduced herd production per hectare. Moving to the right, past point H results in a steady decline in total herd production while individual animal production remains at the maximum to the right of point I.

If maximum individual animal production and maximum herd production per hectare are plotted at the same level on the production axis, the lines will intersect at point B. On the original production curves developed for Blue Grama ranges in Colorado, the highest dollar return per hectare was made where the two lines intersect. This was the point where 336 kg/ha of vegetation was left ungrazed and livestock numbers were in balance with the vegetation. Leaving a residue of 336 kg/ha of vegetation optimised animal production and maintained forage production and soil stability. Grazing intensities that produced maximum herd gain per hectare were too heavy and reduced forage production. Livestock production curves developed on grazing trials in Iceland and Africa show similar results, except that the quantity of vegetation left ungrazed at point B varies with the vegetation type and the growing conditions. On a bog type pasture in Iceland, the quantity to be left ungrazed at point B was nearly a ton per hectare. In Niger, on an annual grassland, the quantity to be left ungrazed at point B was 185 kg/ha. The proper amount of vegetation to be left ungrazed must be determined for each important vegetation type in the project.

There are four basic questions a range manager must answer logically to manage an area effectively. These are: When should animals be put into the area, how many should be put in the area, when should they be taken out of the area, and where should they go. Having a set of production curves for the vegetation being utilized makes it possible to answer these questions logically to optimize production. The key is the balance point B.

Animals should be put into an area only when there is more vegetation than the amount at point B. If the amount indicated at point B for the vegetation type being managed were 300 kg/ha, then the animals should not graze the area until there is more than 300 kg/ha of vegetation available.

How many animals to use depends on how much more vegetation there is than the 300 kg/ha. If there were 400 kg/ha, 100 kg/ha could be grazed. Multiply 100 kg/ha be the number of hectares in the pasture to determine the amount of vegetation available for grazing. Using 3 percent of the body weight of the animals as their daily dry matter intake, divide the daily dry matter intake into the quantity of grazable forage to determine the number of animal days of grazing available. (Remember, of course, that the available forage has to be useable, and dry matter intake may not reach 3 percent if the forage has too high a water content). Put a large number of animals in for a short period or fewer animals in for a longer period.

Take the animals out of the pasture when the vegetation is grazed

down again to 300 kg/ha. Do not let the calculation of how many animal days of grazing were available determine when the animals are taken out. Forage growth often occurs while the animals are grazing and the calculated period can be extended. In some cases, the quantity of forage is reduced by storms or other incidents and animals must be removed earlier than anticipated.

Where to take the animals depends on where and what kind of feed is available. The improved ranges should not be grazed below the balance point. If there are no ranges left with more vegetation than that at the balance point, the animals should move to crop stubble, be fed hay or other supplements or be sold or slaughtered.

b. Feed Source and Livestock Response Calendars:

In order to determine how best to balance the animals with the vegetation it is necessary to have a feed source calendar showing what time of year the different types of forages, hay and concentrate are available for sheep in the area. An animal response calendar should also be developed to show how animal gains or losses fluctuate throughout the year with the different kinds of feed. These feed source and animal response calendars provide a basis for balancing the animal feed and forage budget for the year. The animal response calendar often shows where and when the improved rangeland can be most effectively used to optimize sheep production.

It is important to know the capacity, capability and cost of each segment on the feed source calendar. It is also important to know how changes in one feed source will affect the others.

The feed source and sheep response calendars will show how best to use the livestock production curves. For example, when ranges improved with perennials are grazed, production from these ranges may be optimized either by using a large number of animals for a short time or fewer animals for a longer time.

In the project area it is likely that the feed source calendar and the sheep response calendar will show that to optimize production from the whole system it is better to use fewer animals and extend the time that they are on the higher quality feeds of the improved ranges. This could be particularly important during steaming and flushing periods. This grazing system could reduce the amount of hay and concentrates required in the critical August - September dry period.

On the other hand, without understanding the feed source and animal response calendars, the improved ranges might be grazed to optimize production by using more animals for a shorter time. This kind of utilization, considering only the rangelands, would result in additional stress on the other feed sources on the calendar.

Where fat stored in the tail of the sheep is a source of energy

used during periods of low feed availability, it may be important to optomize production in terms of theamount of fat stored in the tail. Production optimization curves for the improved rangelands could be developed using stored fat as the measure of production rather than animal weights or milk production. The circumference of the tail at the largest portion might be a suitable measure.

Each segment of the feed source system available to the livestock producer must be considered in developing his management system. The project is currently checking the feasibility of adding anhydrous ammonia to the straw to improve the quality of that segment of the feed source system.

Where moisture is such a limiting factor, there is another segment of the feed source systtem that could be improved. The so-called "fallow system" where weeds are allowed to grow on rested cropland wastes the precious water. The palatable weeds are either grazed or harvested and stored for future use, but the unpalatable weeds area allowed to grow and use moisture to produce vegetation that cannot be used. The feasability of a cereal cropland resting technique, such as a rotation with annual medics, that produces only palatable plants to be used in the feed system should be investigated in more detail.

