FINAL REPORT

ACTIVITIES, FINDINGS AND CONCLUSIONS

OF

THE RANGE MANAGEMENT IMPROVEMENT PROJECT 608-0145

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PROJECT DESCRIPTION:

THE RANGE MANAGEMENT IMPROVEMENT PROJECT AS AN INSTITUTION BUILDING PROJECT

BACKGROUND

The Range Management Improvement Project (RMIP) (USAID Project #608-0145) began in March 1981 and ended in August 1986. The project was implemented by Utah State University (USU) under a host country contract with the Direction de l'Elevage (DE) of the Ministry of Agriculture and Agrarian Reform (MARA), and was directed at strengthening the institutional capability of the Service de l'Amenagement et de la Mise en Valeur des Terrains de Parcours (DE/SP).

The RMIP was designed to assist in the planning and implementation of extension programs in range management and range livestock improvement. The specific goal was to improve both livestock production and production efficiency and thereby increase the incomes of Moroccan livestock producers.

The first project evaluation was carried out in January 1984 and, based on the need for quantified information and recommendations of the evaluation team, resulted in various changes in the project design. A more concretely defined strategy emerged and the RMIP management structure was reorganized to ensure improved coordination. The redesigned project consisted of four components:

* **applied research,**
* **extension,**
* **long- and short-term training, and**
* **the development of a Plant Materials Center (PMC).**

Project activities were centered in five provincial offices of the Service de l'Elevage: Beni Mellal, Meknes, Midelt, Oujda and El Jadida. The geographic location of these sites of field activity are indicated on the map of northern Morocco presented as Figure 1.

RMIP COMPONENT ONE: Applied Research

It had become obvious in the early years of project implementation that it was necessary to undertake certain research tasks in order to develop a credible extension and range management program. DE/SP effectiveness depended upon further developing the capability to plan, implement and evaluate research efforts and to utilize the research results. In order to assist the DE/SP in meeting information needs, the RMIP applied research activities focused on:

* **evaluating current production systems,**
* **analyzing production problems,**
* **identifying viable production alternatives, and**
* **determining methods of information transfer that would assure acceptance of superior alternatives.**

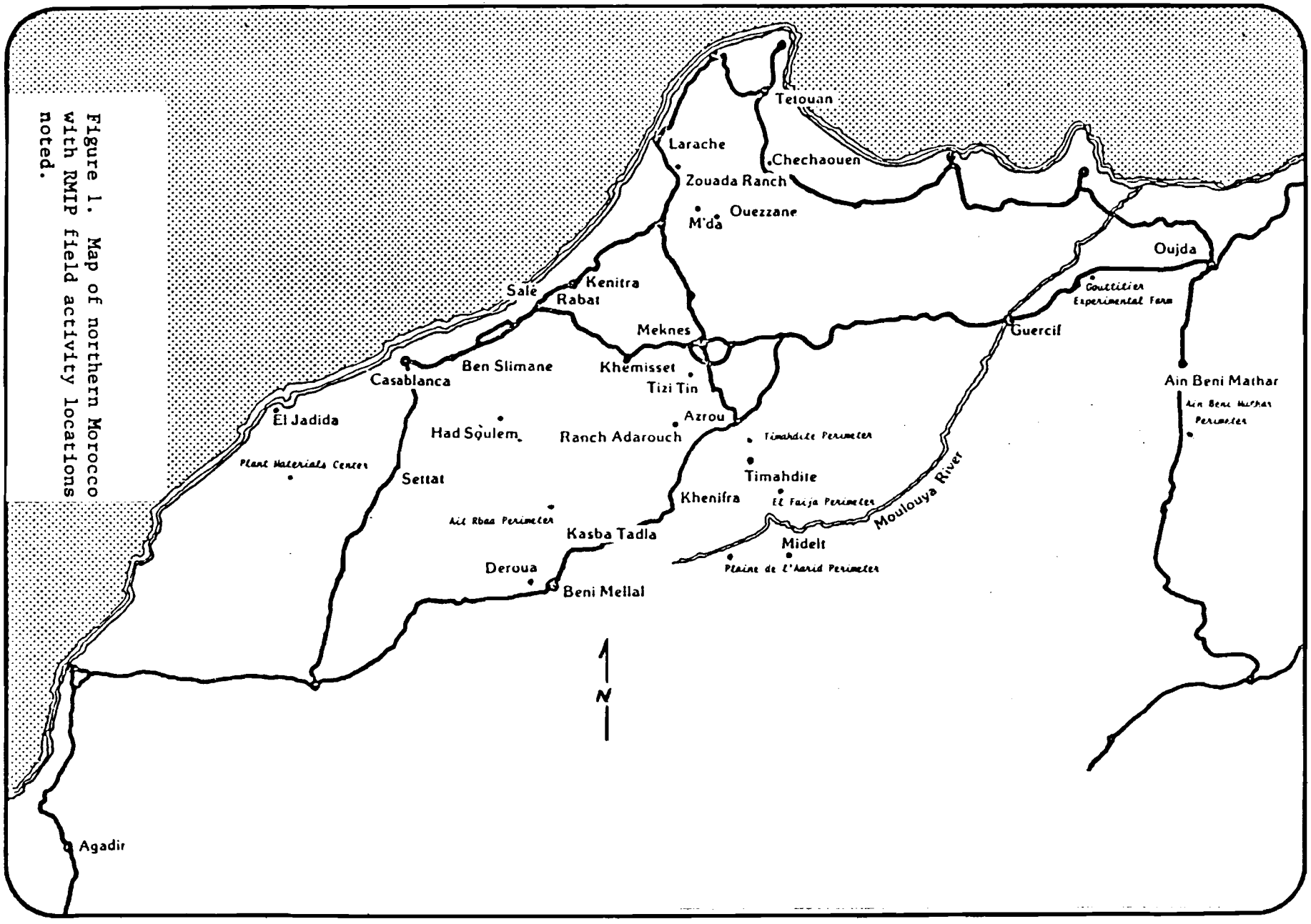

Figure 1. Map of northern Morocco with RMIP field activity locations noted.

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Specifically, evaluating and analyzing current production systems and problems involved:

* **identifying the sources and seasonal availability of livestock feed and forage including natural vegetation, fallow, crop residues and supplemental feeds, and**
* **estimating production parameters, estimates of total livestock production and production efficiency by level of management.**

Identifying viable production alternatives included:

* **estimating current and alternative livestock/crop production costs and returns,**
* **assessing potential alternatives including the seeding of marginal cropland and selected range sites, manipulating the soil surface to enhance moisture infiltration and grazing management, and**
* **balancing animal nutritional requirements with available forage and feeds, culling and selection programs and synchronization and timing of lambing.**

Determining acceptance of superior alternatives involved:

* **identifying producer perceptions of resource availability and the current production system, and**
* **determining the social and cultural ramifications for technological production alternatives.**

Models of the current livestock and forage production systems in the various zones were needed in order to gain more complete understanding of production problems and to provide means of simulating the effects of production alternatives. Through the research effort the project strengthened the ability of DE/SP staff to improve range management practices and assure active producer participation.

RMIP COMPONENT TWO: Extension

The RMIP applied research program was designed to create the basis of a functional extension program. Extension program development relied on:

* **developing audience profiles from the stratification of the producer population,**
* **assessing production and profit estimates of current production systems by audience, and**
* **identifying intervention opportunities and potential acceptance of alternative strategies.**

Once information had been synthesized, extension program implementation involved:

* **formulating technical interventions relevant to the identified audiences,**
* **planning an extension program based on those**

interventions, and
* **evaluating audience response.**

Thus, an extension effort was started to address critical producer needs for forage resources and animal management. The extension materials developed from the RMIP research are appropriate for the range livestock production systems in Morocco. DE/SP staff have been trained to continue the program and have been instrumental in its establishment.

RMIP COMPONENT THREE: Long- and Short-Term Training

Since continued program success depends upon the capability and credibility of DE/SP staff, training may well prove to be the most essential component of the project. Training efforts made through RMIP included:

* **long-term degree training in the U.S.,**
* **short-course training in the U.S., and**
* **administrative, computer and extension seminars in Morocco.**

Specifically, through long-term training,

* **RMIP participants were to receive MS degrees in range management, extension and rural sociology.** All of these participants were to complete their programs and to be contributing to the range management and range livestock improvement program of MARA by the end of the project.

Through short-term training,

* **non-degree training in range management and extension practices was to be provided in the U.S. for DE technicians and administrators,**
* **two one-week technical seminars were to be sponsored through the RMIP in collaboration with other Moroccan institutions, and**
* **one-day RMIP seminars were to be sponsored at different sites throughout the country to train local DE technicians.**

Again, in terms of long-term impact, training may prove to be the most successful RMIP component.

RMIP COMPONENT FOUR: The Plant Materials Center

The Plant Materials Center (PMC) was created as a support facility for the RMIP research and extension efforts. In addition, the PMC was designed with the long-range objective of multiplying seeds of forage species and (as more producer needs were identified) of producing fuel and fodder shrubs for revegetating Moroccan rangelands. Thus, the PMC functions included:

* **producing seed of range forage species,**
* **developing a shrub seed production nursery and increasing shrub production for the perimeters,**
* **producing certified seed for the National Seed Marketing Company (SONACOS) to generate revenue and introduce the PMC to the certification system, and**

The most essential function of the PMC may prove to be collecting and assessing native and exotic species by:

* **establishing nursery plots for collected native species,**
* **evaluating and multiplying the most promising species,**
* **establishing pilot production of breeder seed,**
* **training range technicians in native plant collection techniques, and**
* **developing a collection program for all of Morocco.**

As a well-equipped operating facility capable of identifying and producing plant materials, the PMC can also assess the possible economic value of native and exotic forage species for Morocco. With its well-trained staff in place, the PMC can contribute leadership and technical expertise to the development of plant material quality standards in Morocco.

PROJECT SUMMARY:

MAJOR FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

INTRODUCTION

Nearly 600,000 families (with an average family size of eight) or approximately 4.8 million Moroccans depend directly on sheep and goat production for their livelihood. For this reason, the current levels of productivity and efficiency of range livestock production systems in Morocco are grounds for concern at the national level. Not only do these families form one of the lowest income groups in society, but also, the production practices they employ have serious, negative, long-term impacts on land resources that serve the needs of society. These include:

* **excessive erosion and sediment production associated with the continual degradation of rangeland,**
* **the resulting increase in xeric conditions at the point of origin, and**
* **the resulting reduction in the productive life of reservoirs and intensive agricultural developments downstream.**

Moroccan rangelands are situated over diverse climatic and ecological zones and productive rangelands can often be converted to marginal croplands. Therefore, more and more rangeland is being converted to cultivated cereal crops each year by a rapidly expanding population despite the fact that little or no profit from subsequent grain harvests can be realized.

Since crops provide a standing forage crop even as stubble, Moroccan producers compensate for poor range forage productivity by producing a very marginal cereal crop while simultaneously controlling the land for their personal use. Cereal crop subsidies and land tenure policy by the Moroccan Government encourage this practice and, as a result, pastoralism has nearly completely given way to an agro-pastoral way of life to the detriment of rangeland productivity and the communal rangeland users.

Major findings resulting from the RMIP indicate the extent to which rangeland degradation and deterioration of livestock production have occurred in Morocco. Detailed descriptions and recommendations for future actions follow.

RMIP COMPONENT ONE: Applied Research

Findings: Range Forage Production

Where productive rangeland has been converted to poor cropland, pasturage is scarce. What rangeland remains is excessively used, usually in the complete absense of any kind of management or control. A vivid example of this abuse can be noted at Ait Rbaa Perimeter which is located in the midst of a large agricultural area dominated by irrigated and dryland crop

production. Much of the forage which animals at Ait Rbaa consume is comprised of crop residues and weedy fallow. After harvest, shepherds herd large flocks through cropland to eat stubble and weeds. However, when planting begins the livestock must withdraw from the cereal fields. They are then herded onto a relatively small area of communal rangeland where they quickly consume emerging vegetation. Under this excessive grazing pressure, the range continues to deteriorate and the herds must receive large amounts of supplemental feeds including barley, straw and residual products from agricultural processing factories such as sugar beet pulp and cottonseed based feeds.

Thus, many Moroccan rangelands are generally devoid of the original stands of palatable, perennial, herbaceous vegetation. **Many forage species, both legumes and grasses, which were reported during the earlier USAID Range Improvement Project (608-64-4) could not be located by a former team member of that project, Mr. Walter Graves, during his TDY visit in 1985.**

Project staff also noted that **soils on grazing perimeters were so severely eroded and compacted that moisture rarely penetrated sufficiently enough to establish forage plants even in years of greater than average rainfall.**

In attempting to increase water penetration through the soil surface and to revegetate selected rangelands, the following range improvement practices proved to be potentially useful:

* **ripping of the soil and construction of contour terraces,**
* **use of shrubs and herbaceous species (native and introduced) for revegetation, and**
* **use of conventional disc, plow and roller seedbed preparation methods in seeding during years of below average precipitation.**

Specifically, ripping of the soil and the construction of terraces on the contour were highly successful range improvements installed at Fritiss (Ain Beni Mathar), Gouttitier and Ait Rbaa Perimeters. Although not a year old, ripping and terracing activities at the El Faija Perimeter appear to have markedly encouraged revegetation and increased forage production.

Experience indicates that seeding of most introduced species on small plots of marginal cropland is an intervention that is generally too risky to be assumed by private producers. A farmer would rather have a poor stand of barley or wheat from which he may obtain grain and stubble annually than a year of limited or no use which he considers lost. Furthermore, success in establishing perennial forage species has been limited due to competition from weeds on old fields and low amounts of precipitation. Thus, **establishment of perennial, introduced species has been generally difficult and expensive.**

Stands which have become established, such as those in the perimeters administered by the Midelt Office, are the result of adequate seasonal precipitation and few problems such as seed quality and competition from weedy species. Although a number of

stands composed of introduced species from the genus Agropyron are managed at Plaine de l'Aarid Perimeter, the condition of these stands has undergone substantial deterioration in recent years (many of the stands are over 10 years old). Juvenile plants appear to be lacking and the remaining mature plants are decadent with some stands in need of renovation.

In addition, warm-season grasses, including native species, have proven difficult to establish on Moroccan rangelands. Seeds of warm-season grasses are generally small and relatively expensive. Successful establishment depends upon adequate precipitation during and after germination, and planting depth must be carefully controlled by technicians. The possibility of failure is too great to make this a viable alternative unless techniques are improved.

Species adaptability trials are a vital component to the success of future range seeding efforts. There will always be new species, both introduced and native, that will require testing and evaluation. Species must be evaluated for seed germination and seedling establishment, the keys to successful stand establishment. Adaptability of the species to local conditions, including grazing tolerance, is essential to longevity and persistence of seedings. Forage productivity along with stand longevity affect the economic feasibility of seeding efforts. The results of the RMIP trials have shown substantial differences in adaptability and productivity among varieties within species.

In particular, the overall poor performance of introduced species was in contrast to the relative vitality of the few native species within the trials and found in growing locally in various protected areas. This observation prompted a change in project emphasis from solely evaluation of introduced species to additional efforts in the research and development of native species.

The potential of plants native to Morocco is the most promising aspect of the RMIP work with range forage species. Among these plants are ecotypes highly adapted to climatic, grazing and soil conditions on the grazing perimeters. Among accessions from the native seed collection being propogated at the PMC and undergoing trials at the perimeters are annual species which have the ability to produce the large numbers of seed necessary to maintain a presence on managed communal rangeland. These include leguminous annuals, especially from the genus Medicago, which exhibit sprawling forms and subterranian fruits capable of persisting under heavy grazing pressure. These species characteristically produce forage of high quality and large numbers of seeds in protective pods. The use of native annuals may be one key to reducing the risk of failure of a range revegetation investment in some zones.

Several basic range planting techniques were tested in the Midelt area. The conclusion drawn was that conventional seedbed preparation methods using a plow, disc and roller were most successful during the years methods were tested (generally lower

than average precipitation periods). The rangeland drill, which scarifies soil surface and seeds in areas of rough topography, did not prove effective during drought years because seedbeds were inadequate for seed germination and seedling establishment under marginal soil moisture conditions. Where interseeding with the rangeland drill in sagebrush stands was attempted, seedlings could not compete with established plants for limited moisture.

Recommendations: Range Forage Production

The need for range management and the adherence to basic ecological concepts needs to be observed throughout the grazing perimeters studied. This can only be affected through the cooperation of the people using the resource. Benefits that accrue to producers must be developed and demonstrated in order to reverse the trend toward further resource degradation. Thus, proper management of grazing must occur if the range forage resource is to improve.

Specific conclusions include:

* **Range improvement is possible through manipulating the soil surface and redistributing water. Soil ripping and construction of contour terraces should be considered prior to seeding rangelands. Where native residual plant cover still exists, the treatment can be used to capture rainfall and increase productivity without seeding.**

* **Range improvement research is essential. DE/SP must either decide to dedicate personnel and materials to research or make the proper contractual agreements to continue range research in identified topical areas through the auspices of such existing research organizations and programs as INRA, INAV, ENA or the SR-CRSP.**

* **Species adaptability trials should continue. Comparisons of standard introduced varieties and newly released varieties as well as comparisons among native species should proceed. Despite unpredictable weather conditions, it is essential that trials continue to be planted and evaluated, preferably on a yearly basis.**

* **Coordination is mandatory between local offices and the PMC. The PMC research supervisor must keep personnel at the grazing perimeters informed of the details of the PMC production program. Otherwise little success can be expected from the PMC.**

A combination of range improvement techniques and development of adapted forage species can improve the possibilities of successful revegetation. Only through reducing the risk of rangeland seeding can seeding of denuded range and submarginal cropland become a viable alternative for producers. The acceptance of rangeland management in the private sector, however, is not the only consideration. Large-scale government

direction and investment is necessary in order to conserve the dwindling Moroccan range resource.

The continual push of dryland farming into more and more marginally productive areas has accounted for an irreparable loss of topsoil and the local extinction of many forage plant species. Government intervention and expenditure will be necessary to save soil and vegetation even if only to protect watersheds. The continued emphasis on dryland farming by the Moroccan Government and USAID without a balanced effort in the rangeland production sector is a policy which encourages environmental degradation of natural resources in Morocco. Social and economic consequences of policies that foster unwise land use will undoubtedly be felt at the national level through increased rural poverty and urban migration.

Findings: Range Livestock Production

Livestock populations in Morocco consist primarily of sheep with smaller numbers of goats, cattle, camels, horses, mules and donkeys. Livestock production systems and levels of production varied across the country. Based on information gathered through project efforts, the following conclusions can be drawn:

* **level of livestock management is reflected by the producer income levels,**
* **types of forage resource and times of use vary among producers and project sites,**
* **currently applied animal health care practices are more curative than preventive, and**
* **particular problems in sheep management and production exist across the country.**

Specifically, livestock management is reflected by the producers' income levels in several respects:

* **the high-income producers generally provide more intensive management through use of multiple flocks and forage sources making feeding of supplements and administering animal health care more feasible; and**
* **low-income producers maintain only one flock in which all animals are generally treated equally and animal husbandry practiced is quite poor.**

While all producers feed their livestock supplements sometime during the year, the degree to which animal species, class and stage of reproduction are differentiated and the amount of supplements fed varies among producers. Producers at the higher income levels utilize supplemental feeds to a greater advantage and often to a greater extent than do poorer producers.

Types of forage resources and times of use vary among producers and locations. Animal movement and forage used are dictated by what resources are available. Producers use preferred resources first and then move on to less desirable sites as the forage availability diminishes. The more prosperous

the producer, the more abundant and flexible are his opportunities to find adequate forage to meet livestock needs. For example, mid- and high-income producers have access to crop residues and are able to haul or herd flocks to leased land to graze, and low-income producers are limited to the forage available on communal land where available forage is generally insufficient to meet livestock nutritional needs.

Animal health care practices are most often curative rather than preventive and, throughout Morocco, livestock are penned at night. While these corrals provide good protection from predators, the permanence of the structures and negligence in keeping them clean results in many health-related problems. Animals treated for internal parasites are immediately returned to the same corrals and grazing areas used before treatment. The animals are thus immediately re-exposed to parasite eggs and larvae and soon become infested again. Furthermore, during discussions with producers throughout Morocco a common concern was raised over the quality and effectiveness of the animal health care provided by the government. Why these concerns were voiced is unknown and no effort was made to determine the reasons.

Particular problems in sheep management and production across the country include:

* **excessive numbers of low quality breeding rams,**
* **late weaning of lambs,**
* **lambing at times when mortality is high,**
* **low levels of animal nutrition,**
* **poor sheep selection practices, and**
* **low quality wool.**

Specifically, producers in Morocco generally keep an excessive number of rams in their flocks year round allowing indiscriminate breeding. This practice is unnecessary resulting in inefficient use of forage and lambing at various times throughout the year with little or no selection for genetic improvement. Ram-to-ewe ratios vary but are often around 1:20.

Intentionally weaning lambs is a management practice rarely used by Moroccan livestock producers. Project studies showed that by early weaning of lambs, producers could receive the health, nutritional and reproductive benefits without a reduction in lamb growth and development. The combination of a grazing management program coupled with early weaning allowed young lambs access to quality forage and reduced the time required to reach a marketable size while ewes remained in better condition allowing them to breed back more readily.

Across project sites, lambs are born throughout the year with a higher incidence of births during the spring, fall, and winter months. Most lambs are born during periods when the risk of mortality is high. The incidence of lambing intervals that exceeded 13 months was common. This primarily reflected a lack of sufficient forage to meet the ewes' nutritional requirements for reproduction.

Death losses occurred year round but a higher incidence of deaths occurred during the late fall and winter when the weather was harsh and forage was limited. Producers reported normal death loss to be 7% to 9% for lambs and 3% to 4% for breeding animals while the project producer study subsample experienced a 6.9% lamb loss.

Poor sheep selection practices and reproduction problems were common at all project sites. Problems encountered included:

* **ram infertility,**
* **producer failure to identify production and reproduction related problems in animals for selection of replacement ewes, breeding rams and cull animals; and**
* **poor management of animal nutrition.**

Specifically, ram fertility problems were found at all project sites and 22% of 217 rams checked for reproductive problems were to be determined sterile or nearly so. Reproductive problems encountered ranged from low sperm motility and concentration to cryptorchidism in rams. Project and SR-CRSP staff trained technicians to recognize ram reproductive problems and a voluntary program for checking producers' rams is in the initial phase.

The criteria for the selection of lambs as replacement ewes were so different around the country that many undesirable animals remain in producers' flocks. Out of 3,942 breeding animals examined in the project classification and selection program, 26% were rated as inferior animals, and 15% of all animals examined were incapable of reproduction. Unproductive animals require the same investment in forage resources, supplemental feed and medical care as productive animals at the cost of reduced efficiency and profits to the producers.

The low nutritional status which animals suffer as a result of insufficient forage resources produces a severely depressed reproductive capacity. Few, if any, animals are allowed to express genetic potential for production. In addition, measured weight losses of animals were due to inadequate forage quantity and, possibly, quality. Ewes weights were monitored for a year and most lost weight during the last trimester of gestation with some showing weight loss throughout the entire gestation period.

The weight changes experienced by ewes in the producer study indicated that the ewes gained weight in the spring and lost weight during the remainder of the year regardless of the lambing date. This pattern is in sharp contrast to the weight changes expected in an average ewe's reproductive cycle and has a substantial negative impact on overall reproductive performance.

Wool grades in sheep at project sites were generally low. Fleece grades ranged from 40 to 60 with most being between 40 and 50. Kemp and/or hair was present in roughly two-thirds of the fleeces. Despite demand for quality wool stemming from the Moroccan carpet industry, livestock producers generally consider

wool a by-product of animal production and have little interest in its improvement because each individual producer deals with a relatively small quantity.

Recommendations: Range Livestock Production

Based upon observations and experience gained at the various project sites, it is recommended that research and extension programs include aspects to increase forage productivity and to improve animal husbandry practices. Significant improvement in forage production and, subsequently, animal production can be expected in many areas through grazing management combined with improved animal management practices.