To manage effectively, the sheep producer must understand each segment of the feed source system and be able to manipulate each segment to his advantage. He needs to balance his animal numbers with each segment of his feed source budget.

It is important that the project begin as quickly as possible to develop livestock production curves on the important vegetation types and prepare feed source and sheep response calendars for the different areas.

Sheep production curves are developed on demonstration areas grazed at different levels. These areas not only provide the information needed to plot the production curves, but demonstrate tothe farmers the sheep prodcution that coan be made at the different intensities of grazing. The important thing is that those demonstrations shhow the farmers how much vegetation must be left ungrazed if he is to optomise sheep production. With these optimization curves, we can also determine the net benefit or cash income that can be obtained from the different vegetation types. Comparing these with figures on the various types of interventions we will have precise economic and financial returns on ranges.

To create the domonstrations and produce the sheep production curves, at least three pastures must be available on the vegetation type being used. Grazing must be carefully controlled on these pastures to give three distinct degress of grazing intensity. If it is necessary to construct fencing, the size of the moderately grazed pasture should be large enough to support at least 20 sheep and result in good gains. Each pasture would be stocked with the same number of sheep but the heavily grazed

pasture should be half the size of the moderately grazed pasture and the lightly grazed pasture should be the size of the moderately and heavily grazed pastures combined (Figure 2).The actual size of each pasture must be determined in hectares.

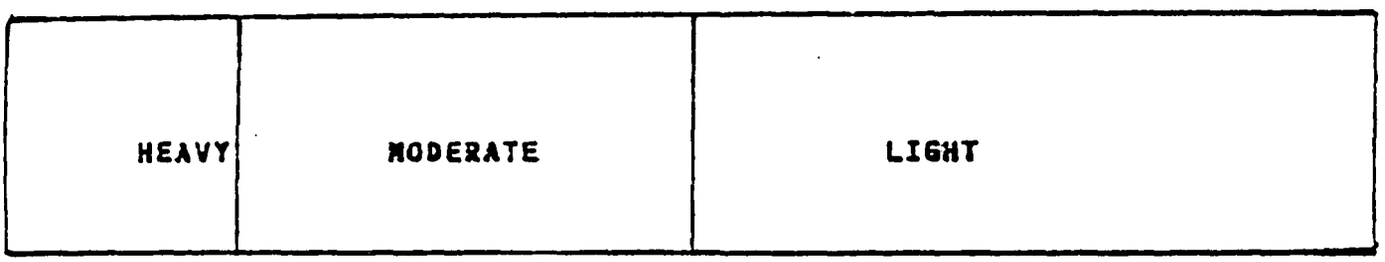


Figure 2 - Relative Size for Grazing Demonstration Trials

With equal sized pastures that are already fenced, the three desired grazing pressures can be obtained by adjusting animal numbers. The moderately grazed pasture should have twice as many animals as the lightly grazed pasture and the heavily grazed pasture should have three times the number as the lightly grazed pasture. Where pastures are not of equal size, animal numbers should be adjusted to the area available in each pasture to give a grazing pressure ratio of 1 : 2 : 3 for the light, moderate and heavy use pastures.

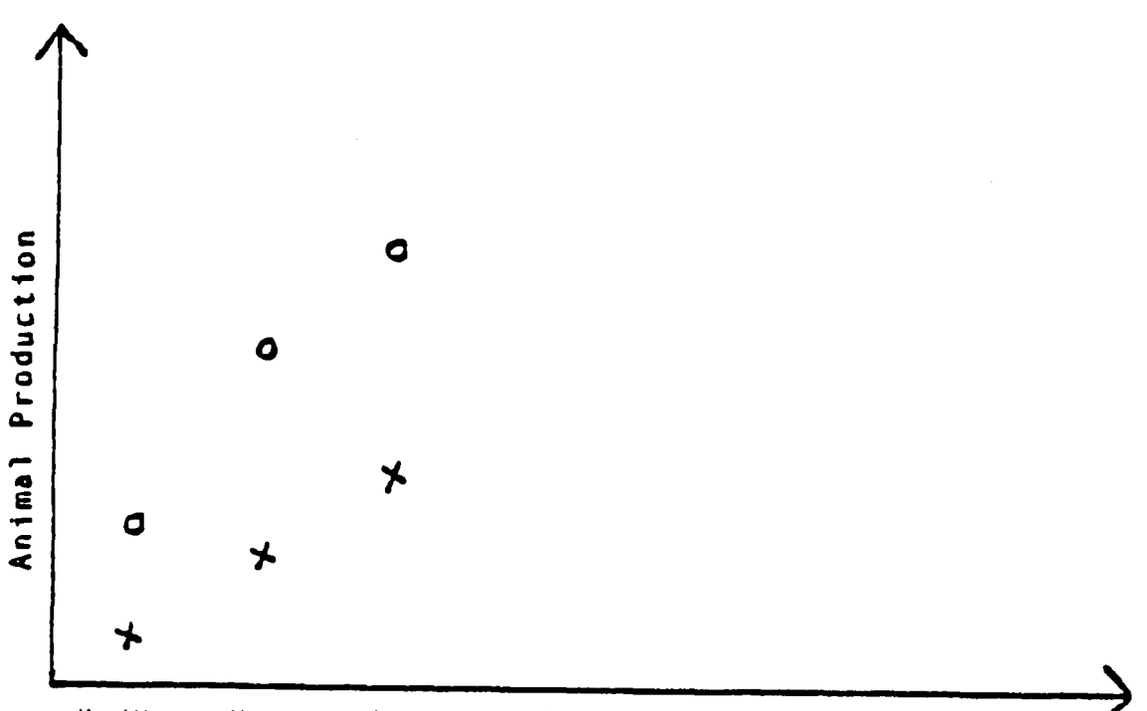
The vegetation community in each pasture is monitored and defined using the frequency method placing quadrats along permentaly narked transects. The quadrat size should give a frequency of about 80% for the most abundant species. The frequency sampling should be done at least annually to show changes in plant composition resulting from grazing and weather. Changes in plant species, especially annuals, may be caused by precipitatin patterns and require that the vegetation community be defined more than once a year.

The quantity of vegetation is next determined for each pasture using the double sampling method where lthe amount of vegetation growing on small plots is estimated. One tenth of th plots are clipped after estimation to give actual quantity. A regression equation is then used to adjust the other estimates. This sam-

pling is done on a permanently located transect adjacent to the one used for frequency sampling. The quantity of vegetation on each pasture is determined each time the animals are weighed in or out of the pasture.

As soon as the initial vegetation weight has been determined an equal number of animals are put in each pasture. At least 20 animals should be used in each pasture. If ewes with lambs are used for the demonstration then there should be twenty ewes. Ewes and lambs should both be weighed. It is the ewe weights that will show the first decrease due to heavy grazing. If lamb weights only are used the decrease in lamb weight due to heavy grazing will be masked by the ewe pulling her own body weight down to provide for the lamb.

At monthly intervals, animal weights and standing vegetation measurements should be taken to calculate average individual animal gain and total herd gain per hectare for each pasture. These monthly measurements show the animal response to grazing intensity, indicate the quality of forage by months and make it possible to calculate plant growth during each month. At the end of the grazing season the average individual animal gain and the total herd gain per hectare for each pasture are plotted over the amount of vegetation left ungrazed at the end of the season. Each pasture gives a point on each line. If the data plots like that in Figure 3, the pastures have been too heavily stocked and should be adjusted be reducing animal numbers in relatio to the quantity of vegetation available in the following year.