Given the limited number of trained professionals and the scarcity of program funds in Morocco, it is essential that efforts of the range management personnel be concentrated in areas where an attitude of local concern and cooperation exists. In some areas, livestock producers have recognized the value of formally organizing themselves to try and deal with common range management and livestock production problems. These are the areas where production problems can be successfully addressed. Once groups are formally organized and grazing management is established by the group of producers and technicians, range development projects such as seeding and other forage improvement efforts can be planned and implemented. Under these circumstances the expenditure of limited development funds is justified.

Improved animal husbandry practices that should be considered include:

* **timing lambing periods to coincide with periods of increased forage production so as to better utilize available resources, improve ewe condition and reduce producers' dependence on costly supplemental feeds;**
* **culling unproductive ewes to allow productive animals more available forage;**
* **separating rams from the ewes except during a specified breeding season thus enabling producers to better synchronize lambing periods and other critical nutritional periods with times of high forage availability;**
* **preventing inferior rams from breeding by such separation or by practicing the short scrotum technique for sterilization;**
* **ridding herds of other unproductive members and encouraging producers to select for high quality productive animals and not just increased animal numbers;**
* **establishing superior breeding herds through a selection and classification program and banding sheep into larger flocks when appropriate to increase livestock production efficiency; and**
* **establishing extension programs to train producers in preventive animal health care which could ensure that treatments are scheduled when animals are moved to new pastures and corrals thereby disrupting parasite life**

cycles.

In addition, extension program efforts should be made in the areas of:

* **wool quality improvement and marketing, and**
* **goat production.**

Since wool quality characteristics (degree of contamination with kemp and hair, fleece weight, staple length and fiber diameter) are some of the most heritable traits in sheep, wool quality could be rapidly improved through herd selection. Improved wool quality, coupled with improved marketing through quality control and pooling of fleeces), could aid Moroccan producers in meeting the local demand for carpet grade wool. The Moroccan carpet industry currently imports approximately 20,000 metric tons of carpet grade wool annually at hard currency cost because Moroccan wool does not meet quality standards established in the world market and the supply is dispersed in relatively small quantities over the entire nation. Development of wool cooperatives for accumulating, grading, pooling and marketing of wool could lead to mutual benefits for both producers and the export carpet industry in terms of employment, prices and raw materials importation issues.

Producers with limited resources may be well advised to raise animals that can produce on the resources available instead of attempting to raise animals that require supplemental feeds at costs that are difficult to recover. More effort should be expended in exploring the potential of goats for efficiently producing meat and fiber. Although the project effort to compare goat and sheep production on limited resources was not conclusive, it is possible that goats are capable of higher and more efficient production than sheep under severe conditions.

Findings: Sociological Research

The sociological research carried out under the project sought to:

* **determine producer perceptions of their production needs and constraints, and**
* **identify social constraints to the adoption of new technologies.**

Coordinated and systematic project-wide studies were undertaken in the spring of 1985 and continued throughout the final 18 months of the project. Staffing arrangements allowed Moroccan personnel to gain direct experience in conducting social research in relation to range management and livestock management improvement. The RMIP social research teams were involved in two major work activities:

* **an on-going study of prices of agricultural commodities in local souks (weekly markets) to identify prices relevant to local producers, and**

* **a series of case studies of producers within producer categories thought to represent the range of production systems found at each site.**

Producer perceptions of the market values of crops and livestock products were similar to those found in most societies -- "prices are lower than they were several years ago". There seems to be a tendancy to remember the "good" times and to regard them as the norm. In reality prices are generally higher than ever but real profits are lower because of increased production costs and inflation.

Producer perceptions of their production environment generally centered on the issues of low productivity and their limited ability to provide for proper nutrition and health care of animals due to high costs. Drought and overstocking were identified as major problems associated with low productivity but were deemed beyond the individual's control. Most producers felt that conditions were gradually worsening over time. Producers felt that drought was keeping the production of supplemental feeds low and, therefore, keeping feed prices high. Animal health programs were valued and thought to be needed, however, many producers were sceptical about the effectiveness of existing programs and were not aware of the management aspects necessary for effective disease and parasite control programs.

Social constraints related to marketing of products were few. However, the market limitation affecting controlled breeding of livestock (generally accomplished through castration of males not kept for breeding) was important. Male animals are marketed with the testicles intact on the carcass and demand a higher price than do female animals. Likewise, docking of tails as a sanitation measure is not appropriate since tails on carcasses are a traditional means by which consumers differentiate sheep carcasses from goat carcasses.

Constraints to acceptance of new technology were generally not found to be cultural. An exception is the aversion within the culture to undertaking any management practices that results in animals bleeding from an open wound. This limitation disallows docking of tails or castration and affects sanitation and controlled breeding efforts. Other constraints to acceptance of technology are generally centered around individual producer resource limitations or scale and producer dependence on common resources. Individual actions involving communally owned resources have essentially no effect. Group actions are needed under these circumstances and, unfortunately, the traditional mechanisms for control and management of communal resources (such as the jema'a) have, for all practical purposes, disappeared in many areas.

Recommendations: Sociological Research

Dealing with limitations to the acceptance of new technology is therefore related to introducing techniques for improving management that fit within the existing cultural constraints and

that encourage management of communally owned resources. In the case of controlled breeding of animals, bloodless male sterilization techniques that do not remove the testicles are in order. The short-scotum technique introduced through the project is one appropriate approach to accomplishing controlled breeding. Another approach to this issue as well as many other animal and range management issues is the formation of producer cooperatives on communal land whereby it is possible and practical to form larger herds according to animal class. Through this practice, breeding animals can be herded separately from market animals and managed according to the specific needs of the animal class. This also allows for the control and management of grazing. Such group efforts have been successfully tried at the Fritiss Grazing Perimeter near Ain Beni Mathar. The key to improved range and animal management is involvement of the producers as a group that can and is willing to act in the interest of the entire group.

Findings: Economic Analysis

The objectives of the economic analysis were to:

* **identify economically feasible alternatives that would increase production and production efficiency of livestock systems in Morocco, and**
* **estimate the magnitude of production and ultimate net income increases given a range of producer accepted alternative production strategies.**

The economic analysis process consisted of:

* **development of a descriptive model that could be used for budgeting and partial budgeting based on production parameters, the costs of resources used in production and the prices of products;**
* **integration of biological and socioeconomic information in order to identify feasible alternative range and livestock management practices; and**
* **comparison of alternatives in terms of investment costs and the subsequent increases in forage production required to produce a given real rate of return on investment.**

Data pertaining to the productivity of existing livestock production systems were collected in each of the four project areas and included estimates of:

* **herd structure and productivity,**
* **feed and forage resources used,**
* **revenue from livestock production,**
* **livestock production costs,**
* **crop productivity,**
* **revenue from crop production,**
* **crop production costs,**
* **income and costs from other activities,**
* **production system net revenue, and**
* **forage use efficiency.**

The analysis of the production systems identified basic economic problems in Moroccan livestock production including high production costs and low productivity. High production costs result from the dependence on expensive sources of feeds for maintaining animals and supporting unproductive animals. Low levels of productivity result from:

* **drought,**
* **abusive land use practices,**
* **outdated animal and grazing management practices, and**
* **resource limitations (biological and financial).**

While these problems of high production costs and low productivity were common to both livestock and crop production, the project emphasized livestock production alternatives thereby balancing other more widespread efforts in Morocco directed toward solving agronomic problems. Alternatives addressed livestock production costs in two major areas:

* **improved animal husbandry and management, and**
* **increased production of range forage as a substitute for high cost feeds.**

Production costs could be reduced through culling of non-productive animals, adjusting management to reduce disease and parasite infestation, and managing feed and forage resources based on animal requirements (supplemental feeding programs and practices such as early weaning).

When range forage is valued as a substitute for supplemental feeds and sites having adequate inherent potential are treated, economically feasible increases in range forage production are possible through various practices. Based on studies initiated as project activities, management practices considered as viable approaches on specific sites include:

* **grazing management,**
* **contour terracing,**
* **shrub planting,**
* **chiseling,**
* **seeding with the rangeland drill,**
* **seeding by conventional methods, and**
* **combinations of these practices.**

The degree to which improvement practices can be applied on rangeland is determined to a great extent on the capacity of the land to produce forage. In the RMIP analysis, approximately 70% of the rangeland in Morocco was considered to have limited potential for forage production because of aridity. These lands were considered for improvement only through investment in extensive practices such as grazing management. The expected average increase in available forage production through grazing management alone was conservatively estimated to be 57%. The remaining 30% of the land was considered to to have adequate production potential to qualify for more investment intensive improvement practices. The potential average forage production

increase on these lands was conservatively estimated to be 200%.

Recommendations: Economic Analysis

There are probably many biological and economically feasible ways in addition to those attempted through the RMIP by which animal and forage production can be increased. The critical element is the degree of interest and desire that producers have in improving their situation. Producers can be successfully assisted in improving their animals and range resources but it is highly doubtful that improvement can be handed to them. Producer involvement and participation in all phases of development including investment is needed to ensure that the commitment to improvement exists.

The effect of improved management of livestock production systems can be important at the local and broader regional or national levels. For example, even at a relatively low yet perhaps realistic level of producer acceptance of 25%, substantial improvement in average production (33%), production efficiency (44%) and, more importantly, net revenue could be expected. The average increase in net revenue per family member is projected to be 49% at the 25% adoption level and is estimated to be much higher as producer acceptance increases.

Estimates of average national annual production and product value based on 25% producer acceptance would result in substantial increases in production (33%) and product value (32%) thus contributing to the long-term possibility of reestablishing export markets for meat and meat products and so strengthening the national economy.

The following actions are needed to strengthen the efforts to improve range management and livestock production:

* **a national strategy accompanied by clear statements of policy should be formed to serve as a guide for the development of programs that are of high interest to producers and have high levels of improvement potential;**
* **a systematic approach to planning and evaluation of programs should be established to ensure that local programs are effective in addressing the policy goals of the national strategy and that a systemmatic approach be used to analyze problems and alternatives;**
* **development efforts should be directed in those areas where producer interest and commitment is high and at those investment opportunities that directly and quickly increase production;**
* **recipients of development assistance should be required to participate in the financing of developments in some form to ensure their involvement and commitment;**
* **efforts to increase the amount of biological, social and economic information on range and livestock production systems should be strengthened along with the lines of communication among professionals working in research, education, extension and management; and**

* **a national commitment should be made to continue the search for better development applications in semiarid and arid zones.**

RMIP COMPONENT TWO: Extension

Findings: Extension Program Development

The project extension program development relied on:

* **determining audience profiles,**
* **assessing current production systems, and**
* **identifying potential interventions and producer acceptance of alternatives.**

In regard to audience profiles, essentially two producer audiences exist in the extensive livestock sector in each region:

* **high-income producers who comprise a small group of families with most of the wealth and income-producing capability, and**
* **low-income producers who make up the majority and control only small resource sets with a low capability of producing income.**

This resource distribution pattern affects the design and implementation of range and livestock extension programs as both audiences have divergent needs and varying abilities to respond to proposed interventions. **Producers controlling most of the private land can benefit from programs providing crop and rangeland improvements including improved crop varieties, range seeding, terracing, water spreading and development, herd improvement, animal health and animal selection. Producers with less control over resources would benefit from cooperative organizations through which they can improve the management of collective land to which they have access allowing programs such as animal health, animal selction, range improvements, and record-keeping and analysis to be implemented.**

In assessing current production systems, the principal production constraint for the majority of Moroccan producers does not appear to be a lack of interest in new technology nor a desire to produce by traditional methods but rather a resource base so small that it cannot produce a profit that allows the producer to raise or, in many cases, even maintain his standard of living.

Small ruminants form the basis for the production system in the arid and semiarid zones of Morocco. In these zones, the potential for major increases in grain production is limited by inherently low productive potential determined by climate and soils and of local significance only in the context of its integration into the livestock production scheme. Project extension efforts were therefore directed primarily towards livestock production and improving forage crop production. This

was a reversal of current Moroccan government programs in which the focus of extension has been directed primarily on crop production for grain. Producer interest was the criteria thought to be the most important determinant to acceptance.

Recommendations: Extension Program Development

Based on project experience, the necessary ingredients to successful range extension program development in Morocco are:

* **organization of collective rangeland users into entities that are capable of managing the range resource,**
* **continuous effort to develop and test new range and livestock improvement practices that benefit producers, and**
* **development of programs that introduce technology that provides benefits to the producers in the short-term and that will open the door to introduction of technology that provides long-term benefits to the producers and society.**

An example of an appropriate extension program initiated by RMIP personnel is the animal selection program carried out with the producers at the Fritiss Perimeter near Ain Beni Mathar. The producers quickly learned how to apply animal selection criteria for herd improvement and realized benefits of the program through savings in production costs and improved animal production efficiency and quality.

RMIP COMPONENT THREE: Training

The training component was one of the most successful aspects of the project. Combined with the training achievements realized through other assistance projects, a substantial number of individuals who received either short-term or long-term training in disciplines pertinent to range and livestock development are now in place. These people will have an important influence on future development efforts in Morocco.

Findings: Long-Term Training

Through RMIP efforts, a total of 11 people were trained to the MS level in range management, extension or rural sociology. These individuals have all returned to be assigned in various locations around Morocco.

Recommendations: Long-Term Training

Training efforts should continue in order to fill specific areas where trained people are needed (such as sheep and wool production), to replace individuals leaving the workforce and to increase the total number of trained professionals involved in range and livestock development. The number of individuals needed should be projected based on the national strategy for

development and management set by MARA and DE.

Findings: Short-Term Training

Short-term training was an effective training tool in the overall training effort. Special workshops, seminars and shortcourses provided the kinds of "hands on" experience needed by many of the technicians involved. A total of 98 person-months of training in range and livestock management, extension, plant materials production or farm management were provided for DE technicians and administrators. In addition, two one-week technical seminars and numerous one-day seminars were held at various locations in Morocco.

Recommendations: Short-Term Training

While short-term training was not an adequate substitute for degree training, it did serve a very useful purpose. It provided technicians with experience that builds confidence and technical credibility. Short-term training, both in Morocco and in other locations, should be continued. In-country technical seminars or in-service training sessions raise skill levels, give technical staff an opportunity to learn of different approaches to solving similar problems and provide the mechanism for open discussion of technical and professional issues.

RMIP COMPONENT FOUR: The Plant Materials Center

The development of the Plant Materials Center represents the primary effort in development of physical structures. Certain philosophical aspects like determination of goals of such an activity and function of the facility were equally important parts of the development process. At the close of the project some confusion remained regarding the goals and function of the PMC due to some confusing signals transmitted to MARA by USAID. Because of difficulties in adapting government financial support to a farm production situation, USAID suggested that private sector involvement or "privatization" of the facility was preferred due to the cost of public operation of such a facility. This line of reasoning essentially removes the public service aspects which were the driving force behind the original concept of the PMC. Originally, the PMC was envisioned as a facility that would lead the way in the development and production of seed and plant materials which would be useful in solving forage production and soil and water conservation problems in semiarid and arid zones of Morocco and North Africa.

Findings: Plant Materials Center

The PMC facility was completed in 1986. It included offices, housing, shops, seed cleaning equipment and facilities, seed laboratory and storage facilities, seed production equipment and irrigated agricultural land for plant materials production

and research. Some of the land was devoted to a shrub nursery and research trials on native and introduced species. At the close of the project, most of the land area was scheduled for the production of the seed of legume species which have been imported in recent years.

Recommendations: Plant Materials Center

While the original goals of the PMC emphasized the production of seed of cool-season forage species, based on production difficulties with these species, this emphasis should be changed. Legume species (both native species and introduced cultivars) are well adapted to production at the Khemis M'touh area. Other goals such as production of foundation seed, development of seed certification standards and promotion of an extension program for seed production are still valid. Five additional recommendations for strengthening the role of the PMC in Morocco are as follows:

* **Continue the program of research and development of native plant species for forage and conservation use even if satellite locations are needed for the production of some species.**
* **Obtain budget autonomy in order to allow the flexibility required for the PMC to function in the role that has been identified.**
* **Use the PMC facilities to generate revenue by producing high quality seed of forage or agronomic crops for more humid zones to the extent that such activities do not take place to the detriment of the established program.**
* **Integrate the PMC seed laboratory and the DPVCTRF program.**
* **Develop a laboratory for inoculum production that will complement the program of research and development of native legume species.**

CHAPTER ONE: **APPLIED RESEARCH -- RANGE FORAGE PRODUCTION**

INTRODUCTION

In order to determine acceptable strategies of intervention into the livestock production sector, project participants working in the field at local offices had to answer the following questions: 1) What are the forage resources and level of production available to livestock at each site? 2) What specific range improvements are available to range managers and private producers at each location? 3) How will these range improvements affect forage production?

Project technicians collected range forage and crop production data from local administrative sources. In each perimeter, they planned a program of field research to determine range improvements which might increase forage production and halt the loss of soil and vegetation resources. The following chapter provides the objectives, methods, results, and conclusions of range research which was implemented on the grazing perimeters during the term of the Project.

IDENTIFICATION OF MAJOR FORAGE RESOURCES: **AIT RBAA GRAZING PERIMETER, Beni Mellal Office**

Abiotic Influences on Production

Site Topography and Location

The Ait Rbaa Perimeter, under the responsibility of the Beni Mellal Office, is located on an outwash plain of the Middle Atlas Mountains about 40 kilometers north of Beni Mellal and 13 kilometers north and west of Kasba Tadla (Figure 1.1). The average elevation at the perimeter is approximately 560 meters above sea level.

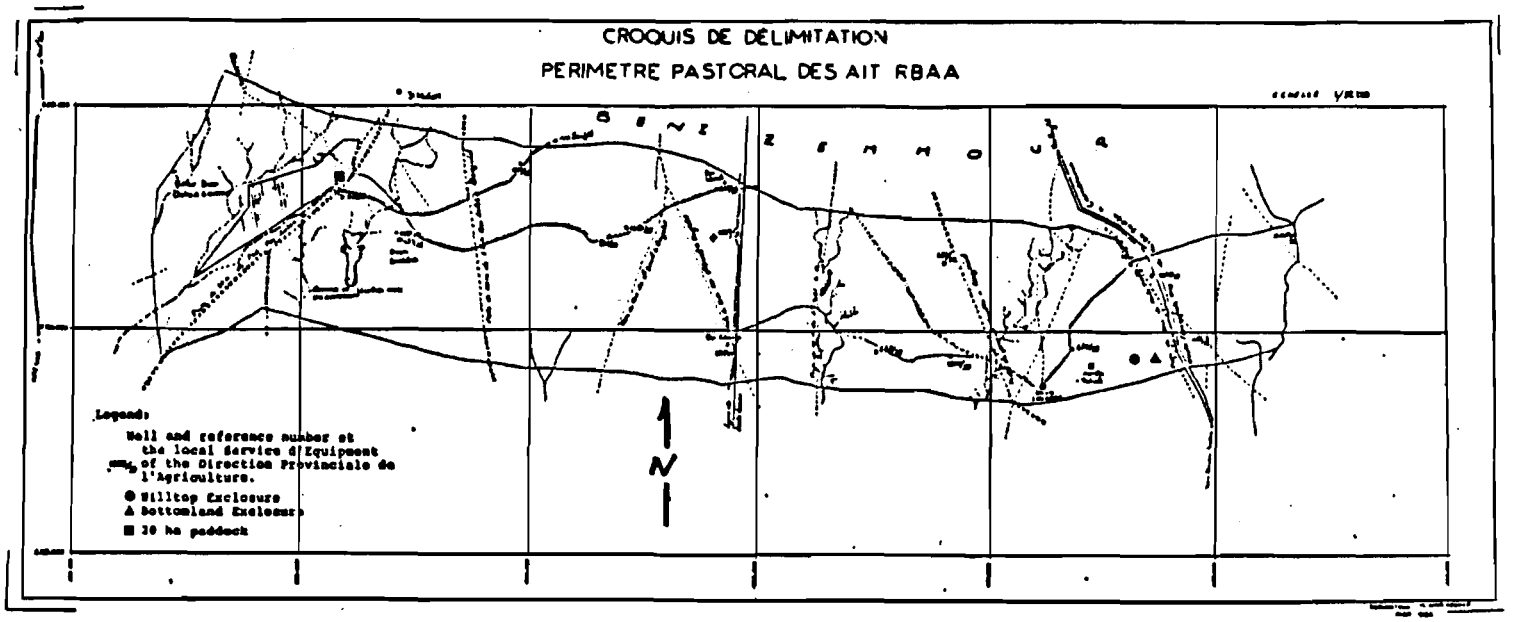

Figure 1.1. Map of Ait Rbaa Grazing Perimeter showing locations of watering points and experimental grazing exclosures.

Soils

Soils in the area are primarily calcareous clays formed over an extensive limestone layer. Soils vary in depth from a few centimeters on hilltops to more than one meter on the bottomland. The soil is mixed with a large proportion of rock, which is mostly composed of chert, ranging in size from gravel to small boulders. Rocky outcroppings and gravel fields are common throughout the area.

Climate

The climate is true Mediterranean characterized by hot, dry summers and moist, cool winters. Summer daytime temperatures reach as high as 45+^{o}C and there are occasional days of freezing

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temperatures in winter (Figure 1.2). The distribution of precipitation is variable over the perimeter and varies greatly from year to year. The pattern of rainfall is generally bi-modal with the peaks usually falling in November and April (Figure 1.3). Recorded amounts of precipitation range from a low of 95 mm annually to a high of 600 mm, averaging near 350 mm per year (Figure 1.4).

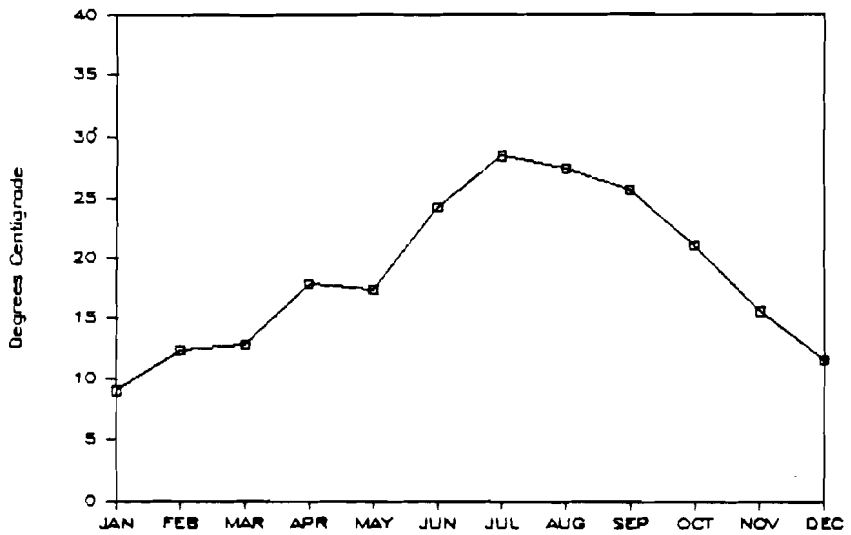

Figure 1.2. Average monthly temperatures (^{o}C) for the Beni Mellal region (Beni Mellal Office).

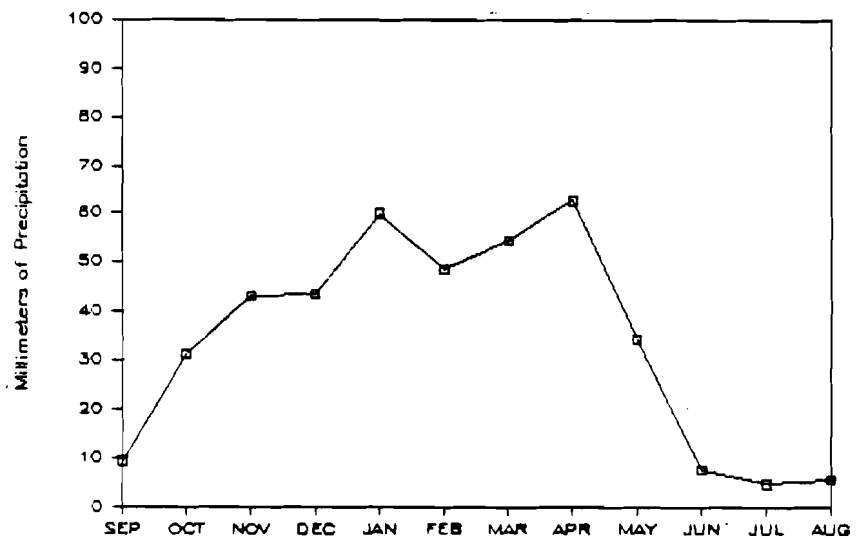

Figure 1.3. Average monthly precipitation (mm) for the Beni Mellal region (Beni Mellal Office).

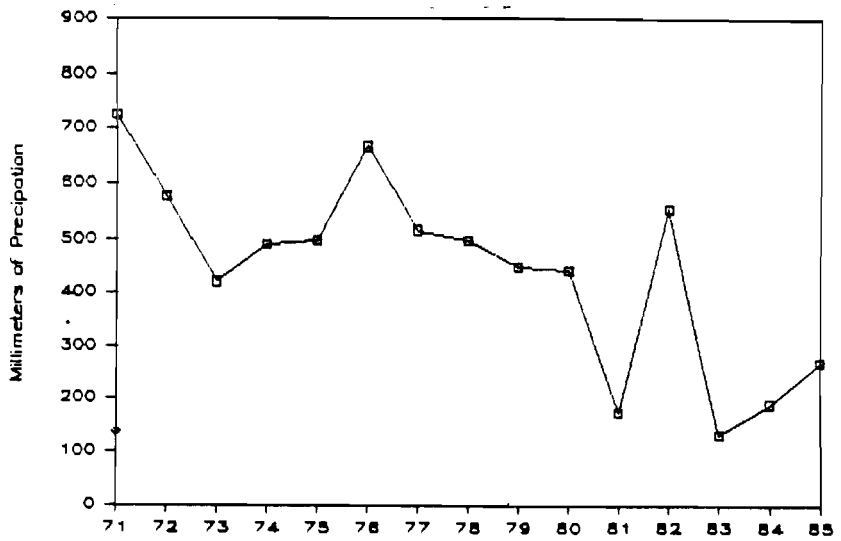

Figure 1.4. Annual precipitation (mm) for the Beni Mellal region for 1971-1985 (Beni Mellal Office).

Forage Crop Production Estimation: **BENI MELLAL REGION**

Native Range

The original vegetation of Ait Rbaa was probably composed primarily of annual and perennial grasses and legumes, but heavy grazing has reduced the composition of the plant communities to mostly annual forbs. Major plant species include *Cynodon dactylon*, *Asphodelus tenuifolius*, *Malva parviflora*, *Medicago laciniata*, and *Stipa retorta*. A major perennial component of the vegetative cover is a thorny shrub, jujubier (*Zizyphus lotus*), which is somewhat resistant to grazing, but is heavily harvested for firewood and for materials for construction of corrals.

Forage production on the perimeter was estimated during a 1984/85 forage study, in which unpalatable plant species were also collected. The following table has been corrected to estimate only usable forage (Table 1.1).

Cultivated Lands

Cultivated lands are an important source of forage for livestock raised in the area. The following table (Table 1.2) presents estimates of forage availability for the Kasba Tadla area from forage crops and crop residues. These figures were computed from a table on cultivated land use. In order to estimate crop residues the following formulas were used:

- Roughage from wheat or barely..= Production x 1.08
- Beans.....= Production x 1.50
- Peas.....= Production x 1.00
- Sugar beets.....= Production x 0.20

Table 1.1. Average annual herbage production estimates by land category on the Ait Rbaa Grazing Perimeter (Beni Mellal Office).

LAND CATEGORY	AREA (ha)	RATE (kg dm/ha)	YIELD (T)
Slightly Eroded	4,615	1,500	6,922.5
Moderately Eroded	1,680	1,100	1,848.0
Highly Eroded	877	350	307.0
Bottomland	2,500	600	1,500.0
Rock Outcrop	112	0	0.0
TOTAL	9,784	1,081	10,577.5

Table 1.2. Estimated average annual crop production and crop residue available for livestock in the area surrounding the Ait Rbaa Grazing Perimeter (Beni Mellal Office).

CROPS	AREA (ha)	CROP YIELD (T)	RES. YIELD (T)+
Forage Crops			
Alfalfa	428	3,809.2	
Bersim	40	180.0	
Oat-Vetch	43	309.6	
Pea-Barley	148	310.8	
Corn	67	254.6	
Others	71	269.8	
SUBTOTAL	797	5,134.0	
Cereal Grains			
Hard Wheat	14,280	28,560.0	39,984.0
Soft Wheat	22,827	59,350.2	63,915.6
Barley	16,959	28,830.3	32,222.1
Corn	88	176.0	378.4
Legume Grains			
Broad Beans	1,664	1,830.4 *	2,496.0
Peas	4,013	2,809.1 *	3,611.7
Chick Peas	789	-	-
Lentils	694	138.8 **	13.9
Green Beans	-	-	-
Industrial			
Sugar Beets	1,587	64,432.2	12,466.2
Fallow	8,997		20,693.1
TOTAL	>72,695		>175,780.7

* Two years of data (1983/84 - 1984/85)
** One year of data (1984/85)
\+ Crop residue estimates:
Straw from wheat or barley = grain production x 1.08
Aftermath from beans = grain production x 1.50
Aftermath from peas = grain production x 1.00
Dry pulp from sugar beets = production x 0.20

Abiotic Influences on Production

Site Topography and Location

Two recognized grazing perimeters fall under the administrative jurisdiction of the Midelt Office of the Service des Parcours: El Faija Perimeter, a 4000 ha area near Itzer, and Plaine de l'Aarid Perimeter, a 12000 ha area 45 km west of Midelt. Both grazing perimeters are situated on high plateaus located along the eastern edge of the Middle Atlas Mountains and are found at elevations ranging from 1600 to 1800 m.

Soils

Soils have developed from old sedimentary deposits and overlying alluvial outwash. Soils have been described as mostly clays, containing a calcic horizon.

Climate

The climate is semi-arid Continental, characterized by relatively cold winters (Figure 1.5). Annual precipitation averages approximately 300 mm, 90% of which falls between October and June (Figures 1.6 and 1.7).

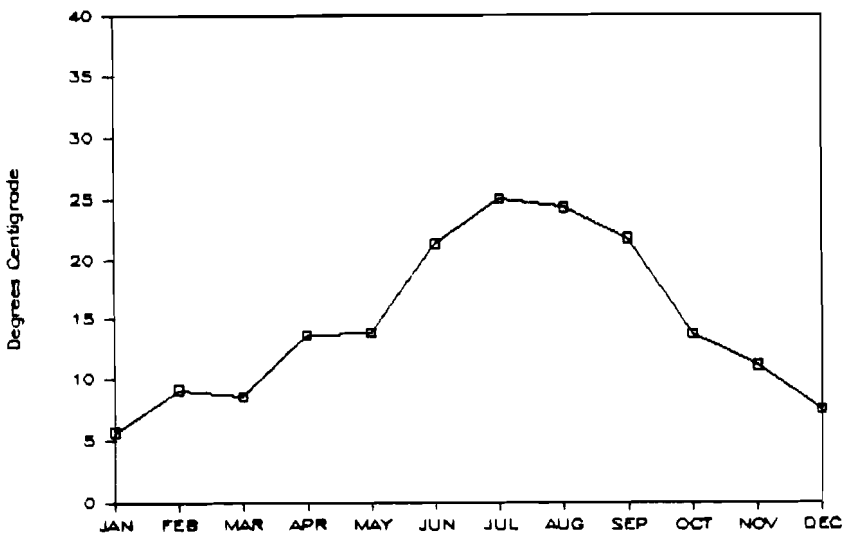

Figure 1.5. Average monthly temperatures (^{o}C) for the Midelt region (Midelt Office).

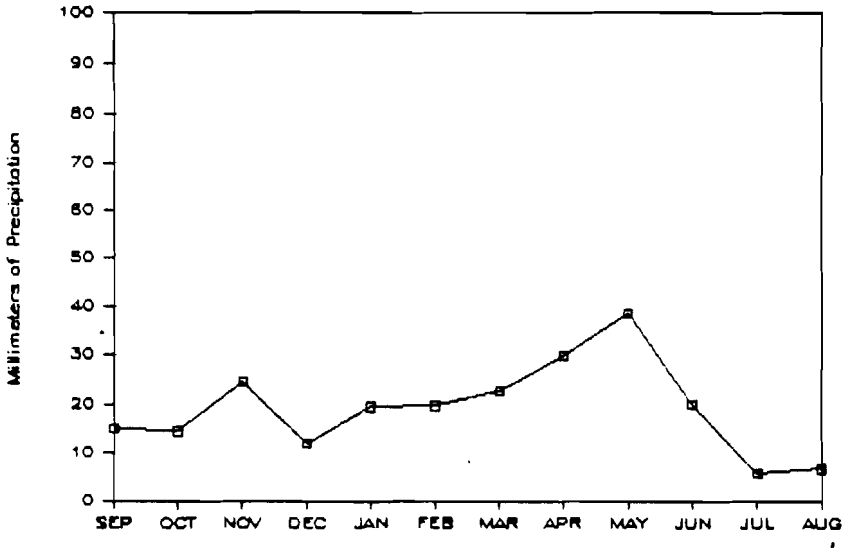

Figure 1.6. Average monthly precipitation (mm) for the Midelt region (Midelt Office).

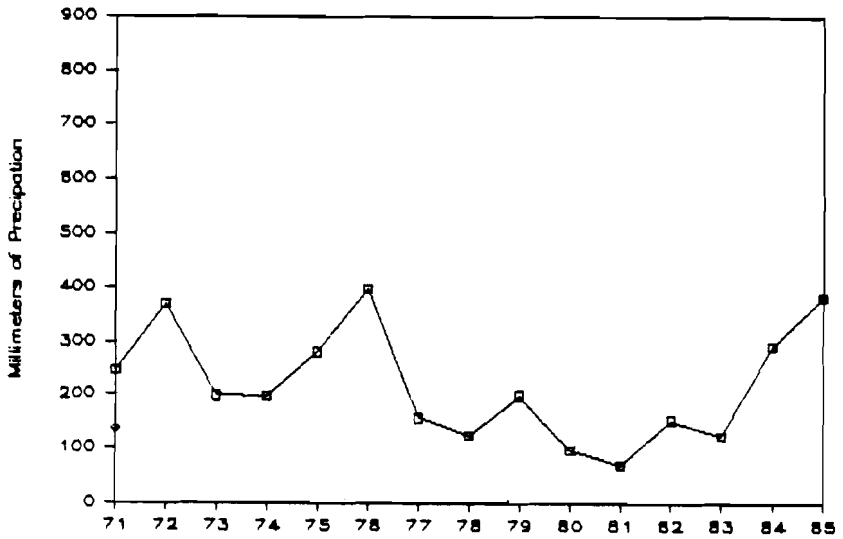

Figure 1.7. Annual precipitation (mm) for the Midelt region (Midelt Office).

Forage Crop Production Estimation: **MIDELT REGION**

Native Range

Native rangelands of the area are commonly characterized as the sagebrush type (dominated by *Artemisia herba alba*) and the alpha-grass type (dominated by *Stipa tenassicima*). The sagebrush

type generally occurs on areas of even to rolling topography with more mesic site characteristics while the alpha-grass type occurs on the areas of greater topographic relief exhibiting more xeric site characteristics. Estimates of production on native rangelands following drought are presented in Table 1.3.

Table 1.3. Estimated annual herbage production on grazed native rangeland near the El Faija and Plaine de l'Aarid Grazing Perimeters following drought (Midelt Office).

VEGETATION TYPES	AREA (ha)	RATE (kg dm/ha)	DM YIELD (T)
Sagebrush/Grass	133,000	23.0	3,059.0
Alpha-grass	131,000	5.0	655.0
TOTAL	264,000	14.0	3,714.0

Cultivated Land

Cultivated lands in the area are primarily devoted to cereal production. Some fruit orchards and forage crops are also produced on irrigated lands. Estimates of forage produced on cultivated lands are given in Table 1.4.

Table 1.4. Estimated average annual forage production from Midelt area crops and crop residues for a five year period (1980-84) including drought (Midelt Office).

CROPS	AREA (ha)	CROP YIELD (T)	RES. YIELD (T)
Grain Crops			
Hard Wheat	16,270	42,302.0	45,556.0
Soft Wheat	1,001	2,803.0	3,003.0
Barley	1,060	636.0	742.0
Corn	716	787.6	1,217.2
Forage Crops			
Alfalfa	1,247	890.7	
TOTAL	20,294	47,419.3	50,518.2

IDENTIFICATION OF MAJOR FORAGE RESOURCES: **FRITISS GRAZING PERIMETER AND GOUTTITIER EXPERIMENTAL FARM, Oujda Office**

Abiotic Influences on Production

Site Topography and Location

The Fritiss Grazing Perimeter is located 17 km south of Ain Beni Mathar (Figures 1.8 & 1.9). It is situated between the

plains of Berguent to the north and Tendrara to the south. Approximately 60% of the surface area (total: 10,000 ha) occurs as hills, breaks and plateaus. The remainder of the area is comprised of lowland plains, basins and drainages. The Gouttitier Farm is located on rolling plains, about 130 km west of Oujda along the road to Taza (Figure 1.10). The Gouttitier Experimental Farm was incorporated into the Bureau des Parcours administration in 1984. This farm was reserved for the needs of future rangeland research for the Oriental Region of Morocco. With some 2000 hectares of degraded rangeland, this area will hopefully become an oasis for the demonstration of advanced agricultural management practices in the region. Of the 2000 hectares, 40 hectares can be irrigated. Rangelands of the region generally occur at elevations ranging from 500 to 1500 meters.

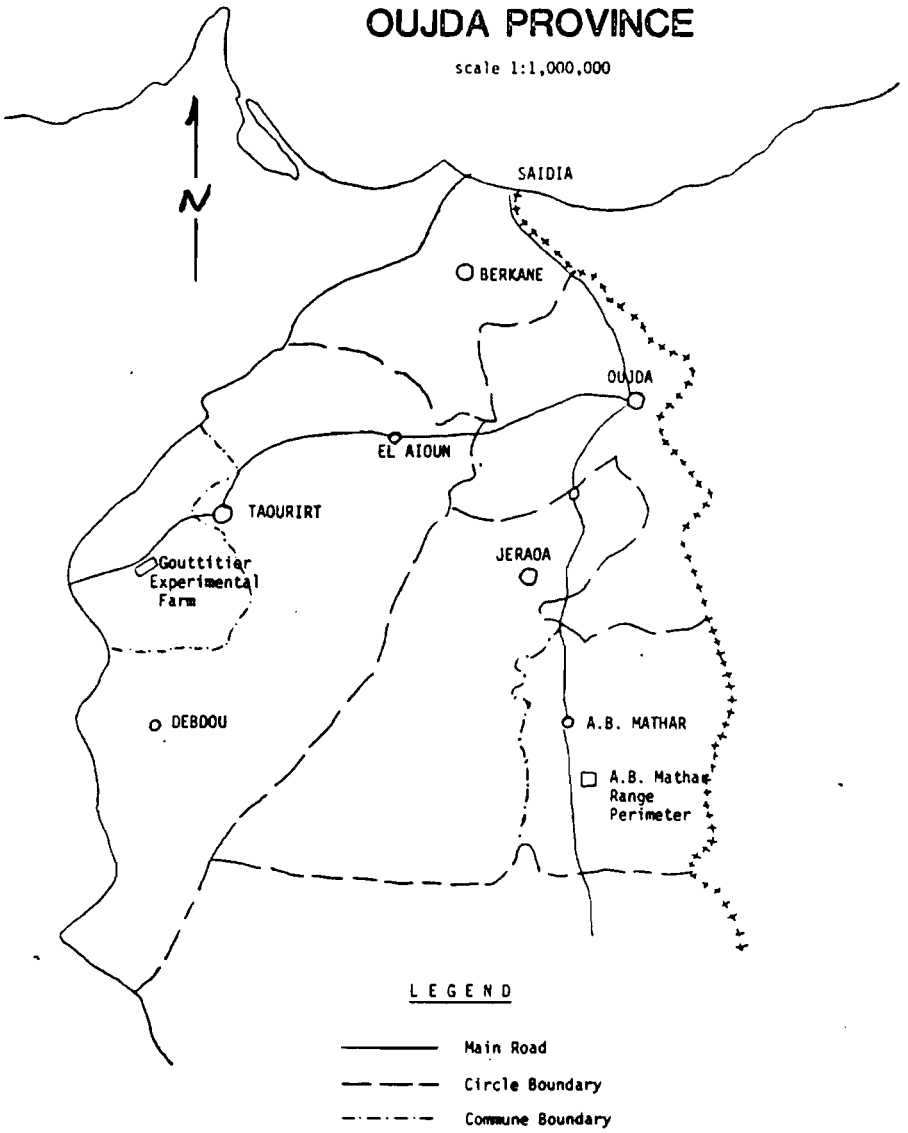

Figure 1.8. Map of Oujda Province indicating Fritiss Grazing Perimeter (Oujda Office).

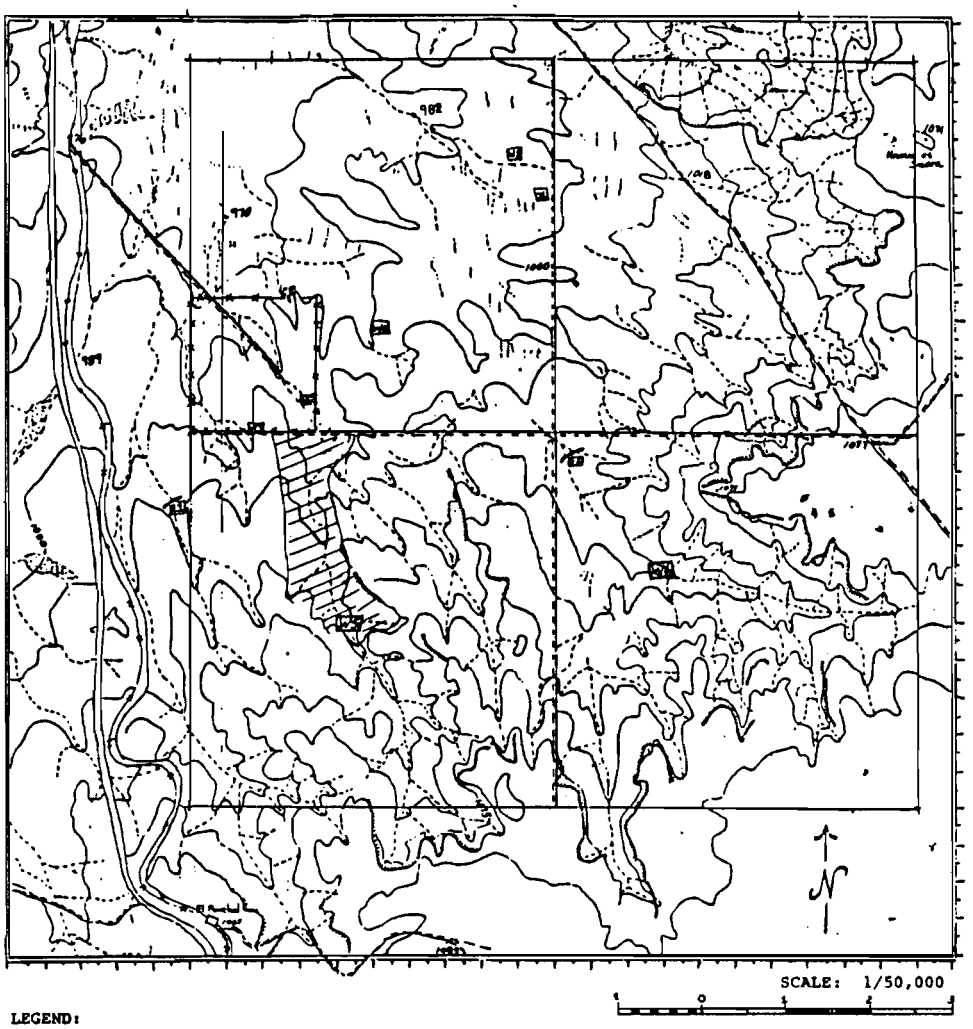

Figure 1.9. Map of Fritiss Grazing Perimeter (Oujda Office).

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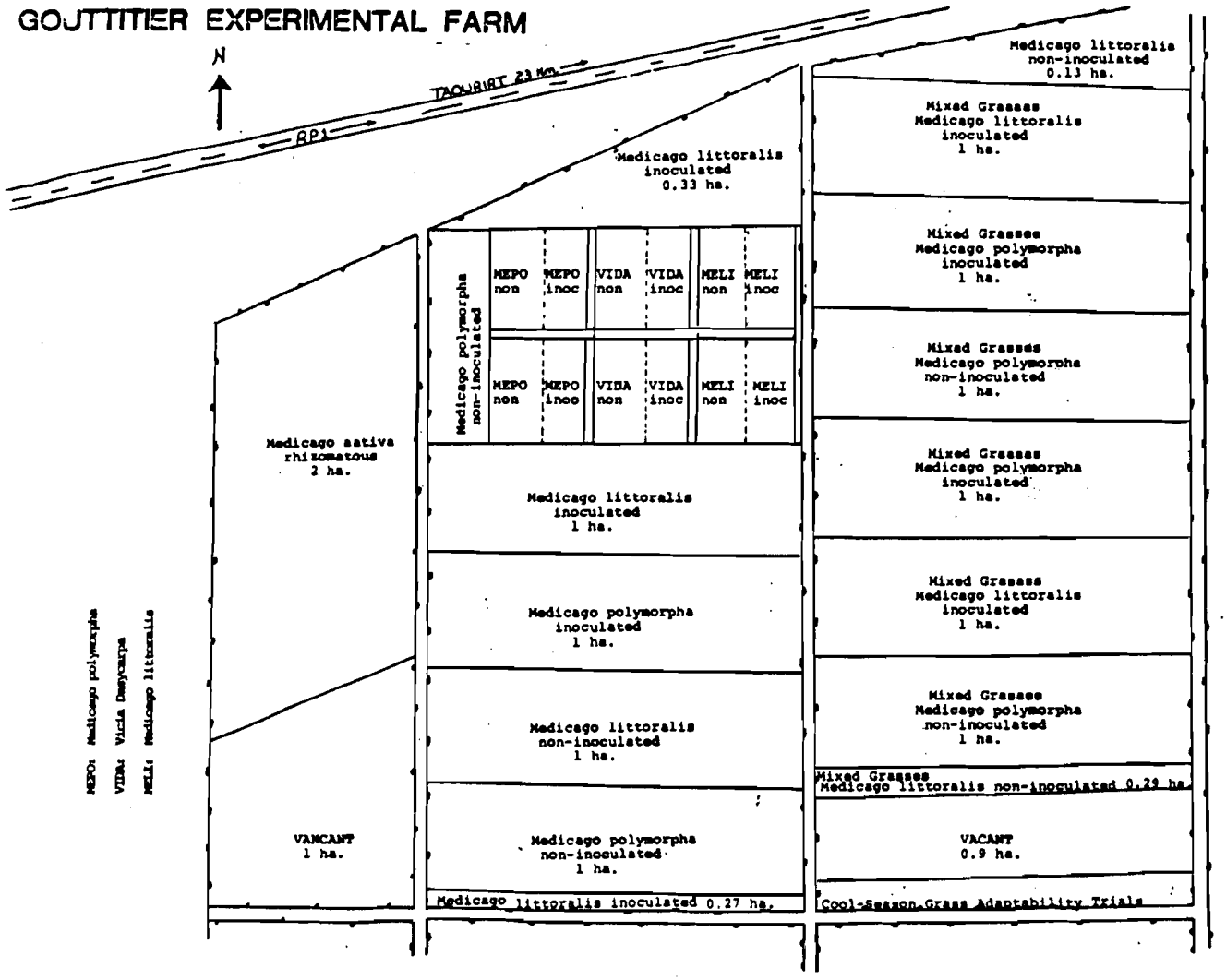

Figure 1.10. Map of the Gouttitier Experimental Farm indicating present plantations (Oujda Office).

Soils

Surface soils originated from localized sedimentary sources, varying in texture from coarse gravels, to sand, and then clay. Underlying this entire region is a petro-calcic horizon (caliche layer) which varies in thickness and depth throughout the area. Thickness of the caliche layer ranges from 10 cm to 50 cm and depth ranges from barren outcrops to several meters deep in bottomland sites. This horizon can limit infiltration of precipitation but contributes to the lateral movement of moisture in the soil. In many areas of eastern Morocco this caliche layer is mined for various construction materials.