Kg/Ha - Ungrazed vegetation per hectare

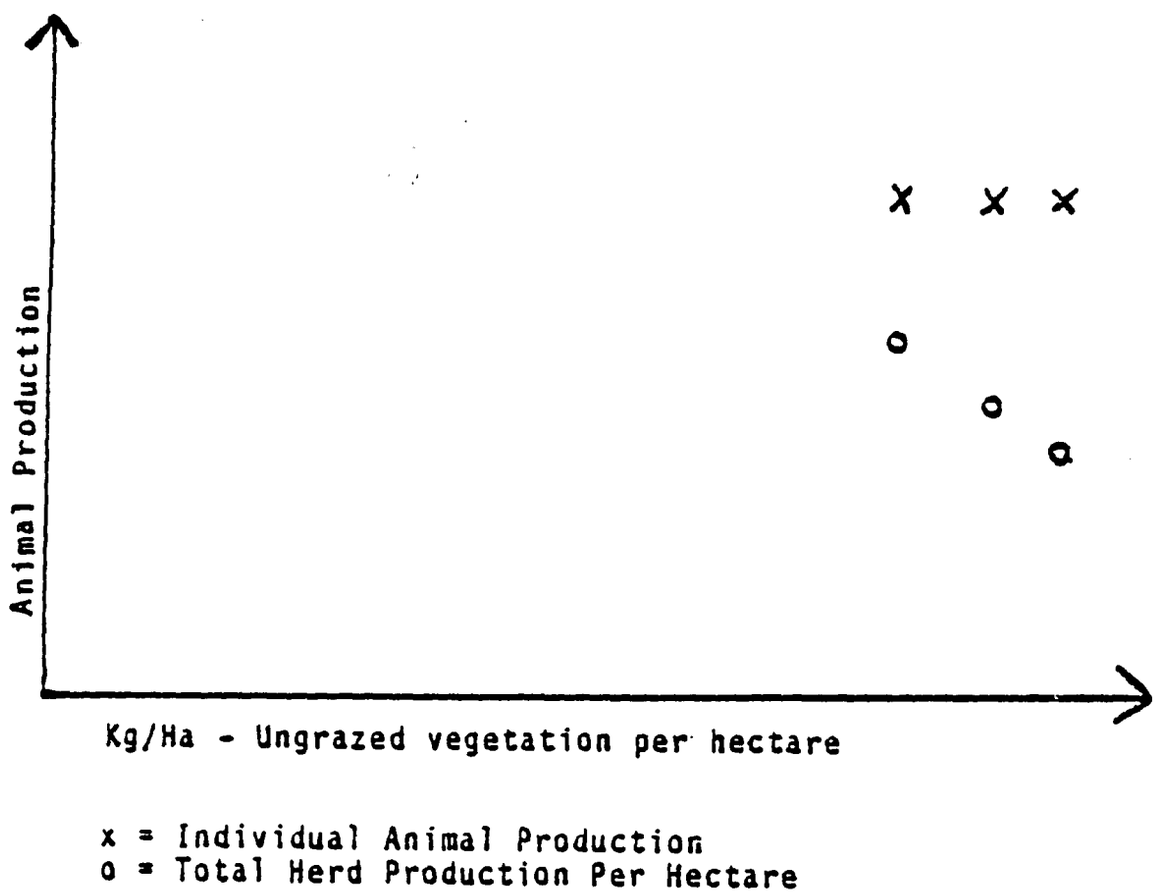
x = Individual Animal Production

o = Total Herd Production Per Hectare

FIGURE 3 - Data from Demonstrations Stocked too Heavily

All three pastures have been grazed too heavily to produce production optomization curves. In this case both individual and total herd gain are increasing from left to right.

If the data plots like that in Figure 4, the pastures have been too lightly stocked and should be adjusted by increasing animal numbers.

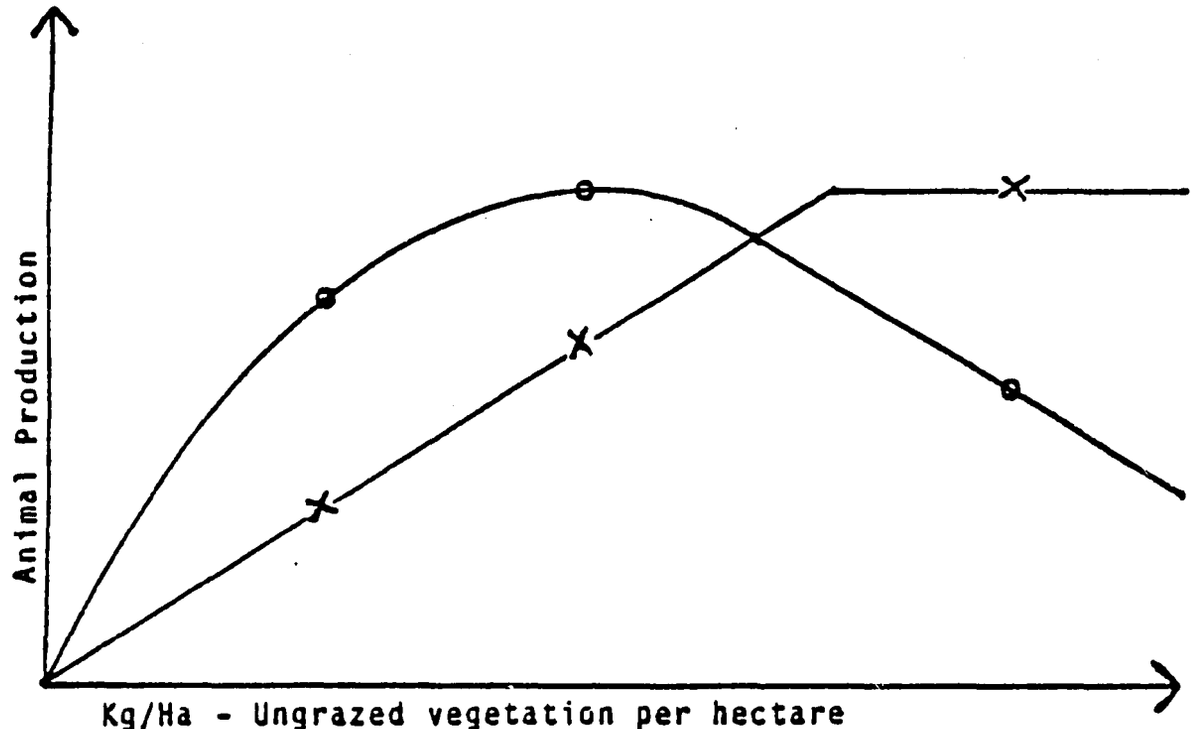


x = Individual Animal Production
o = Total Herd Production Per Hectare

Figure 4 - Data from Demonstrations Stocked too Lightly

All three pastures have been grazed too lightly to produce production optomization curves. In this case individual animal production is at the maximum level and total herd gain decreases from left to right

When the data plots like that in Figure 5, the pastures have been correctly stocked to produce the production optimization curves. For this to be the case both sides of the total herd gain per hectare curve must be indicated.



Kg/Ha - Ungrazed vegetation per hectare
x = Individual Animal Production
o = Total Herd Production Per Hectare

Figure 5 - Data from Demonstrations Stocked Properly

The lightly grazed pasture shows the location of the maximum individual animal production line and the decreasing side of the total herd production per hectare curve. The moderately and heavily grazed pastures show the slope of the individual animal production curve and locate the zero production point on the vegetation scale and the point where the slope meets the maximum individual animal production. The heavily and moderately grazed pastures show the increasing side of the total herd production per hectare curve. This curve is constructed using the zero point and the three herd production points.

The resulting production curves will relate animal production to quantity of vegetation left ungrazed and serve as a guide to optimize animal production.