Climate

The climate in this region of Morocco is semi-arid to arid, extremely variable and is more typically Continental than Mediterranean. Ain Beni Mathar lies in the semi-arid zone with an average rainfall of 200 mm (Figure 1.11). Over the last 15 years annual precipitation has varied from near 100 mm to almost 300 mm. There are two peak precipitation months, October and April, but these peaks vary considerably (Figure 1.12). Temperatures peak in July at about 25° C., and are lowest in January (Figure 1.13).

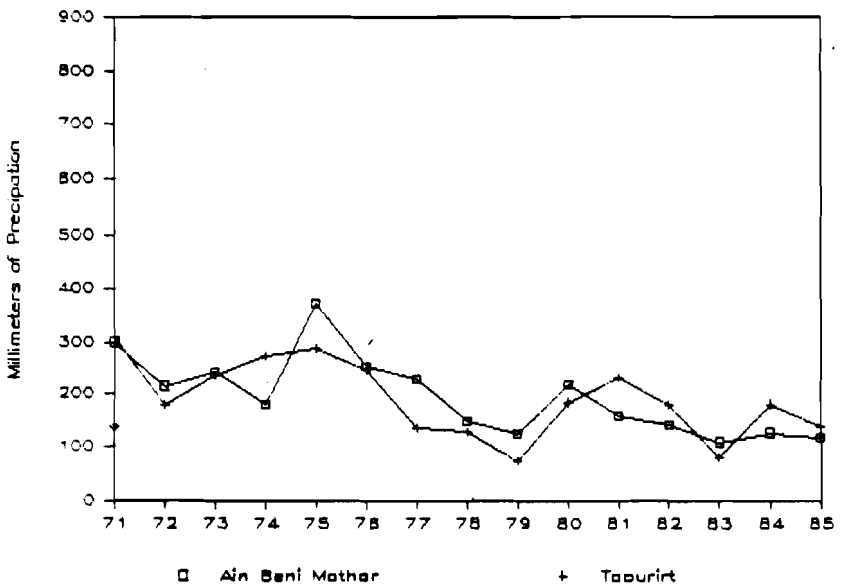

Figure 1.11. Annual precipitation (mm) from 1971-85 for Ain Beni Mathar and Taourirt (Oujda Office).

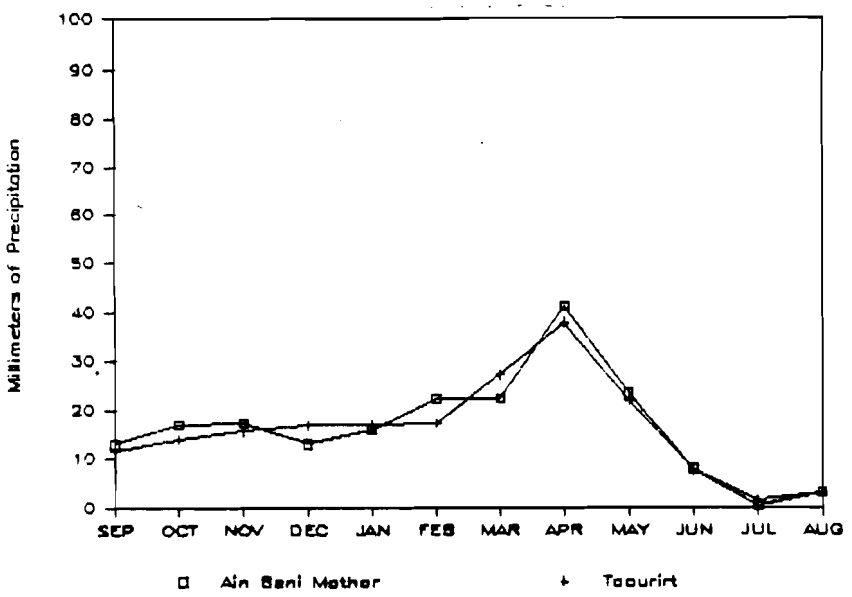

Figure 1.12. Average monthly precipitation (mm) for Ain Beni Mathar and Taourirt (Oujda Office).

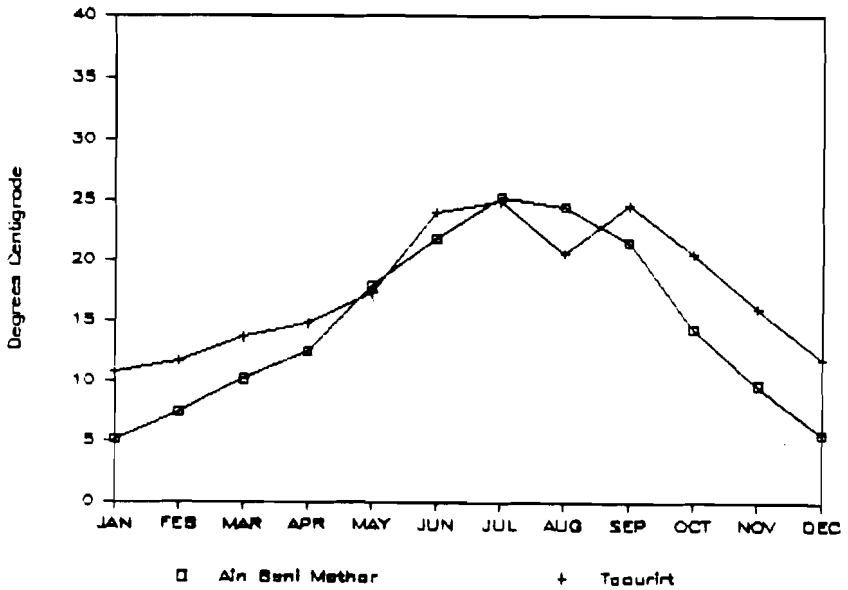

Figure 1.13. Average monthly temperatures (^{o}C) for Ain Beni Mathar and Taourirt (Oujda Office).

Forage Crop Production Estimation

Native Range

Areas of topographical relief, such as hills and ridges, are covered with nearly pure stands of alpha-grass (*Stipa tenacissima*) in this region. The other 40% of the area is

composed of transition zones vegetated with mixtures of alpha-grass and sagebrush, and drainages and basins of nearly pure stands of sagebrush (Artemisia herba alba). Estimates of forage production on grazed rangelands are presented in Table 1.5.

Table 1.5. Estimated average annual herbage production on native range following drought for Ain Beni Mathar and Gouttitier Grazing Perimeters (Oujda Office).

VEGETATION TYPES	AREA (ha)	PROD. RATE (kg dm/ha)	YIELD (T)
Alpha-grass (Domaine d'Etat)	192,700	3.0	578.1
Sagebrush/Grass (Collective Range)	358,065	13.8	4,941.3
TOTAL	550,765		5,519.4

Cultivated Lands

Crop production is limited to a small portion of the total land area of the region. At Ain Beni Mathar, cultivated land comprises approximately 11% of the local area (1% irrigated and 10% dryland). Barley and wheat are the primary dryland crops produced and forage crops such as alfalfa are the primary crops produced on irrigated land. Estimates of forage production resulting from cropping activities are presented in Table 1.6.

Table 1.6. Estimated annual forage production from crops and crop residues following drought in the Ain Beni Mathar region (Oujda Office).

CROPS	AREA (ha)	PROD. RATE (kg dm/ha)	FORAGE (T)
Dryland			
Hard Wheat	1,355	150	203.25
Soft Wheat	475	150	71.25
Barley	19,250	300	5,775.00
Oats	600	150	90.00
Irrigated			
Hard Wheat	450	1,800	810.00
Soft Wheat	100	1,950	195.00
Barley	20	2,100	42.00
Oats	50	1,800	90.00
Corn	60	3,000	180.00
Alfalfa	632	8,000	5,056.00
TOTAL	22,992		12,512.50

Abiotic Influences on Production

Site Topography and Location

The Timahdite Grazing Perimeter is a loose collection of private and tribal land on which the government technical services have no formal jurisdiction, except for a small experiment station (Touna Station) which has been dedicated to range research. It is composed of upper elevation shrublands and grasslands and is located in the Middle Atlas Mountains, south of the village of Azrou, bordering the Provinces of Khenifra and Boulemane. The perimeter is divided into three major topographical zones: an undulating plateau at an average elevation of 1800 m, a narrow valley along the Guigou River, and a series of rocky peaks, one of which rises to 2400 m.

Soils

The Timahdite region is characterized by two major types of parent material: a limestone substratum and, generally above this formation, a layer of basalt resulting from volcanic activity in the Quarternary Period.

Climate

The climate of the area can be described as Continental. The region has an average annual precipitation of 400 mm (Figure 1.14) with hot summers and very cold (Figure 1.15), snowy winters. There is much climatic variation along altitudinal gradients. Snow falls on the area from 15 to 40 days annually, with the majority falling during December and January.

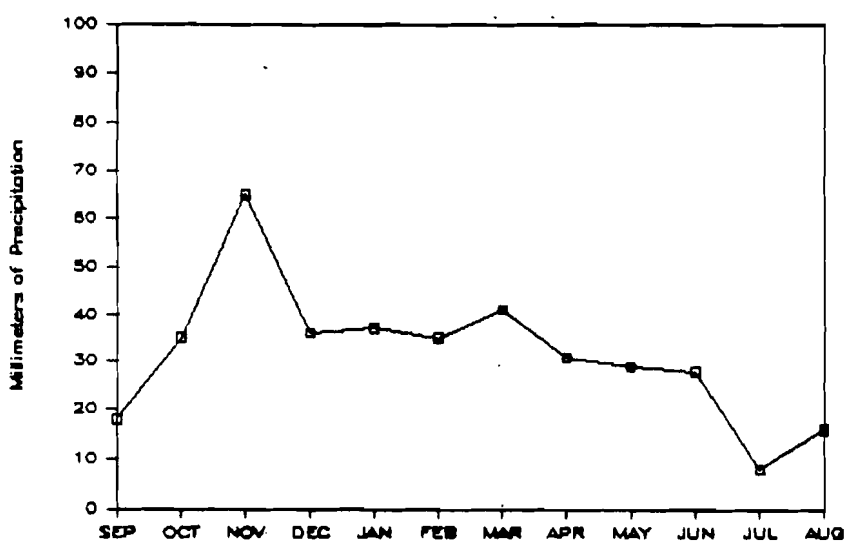

Figure 1.14. Average monthly precipitation (mm) for the Timahdite region (Meknes Office).

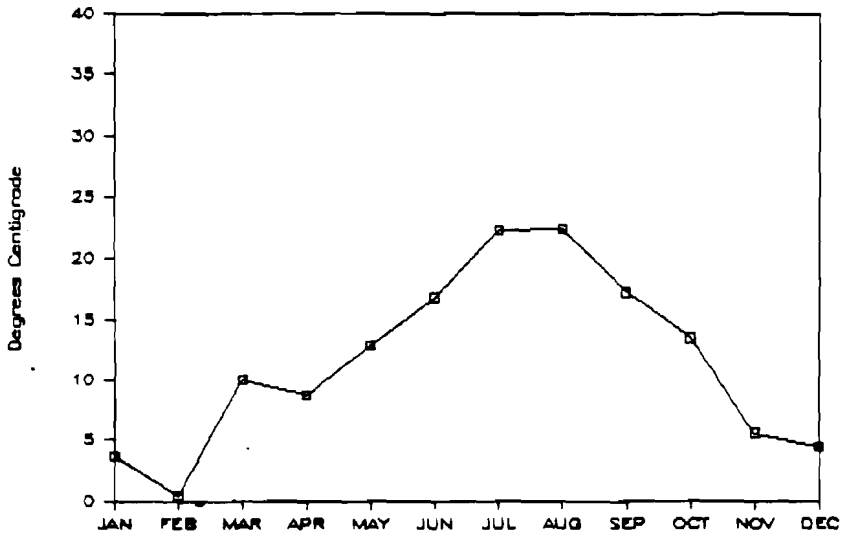

Figure 1.15. Average monthly temperatures (°C) in the Timahdite region (Meknes Office).

Forage Crop Production Estimation: **TIMAHDITE REGION**

Native Range

Rangeland plant communities of the area are dominated by various shrubs and perennial grasses. Estimates of the forage productivity of these lands are presented in Table 1.7.

Table 1.7. Estimated average annual herbage production on native rangeland following drought in the Timahdite region (Meknes Office).

VEGETATION TYPES	AREA (ha)	PROD. RATE (kg dm/ha)	YIELD (T)
Oak-Cedar-Juniper Forest	13,100	Not Estimated	
Rangelands - from the following types: Genista-Palouse Thymus-Palouse Helianthamum Tran. Sagebrush	31,145	424	13,205.5

Cultivated Lands

Wheat and barley are the primary agronomic crops in the area although other crops such as corn, potatoes and various vegetable crops are also common, especially on irrigated parcels. Estimates of forage production contributions from cultivated lands are presented in Table 1.8.

Table 1.8. Estimated annual production available for livestock in the form of crops and crop residues following drought in the Timahdite region (Meknes Office).

CROPS	AREA (ha)	PRODUCTION (T)	RESIDUE (T)
Cereal Crops			
Hard Wheat	4098	4,507.8	4,917.6
Soft Wheat	63	56.7	63.0
Barley	2719	2,175.2	2,447.1
Corn	363	217.8	1,887.6
SUBTOTAL	7243		
Forage Crops			
Alfalfa	35	175.0	
Oats	78	234.0	257.4
Barley	57	171.0	
Other	62	-	
SUBTOTAL	232		
Vegetables			
Potatoes	39	390.0	
Other	9	-	
SUBTOTAL	48		
Arboriculture	7	-	
SUBTOTAL	7		
TOTAL	7530	(Incomplete)	(Incomplete)

Species Adaptability Trials

Program Development

The objective of these trials was to introduce and test, under Moroccan range conditions, forage species proven to be successful on rangelands in other countries with similar range environments. The major achievements in this activity were 1) the establishment of a species adaptability trial program as a continuing part of DE programs in the field, 2) the development of a standardized evaluation system for species trials, and 3) the identification of a number of range forage species and varieties which are usable in each location.

At each field office, species selection, requests for seed, and trial establishment were the responsibility of the DE project leader. The PMC staff distributed seed and inoculum, and assisted the DE project leaders when requested. Beginning in 1982, replicated trials were established in single five meter rows, with spacing of one and one-half meters between rows. Evaluation procedures were recommended by Dr. Mel George, ("Range Seeding, Fertilization and Management", Oct. 28, 1981), yet no uniform methods were followed until late in the program.

After seedbed preparation, using manual labor and hand tools, the trials were planted by hand. Establishment varied each season. Drought was a major impediment to success. Waiting for the first fall rains, the usual practice in dryland crop production, caused considerable delays each year. Germination was delayed even more for trials that were planted in late November and December. In some locations and in some years, trials were not planted at all. The continuing periods of drought during spring months created additional problems for survival.

Species were chosen for trials based upon recommendations from Dr. George's report written after a visit to each of the project sites in 1981. He ordered the seed for the 1982 trials, while seed orders for the subsequent adaptability trials were placed by the PMC.

In the final year of the Project (1985-86) staff at the PMC and grazing perimeters collaborated to update and improve species adaptability trials through five distinct changes: 1) the testing of introduced species continued, but with emphasis shifted to testing varieties of these species which were "known to be adapted" based upon the experience of earlier Project trials, 2) during the last year, native species were entered for the first time in a controlled experiment, 3) as a result of the unsuccessful establishment of most species in the trials between 1982-84, new methods were implemented. Attention was focused on planting dates and water catchment, 4) a new "Species Adaptability Evaluation Form", prepared in both English (Figure 1.16) and French (Figure 1.17), was devised and simplified to encourage usage, and 5) reporting procedures were standardized, for simple, concise interpretation.

FORM FOR ADAPTABILITY TRIAL EVALUATION

DIRECTION DE L'ELEVAGE, Perimeter of _____
YEAR: _____

Scientific Name: _____ _____
GENUS SPECIES
Variety Name: _____
Origin: Maroc USA Other:
Trial Location: _____
Planting Date: _____
Seeding Rate: High Medium Low

1. EVALUATION OF GERMINATION AND EMERGENCE: (NOV/DEC)
EVALUATED BY: _____

Date of Observation: _____
Estimate Emergence Date: _____
Percent of Row Established: _____
Plant Vigor High Medium Low
Other Observations: _____

2. EVALUATION OF WINTER HARDINESS: (JAN/FEB/MAR)
EVALUATED BY: _____

Date of Observation: _____
Winter Hardiness: High Medium Low
Percent of Row Established: _____
Other Observations: _____

3. EVALUATION OF SPRING GROWTH: (APR/MAY)
EVALUATED BY: _____

Date of Observation: _____
Foliage Rating: High Medium Low
Percent of Row Established: _____
Other Observations: _____

4. EVALUATION OF DROUGHT RESISTANCE: (JUN/JUL)
EVALUATED BY: _____

Date of Observation: _____
Drought Resistance: High Medium Low
Percent of Row Established: _____
Other Observations: _____

5. SUMMARY EVALUATION BY: _____

Seed Maturity Date: _____
Plant's Potential for
Future Utilization: High Medium Low
Other Observations: _____

Figure 1.16. English language version of the standardized form in use for evaluation of the Species Adaptability Trials on grazing perimeters.

RELEVE D'EVALUATION DES ESSAIS D'ADAPTABILITE

DIRECTION DE L'ELEVAGE, Perimetre de _____
ANNEE: _____

Nom Scientifique: _____ _____
GENRE ESPECE
Nom de la Variete: _____
Pays de Provenance: Maroc USA Autre:
Lieu de l'Essai: _____
Date de Semis: _____
Densite du Semis: Forte Moyenne Faible

1. EVALUATION de la GERMINATION de la CROISSANCE: (NOV/DEC)
   EVALUEE PAR: _____

   Date d'Observation: _____
   Estimation de la date de levee: _____
   Nombre de plantes levees par m2 ou ml: _____
   Vigueur des plantes: Forte Moyenne Faible
   Autres Observations: _____

2. EVALUATION DE LA RESISTANCE AU FROID (JAN/FEV/MARS)
   EVALUEE PAR: _____

   Date d'Observation: _____
   Resistance au froid: Forte Moyenne Faible
   Pourcentage de plantes etablies: _____
   Autres Observations: _____

3. EVALUATION DE LA CROISSANCE AU PRINTEMPS: (AVRIL/MAI)
   EVALUEE PAR: _____

   Date d'Observation: _____
   Quantite de feuillage: Forte Moyenne Faible
   Pourcentage de plantes etablies: _____
   Autres Observations: _____

4. EVALUATION DE LA RESISTANCE A LA SECHERESSE: (JUIN/JUILLET)
   EVALUEE PAR: _____

   Date d'Observation: _____
   Resistance la secheresse: Forte Moyenne Faible
   Pourcentage de plantes etablies: _____
   Autres Observations: _____

5. RESUME DE L'EVALUATION PAR: _____

   Date de la maturation des grains: _____
   Potential de la plante pour
   une future utilization: Fort Moyen Faible
   Autres Observations: _____

Figure 1.17. French language version of the standardized form in use for evaluation of the Species Adaptability Trials on grazing perimeters.

RESULTS AND CONCLUSIONS OF ADAPTABILITY TRIALS BY SITE

Midelt Office: Initial Results

Early trials (1972) provided information on which to start a seed production program at the PMC. The most promising species from the region were: *Agropyron intermedium*, *A. elongatum*, and

A. trichophorum. Subsequent trials on Plaine de l'Aarid and El Faija Grazing Perimeters resulted in the identification of the following varieties as adapted:

1983 - A. intermedium, var. Tegmar and Slate
A. elongatum, var. Jose and Largo
A. trichophorum, var. Topar and Luna

1984 - A. intermedium, var. Oahe
A. smithii, var. Rosana
A. riparium, var. Sodar
Melilotus officinalis
Onobrychis viccifolia
Trifolium hirtum, var. Hykon
Medicago sativa, var. Ladak
Vicia dasycarpa, var. Lana
Astragulus cicer, var. Lutana

Midelt Office: 1985 results

Animal pests destroyed the trial at El Faija.

Beni Mellal Office: Initial Results

The 1982 and 1983 trials were planted in December and failed to become established. The 1984 trial was planted in October. By January, due to lack of precipitation, two artificial methods were attempted to promote stand establishment. In the row trials, supplemental water was applied to one replication twice to offset the lack of precipitation. In another trial, mature plants were transplanted from the PMC to determine if a developed plant had a better chance for survival compared to a seedling. Establishment of these transplants was negligible, probably due to inadequate precipitation and to damage to the plants that occurred during transplanting and transporting.

Beni Mellal Office: 1985 Results

Perimeter personnel summarized their findings (using the standardized PMC form) and made recommendations for species with potential. These species should be multiplied at the PMC for additional testing and demonstration plantings.

Grass species with high potential for establishment:

1. Bromus mollis, var. Blando (annual)
2. Lolium rigidum, var. Wimmer-62 (annual)

Grass species with medium potential for establishment:

1. Agropyron elongatum, var. Jose (perennial)
2. Agropyron intermedium, var. Tegmar (perennial)
3. Agropyron elongatum, var. Largo (perennial)
4. Agropyron intermedium, var. Slate (perennial)
5. Dactylis glomerata, access. GR-659 (perennial)
6. Agropyron trichophorum, var. Mandan (per.)

Legume species with high potential for establishment:

1. Medicago laciniata, access. Ait Rbaa (annual)
2. Trifolium cherleri, access. GR-423 (annual)
3. Trifolium cherleri, access. GR-307 (annual)
4. Medicago laciniata, access. GR-215 (annual)
5. Medicago laciniata, access. GR-222 (annual)
6. Medicago laciniata, access. GR-201 (annual)

Legume species with medium potential for establishment:

1. Medicago truncatula, access. GR-153 (annual)
2. Medicago littoralis, access. GR-221 (annual)
3. Medicago laciniata, access. GR-776 (annual)
4. Medicago laciniata, access. GT-8101 (annual)
5. Medicago laciniata, access. GR-211 (annual)
6. Medicago aculeata, access. GR-138 (annual)
7. Medicago aculeata, access. GR-196 (annual)

Of special interest in the legume trial (listed above) was the introduction of locally collected species. The Medicago laciniata accession from Ait Rbaa was originally collected at the perimeter in July 1984 and planted at the PMC for multiplication in November 1984. The seed, harvested in June 1985, was then returned to the perimeter for this trial. The most interesting difference between the two samples was that the original collection had an average of five to six seeds per pod and produced small seeds. The PMC generation produced nine to eleven seeds per pod, with a seed size three times larger. This seed size could be a major factor in the success of its return to the perimeter. Seed pods harvested from this trial at Ait Rbaa in May 1986 contained seven to nine seeds per pod, with an increase in seed size over existing native plants.

Oujda Office: Initial Results

No trials were planted.

Oujda Office: 1985 Results

Ain Beni Mathar trials were installed within the contour system of the "America Plantation", southwest of town on the road to Merija. No seed from native species was available for planting.

Due to the cold temperatures and very low precipitation during January and February, little growth was observed. Most of the species germinated, but the survival was very low, with only Agropyron elongatum, A. smithii, A. intermedium, A. trichophorum showing any promise. These trials continue to be monitored on a monthly basis.

Within the contour system at the Gouttitier Experimental Farm, a trial was established for 38 species. Here, too, cold temperatures and very low precipitation resulted in a lack of extensive growth. The same species of Agropyron which show promise of survival in Ain Beni Mathar appear to be acceptable for the Gouttitier region. In addition, seedlings of some late germinating species were noticed by technicians, prompting them

to continue to monitor trials on a monthly basis.

Meknes Office: Initial Results

In the 1982 Touna Station trial, the following species germinated and persisted:

Agropyron elongatum, var. Largo (perennial)
Agropyron smithii, var. Arriba (perennial)
Agropyron desertorum, var. Nordan (perennial)
Agropyron intermedium, var. Oahe (perennial)
Agropyron trichophorum, var. Topar (perennial)
Bromus marginatus, var. Bromar (perennial)

The 1983 trial was planted in December and failed to establish. No trial was planted in 1984.

Meknes Office: 1985 Results

The trial was established, yet no observations have been recorded.

Summary of Trials

Species entered into these adaptability trials (see Tables 1.9 and 1.10 for seed distribution lists) were not exposed to conditions favorable for germination, establishment, or survival during the life of the project due to drought conditions. Therefore, it would be unwise to eliminate any one species from future experimentation, with few exceptions. Morocco, with its long, hot summers, appears to be ideal for some warm-season grasses. Remnants of a few native perennial grass species (in the genera *Cynodon*, *Pennisetum*, *Cenchrus*) are even found in protected areas. The missing components for stand establishment and survival have been timing and seeding technique. In recent years of low precipitation, moisture has also been limiting in the late spring and early summer when temperatures have been conducive for germination and growth of these species. The expense of these seeds, compared to their limited chance for establishment, minimizes their utility. The situation which may permit their utilization is in plantings behind terraces where rainfall runoff can be captured and soil moisture is retained.

Table 1.9. 1985 adaptability trial seed distribution list.

MEKNES

Scientific Name	Common Name	Variety/I.D.
Grasses		
Agropyron elongatum	Tall Wheatgrass	Jose
Agropyron elongatum	Tall Wheatgrass	Alkar
Agropyron elongatum	Tall Wheatgrass	Largo
Agropyron intermedium	Intermediate Wheatgrass	Slate
Agropyron intermedium	Intermediate Wheatgrass	Tegmar
Agropyron intermedium	Intermediate Wheatgrass	Oahe
Agropyron intermedium	Intermediate Wheatgrass	Greenar
Agropyron smithii	Western Wheatgrass	Arriba
Agropyron smithii	Western Wheatgrass	Rodan
Agropyron smithii	Western Wheatgrass	Rosana
Agropyron smithii	Western Wheatgrass	Flintlock
Agropyron smithii	Western Wheatgrass	Barton
Agropyron trichophorum	Pubescent Wheatgrass	Mandan
Agropyron trichophorum	Pubescent Wheatgrass	Topar
Dactylis glomerata	Orchardgrass	GR-526
Dactylis glomerata	Orchardgrass	GR-539
Dactylis glomerata	Orchardgrass	GR-572
Dactylis glomerata	Orchardgrass	Palestine
Lolium rigidum	Annual ryegrass	Wimmer-62
Phleum pratense	Timothy	Climax
Legumes and Forbs		
Hedysarum coronarium	Sulla Sweetvetch	GR-862
Hedysarum carnosum	Sweetvetch	Tunisia
Hedysarum boreale	Northern Sweetvetch	Common
Lotus corniculatus	Dwarf Birdsfoot Trefoil	Kalo
Lotus creticus	Annual Trefoil	GR-12
Lotus creticus	Annual Trefoil	GR-560
Medicago aculeata	Annual Medic	GR-514
Medicago ciliaris	Annual Medic	GR-860
Medicago laciniata	Annual Medic	Ait Rbas
Medicago minima	Annual Medic	GR-509
Medicago minima	Annual Medic	GR-548
Medicago orbicularis	Annual Medic	GR-493
Melilotus officinalis	Yellow Sweet Clover	Madrid
Trifolium cherleri	Annual Clover	GR-307
Trifolium subterraneum	Subterranean Clover	GR-435
Trifolium subterraneum	Subterranean Clover	GR-448
Trifolium subterraneum	Subterranean Clover	GR-494
Trifolium subterraneum	Subterranean Clover	GR-519
Trifolium subterraneum	Subterranean Clover	GR-567
Trifolium vesiculosum	Arrowleaf Clover	Amclo

MIDELT

Scientific Name	Common Name	Variety/I.D.
Grasses		
Agropyron cristatum	Crested Wheatgrass	Ephraim
Agropyron cristatum	Crested Wheatgrass	Ruff
Agropyron elongatum	Tall Wheatgrass	Alkar
Agropyron elongatum	Tall Wheatgrass	Jose
Agropyron elongatum	Tall Wheatgrass	Largo
Agropyron intermedium	Intermediate Wheatgrass	Slate
Agropyron intermedium	Intermediate Wheatgrass	Tegmar
Agropyron intermedium	Intermediate Wheatgrass	Oahe
Agropyron intermedium	Intermediate Wheatgrass	Greenar
Agropyron smithii	Western Wheatgrass	Rodan
Agropyron smithii	Western Wheatgrass	Arriba
Agropyron smithii	Western Wheatgrass	Rosana
Agropyron smithii	Western Wheatgrass	Flintlock
Agropyron smithii	Western Wheatgrass	Barton
Agropyron spicatum	Bluebunch Wheatgrass	Secar
Agropyron spicatum	Bluebunch Wheatgrass	Whitmar
Agropyron trichophorum	Pubescent Wheatgrass	Mandan
Agropyron trichophorum	Pubescent Wheatgrass	Topar
Dactylis glomerata	Orchardgrass	GR- 659
Dactylis glomerata	Orchardgrass	Palestine
Dactylis glomerata	Orchardgrass	Paluta
Elymus angustus	Altai Wildrye	Prairieland
Oryzopsis hymenoides	Indian Ricegrass	Paloma
Oryzopsis hymenoides	Indian Ricegrass	Nezpar
Legumes and Forbs		
Hedysarum boreale	Northern Sweetvetch	Common
Hedysarum carnosum	Sweetvetch	Tunisia
Hedysarum coronarium	Sulla Sweetvetch	GR-862
Medicago minima	Annual Medic	GR-585
Medicago minima	Annual Medic	GR-729
Melilotus officinalis	Yellow Sweet Clover	Madrid

HAUT MELLAL

Scientific Name	Common Name	Variety/I.D.
Grasses		
Agropyron elongatum	Tall Wheatgrass	Jose
Agropyron elongatum	Tall Wheatgrass	Largo
Agropyron intermedium	Intermediate Wheatgrass	Slate
Agropyron intermedium	Intermediate Wheatgrass	Tegmar
Agropyron smithii	Western Wheatgrass	Arriba
Agropyron smithii	Western Wheatgrass	Flintlock
Agropyron trichophorum	Pubescent Wheatgrass	Topar
Agropyron trichophorum	Pubescent Wheatgrass	Mandan
Bromus mollis	Soft Chess	Blando
Dactylis glomerata	Orchardgrass	GR-659
Festuca arizonica	Arizona Fescue	Redondo
Lolium rigidum	Annual ryegrass	Wimmer-62
Oryzopsis hymenoides	Indian Ricegrass	Nezpar
Oryzopsis hymenoides	Indian Ricegrass	Paloma
Oryzopsis miliacea	Smilograss	GT-129
Oryzopsis miliacea	Smilograss	GT-860
Oryzopsis miliacea	Smilograss	GT-920
Oryzopsis miliacea	Smilograss	GT-940
Schizachyrium scoparium	Little Bluestem	Cimmeron
Legumes and Forbs		
Hedysarum boreale	Northern Sweetvetch	Common
Hedysarum carnosum	Sweetvetch	Tunisia
Medicago aculeata	Annual medic	GR-196
Medicago aculeata	Annual medic	GR-138
Medicago rigidula	Annual medic	GR-145
Medicago intertexta	Annual medic	GR-188
Medicago polymorpha	Annual medic	GR-824
Medicago polymorpha	Annual medic	GR-154
Medicago laciniata	Annual medic	GR-187
Medicago laciniata	Annual medic	GR-209
Medicago laciniata	Annual medic	GR-869
Medicago laciniata	Annual medic	GR-215
Medicago laciniata	Annual medic	GR-222
Medicago laciniata	Annual medic	Ait Rbas
Medicago laciniata	Annual medic	GR-776
Medicago laciniata	Annual medic	GR-201
Medicago laciniata	Annual medic	GR-211
Medicago laciniata	Annual medic	GT-8101
Medicago laciniata	Annual medic	GT-8108
Medicago littoralis	Annual medic	GR-221
Medicago littoralis	Annual medic	GR-152
Medicago truncatula	Barrel medic	Akbar
Medicago truncatula	Barrel medic	GR-153
Melilotus officinalis	Yellow Sweet Clover	Madrid
Trifolium cherleri	Annual Clover	GR-307
Trifolium cherleri	Annual Clover	GR-423
Trifolium subterraneum	Subterranean Clover	Geraldton
Trifolium subterraneum	Subterranean Clover	Northam
Trifolium subterraneum	Subterranean Clover	Mungarin

OUJDA

Scientific Name	Common Name	Variety/I.D.
Grasses		
Agropyron elongatum	Tall Wheatgrass	Alkar
Agropyron elongatum	Tall Wheatgrass	Jose
Agropyron elongatum	Tall Wheatgrass	Largo
Agropyron intermedium	Intermediate Wheatgrass	Slate
Agropyron intermedium	Intermediate Wheatgrass	Tegmar
Agropyron intermedium	Intermediate Wheatgrass	Oahe
Agropyron intermedium	Intermediate Wheatgrass	Greenar
Agropyron smithii	Western Wheatgrass	Arriba
Agropyron smithii	Western Wheatgrass	Rodan
Agropyron smithii	Western Wheatgrass	Rosana
Agropyron smithii	Western Wheatgrass	Flintlock
Agropyron smithii	Western Wheatgrass	Barton
Agropyron spicatum	Bluebunch Wheatgrass	Secar
Agropyron spicatum	Bluebunch Wheatgrass	Whitmar
Agropyron trichophorum	Pubescent Wheatgrass	Topar
Agropyron trichophorum	Pubescent Wheatgrass	Mandan
Bothriochloa ischaemum	Yellow Bluestem	Canada
Bromus mollis	Soft Chess	Blando
Cynodon dactylon	Bermudagrass	Common
Festuca arizonica	Arizona Fescue	Redondo
Lolium rigidum	Annual ryegrass	Wimmer-62
Muhlenbergia wrightii	Spike Muhly	El Vado
Oryzopsis hymenoides	Indian Ricegrass	Paloma
Oryzopsis hymenoides	Indian Ricegrass	Nezpar
Oryzopsis miliacea	Smilograss	GT-129
Oryzopsis miliacea	Smilograss	GT-860
Oryzopsis miliacea	Smilograss	GT-801
Oryzopsis miliacea	Smilograss	GT-132
Oryzopsis miliacea	Smilograss	GT-920
Oryzopsis miliacea	Smilograss	GT-940
Schizachyrium scoparium	Little Bluestem	Cimmeron
Schizachyrium scoparium	Little Bluestem	Pasture
Sporobolus airoides	Alkali sacaton	Salado
Sporobolus cryptandrus	Sand Dropseed	Common
Legumes and Forbs		
Hedysarum boreale	Northern Sweetvetch	Common
Hedysarum carnosum	Sweetvetch	Tunisia
Lotus corniculatus	Birdsfoot Trefoil	Cascade
Lotus corniculatus	Dwarf Birdsfoot Trefoil	Kalo
Lotus pedunculatus	Big Trefoil	Marshfield
Medicago aculeata	Annual medic	GR-138
Medicago laciniata	Annual medic	Ait Rbas
Medicago rigidula	Annual medic	GR-145
Medicago intertexta	Annual medic	GR-188
Medicago polymorpha	Annual medic	GR-824
Medicago laciniata	Annual medic	GR-869
Medicago laciniata	Annual medic	GT-8101
Medicago truncatula	Barrel Medic	Akbar
Melilotus officinalis	Yellow Sweet Clover	Madrid
Trifolium hirtum	Rose Clover	Hykon
Vicia dasycarpa	Woolyped Vetch	Lana
Penstemon palmeri	Palmer Penstemon	Cedar

BEST AVAILABLE COPY

Table 1.10. 1982-84 adaptability trial seed distribution list including species previously distributed in addition to the 1985 list.

Scientific Name	Common Name	Variety/I.D.
Grasses		
Agropyron desertorum	Crested Wheatgrass	Nordan
Agropyron cristatum	Fairway Wheatgrass	Fairway
Agropyron intermedium	Intermediate Wheatgrass	Amur
Agropyron trachycaulum	Slender Wheatgrass	Revenue
Agropyron trachycaulum	Slender Wheatgrass	Primar
Andropogon geradi	Big Bluestem	Common
Bromus carinatus	Sweetbrome	Cucamonga
Bromus carinatus	Sweetbrome	Deboran
Bromus inermis	Smooth Bromegrass	Manchar
Bromus marginatus	Mountain Bromegrass	Bromar
Cenchrus ciliaris	Buffelgrass	Common
Cenchrus ciliaris	Buffelgrass	Llano
Cenchrus ciliaris	Buffelgrass	Higgins
Cenchrus ciliaris	Buffelgrass	Nueces
Dactylis glomerata	Orchardgrass	Berber
Dactylis glomerata	Orchardgrass	Currie
Ehrharta calycina	Perennial Veldtgrass	Mission
Elymus junceus	Russian Wildrye	Common
Eragrostis curvula	Weeping Lovegrass	Catalina
Eragrostis curvula	Weeping Lovegrass	Common
Eragrostis curvula	Weeping Lovegrass	A-84
Eragrostis curvula	Weeping Lovegrass	Renner
Eragrostis lehmanniana	Lehmann Lovegrass	Kulvato
Eragrostis lehmanniana	Lehmann Lovegrass	Common
Eragrostis superba	Wilman Lovegrass	Polar
Eragrostis trichoides	Sand Lovegrass	Bend
Eragrostis pilifera	Sandhill Lovegrass	Mason
Festuca arundinacea	Tall Fescue	Demeter
Festuca longifolia	Hard Fescue	Durar
Festuca ovina	Sheep Fescue	Cover
Festuca rubra	Red Fescue	Fortress
Lolium multiflorum	Annual Ryegrass	Common
Phalaris tuberosa	Hardinggrass	Seedmaster
Phalaris tuberosa	Hardinggrass	Sirosa
Phalaris tuberosa (Mirt)	Perlagrass	Perla
Poa ampla	Big Bluegrass	Sherman
Poa canbyi	Canby Bluegrass	Canby
Poa compressa	Canada Bluegrass	Reubens
Sporobolus airoides	Alkali Sacaton	Common
Sporobolus airoides	Alkali Sacaton	Saltalk
Vulpia myuros	Rattail Sixweeksgrass	Zorro
Legumes and Forbs		
Astragalus cicer	Cicer Milkvetch	Lutana
Medicago littoralis	Strand Medic	Herbinger
Medicago rugosa	Gama Medic	Paraponto
Medicago sativa	Alfalfa	Drylander
Medicago sativa	Alfalfa	Raeblar
Medicago sativa	Alfalfa	Rangelander
Medicago sativa	Alfalfa	Teton
Medicago sativa	Alfalfa	Travois
Medicago sativa	Alfalfa	Spreader 2
Medicago sativa	Alfalfa	Ladak
Medicago sativa	Alfalfa	Rhyzoma
Medicago scutellata	Snail Medic	Snail
Medicago truncatula	Barrel Medic	Cyprus
Medicago truncatula	Barrel Medic	Hannaford
Medicago truncatula	Barrel Medic	Jemalong
Onobrychis viciifolia	Sainfoin	Common
Ornithopus compressus	Serradella	Common
Sanguisorba minor	Small Burnet	Delar
Trifolium hirtum	Rose Clover	Kondinin
Trifolium hirtum	Rose Clover	Wilton
Trifolium incarnatum	Crimson Clover	Dixie
Trifolium subterraneum	Subterranean Clover	Clare
Trifolium subterraneum	Subterranean Clover	Dalkeith
Trifolium subterraneum	Subterranean Clover	Howard
Trifolium subterraneum	Subterranean Clover	Mt. Barker
Trifolium subterraneum	Subterranean Clover	Seaton Park
Trifolium subterraneum	Subterranean Clover	Trikkala
Trifolium subterraneum	Subterranean Clover	Woogenellup
Sphaeralcea grossulariaefolia	Gooseberryleaf Globemallow	
Shrubs		
Acacia cyanophylla	Acacia	
Atriplex semicola	Saltbush	
Atriplex canescens	Fourwing Saltbush	Marana
Atriplex canescens	Fourwing Saltbush	Rincon
Atriplex canescens	Fourwing Saltbush	Wytana
Atriplex confertifolia	Shadescale	
Atriplex cuneata	Castle Valley Clover	
Atriplex gardneri	Gardner Saltbush	
Atriplex halimus	Mediterranean Saltbush	
Atriplex lentiformis	Quailbush	Casa
Atriplex nummularia	Oldman Saltbush	
Atriplex semibaccata	Australian Saltbush	Corto
Atriplex tridentata	Tridenta Saltbush	
Atriplex undulata		
Ceanothus montanus	True Mountain Mahogany	
Ceratoides lanata	Winterfat	
Purshia tridentata	Bitterbush	Antelope
Simmondsia chinensis	Jojoba	

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Species adaptability trials are a vital component to the success of future range seeding efforts. Seed germination and seedling establishment are the keys to revegetation. Adaptability of the species to local conditions (including grazing) is the key to longevity and persistence of seedings. Forage productivity along with stand longevity affect the economic feasibility of seeding efforts. There will always be new species, both introduced and native, that will require testing and evaluation. The results of trials in the Midelt region have shown substantial differences in adaptability and productivity among varieties within species. Comparisons of the standard varieties and newly released varieties, as well as comparisons among native species, should continue.

The weather conditions will remain unpredictable, be it a drought or monsoon. Since this risk is inevitable in semi-arid and arid environments, efforts in making this factor manageable by using techniques that are known to be effective should be continued. A certain degree of discouragement will always prevail, yet it is essential that these trials continue to be planted and evaluated, preferably on a yearly basis.

In contrast to the overall poor performance of introduced species was the relative vitality of the native species, which appeared as "weeds" within the trials. This observation prompted a change in Project emphasis from evaluation of introduced species to research and development of native species.

The total responsibility for these Species Adaptability Trials, and for the native species, should be assigned to one individual as a Research Supervisor. This would require extensive travel to all locations, including the PMC. Coordination and evaluation of all the trials would best be handled by this person.

Guidelines for Research Supervisors

1) A desire and willingness to work is required. Establishing, maintaining and evaluating trials is not an easy task. It requires constant planning, coordination and consistent attention.

2) Advanced planning and preparation are essential. Though weather caused delays during the Project, the most serious problems which occurred were the result of a lack of interest on the part of Project personnel in preparing to undertake the trial. Seed requests and procurement must begin in March, with October as the target for planting.

3) Coordination is mandatory. There must be continuous communication between local offices and the PMC. The Research Supervisor must keep personnel at grazing perimeters informed of all details of the PMC production program. Without such communication, little success can be expected from this program.

Wheatgrass Seedings: **Plaine de L'Aarid and El Faija.**

Early Field Trials: **Plaine de l'Aarid**

About 200 varieties of various grass species were planted in row and field trials in 270 to 330 mm precipitation zones in 1970 (Table 1.11). Only a fraction of these remain. Original evaluations of these trials were based on observations one year after establishment in 1971. Unfortunately, dry matter yield data for the original field trial evaluations in 1971 were not available. When the trials were evaluated in 1982, species from the genus Agropyron exhibited the greatest persistence. While none of the 1982 dry matter yields were impressive, it was the first growing season after a severe drought, and therefore, an important indication of drought tolerance, persistence and recoverability.

Tall wheatgrass (A. elongatum var. Largo) performed well during the 1971 evaluations and was subsequently seeded on a large scale at Plaine de l'Aarid. In 1982, yields of four and twelve year old stands of tall wheatgrass were compared on similar soils in the 330 mm precipitation zone. Yield of the four year old stand was almost double that of the twelve year old stand. There appeared to be more plants per unit area in the twelve year old stand due to basal expansion of original plants, but there was a higher degree of mortality and stagnation.

A difference in yield was not detected between tall and pubescent wheatgrasses (A. elongatum var. Largo and A. trichophorum var. Luna) in twelve year old stands at 330 mm average annual precipitation (Table 1.11). Again, there were low yields after drought and previous years of heavy grazing at that site. The growth form of pubescent wheatgrass at 330 mm precipitation was strongly rhizomatous and appeared to withstand grazing. This variety demonstrated longevity and reproduced vegetatively under severe conditions. Tall wheatgrass matured later than pubescent and showed no sign of reproduction. Weeds were not a problem in either stand.

At the location receiving 270 mm average annual precipitation, tall wheatgrass was not considered a suitable alternative for range seeding. Yield for pubescent was double that of tall wheatgrass. Crested wheatgrass (Agropyron desertorum) yield was between three and four times that of tall wheatgrass. There was considerable stand mortality for tall wheatgrass in the 270 mm precipitation zone even though it was largely protected from grazing.

Crested wheatgrass was the highest yielding species in the 270 mm zone and produced large seed yields, possibly due to an exceptionally wet spring. Numerous crested wheatgrass varieties were impressive in both the 220 mm and 330 mm precipitation zones. However, early seedings of crested wheatgrass did not persist in some areas within the 330 mm precipitation zone. Almost pure stands of sagebrush have become established on these sites.

It appears that tall wheatgrass is a reasonable choice for a

seeding program at 330 mm precipitation and above. Pubescent wheatgrass is rhizomatous and persistent through a wider range of precipitation. What pubescent wheatgrass lacks in productivity could be offset by persistence and survivability. Perhaps a mixture of the two species would reduce the risk inherent in

Table 1.11. Production from row and field trials established in the 1970's at the Plaine de L'Aarid Grazing Perimeter. Values within columns by grouping are not significantly different ($P<.05$) if they are assigned the same superscript. Samples were oven dried 48 hours at 60°C.]

	Yield (kg/m^2)	Plants ($\#/m^2$)	Inflorescences ($\#/m^2$)
1.) 12 year old stand (330 mm ppt. zone)			
Agropyron elongatum	600^a	11^a	
A. trichophorum	645^a	85^b	
Elymus junceus	180^b	6^c	
2.) 12 year old stand (270 mm ppt. zone)			
A. elongatum	126^a	5^a	1.2^a
A. trichophorum	232^b	45^b	12.0^b
A. cristatum	421^c	10^c	104.0^c
3.) Two *A. elongatum* stands (330 mm ppt. zone)			
4 year old stand	1136^a	7.2^a	34^a
12 year old stand	600^b	11.4^b	32^a

planting a pure stand of either species. Crested wheatgrass appears to be productive in both the 270 mm and 330 mm zones, however, there is no local yield data for this species in the 330 mm zone or above.

Range Improvement Trials: **Plaine de l'Aarid**

Five species of perennial grasses from the genus Agropyron were seeded using the rangeland drill and a Belgian made grain drill in the 300 mm precipitation zone on the Plaine de L'Aarid Perimeter during late fall, 1983. The rangeland drill was used to plant directly into native Artemisia herba-alba and an area that had previously been planted to Agropyron intermedium. As a result of heavy grazing pressure the original stand had been virtually eliminated. The land was not mechanically prepared prior to seeding with the rangeland drill. Earlier soil manipulation for the initial A. intermedium stand left a seedbed and eliminated competition from native plants. The more accepted practice of plowing, discing, and rolling prior to planting the seed with a standard grain drill was performed. Treatments of seeded species were: Agropyron cristatum (Fairway), native A. cristatum, A. elongatum (Largo), A. sibericum (P-27), A. smithii (Arriba), and A. trichophorum (Luna) and an unseeded control. Plots treated were five by forty meter strips and replicated three times for each treatment.

The ability of selected grasses to establish, persist and produce when drilled directly into native vegetation or a weakened introduced stand via the rangeland drill was compared to an accepted practice of planting. Low precipitation is probably responsible for the resulting low rate of germination for all species on all treatments. Plant establishment did not occur. Initial treatment with the rangeland drill reduced shrub canopy cover (live canopy intersect) by 28% and shrub density by 27% on the Artemisia herba-alba site. Two years later no significant difference was found between treated and control plots for either shrub canopy or density characteristics.

Range Improvement Trials: **El Faija**

In September, 1984, two range improvement trials were established on El Faija Perimeter using seedings of wheatgrasses. These were designed to compare different land preparation and planting methods of Agropyron cristatum, A. elongatum, A. intermedium and A. trichophorum on a variety of soil types.

One of these trials was performed on a sloping area dominated by Stipa tenacissima (alpha-grass). The site was burned to remove existing alpha-grass, then one third of the plots were plowed, disced and rolled before a grain drill was used to plant either Agropyron cristatum or A. elongatum at approximately seven and 12 kg pure live seed/ha, respectively. The remaining plots were planted with the rangeland drill with no land preparation prior to seeding. One half of the remaining plots were planted using the rangeland drill with six discs to open furrows. The other half were planted with the rangeland drill using ten discs. The six-disc version has a wider row spacing and heavier discs than the 10-disc version, thus the distance between rows was greater and furrows were deeper. The same species were planted with both the rangeland drill and grain drill. Plots were 10 m x 25 m and treatments were replicated four times.