The feed source and livestock response calendars should also be developed as quickly as possible for the different areas of the project. The production curves for the rangelands themselves are not enough to develop a suitable grazing system for the sheep producer. To optimize sheep production and develop a management system that is socially acceptable to the local farmers, it is necessary to have the sheep production curves for the local rangelands, the local feed source calendar and the local live-

stock response calendar. Sheep, donkeys, mules, horses, cattle, camels and goats should be included in the animal response calendar.

Figure 6 shows how a combined feed source and sheep response calendar might look in some parts of the project. A plan for obtaining data to put actual numbers on the calendar should be implemented for the different management areas of the project.

A sample of the different classes of animals from selected farms should be weighed at least at monthly intervals. The feed source calendar as it is developed will show the critical times for weight taking. Not all animals on a farm need to be weighed. Tester animals in each flock can give good data if the same tester animals are weighed each time. A weight response line can be plotted for each species and class of animal on the farm. The sheep calendar should show weights for ewes, lambs and rams.

FIGURE 6
FEED SOURCE CALENDAR

June July	Aug Sept	Oct Nov Dec Jan Feb	March April May
Rangelands Grain Stubble, grain residues in fields	Graze cactus buy hay, concentrate feed wheat bran and barley, most critical period	Some green growth on ranges depending on rainfall. too cold for good growth	Best rangelands warm weather.
	160 kgs. hay per ewe needed @ 1 kg./day Ammonification of hay here		
As grain is threshed, stalks, roots and weeds put in stack.			

SHEEP RESPONSE CALANDER

Individual Animal Weight

F. ECONOMIC ANALYSIS:

1. General:

The project Paper calculated the IRR for rangeland improvement at 29.2%. This rate was based on improving 36,000 hectares of rangeland during the project and maintaining a rate of improvement at 12,000 hectares per year for an additional 10 years. Benefits, measured in increases in lamb production, came from an increased lambing rate, rising from 40% to 95%, and increased lamb weights, from 18 kgs. to 29 kgs., while total numbers of sheep were reduced. The rationale was that increased quantity and quality of forage, combined with improved management of the animals and improved animal health, would lead to increases in lambing rates, birth weights, survivability and growth rates. The technical basis for these assumptions appears to be basically sound. The improvement of rangelands were estimated to increase the liveweight yield of pasture from 7.2 kgs./ha., to about 20 kgs./ha.

The need to do extensive reseeding of rangeland to improve pastures, as opposed to deferred rotations with little other intervention, has greatly increased the per hectare cost of grassland improvement. In addition, this shift has reduced the rate of range improvement, and therefore increased the overhead costs per hectare in the early years. This would naturally lower the IRR unless benefits can be increased.

2. Analysis of Interventions:

The determination of the economic returns to rangeland interventions (drilled seeding, scarifying with broadcasting and without broadcasting seed, deferring, subsoil ripping, shrub transplanting and direct shrub seeding), requires knowing the cost of the intervention and the production of lamb and wool in either ewe-lamb or lamb fattening operations. Several things must be kept in mind when setting up the systems for data collection needed to perform the analysis. First, the establishment of forage by any chosen method must take into account the chances of getting some pre-determined level of success. That is, the percentage of hectares on which the intervention was done, succeeded, on the desired level of range improvement. Secondly, a calculation should be made of the foregone production of not using the range while the intervention takes place. For example, if establishing a perennial grass requires deferring grazing on the land for two years, then the value of the lost grazing must be calculated. Finally, the increased production of the range after the intervention has taken place must be measured.

In a ewe-lamb operation, the value of the rangeland must be measured as the value of the lamb (meat) produced plus the wool produced per hectare. This value can only be accurately measured by the actual animal production from the feed produced. We can make estimates of the increased productivity from the measurements of forage produced (cuttings), but accurate measurements

can only be obtained from actual weights obtained under grazing trials, because under grazing only the utilizable plant material will be measured as the animals will selectively chose desired species. Feed conversion ratios will also not need to be estimated, as the ability of the forage to produce meat will be measured in the livestock gains. Total beneficial production of plant material can be measured when the intensity of grazing reaches the point where weight gains on animals no longer occurs. Therefore, weighing animals when they are placed on the pastures, and taking periodic weight measurements, we can establish exact production levels from improved rangelands. These measurements should be taken from lands treated in various ways, and compared with untreated lands. the costs of each treatment would be compared with increased production to determine the returns to the investment.

Given the variability of climatic conditions, particularly rainfall distribution and quantity, in Central Tunisia, and the large fluctuations from year to year, probability factors should be attached to the costs and benefits of rangeland improvement. For example, if reseeding of perennial grass is done, and a grass stand is not achieved, a second year of reseeding may be required. This will increase the costs and delay the benefits. Likewise, low rainfall years may lower production considerably below the average established for a period of years.

In order to have a major impact on the rangelands of Central Tunisia, the Project will have to convince livestock growers to undertake range improvements and follow with proper grazing management. To accomplish this, the stockmen will have to be convinced that the interventions will work, will pay investment costs, and can be done with the minimum of risk. For the stockmen in Central Tunisia it is also essential that he recover his capital investment in the shortest time possible.