A second trial repeated in the sagebrush (Artemisia herba-alba) type on both shallow and deep soil sites, compared the

rangeland drill with six and 10 discs and the grain drill with prior seedbed preparation as in the first experiment. The same four Agropyron species were used in the trial. Plots were 10 m x 25 m and replicated three times.

Germination was slow for all species in all trials due to low precipitation in the El Faija area. Stand densities were measured the following fall (September, 1985) using a one m^2 frame. The conventional method of plowing, discing and rolling prior to planting with a grain drill showed better stand establishment than either of the rangeland drill techniques on the sagebrush shallow soil site. The RD-10 outperformed the RD-6 on this site also. No significant differences were found between treatments on the Artemisia herba-alba, deep soil site and the Stipa tenacissima site. Agropyron cristatum had the lowest stand density for all treatments on all sites. In this trial and other trials previously established, small seeded species were difficult to establish. Though plots were not clipped to estimate production (grazing occurred on the stands prior to their being clipped for production), the most robust plants appeared to be on the plots seeded to A. trichophorum. Stand densities by planting treatment and by species are shown in Tables 1.12 and 1.13, respectively.

Table 1.12. Mean number of plants per $meter^2$ by site and seeding technique for trials at El Faija Perimeter performed in 1984.

Planting Treatments	Artemisia herba-alba Shallow Soil	Artemisia herba-alba Deep Soil	Stipa tenacissima
Conventional	22.55^a	7.05^a	7.58^a
Rangeland Drill (25 cm row spacing)	12.50^b	7.83^a	6.65^a
Rangeland Drill (15 cm row spacing)	6.42^c	1.98^a	4.78^a

Values within columns with like superscripts are not significantly different (P>.01).

Table 1.13. Mean number of plants per $meter^2$ by site and species at El Faija Perimeter for trials established in 1984.

Seeded Species	Artemisia herba-alba Shallow Soil	Artemisia herba-alba Deep Soil	Stipa tenacissima
Agropyron cristatum	1.80^a	2.31^a	0.72^a
A. elongatum	20.16^b	7.38^b	11.95^b
A. intermedium	18.64^b	6.24^b	-
A. tricophorum	14.69^c	6.56^b	-

Values within columns with like superscripts are not significantly different (P>.01).

Seeding and Interseeding Trials: **Plaine de l'Aarid and El Faija.**

Field Trial: **Plaine de l'Aarid**

A field experiment, applied to both shallow and deep soil sites, examined the possibility of seeding a mixture of two legume species (*Trifolium hirtum* (Hykon) and *Vicia dasycarpa* (Lana)) with four perennial grass species from the genus *Agropyron*. This mixture was tested with two seedbed preparation techniques, conventional preparation and use of the rangeland drill. In the conventional preparation treatment, plots were plowed, disced and rolled prior to seeding. On the remainder of plots, the rangeland drill with ten disc openers was used only to create furrows. All plots were hand seeded; one third received the grass seed mixture with *T. hirtum*, one third received the grass seed mixture with *V. dasycarpa*, and the remaining third received the grass seed mixture without a legume. Plots were five by ten meters and each treatment was replicated two times.

Germination was slow for all species regardless of the treatment in all trials due to low precipitation. Stand densities were measured the following fall (September, 1985) using a one m^2 sampling frame.

Total plant density was significantly higher ($P<.05$) for the treatment with *Vicia dasycarpa* using the conventional method of seedbed preparation. When seeding in arid zones or during periods of drought, adequate seedbed preparation appears to be critical to stand establishment. Species seeded (adaptability) and seed size also play important roles when moisture available for plant growth is perhaps the most limiting factor. Trials should continue in order to explore the possibilities that may exist with native species such as *Dactylis glomerata* and the local *Agropyron* species. Seeding techniques should also be evaluated further and under different environmental conditions since the cost of applying these techniques plays a major role in the determination of economic feasibility of rangeland seeding.

Field Trial: **Plaine de L'Aarid**

Technicians from the Midelt Office supervised the interseeding of two legume species, sainfoin (*Onobrychis viccifolia*) and sweetclover (*Melilotus officianalis*) within an established stand of *Agropyron elongatum* on the Plaine de L'Aarid Grazing Perimeter. An experimental area was interseeded with legumes (17 kg pure live seed/ha) and fertilized with triple super-phosphate at three different levels during the first week in October, 1983. A separate trial was performed for each of the legume species. Two treatments for each legume were tested, inoculation and fertilizer rate, in a 3x3 factorial design (split-plot). Inoculation treatments were inoculated seed, seed without inoculum, and no seed planted. Triple super-phosphate was applied at zero, 40, and 80 kg/ha.

Sainfoin displayed limited germination but failed to become established. Sweetclover did not germinate. Plots were clipped in mid-July, 1984. No significant difference in legume cover was found among any of the trials. The lack of establishment of these leguminous species was probably due to the limited

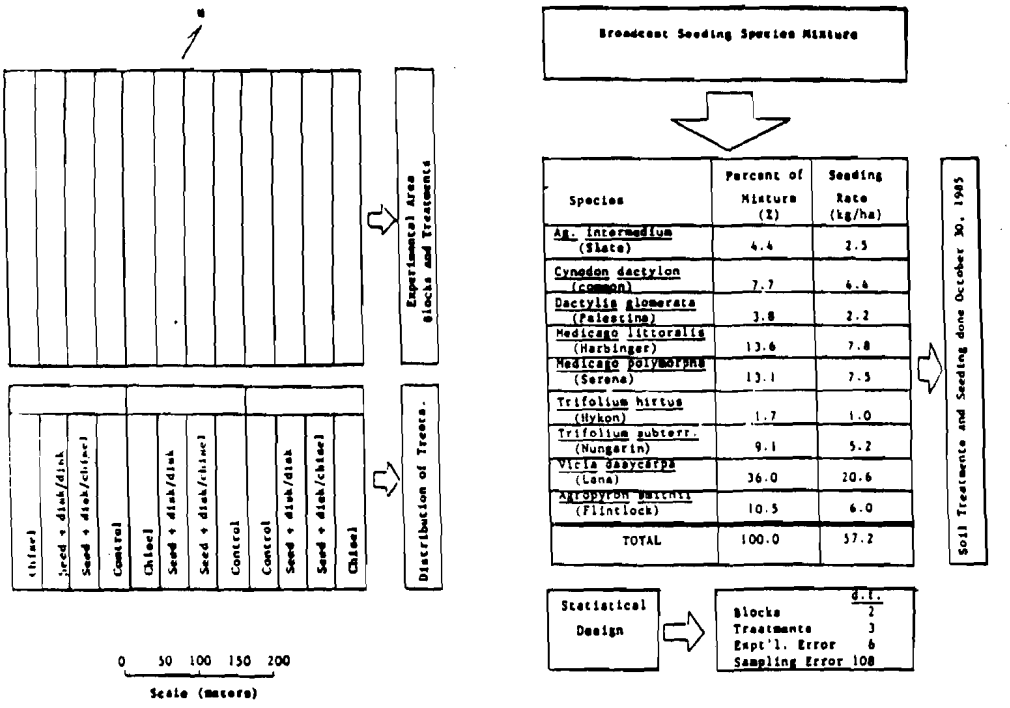
precipitation received during the 1983-84 season.

Seeding with Limited Land Preparation: **Ait Rbaa**

Experimental Seeding

The 20 hectare parcel used in this experimental range improvement attempt is located on the extreme west end of the grazing perimeter on deep, flat bottomland soils. The trials were designed to determine the effects of soil treatments and seeding on forage production.

A mixture of five legumes and four grasses was used in the seeding treatments (see Figure 1.18 for plot layout and species mixture). Soil was prepared using a 24 disc offset harrow and a chisel. Land treatment and seedings were both performed on October 30, 1985. The effort benefited from rains received shortly after treatments were installed. By the middle of March, the 20 hectare ripped area was dominated by a solid stand of native annuals, composed mainly of a yellow mustard (Raphanus raphanistrum) which reached over 1.25 meters in height. These native annuals accounted for more than 90% of the cover. The remainder was composed of Vicia dasycarpa (5%), seeded perennial grasses including Agropyron intermedium (Slate) and Dactylis glomerata (Palestine) (3%), and another seeded legume Medicago littoralis (Harbinger) (1%).



Species	Percent of Mixture (%)	Seeding Rate (kg/ha)
Ag. intermedium (Slate)	4.4	2.5
Cynodon dactylon (common)	7.7	4.4
Dactylis glomerata (Palestine)	3.8	2.2
Medicago littoralis (Harbinger)	13.6	7.8
Medicago polymorpha (Serena)	13.1	7.5
Trifolium hirtus (Hykon)	1.7	1.0
Trifolium subterr. (Nungarin)	9.1	5.2
Vicia dasycarpa (Lana)	36.0	20.6
Agropyron smithii (Flintlock)	10.5	6.0
TOTAL	100.0	57.2

Figure 1.18. Plot layout and species mixture seeded at Ait Rbaa Grazing Perimeter.

Small Demonstration Site with Limited Land Preparation

The objectives of this demonstration area were to develop a visual demonstration site showing the effectiveness of developing terraces on natural contours for watershed management and for increasing forage production.

The site of the demonstration was located on the eastern end of the Ait Rbaa Perimeter in fenced exclosures (two exclosures are present at that site, a ridgetop exclosure and an exclosure located in a swale; the demonstration was located in the lowland exclosure). Contours were surveyed by technicians at the Beni Mellal office. Terraces were dug by local hire. The local Centre de Travaux (CT) was contracted to chisel the area behind each terrace. A mixture of six species (*Cynodon dactylon*, *Agropyron intermedium*, var. Slate, *Trifolium subterranium* var. Clare, *Dactylis glomerata* var. Palestine, *Vicia dasyacarpa* var. Lana, and *Eragrostis curvula*) were applied at a rate of four kilos each for a total of 24 kg/ha. Three varieties of *Atriplex* shrubs were planted behind the terraces facing the upper part of the watershed. Grass clumps provided by the PMC were planted at the junction of the terrace and the chiseled ground. It was hoped that clumps, being mature, live plants, would have a higher rate of survival than hand seeded species. Results of these trials are presented in Table 1.14.

Table 1.14. Names, number and survival of planted species.

Hand Seeded	**kg Seed Planted**	**Germination**
Cynodon dactylon	4	med
Agropyron intermedium var. Slate	4	med
Trifolium subterranium var. Clare	4	med
Dactylis glomerata var. Palestine	4	low
Vicia dasycarpa	4	high
Transplanted Grasses	**No. Planted**	**Survival**
Erharta calycina var. Mission	37	27
Eragrostis lehmanniana	26	4
Agropyron desertorum var. Nordan	48	43
Dactylis glomerata var. Berber	40	38
Sporobolus airioides	37	0
Phalaris tuberosa var. Seedmaster	58	31
Phalaris tuberosa var. Serona	46	28
Cenchrus ciliaris var. Nueces	68	8
Agropyron trichophorum var. Lana	36	26

Table 4.14 (continued). Names, number and survival of planted species.

Dactylis glomerata var. Palestine	34	32
Eragrostis curvula var. Catalina	23	20
Eragrostis superba var. Palar	52	9

Hand Seeding in Zizyphus Clumps on Degraded Range

This study was initiated to determine whether the area under the Jujubier clumps, due to the high levels of organic matter, visibly less compact soils, and protection from grazing, would be a suitable site to reintroduce perennial rangeland grasses by hand seeding.

Twelve paired Jujubier (Zizyphus lotus) plants were chosen within the confines of an exclosure on the eastern end of the Ait Rbaa Perimeter. A one m^2 plot was staked surrounding each pair of plants. The area was raked of debris and then randomly seeded with one of the following species: Agropyron intermedium var. Slate, Cynodon dactylon, Cenchrus ciliaris, or Erharta calycina. One plant from each pair was seeded at a rate of 12 kg/ha. The experiment was maintained for only a single season. During the summer months the majority of the shrubs were illegally removed by area herders for firewood and fence building material. The results of this study failed to show that this seeding method is a reasonable alternative with any of the species used during years of below average precipitation.

LAND TREATMENTS

Ripping and Terracing: **Oujda Office**

Construction and Evaluation of Contour Terraces

The decreased plant cover on Eastern Moroccan rangelands, caused by animal and human pressure coupled with drought, has accelerated the amount of soil erosion. Technicians at the Oujda Office took measures to capture precipitation runoff, increase plant cover, and forage production through investments in major land treatment. The goal of the construction of contour terraces was to manipulate the soil to insure maximum water retention and survival of plantings of Atriplex nummularia. This shrub species was chosen for planting because of its demonstrated potential for forage production in the harsh climate of Eastern Morocco.

In installing these contours, objectives were threefold: 1) to determine the survival rate of Atriplex nummularia within the contour system, 2) to determine the annual forage production of the species, and 3) to determine the effects of the contour terraces on native vegetation production. It was expected that A. nummularia would survive in the contour system at a level sufficient to warrant large scale use of this method of

plantation. Native vegetation was also expected to benefit from increased soil moisture due to the water harvesting effect of the contour terraces.

The contour terraces were constructed with hand labor, using picks and shovels provided by a Promotion Nationale grant. These grants are to be used for labor on projects for the betterment of the community. In the Ain Beni Mathar area, the site chosen for the demonstration was on the Fritiss Range Perimeter, where contours were used to harvest runoff from the alfa-grass zone and allow infiltration into the productive soils of the sagebrush zone. The contours were surveyed in at 10 meter surface distance intervals.

The first step in the construction process was to dig a trench 20 cm wide x 20 cm deep which would become the rooting zone for the shrubs. The top soil from up the slope (1-1.5 m) was shoveled down to fill the trench and make a furrow of "good soil." After completion, the contour terrace was approximately 40 cm high and packed to resist erosion. In places of expected heavy runoff the contours were fortified with a rock backing covered with soil.

The Atriplex nummularia plants were supplied by the Forest Service nursery in Bouarfa and planted at two meter intervals along the terraces throughout the system. Each of the 5,000 plants was given five liters of water on planting day.

Shrub production data was collected on the Ain Beni Mathar Perimeter after the shrubs were in place for one year. Production was evaluated by ranking each of the 5,000 shrubs into one of five classes, based on visual observation. Rank one was considered poor production and rank four very high production. A zero rank was given to dead plants. To convert these classes into production, four representative plants of each rank were stripped of all forage material and the material was bagged, dried and weighed. The dry matter forage productivity estimates presented in Figure 1.19 are based upon the average of these samples.

RANK	% POPULATION	PRODUCTION/PLANT
0	9	---
I	25	17.12 g
II	23	33.80 g
III	30	69.85 g
IV	13	245.44 g

Figure 1.19. Production classes of Atriplex nummularia shrubs on contour terraces on the Fritiss Range Perimeter near Ain Beni Mathar.

With a plantation density of 1,000 plants per hectare, the first year production of Atriplex nummularia was estimated at 63.9 kg/ha of dry matter. Although this level may seem low, it represents only part of the total annual production of the site. The average forage dry matter production of sagebrush on contour terraced sites was 447.4 kg/ha making the combined estimated

forage production of sagebrush and A. nummularia on the terraced area 511.3 kg/ha, or over five times the production of sagebrush sites that were protected from grazing. (On grazed sagebrush sites, total production was estimated to be only 17.3 kg/ha. The site yield under protection from grazing was estimated to be 84.0 kg/ha). The water harvesting effect of the contour terraces adds considerably to production of forage on sagebrush sites. It was demonstrated that transplanted shrubs can also be used successfully with this technique to extend the forage base. Longer term effects of terracing and shrub planting will be monitored. As transplanted shrubs reach maturity and full size, their contribution to forage production should increase several fold. The presence of the Atriplex plants should also have a moderating effect on the microenvironment of the site making it more mesic than the surrounding area. If this proves to be the case, production of sagebrush and other forage species could be expected to increase.

The site chosen for contour terrace construction at the Gouttitier Experimental Farm was a moderately sloping shallow soil site. This site was selected because of its close proximity to the main highway.

The construction method used was similar to that employed at Ain Beni Mathar, though modified to fit the shallow soil sites. Construction was by hand labor using picks and shovels. A 20 cm x 20 cm x 20 cm hole was dug at two meter intervals to serve as the planting site. These holes were then connected by a contour terrace of soil from the up slope side. Holes were filled with top soil from up slope. The finished contour terrace was 30 cm in height and was packed to resist erosion.

The contours were planted with Atriplex nummularia supplied by the Forest Service nursery in Taourirt. Each of the 3,700 shrubs were given five liters of water on planting day.

The Gouttitier contours exhibited many of the problems of the Ain Beni Mathar contours. The major problem was caused by the slope of the site and the nature of the storms in the Taourirt area. Precipitation events in this region are characteristically of high intensity and short duration. This causes considerable runoff which in turn causes damage to the terraces. Many of the problems of structural failure could be solved by proper forethought in placement and consideration of soil types involved. A site with a greater productive potential and less slope could have been chosen for the demonstration at Gouttitier but it would not have been possible to locate it in an area that could be readily seen from the highway.

Production data (Figure 1.20) was estimated using the sample unit method employed at Ain Beni Mathar. With a plantation density of 1000 plants per hectare, the first year production was estimated to be 28.6 kg/ha. This low level of productivity gives some indication of the limitations imposed by the slope and shallow soils at the plantation site.

RANK	% POPULATION	PRODUCTION/PLANT
0	25	---
I	26	16.30 g
II	32	26.70 g
III	9	63.80 g
IV	8	126.65 g

Figure 1.20. Production classes for Atriplex nummularia planted on contour terraces at the Gouttitier Experimental Farm.

After a high intensity storm, it was observed that long terraces needed breaks to allow water to pass to the next terrace. Flow of water can only be slowed, not stopped altogether. Breaks at 30 - 50 m intervals were opened and alfa-grass and rocks placed over the exposed ends of terraces to protect them from erosion. Any watershed management program involving contour terracing (or other improvements involving water management) must start at the head of the watershed basin to gain control of the system.

Sites with deeper soils responded considerably better in overall shrub production than the poorer sites. A petro-calcic horizon very near the surface of the poorer sites appears to inhibit plant growth. Conversely, this same petro-calcic horizon on the deeper soil sites seems to aid in downstream percolation of soil moisture. The water infiltrates and flows laterally on the petro-calcic horizon adding to the available soil moisture for native vegetation down slope.

One major problem that added to structural failure in an intensive runoff event was rodent damage. Newly formed terraces of fresh soil provided a perfect nesting place for many of these nocturnal desert dwellers. Many places in the contour terraces were literally honeycombed with burrows.

Additional Terracing Trials

The Bureau des Parcours was allocated funding to reclaim 400 hectares in the Ain Beni Mathar area. The America site (the site of an American Air Force Base during the North African Campaign of World War II) was selected because of its close proximity to a major highway and the local population. The area is divided into two sections, the site of a ten year old Forest Service plantation that failed and a small watershed. The plantation site was planted using a method of impluvium or "hoovera", a pit surrounded with a crescent shaped terrace for water catchment and storage. The small watershed was planted using a system of contour terraces. This will be an excellent chance to compare the two plantation methods for survival and plant production. The Forest Service method has been widely used in all parts of Morocco in tree plantations. Its utility or effectiveness in the semi-arid and arid zones appears to be negligible however.

The contour terraces were surveyed in at each 20 cm drop in elevation (about 20 meters between contours). The construction was done in two stages: 1) a rooting zone was cut and an initial

terrace was constructed by tractor and three disc plow, and 2) hand labor was used to complete the construction of the terraces. The tractor and plow ran along the contour in one direction to the end of a contour, then reversing direction, ran along the same cut to the starting point of that contour. This method caused a 20 cm trench to be cut and the soil was thrown in a rough terrace on the down slope side. Laborers then filled the trench with top soil from up slope and worked the terrace to stabilize the soil. The contours were broken every 50 meters to allow flow of water to proceed down slope at a slower rate. The ends of the breaks were rocked to protect them from erosion.

The area was planted with Atriplex nummularia supplied by the Ain Beni Mathar Forage Plant Nursery and the Forest Service nursery in Oujda. A total of 260,000 shrubs were planted at two meter intervals with each receiving five liters of water on the planting date.

A disc plow was used to scarify the soil to a depth of five to seven cm at three different sites within the contour system. This was done to open the soil for increased infiltration. Two of the three sites disced were planted with a mixture of Eragrostis lehmanniana and Sporobolus airoides seeded by hand. Seed was then covered with a clump of jujubier branches drawn over the ground by a donkey.

The native vegetation showed somewhat more robust growth in the disced areas than it did in untreated areas. Stipa parviflora was definitely more productive in these areas compared to the untreated sites. Plants broken by the disc seem much more healthy than those untouched. There was also a marked increase in the native shrub growth in the treated areas. As of May 1, 1986, seeded areas had shown no sign of germination of the seeded species. This is probably due to the low temperatures and lack of moisture during the four months after planting. A major sandstorm occurred three weeks after seeding with winds of 150 km/hr. Since the two species used have very small seeds, this storm may have removed much of the seed from the ground.

The Atriplex nummularia shrubs will be evaluated four times annually. The first quarter evaluation showed a death loss of 25%. Much of this loss can be attributed to damage done by windstorms. Many of the impluvium planted shrubs were literally covered with sand.

This range improvement was done by a hired contractor. Many problems could be eliminated if a representative of the Bureau des Parcours was on site at all times to oversee the work.

Fertilization and Ripping: **Ait Rbaa**

The cumulative effects of increased animal numbers, drought, uncontrolled use and soil nutrient deficiencies have, over time, reduced available forage on the Ait Rbaa Perimeter. Sulfur fertilization and mechanical chiseling of the soil were two treatments introduced on the perimeter with the objective of providing an inexpensive method of increasing forage production from native species.

The study site was located at the eastern end of the Ait Rbaa Perimeter. Two locations, situated within a fenced exclosure, were assessed to be representative of sloping upland

and bottomland sites found on the perimeter. Three replications of six different treatments in a randomized block design were installed at each location. Elemental sulfur was applied at three different levels (0, 30, and 60 kg/ha of 98% pure sulfur). Plots were either chiseled or left undisturbed. Soil moisture and water infiltration rates were monitored seasonally. Forage production was determined at peak season for native legumes, other forbs, and native grasses.

Graphs of soil moisture data collected over two growing seasons indicated that, regardless of location, chiseled sites were more capable of retaining soil moisture than non chiseled sites, both at soil depths between 0 and 10 cm and between 10 and 20 cm (Figures 1.21, 1.22, 1.23, and 1.24). Though statistical analysis has not yet been performed on the data, the values are encouraging. This range improvement practice may be useful at Ait Rbaa Perimeter and other areas with similar climate and soils.

Figure 1.21. Soil moisture, Location I (1984-85).

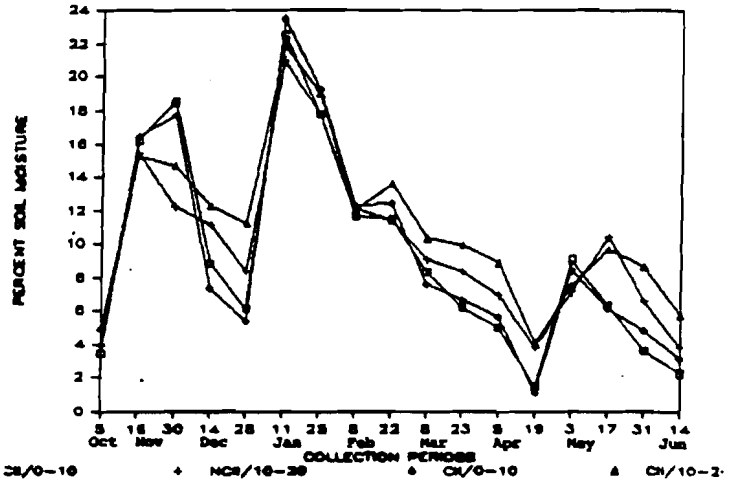


Figure 1.22. Soil moisture, Location II (1984-85).

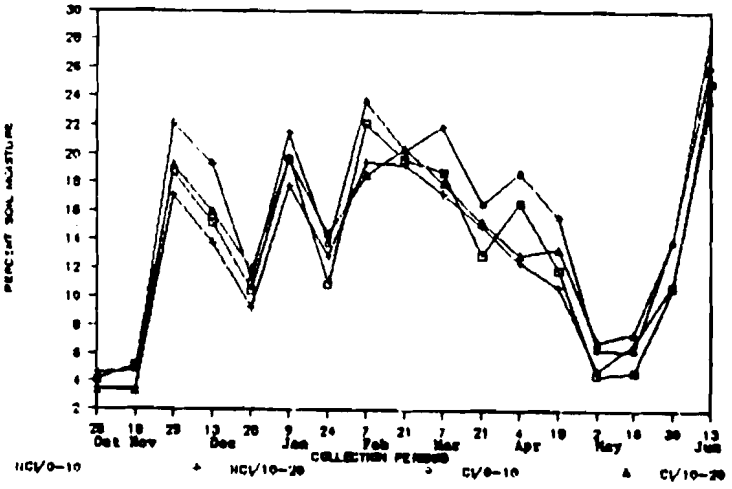


Figure 1.23. Soil moisture Location I (1985-86).

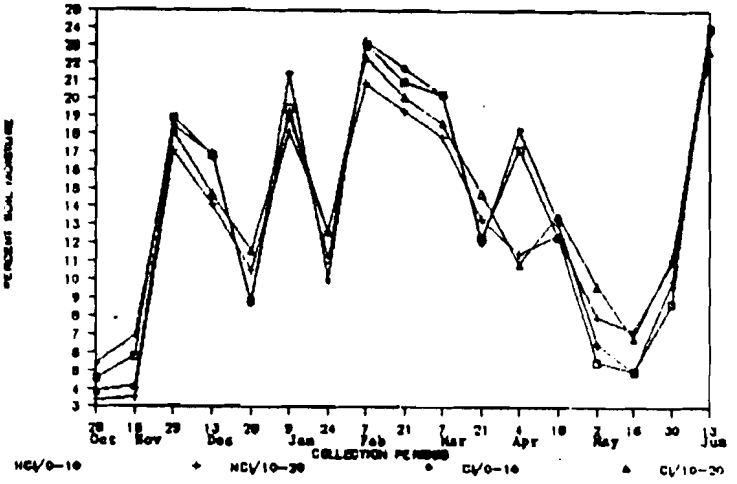


Figure 1.24 Soil moisture Location II (1985-86).

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The results of measurement of soil infiltration (Figures 1.25 and 1.26), at least when plotted, indicate that during the first year after chiseling, higher mean infiltration rates can be expected in the chiseled areas than in the non chiseled areas. During the second year after chiseling, the treated areas were again showing higher infiltration rates, but the differences between the chiseled and non chiseled areas were not as pronounced. This might be expected since both areas were protected from grazing and plant cover and growth were increasing annually. This plant cover and biological activity in the soil and at the soil surface was obviously changing the soil characteristics in terms of compaction. The actual effect of chiseling may be only short term, especially if grazing practices are not changed to reduce trampling and compaction of the soil.

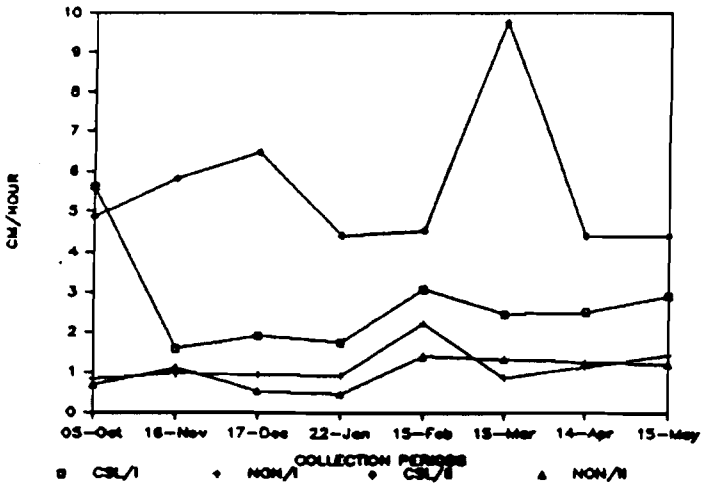

Figure 1.25. Infiltration rates, 1984-85.

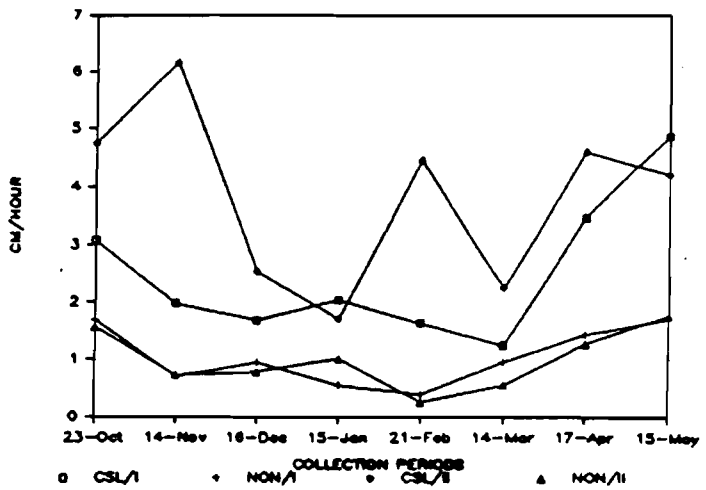

Figure 1.26. Infiltration rates, 1985-86.

There was a statistically significant increase ($P<.05$) in legume production on chiseled over non chiseled sites. Native annual legumes provide a large portion of the available palatable forage produced at Ait Rbaa Grazing Perimeter, especially in dryer years (around 30% in 1984-85). Within each forage type (leguminous forbs, non-leguminous forbs and grasses), no significant differences in production were detected among the three levels of sulfur. Positive effects of the sulfur application may emerge in future years. Given the data from the initial two years of sampling, however, sulfur fertilization with elemental sulfur shows little promise for increasing forage production.

Fertilization Trials: **Plaine de L'Aarid**

Stands of perennial grass species, which were established in field trials planted on Plaine de L'Aarid Perimeter in 1970, have persisted into the 1980's. The vigor and productivity of these stands, however, has declined substantially. In September 1983, technicians from the Midelt Field Office applied nitrogen (N) and

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phosphorous (P) fertilizer to stands of Agropyron elongatum, A. intermedium, A. trichophorum and Elymus junceus. The trials were designed to show forage production response at various levels and combinations of N and P. An experiment with a 5x5 factorial design and four replications was installed. The N source was ammonium nitrate at 0, 20, 40, 60 and 80 kg/ha. The P source was triple super-phosphate also applied at 0, 20, 40, 60 and 80 kg/ha.

Agropyron elongatum and E. junceus plots were clipped in mid-July 1984 to determine the response in productivity which resulted from fertilizer treatments. No significant differences were found among treatments. Limited precipitation during the trial year made water such a limiting factor that possible responses to fertilizer were unlikely. Current vegetative growth on the A. intermedium and A. trichophorum stands was virtually nonexistent that year. No production data was collected from the plots.

Alpha-grass Trial: **El Faija**

Trials established on the Moulouya Plain in recent years have produced little information other than the fact that, during periods of drought, little or no plant establishment and growth occurs due to insufficient soil moisture. Infrequent precipitation and quick runoff when rain occurs, results in low levels of available soil moisture. An increase in available soil moisture could enhance plant establishment and subsequent forage production under dry or more humid conditions. A trial to determine the effects of integrating contour terracing into range seeding efforts on burned Stipa tenacissima sites was established on the El Faija Perimeter during the fall of 1985. The trial was designed to assess the effectiveness of terraces constructed on contours in reducing runoff and to assess the potential for harvesting water (concentrating runoff from precipitation onto productive zones).

Six contours were surveyed on the study area. A two tine ripper with tines set one meter apart was used to rip soil along contours to a depth of approximately 30 cm apart. Terraces were constructed by hand along the lower edge of the ripped area. A 2x3 factorial split-plot experiment was designed where terraces were tested as primary treatment plots and planting methods were tested within plots. Three planting methods, compatible with the terraces were evaluated: 1) the total surface area between the terraces was planted, 2) the lower one half of the surface area between the terraces was planted, and 3) no planting (control).

Previous research at El Faija had indicated the techniques and species that were most likely to be effective. Conventional seedbed preparation (plow, disc, and roll) prior to planting with a grain drill has produced higher levels of plant establishment than direct planting with a rangeland drill in the majority of recent research and demonstration efforts. A mixture of seven grasses (A. elongatum (Alkar), A. elongatum (Jose), A. intermedium (Slate), A. intermedium (Tegmar), A. trichophorum (Manden), A. trichophorum (Topar) and Dactylis glomerata (Palestine)) and two legumes (Trifolium hirtum (Hykon) and Vicia dasycarpa)) were seeded on the study area. Two species of

saltbush (Atriplex) shrub seedlings were transplanted at two meter intervals in the trough above the terraces (if terraces were not present shrubs were planted in the lower rip along each contour). Atriplex nummularia was planted along the first, second, fifth and sixth contours. Atriplex corrugata was planted along the third and fourth contours of the study.

Terrace construction was continued up the slope to the hilltop above the study area to prevent runoff damage to the trials. Terraces were built along the contour, with one meter increments in elevation between terraces until the hillside became steep. The increments were then increased to one and one-half meters, and finally to two meters.

Students from INAV Hassan II will monitor the trials for effects on available soil moisture and corresponding changes in the grass/legume mixture, shrub establishment and production. Four moisture measurements should be taken in the interspace between terraces in each treatment. The first should be taken one and one-half meters above the lower terrace and the fourth should be taken one and one-half meters below the upper terrace. Two readings should be taken at equally spaced points between the first and the fourth. Data collection at these locations would enable the researcher to determine if seepage below the terraces occurs, the effects of terracing and land treatment on soil moisture between terraces and the extent to which terraces increase soil moisture in the catchment formed above the terrace. One meter square sampling frames should be used to sample stand density and production between terraces including the locations where soil moisture is sampled. In addition, shrub survival rate and productivity should be estimated.

DEFERMENT FROM GRAZING

Grazing Exclosures: **Ain Beni Mathar**

Four distinct vegetation types occur on the fenced 300 ha experimental area at the Fritiss Grazing Perimeter. The need to monitor these plant communities has been recognized due to the changes in plant composition that have taken place over the last two years with near average precipitation. A number of annual forbs and grasses have been collected that were once thought to be locally extinct.

With the idea that the Experiment Station will be used for grazing studies of various kinds, four 50 m x 50 m exclosures were constructed in 1985, one in each of the four vegetation types. Type #1 was a water collection area where a dense stand of sagebrush had formed. Type #2 was an upland sagebrush site. Type #3 was the sagebrush/alfa-grass transition zone and Type #4 was a unique site where sand from neighboring fallow fields has been accumulating. Permanent transects were established for monitoring purposes. Though quantifiable data on recovery is not presently available, plans have been made to evaluate each plant community annually.

Grazing Exclosures: **Gouttitier Experimental Farm**

The land upon which the Experimental Farm was established has a history of mismanagement. With the completion of an enclosure fence, much of the trespass grazing has been eliminated. Since many sites in the region are similar in that an on site native seed source appears to be virtually nonexistent, monitoring the recovery of natural vegetation on the area will give an indication of the response that can be expected in other local reclamation efforts.

Two 50 m x 50 m exclosures were constructed during 1985 on two different range sites on the Farm. Site #1 is in a degraded sagebrush site which, after a single year of deferment from grazing, has shown a remarkable recovery of vegetation. Site #2 is a degraded upland site occupied by a thin stand of sagebrush. This area has also responded dramatically to deferment. Data on recovery of these two sites will be collected annually.

During the 1983-84 growing season, the amount of available forage was estimated weekly by clipping on two distinct range sites at Ait Rbaa Perimeter (20 plots were clipped each week on each site). The clippings from each plot were separated into three components: grasses, legumes, and forbs. Samples were stored on ice in the field then placed in an oven the same day for 48 hours of drying at 80°C. After weighing to determine productivity, samples were ground in a mill and combined, resulting in one sample per location per weekly sample date. The milled samples were analyzed for crude protein and ash content (minerals) by Dr. Hamid Narjisse at ENA in Meknes.

The two sites were fenced and excluded from grazing in 1982-83. They were located on the eastern end of the perimeter and represented: 1) ridgetop sites with shallow soils, and 2) swale sites with deeper soils. The ridgetop site was dominated by *Malva parviflora* with few grasses. The swale site was dominated by *Asphodelus tenuifolia* with numerous grasses including *Cynadon dactylon* and *Stipa retorta*.

Crude protein was selected as the criteria for evaluating forage quality because it is the most expensive to supplement and because it is often the most limiting nutritional factor for ruminant maintenance and growth. Unfortunately, data for energy were not available. Energy is usually the second most limiting factor, and in this case, may well have been the primary nutritional constraint. Data was compared using an analysis of variance for a completely randomized block design.

Results and Discussion

Peak season forage production occurred on March 19th for the ridgetop site and March 26th for the swale site (Table 1.15) yielding 831.2 and 754.8 kg of oven dry forage per hectare, respectively [Harkousse et al. (1984) for a discussion of the production data]. Clipping began on December 12th when range forage was actively growing following substantial precipitation. This was the low point in production, but yielded the highest levels of crude protein and ash. The level of crude protein in samples from the swale site ranged from a high of 21.71% on a dry matter basis (DM) on December 12th, to a low of 14.41% DM on April 16th. The range of values for crude protein was from 25.36% on December 19th to 17.44% on April 16th for the ridgetop site. Percentage of Ash (DM) followed the same trend indicating some loss through leaching and maturation through the growth cycle.

The percentages of dry matter crude protein (Figure 1.27) and ash (Figure 1.28) gradually declined as vegetation matured through the growing season. Moisture caused an immediate growth response in vegetation (until the time of seed dispersal) regardless of its stage of growth. This quick growth response to precipitation caused small increases in DM protein content throughout the season.

Table 1.15. Kilos of oven dry forage per hectare, moisture content, and crude protein and ash as a percent of dry matter.

	SWALE SITE							UPLAND SITE						
Sample Date	Grass	Legume	Forbs	Total	% Moisture of Total Forage	Crude Protein %	Ash %	Grass	Legume	Forbs	Total	% Moisture of Total Forage	Crude Protein %	Ash %
Dec. 12	4.00	14.40	159.8	178.2		21.71	18.28		18.0	184.6	202.6		23.44	19.71
19	0.24	.72	207.6	208.6		20.29	21.40		14.0	219.4	233.4		25.36	22.18
26	4.40	15.80	433.6	454.0	86.7	20.03	19.58		36.4	544.8	581.2	86.7	22.43	20.82
Jan. 2	2.00	18.80	393.2	412.4	86.3	20.54	17.85		55.6	544.0	600.0	86.3	22.90	20.04
9	1.80	28.00	356.8	386.8	85.6	19.55	17.36		74.0	605.6	680.0	85.1	22.29	19.64
16	1.60	24.80	356.0	382.8	83.4	19.46	17.24		56.4	480.4	536.8	83.4	22.03	16.35
23	3.60	25.20	266.8	295.6	50.5	19.35	16.45	0.6	80.4	616.8	698.0	61.0	23.46	16.50
30	3.40	32.00	331.0	372.0	86.2	18.39	16.06		45.4	608.4	653.4	70.9	21.56	15.80
Feb. 6	3.20	34.00	336.0	373.2	82.9	18.54	14.58		73.6	654.8	728.4	70.7	20.41	15.88
13	16.00	34.80	346.0	371.2	76.0	17.95	14.22		50.8	523.2	574.0	67.4	21.56	15.81
20	4.40	29.20	352.0	385.6	87.6	18.11	13.30		79.2	698.0	777.0	81.3	19.14	17.41
27	23.60	42.40	323.2	289.6	78.2	17.40	14.97		64.4	522.0	586.4	67.8	19.81	16.79
Mar. 5	26.80	54.40	313.6	395.2	75.8	17.63	13.75		84.8	558.4	643.2	76.3	18.54	16.10
12	16.80	54.00	428.4	499.6	71.0	15.71	13.59		72.0	528.4	615.8	71.1	22.65	15.01
19	37.60	77.20	555.4	670.2	65.5	16.31	12.48	0.6	140.4	690.2	831.2	62.1	22.40	14.15
26	56.40	102.80	595.4	754.8	76.8	16.51	14.93	3.2	137.6	649.6	790.4	73.8	19.84	14.91
Apr. 2	27.80	87.80	392.8	508.4	59.7	15.29	10.01	10.0	69.0	499.0	578.0	54.0	18.08	13.01
9	74.60	45.60	575.4	695.6	29.9	16.39	11.03	8.0	110.4	440.4	558.8	49.4	17.74	13.67
16	22.40	40.40	432.4	495.6	54.3	14.41	9.12	6.8	70.4	396.4	473.2	44.0	17.44	14.93

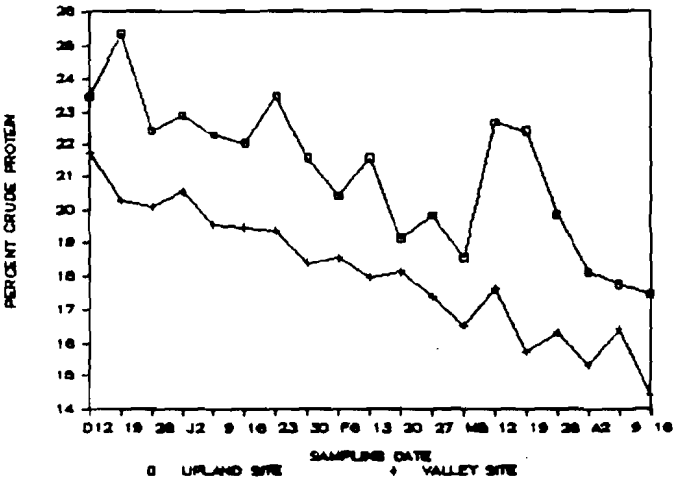

Figure 1.27. Forage crude protein content (dm basis), 1983-84.

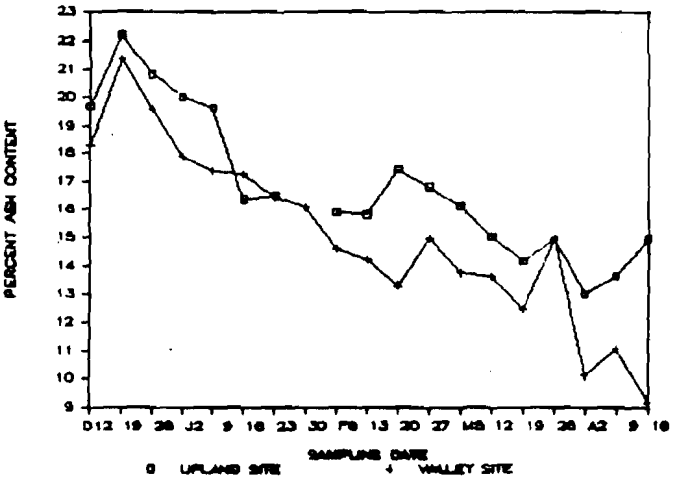

Figure 1.28. Forage ash content (dm basis), 1983-84.

An analysis of variance indicated that there were highly significant differences (P<.01) between locations and between dates of sampling (Table 1.16). Differences between sample dates were normal and followed precipitation patterns and plant development as expected. Real differences between locations indicated that the forage base on sites dominated by Malva parviflora and Medicago laciniata (the ridgetop sites) were truly superior to those dominated by Asphodelus tenuifolia, Medicago

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laciniata, and Cynodon dactylon (the swale sites) as far as DM crude protein content was concerned.

Table 1.16. Analysis of variance of crude protein content of annual forage.

SOURCE	DF	SS	MS	F
Location	l-1=1	87.04	87.04	67.47***
Date	d-1=18	135.65	7.54	5.84***
Error	[l-1][d-1]=18	23.14	1.29	
Total	ld-1=38	245.83		

*** Significant at P<.005.

It must be kept in mind that these crude protein figures were calculated on a dry matter basis. One kilo of green forage consumed by an animal on December 26 at Ait Rbaa would have, on the average, provided only 133 g of dry matter (86.7% moisture content). The same forage contained 20.03% crude protein DM. This means that one kg of green material only contained 26.64 g of crude protein, and even less digestible protein. A 50 kg lactating ewe requires approximately 136 g of digestible protein daily and 1800 g of dry matter. Therefore, she must consume about 5.68 kg of green forage to satisfy her needs for protein, and about 13.5 kg to satisfy her need for dry matter. It is doubtful that a ewe could consume enough forage during a grazing day at Ait Rbaa to satisfy her protein requirement. A ewe would find it impossible to satisfy her dry matter needs. For this reason, there is an obvious need to provide a supplement to the native forage. Sheep in the area were, in fact, supplemented heavily with various feeds including barley, beet pulp and straw.

There was both a forage quantity and quality problem at the Ait Rbaa Perimeter. This conclusion lends credence to the general opinion voiced by government service range management personal in the region that this communal grazing land is simply a holding area during the cereal production season, and it is not expected to provide the requirements of livestock. This may also provide some insight into the attitudes of right-users, who seem resistant to the prospects of range improvements and who appear unconcerned over the continuing degradation of the natural resources of the Ait Rbaa Grazing Perimeter.

CONCLUSIONS AND RECOMMENDATIONS

Existing Forage Resources

Moroccan rangelands are situated over a diverse range of climatic and ecological zones, from desert shrublands to high mountain grasslands. Good rangelands can usually be converted to marginal croplands, and therefore more and more rangeland is being converted to cultivated cereals crops each year by a rapidly expanding population, even though little profit from subsequent grain harvests can be realized. These crops do provide a standing forage crop if only as stubble. By expanding crop production activities into marginal areas, the Moroccan producers have compensated for poor range condition by producing a cereal crop, and at the same time, are controlling the land for their personal use. Cereal crop subsidies and land tenure policy by the GOM encourage this practice, making this practice feasible for the individual at the long-term expense of rangeland productivity and the communal rangeland users.

Pastoralism in Morocco has, nearly completely, given way to an agro-pastoral way of life. In agricultural areas, where good rangeland has been converted to poor cropland, pasturage is scarce and the remaining range areas are used heavily (generally in the complete absense of any kind of management or control). Ait Rbaa Perimeter, located in the midst of a large area devoted to cultivated agriculture, provides a vivid example of this kind of abuse. Sheep depend on crop residues for a large portion of their forage each year. After harvest, shepherds herd large numbers of flocks through cropland to eat stubble and weeds. As planting begins, livestock are withdrawn from cereal fields and herded on communal rangeland until after the harvest. Here they quickly consume emerging vegetation. Most herds, even on native rangeland, receive large amounts of relatively costly supplemental feeds such as barley and by-products from factories which process agricultural products (sugar beets, cotton).

Moroccan rangeland is generally devoid of its original component of palatable perennial herbaceous vegetation. Many forage species, both legumes and grasses, which were reported as present during the earlier USAID Range Improvement Project (608-64-4) could not be found by a former team member of that project, Mr. Walter Graves, during his TDY visit in 1985.

Soils on grazing perimeters were found to be severely eroded and highly compacted. Runoff from precipitation was high, with moisture rarely penetrating the soil in amounts adequate for establishment of perennial forage plants, even in years of greater than average rainfall.

Everywhere evidence of the need for range management and for the adherence to its most basic concepts was observed. **Not until the range manager can control animal numbers and the timing of their access to grazing, can he hope to substantially improve and increase the range forage resource.** This can only be done effectively through the cooperation of people using the resource. The benefits to the people must be determined, demonstrated and developed if the trend toward further degradation is to change.

Alternatives for Rangeland Forage Production

Establishment of perennial introduced species has been generally difficult and expensive. Stands which have become established, such as those in the perimeters administered by the Midelt Office, are the result of adequate seasonal precipitation and hard work on the part of range technicians. Though a number of stands, composed of introduced species from the genus Agropyron, are managed at Plaine de l'Aarid Perimeter; the condition of these stands has undergone substantial natural deterioration in the years since their initial planting. No juvenile plants are present and all remaining grass plants are overmature with some stands in need of renovation.