Trials done in the U.S. on production of lamb through grazing of similar grasslands to those in Tunisia show that ewe lamb combinations will produce one kilogram of lamb,liveweight, with 10 kilograms of drymatter. Using these figures as estimates of the productivity of the grass we can make some estimates of the productivity of the improved Central Tunisian rangeland. From cuttings of forage on non-improved and improved ranges the project has shown that reseeding has increased the dry matter produced, over non reseeded rangelands, by 300 to 600 kgs./ha. on similar land. In some cases results have been even more spectacular, showing dry matter production increases of as much as 1500-2000 kgs./ha. as estimated by range specialists.

In addition to total dry matter gains, the quality of the forage appears also to have increased. Although palatability of the forage and its ability to produce meat can only be determined by actual grazing, it is likely that reseeded ranges will be more productive per unit of vegetation, especially where some species in the non improved rangeland are seldom or never eaten by animals. Data from 1984 have not been completed on total produc-

tion, but samples taken in February show high frequencies of reseeded grass, and high plant populations within the samples. Most areas show plant populations of reseeded grass in excess of 20 per square meter, with at least 1/3 of the area above 40 per square meter. Frequencies are 80% or above in the samples. If these grasses can survive the dry summer months, indications are that high forage production will be possible. In addition, annual legumes seeded with the grasses have developed and set seeds, thus forage production and protein levels should be increased.

Because very little grazing has taken place on reseeded or otherwise treated lands, and no data has been collected on growth performance, fecundity or morbidity and mortality rates of animals, it is impossible at this stage of the project to detemine if progress toward the economic improvements is being made. Given that "without project" rangelands probably did not exceed an average drymater production of 100-150 kgs. of drymatter/ha., and that most reseeded areas exceed 400 kgs./ha., and have reached 2000 kgs./ha., would indicate that meat production targets could be easilly met or exceeded.

The review and redesign team recommends that the expansion of acreage be made largely the responsibility of livestock raisers. The project would function mainly as an advisory service where staff would operate as specialists to backstop OEP extension staff. the project would undertake interventions on a limited area, mainly for applying and evaluating techniques of establishing, improving and managing rangelands under actual production conditions. With this emphasis the key to expanding the area of improved rangeland and therefore spreading overhead costs over a larger area, will be livestok growers' willingness to undertake the investment costs.

An analysis has therefore been undertaken to demonstrate what the minimal required improvement (benefit stream) would need to be to recover capital investment and generate a return to capital. In the analysis, it is assumed that investment would be made by the livestock growers, prices would be current liveweight lamb prices at 2 TD per kilogram, per hectare costs of deferring grazing would be 7 kilograms of liveweight production or 14 TD, and capital recovery would need to be done in either 5 years of 10 years. Generally, 10 years was chosen for shrubs and perennial grasses and 5 years for annual legumes due to the longer deferred grazing period for the shrubs and grasses. A 15 percent discount rate was used both as a representative opportunity cost of capital and as a rate that would repay bank interest rates (7%) and give a return to management. The benefit stream required to give the 15 % IRR per hectare is calculated* and converted into live-

* The calculation is to find the benefit stream that, when discounted over the period of time chosen, at the nterest rate chosen, will jest equal the discounted cost stream. Generally all calculations assume end of year costs and benefits. Discounting takes into account money saved (discounted cost) or money foregone (discounted benefit) due to the investment.

weight lamb and estimated increased forage production needed to produce that lamb under a ewe-lamb operation. For the perennial grasses and annual legumes, results of the last two years indicate that these resultats are obtainable, even in cases where the seeding failed in the first year. Tables III.F.1 to III.F.5. give the estimates of target production the farmer will need to achieve to recover capital costs. No production values have been obtained for acaia or shrubs, as these new transplants are not large enought to determine forage production. the large costs of shrub transplanting has encouraged the project to look at direct seeding of atriplex which looks encouaging.

On a forestry reserve, older, 5 meter high acacia was cut back to 50 cm stumps and allowed to naturally revegetate. 2500 ewes and lambs were grazed on a 100 ha. area for 70 days. According to the forestry management, the forage and trees were completely gone when grazing was stopped on March 15, 1984. Assuming that the ewes weighed 35 kgs., consumed drymatter equal to 3% of their body weight daily for 60 days, then the acacia produced about 1575 kgs. of drymatter per hectare during the period. On May 10, 1984, regrowth was 18" to 2' in the area. This would indicate that drymatter vegetative production on accaia may be adequate to be economical, even with high establishment costs.

In order to ascertain the actual value of the acacia or shrubs, it will be neccessary todetermine if younger tress can be heavily grazed, how often tress can be grazed and if trees can sustain high grazing over several years. Comparing production through actual grazing with costs of plantation establishment, including repeated plantings and costs of deferment, will be necessary to determine economic returns to these plantations, and this analysis should be undertaken over the next 5 years. Data from forest service plantations could be used for part of this analysis.

The above examples would indicate the minimum production required to induce farmers to invest in range management. The comparison of the costs and benefits from the establishment of perennial grass in either one or two years effectively shows the difference between a 100% probability and a 50% probabliity of a successful planting. Although this would be the most accurate way to establish the benefit stream required to cover the investment costs, a close estimate can be made by dividing the cost factors by the probability factor before discounting.

TABLE III.F.1

RESEEDING PERENNIAL GRASS, ONE YEAR SEEDING, TWO YEARS DEFERREMENT
TUNISIAN DINARS PER HECTARE

Year	Fixed Costs	Variable Costs	Deterrement Costs	Total Costs	Discount Factor 15%	Present worth at 28TD
1	30 1/	55 3/	14 3/	99	.870	-86
2			14	14	.756	-10.6
3					.657	18.4
4					.571	16.0
5					.497	13.9
6					.432	12.1
7					.376	10.5
8					.326	9.1
9					.284	2.9
10					.247	6.9
						-1.8

1/ Includes 20TD for spiny cactus fence, 10TD for tractor use.
2/ From Table
3/ Estimated as 7kgs live lamb without project.
Comments: The cash flow required to cover the investment costs would be 28TD in years 3-10. This required an additional 14kgs of live weight lamb. Ewe-lamb operation feed conversion ratio of 10:1 requires 140kgs of additional useable drymatter per hectare.

ANNUAL GRASS OR LEGUME, ONE YEAR SEEDING, ONE YEAR DEFERREMENT
10 AND 5 YEAR CAPITAL RECOVERY - TUNISIAN DINARS PER HECTARE

Year	Fixed Costs	Variable Costs	Deterrement Costs	Total Costs	Discount Factor 15%	Present worth at 19TD	Present worth at 27 TD	
1	20	55	14	89	.870	-77.4	-77.4	
2					.756	14.3	20.4	
3					.657	12.5	17.7	
4					.571	10.8	15.4	
5					.497	9.4	13.4	
6					.432	8.2	11.7	
7					.376	7.1	+ 1.1	5 year disc. cash flow
8					.326	6.2		
9					.284	5.4		
10					.247	4.6		
						+1.1		10 year disc. cash flow

10 year and 5 year capital recovery	10 year	5 year
Annual cash production increase	19 TD	27TD
Live weight lamb increase	9.5TD	13.5TD
Additional drymatter	95kgs	135kgs

TABLE III.F.3

RESEEDING PERENNIAL GRASS, TWO YEARS OF SEEDING, THREE YEARS DEFERREMENT
TUNISIAN DINARS PER HECTARE

Year	Fixed Costs	Variable Costs	Deterrement Costs	Total Costs	Discount Factor 15%	Present worth at 57TD
1	30 1/	55 1/	14 3/	99	.870	-86
2	10 4/	55	14	79	.756	-60
3			14	14	.657	- 9.2
4					.571	32.5
5					.497	28.5
6					.432	27.6
7					.376	21.4
8					.326	18.6
9					.284	16.1
10					.241	14.0
						.379

1/ Fencing 20TD, tractor 10TD
2/ From Table
3/ Est. 7kgs live lamb without project
4/ Tractor

Comments: 57 dinars of extra production will be needed to cover the discounted cash flow requirements to cover investment costs in years 4-10. This requires 28.5kgs of live lamb and 285kgs of additional useable drymatter.

TABLE III.F.4

ACACIA OR SHRUBS, REQUIRING TWO YEARS OF TRANSPLANTING AND THREE YEARS DEFERREMENT, 10 YEAR RECOVERY
TUNISIAN DINARS, PER HECTARE

Year	Fixed Costs	Variable Costs	Deterrement Costs	Total Costs	Discount Factor 15%	Present worth at 227TD
1	20	350	14	384	.870	-334.1
2		350	14	364	.756	-275.2
3			14	14	.657	9.2
4					.571	129.6
5					.497	112.8
6					.432	98.1
7					.376	85.4
8					.326	74.0
9					.284	64.5
10					.247	56.1
						+1.5

Comments: If acacia shrubs would have to be planted two years in order to establish the plantation, then an additional 227TD of production would be required per hectare in years 4-10 to recover investment costs. This represents 113.5kgs of live lamb or 1135kgs of drymatter. The latter figure may be high as acacia or shrubs, particularly combined with other dry forage should produce more meat per kg D.M. than other species.

TABLE III.F.5

ACACIA OR SHRUBS - ONE YEAR TRANSPLANTING TWO YEARS DEFERREMENT
10 YEARS RECOVERY

Year	Fixed Costs	Variable Costs	Deterrement Costs	Total Costs	Discount Factor 15%	Present worth at 10TD
1	20 1/	350 2/	14	384	.870	-334.1
2			14	14	.756	-10.6
3					.657	66.4
4					.571	57.7
5					.497	50.2
6					.432	-43.6
7					.376	37.1
8					.326	32.9
9					.284	28.7
10					.247	24.9
						- 2.1

1/ Fencing with cactus
2/ Estimated from reports ranging from 300-400TD/hectare

Comments: The acacia or shrub would have to generate 102TD/hectare of additional production in years 3-10 to cover capital costs. This could be estimated as 50.5kgs of additional live lamb or 505kgs of drymatter.

3. Internal Rate of Return Analysis:

An Internal rate of Return (IRR) was calculated on the amended project to determine ehe economic viability of the investment. This analysis was done under two scenarios, in order to test the sensitivity of the project to setbacks that might be caused by such effects as extremely low rainfall years.

Scenarios No. 1 & 2; Area of range Improvement

It was assumed that the project would intervene on 300 hectares per year through 1990, 2000 hectares in 1991 & 1992, decrease to 1000 hectares in 1993 and have no interventions after 1994. In 1987-1988 it was assumed that farmers would begin doing range improvement on 500 hectares and this would progressively increase to 5000 hectares by 1995 and 10,000 hectares per year through year 2000, with 15,000 hectares after that.

Range improvement in all cases would be 2/3 completely reseeded, with the remainder split between seed application with sacarifiage, and resting with no other intervention.

Scenario No. 1

This assumed that sucessful interventions would be 50% in 1984 & 1985, 60% in 1986 & 1987, 70% in 1988, and 75% through 1990. This would rise to 85% after 1992, where it would remain constant.

Scenario No. 2

This assumed only a 50% success in interventions, which does not improve throughout the period.

Costs

Costs of interventions were weighted between the three types of interventions. Because it was assumed that farmers would not need to plant cactus fences or hire guards, these costs were not included. Other costs were taken from thje Project cost estimates based on their experience, and an additional cost of 14 dinars per hectare was assumed for each year the grazing land was deferred form grazing while the intervention was being done.

Project overheard costs included the balance of funds committed under the present project plus $3 million USAID funds and 4 million Tunisian Dinar GOT funds. In the latter case the cost of supplemental was deducted, and costed out as a net benefit flow from sheep production. Thus all overhead costs, including technical assistance contracts and the seed production center were treated as overhead costs of the project.

Benefits

The net gain assumed to derive from feeding supplemental feed, 1/2 paid by the project and 1/2 paid by farmers, was calculated

and added to the toal benefit stream. Additionally, a value was added from seed produced at the seed center as all seed production costs had already been calculated in intervention costs.

The benefit from range improvement that accured with the project was calculated as an average of 300 kgs. drymatter per hectare over non improved land, which produced meat at a ratio of 10:1. The live weight meat produced was valued at 2 dinars per kilo. No additional value was given for ewes or wool.

Analysis

Net benefit streams were calculated for both scenarios. In scenario No. 1 the cash flow yielded a 15% IRR including all overhead costs. In the second scenario, the rate drops to 9%. In both cases the rates are affected by the slow adoption rate assumed for the project. In the first case, only 115,000 hectares would be treated by the end of the analysis period (20 years). In the second case, that area is only 70,000 hectares. Accelerating this rate, particularly in the early years of the project would greatly increase the IRR. However, design members were cautious about expecting too optomistic an adoption rate. The extent of range improvement will probably be most affected by the demonstrated results of intervention.

In the analysis we have chosen a rather low per hectare dry matter production rate (300 kgs/ha.). In several cases the project has already demonstrated higher prodcution, particularly on reseeded land. However, given the wide variability in soils and climatic conditions, we have chosen lan average we believe is, albeit low, more indicative of the entire area.

By using probabilities for successful intervention we have demonstrated the effects of higher costs, lower benefits, and delayed expansion. On the low scale we have suggested only one of every two years will interventions be successful. On the high end we have assumed only about 4 of every 5 will be successful. This should cover the range from extremely poor rainfall years to quite moderate years. Exceptional years will not only improve chances of success, but should give much higher production differentials from non improved lands than we have assumed.

No secondary benefits have been calculated in the IRR analysis. It is obvious that considerable benefits would be gained from the reduction in soil loss due to erosion and water runoff. Social benefits gained from improving incomes in the rural areas and slowing the rate of rural to urban migration are also of extreme importance to the Government of Tunisia. Because of no agreed upon formula for calculating these secondary benefits, they have not been quantified and therefore are excluded from the analysis.

Table III.F.3.1

TUNISIA RANGE MANAGEMENT

Anticipated Capital Investment 1/

	$(000) USAID	=	Dinars (000) USAID	GOT	Total
1984	809.5		591	800	1,391
1985	1503.6		1098	1400	2,498
1986	1198.5		875	1400	2,275
1987	923.9		674	800	1,474
1988	60.0		44	800	844
1989				600 2/	600

1/ Includes residual funds from original project allotments ($1.5 million and TD 1.8 million), and new funds ($3.0 million and TD 4.0Million)

2/ 1988and after GOT expense of 300,000 dinars would be required to support a technical staff of avout 20 persons.

TABLE III.F.3.2

TUNISIA RANGE MANAGEMENT
NON RANGE BENEFITS

A. FEED BENEFITS

	Feed Costs-Project 000 dinars	Feed Tons	Meat Production Tons	Meat Production Dinars
1984	33.8	266	26.6	53,200
1985	85.7	675	67.5	135,000
1986	99.4	783	78.3	156,600
1987	100.6	792	79.2	158,425
1988	100.6			158,425
1989	100.6			158,425
	520.7			820,075

B. SEED BENEFITS

	Tons	Tunisian Dinars	
1984	-0-	-0-	
1985	2	6,000	
1985	5	15,000	
1986	10	30,000	
1987	15	45,000	
1988	15	45,000	
1989	20	60,000	
1990	20	60,000	
1991	35	100,000	(held constant after 1991)