Warm-season grasses, even when of native origin, have proven to be difficult to establish on Moroccan rangelands. Seeds are generally small and expensive to purchase. Successful establishment depends upon good precipitation during and after germination and careful control of planting depth by technicians. The possibility of failure is too great to make this an economical venture unless techniques are improved.

Experience indicates that seeding of most introduced species in range improvement programs is an intervention that is generally too risky to be assumed by private producers. A farmer would rather have a poor stand of barley or wheat from which he may obtain some grain and stubble, than a year lost to barren ground and weeds. Years of adequate seasonal precipitation, sufficient to establish adequate stands of these species, are too rare to guarantee any measure of their success in many areas.

The potential displayed by plants native to Morocco is the most promising aspect of the Project work with range forage species. Among these plants are ecotypes highly adapted to climatic and soil conditions on the grazing perimeters. Among accessions from the native seed collection being propogated at the PMC and undergoing trials at the grazing perimeters, there were annual species which have the ability to produce the large amounts of seed necessary to maintain a presence on managed communal rangeland. Leguminous annuals, especially from the genus Medicago, exhibit many vegetative growth forms which may allow them to persist and produce forage under heavy grazing pressure. These species characteristically produce forage of high quality and produce large amounts of seed. Their use may be one key to reducing the risk of failure of an investment in range revegetation in some zones.

Several basic range planting techniques were tested in the Midelt area. The rangeland drill, which scarifies soil surfaces and seeds in areas of rough topography, did not prove effective during drought years. The need for preparing an adequate seedbed was only accentuated under such environmental conditions. Soil surfaces needed to be disturbed and competition from existing vegetation had to be reduced. Conventional seedbed preparation methods, using a plow, a disc and a roller, were most successful.

Because soils are eroded and compacted, rainfall generally runs off without significantly penetrating the soil crust. Range improvement methods which increase penetration of water through the soil surface, and prevent runoff are potentially worthwhile investments. Ripping of the soil and the construction of terraces on the contour were highly successful range improvements

installed at Ain Beni Mathar, Gouttitier, and Ait Rbaa Grazing Perimeters. Ripping and terracing activities at the El Faija site, though not yet one year old, appear to have had a marked positive effect on revegetation and forage production.

Attempts to improve range productivity using chemical fertilizers were unsuccessful. Fertilization with elemental sulfur at Ait Rbaa Grazing Perimeter did not produce detectable improvement after two years. Forms of sulfur that are more available in the soil may produce different results and should be investigated. Adding various amounts of nitrogen and phosphorous to rangeland soils near Midelt did not induce marked differences in plant density or production in drought years. In addition, fertilization is probably too costly to be included in range improvement programs unless very dramatic increases in production can be expected. The adage that "fertilization of soils receiving less than 300 mm of precipitation is valueless", appears to be correct in Morocco.

Range improvement research and species adaptability trials are necessary research which must continue. DE/SP must either decide to dedicate personnel and materials to research, or make the proper contractual agreements to continue range research in identified topical areas through the auspices of existing research organizations (such as INRA, INAV, ENA, and programs such as SR-CRSP).

Recommendations

The following recommendations are offered based upon observation and research at the Project sites:

1) Continue to move forward toward control of grazing through organization of people. No range improvement concerning range vegetation can be made without adequate control of animal numbers and the timing and duration of grazing.

2) Improvement of Moroccan rangeland is possible through manipulation of the soil surface and redistribution of water. Soil ripping and construction of terraces should be considered prior to seeding on some rangelands. Where native residual plant cover still exists, the treatment can be used to capture rainfall and increase productivity without seeding.

3) Development and use of native species must be expanded if a seeding program is to continue. Even the most adapted introduced species can be difficult to establish. Among the limited native species collection initiated by the Project, there are promising forage species which can be used to produce a nutritious, highly palatable forage base capable of reestablishment from seed under adverse conditions.

Only with a combination of range improvement techniques and development of adapted forage species can a range manager reduce the risk of failing to establish a stand. Only through reducing

risk of rangeland seeding can seeding of denuded range be a viable alternative accessible to producers. The acceptance of rangeland management in the private sector, however, is not the only consideration. Large scale government direction and investment is necessary in order to conserve degrading Moroccan rangelands.

The continual push of dryland farming into marginally productive areas has accounted for an irreparable loss of topsoil and the local extinction of many forage plant species. Government intervention and expenditure will be necessary to conserve the natural resources of soil and vegetation, even if only to protect watersheds. The continued investment in dryland farming, by the Moroccan government and USAID, without a balanced effort in the rangeland production sector, is a policy which heralds the deterioration and disappearance of more Moroccan rangeland. It is a program which will undoubtedly provoke dangerous ecological and economic consequences at the national level.

CHAPTER TWO: **APPLIED RESEARCH -- RANGE LIVESTOCK PRODUCTION**

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INTRODUCTION

Animal production activities of the Moroccan Range Management Improvement Project were organized into two components. The first component, the Producer Study, was a survey of local livestock producers' activities at project sites. The study was designed to gain an understanding of current management systems, production levels and available resources; to identify present and potential problems faced by livestock producers; and to provide an entree to permit the introduction of improved methods to producers. An understanding of current practices, resources, and production levels realized by livestock producers, more effectively ensured that recommendations addressing observed critical problems were appropriate for producers' operations.

The second component consisted of cooperative demonstration and applied research programs with producers. In general, these activities were geared towards finding a workable solution to a problem detected in the Producer Study (first component), or as a means to introduce new ideas and techniques to producers. Three areas to improve livestock production were investigated in the second component:

- the introduction of the short scrotum technique as a means of addressing the problem of indiscriminate breeding in Moroccan sheep flocks,

- a sheep classification and selection program as a method for eliminating defective animals from sheep flocks and increasing meat and wool production, and

- an investigation into more efficient use of the limited resources available to low income producers through alternative livestock management techniques.

PRODUCERS STUDY

The Producers Study consisted of interviews with, and observations of, selected livestock producers in order to obtain information on their management systems. Entire flocks owned by selected livestock producers were observed for management practices and general information on herd structure. Quantitative information was derived from subsamples drawn from each flock. Visits to producers' farms were made every four weeks to weigh animals and talk to producers. Intermediate visits were made as necessary. During interviews, flock locations, vegetation types grazed, kinds and quantities of supplemental feeds fed to the livestock, health care practices employed (both prophylactic and curative), and any other activities related to livestock management that had occurred since the previous visit were discussed. In the course of these interviews, information concerning replacement and culling criteria and related programs were gathered. It was also learned what livestock other than small ruminants were raised.

Information acquired through interviews would then be supported by observation of ongoing activities. People associated with livestock production, but not directly involved in the Producer Study, provided aid in keeping track of current livestock production activities and gave insights as to why certain management decisions were made.

The Producer Study design as originally conceived was altered as constraints were encountered. Technicians' work schedules were tight and their time limited. Therefore, in-depth investigations into the quality and quantity of available forage resources utilized and animal behavior were not possible. Rather, the effort was limited to recording kinds of forage grazed and general flock locations. Emphasis was placed on livestock operations and management decisions. The length of time available to conduct the study did not permit the collection of data with seasonal overlaps. Estimates had to be made to project production cycles over a calendar year.

Moroccan counterparts proved invaluable in the initiation of studies and in providing insights. However, counterparts rarely accompanied technicians on routine producer visits (an exception was in Beni Mellal where the Moroccan technicians actually conducted the study). Increased counterpart participation undoubtedly would have enhanced information exchange and the effectiveness of the data collection.

Though these constraints are acknowledged, the study did achieve its goal of providing a documented background understanding of Moroccan livestock production systems. Resources allocated to improve the livestock sector can now be more easily directed towards addressing critical problems that will be appropriate within a producer's operation.

Cooperation from producers involved was good. Working within the producers' systems to follow the animals' progress did have its drawbacks, but the benefits of the effort outweighed the negative aspects because it provided a clearer understanding of producers' attitudes and operations. Frustrations did occur. For example, tagged animals that were part of the sample occasionally disappeared, only to reappear in the next period without explanation.

Producers set aside time from their schedules to describe their systems and answer questions. Most producers aided in monitoring their animals and expressed an interest in weight fluctuations, having received copies of updated animal records during each visit. Technicians' advice and assistance was sought to overcome current problems from time to time. Field days on herd performance by TDY specialist, Dr. Jack Ruttle, were well received by producers. In addition, they participated in ram examinations and exchanged views on animal performance and care. The grading of wool generated less producer interest in some cases, though they readily conceded that kemp and hair was a negative factor effecting wool marketing. Nevertheless, the overall perception of producers' attitudes by Project staff is concern about livestock production problems and genuine interest in methods to overcome them. However, the final acceptance of new methods or suggestions that they invest their own capital, is generally tempered with caution on the part of the producers.

At the inception of the study, one objective was not only to determine the vegetation types grazed by a flock, but the

quantity and nutritional value of the forage available as well. Measures of forage quality and quantity could provide a reference for explaining why weight fluctuations occurred. Initially, plots were clipped and fodder shrub presence estimated to quantify the amount of forage available to herds. Because of time and other constraints, both quality and quantity measurements were dropped from the study shortly after its inception. For the same reasons, studies in animal behavior pertaining to diet selection and animal activity were also eliminated from the study. Facilities were not readily available to analyze forage quality, therefore, data analysis and interpretation centered on forage quantity estimates and existing forage quality information.

It became apparent early in the studies that no excess forage was available (continuous grazing often maintained vegetation height below a level at which it could be clipped). Diet selection was based on palatable plants present, and behavior was dictated by the herder, except during periods of high temperature when animals would cease searching for forage.

Further information that might have been gathered through the continuation of these studies did not warrant the time required to collect the data. Primary investigations did quantify the extreme conditions under which livestock are produced, and enabled technicians to examine the areas grazed. They were able to observe methods and daily procedures in herding the flocks.

During the fall of 1985, producers involved in the Producer Study had their sheep vaccinated against respiratory and gastrointestinal diseases, smallpox and enterotoxemia, and treated for parasites by the project. This activity was a demonstration of recommended health care practices and a display of appreciation for the producers' continued cooperation. As animals were treated, their sex and age were determined and recorded. Sex and age ratios were later established for each herd. The opportunity was also utilized to inquire further about producer attitudes towards animal health care and preventive health programs practiced.

A subsample of twenty ewe/lamb pairs was chosen from each producer's herd, identified with ear tags and monitored throughout the study. Lambs were monitored to establish growth rates and marketing tactics. Ewes were monitored for weight fluctuations throughout their reproductive cycles and for lambing frequency during the study. Lambs born to ewes in the subsample had their birth dates recorded, were weighed and ear tagged, and included in the subsample. Breeding dates were fixed by counting back from parturition dates. An effort was made to include lamb numbers that reflected sex and age proportions in the herd. Producers helped select the ewe/lamb pairs. The sample was probably biased towards higher producing animals as a result. One producer's herd contained less than the desired twenty ewe/lamb pairs so the entire herd was monitored. Ewes and lambs were weighed every twenty-eight days. Producers corral their sheep and goats at night without food or water. This management practice served as a shrink period prior to weight collections.

Wool quality and kemp presence were evaluated for ewes and lambs in the subsamples, and for breeding rams by Dr. Ruttle as part of an animal performance field day. Data from these animals

was used to indicate fleece quality in the producers' herds. Dr. Ruttle checked rams for epididymitis and collected and evaluated semen samples to identify ram fertility problems. Ewes in the subsample were also examined for udder development and fertility problems. Since presence of a lamb was criteria for selection into the subsample, detection of infertility in the ewes was not expected and none was found. Although herd structure information was recorded, no ewes were examined for fertility outside the study subsamples. An indication of ewe fertility was given in another program where fertility was included as a criteria for selection into a breeding herd.

The Producer Study met with various levels of success at the different project sites. Production levels and operation management information gathered for the Middle Atlas and the Moulouya Plain (Azrou and Midelt) was good, and provided insights into limitations and potential of livestock production there. No attempt was made to examine current practices in Oujda. However, in Oujda, a complementary study to determine a possible method to control indiscriminate breeding, and an extension program to improve herd performance through selection, were carried out with project guidance and assistance. At Beni Mellal, the efforts to investigate production systems produced mixed results. A summary of producers' management decisions and operations was written, but initial data on herd performance was limited. Since his return from short course training in the United States in August 1985, Mohamed Driouich (Ingenieur d'Application in Beni Mellal), collected reliable production data. Unfortunately, the available time remaining in the Producer Study was too short to allow complete data collection, thus limited conclusions have been drawn from it.

Producers participating in the Producer Study were not randomly selected, but were chosen to represent various segments of the livestock producer community. Producer willingness to cooperate during initial visits was also a major factor in final selection. To facilitate data collection and complete the study goals, it was more important to have willing participants than a statistically valid sample. When possible, the Project staff attempted to select producers who were also involved with the Project Agro-Pastoral Systems Study.

The results of the study are presented below. The results are segregated according to project sites to illustrate differences in livestock production that might occur across Morocco. A general description of the selected sample is given prior to results for each study site. If major differences occurred among producers within a site, these differences are noted. Given the method of sample selection and the limited sample size, the results are not statistically valid, but they do serve as indicators of sheep production and associated problems in areas surrounding project sites.

Current Livestock Production

Five producers participated in the study at Midelt. Categorized by relative wealth, four were considered to be in the middle income category and one was considered to be in the low income category for livestock producers in the region. All have access to communal land. Two of the four middle income producers were also permitted to graze at least a portion of their flocks for part of the year on Plaine de L'Aarid Perimeter. The four middle income producers owned, or had access to cropland, and utilized crop residues as a forage source. Producer land holdings ranged in size from 10 to 25 hectares. Crops varied between producers, but all produced wheat and barley. Barley was grown almost exclusively for livestock consumption. The low income producer did not have access to crop residues and in general, had limited resources for livestock production. Flock numbers reflected the two groups' resource bases. The middle income producers owned between two and three hundred sheep, and the low income producer had less than twenty. Results will be presented separately for the two income levels.

Herd Characteristics

Sheep comprise the bulk of livestock owned in the Midelt area (Figures 2.1 and 2.2). Goats, equines, and cattle are also present, but in much reduced numbers. The low income producer had roughly as many goats as sheep.

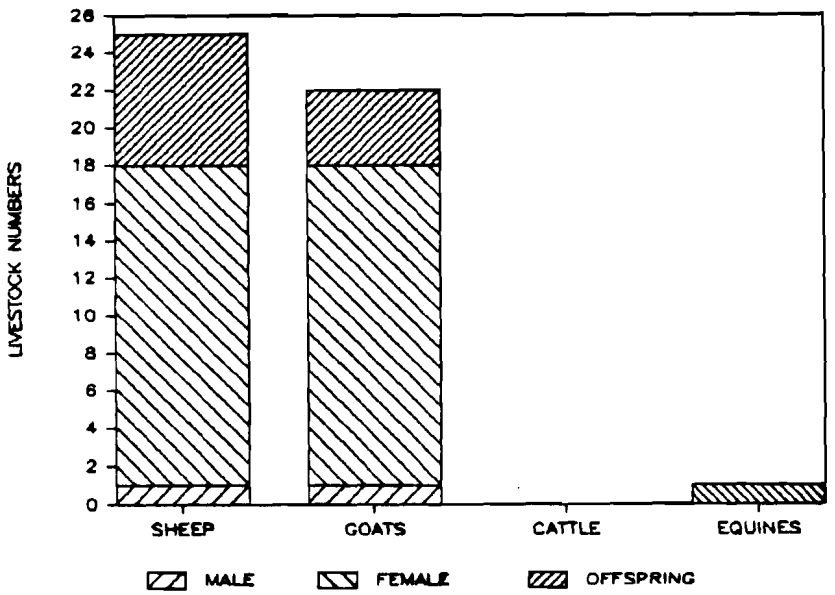

Figure 2.1. Livestock species, class, and number owned by the low income producer in the Midelt area sample.

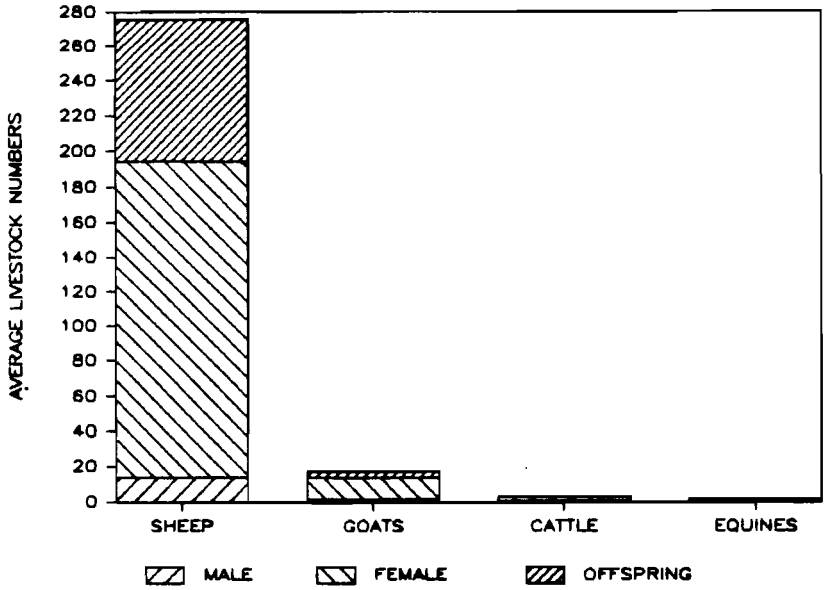

Figure 2.2. Livestock species, class, and average numbers owned by the middle income producers in the Midelt area sample.

Low numbers of three year old ewes present in sheep flocks in Midelt (Figures 2.3 and 2.4) may be attributed to the recent drought. A combination of low and middle income producers' herds provided a ram to ewe ratio averaging approximately 1:21. Rams remain with the ewes throughout the year. One producer, however, owned 28 yearling rams that were to be marketed and these were kept separately from the ewes. These speculation rams were included in the determination of ram age distribution, but not to calculate the ram to ewe ratio.

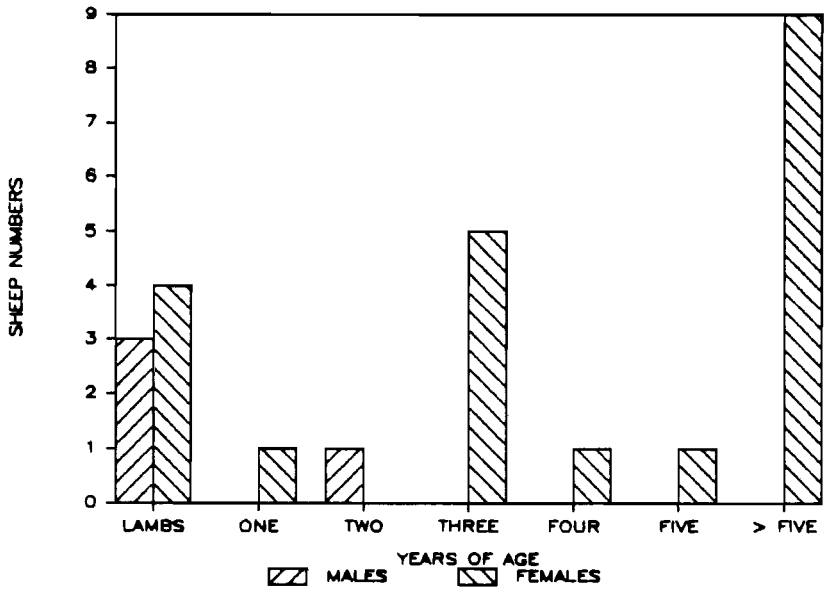

Figure 2.3. Age and sex distribution of sheep owned by the low income producer in the Midelt area sample.

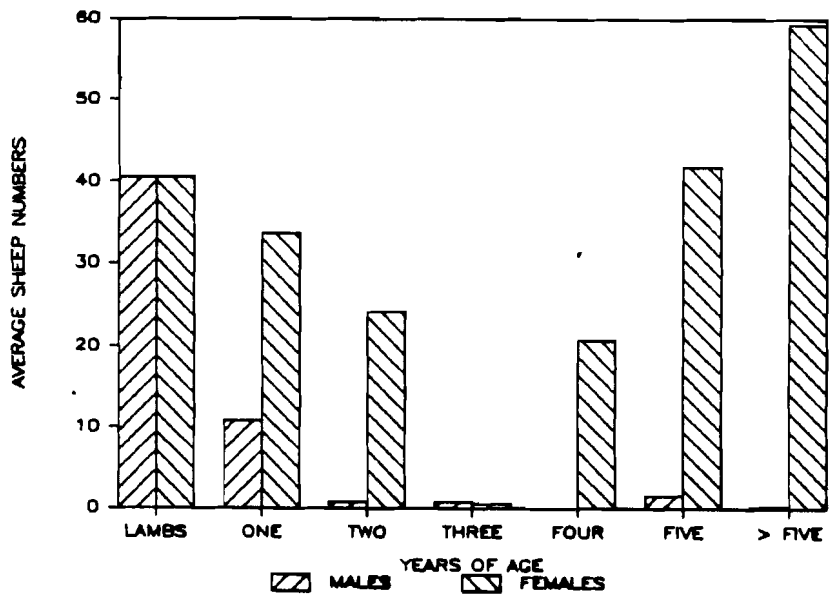

Figure 2.4. Average age and sex distribution of sheep owned by the middle income producers in the Midelt area sample.

The average weight for rams throughout the year in the Midelt area was 33.6 kg, the average weight for ewes throughout the year was 28.8 kg, and the average weights for ram lambs and ewe lambs at nine months of age were 26.7 and 21.0 kg, respectively.

Flock Movement and Management

In Morocco, sheep and goats are generally corralled at night. When animals are located near the producer's dwelling, the corral is generally an enclosed room. Predation is considered a possible problem. One kid, for example, was reported lost to a fox during the study.

All producers used communal land, keeping herds in areas dominated by sagebrush (*Artemisia herba-alba*) from spring to late fall, and moving the animals to alpha-grass (*Stipa tenacissima*) for winter forage. The low income producer, however, began to graze alpha-grass sites in early fall. Access to communal land was possible for all producers from their permanent dwellings. In addition, one producer rented rights to a mountain pasture (Tacksmiert), where he grazed his flock from late April until January. Generally, animals belonging to this producer are moved to Tacksmiert because of its abundant early season forage, and are returned to the area around his house when forage becomes scarce at Tacksmiert and severe weather imperils animal health. All the middle income producers had access to crop residues. Except for the producer whose sheep were moved to the mountain meadow, crop residues were utilized from June to August. Flocks spent most of the day grazing residues, and grazed native vegetation while moving between crop residue sites.

Two producers were allowed to graze animals on Plaine de L'Aarid Perimeter from June to December. Both of these producers took advantage of this right, except for a period in June and

July when one producer pulled his flock off the perimeter to graze crop residues. The other producer maintained a split herd with one flock on the perimeter and the other on crop residues.

The degree to which flocks are divided for management purposes depends heavily on labor availability. One producer combined his flocks in the fall because of a labor shortage resulting from his children returning to school. While rams are run with the ewes throughout the year, most producers separate lactating ewes from the herd to facilitate supplemental feeding programs. A few of the producers included late gestation ewes in this group. Often, young (less than one month old) and weak lambs were kept at the house during the day and returned to the ewes at night. The flock grazed together during the day and then the older lambs (5 months plus) were penned separately at night. The low income producer stated that the reason he did not wean his lambs prior to their being sold was because he felt that milk is a constant and free supplement for lambs (the literature indicates that the ewe is essentially dry 4 months after parturition, and the stress caused by the constant annoyance of the older lambs often causes ewes to fail to rebreed).

Barley was the most common form of supplemental feed and was used by all producers. Rates ranged from 0.2 to 0.5 kilograms per animal per day, depending upon forage availability and the producer. Other supplements fed to livestock included corn, corn stover, sugar beet pulp, alfalfa, straw and Cicalim (Cicalim is a commercially available protein supplement). Producers fed supplements to the entire herd beginning in December and continued until forage became more readily available in the spring. Lactating ewes and lambs were fed supplements earlier in the fall, as the decline in available forage dictated.

Natality, Mortality and Marketing

Lambs were born throughout the year, but there was a higher incidence of parturition during certain periods. Fall (October - early November), winter (early - mid December), and spring (mid January - early March) were noted as the most active lambing periods during the study. All ewes selected for the study subsample had lambs at the time they were selected. Information gathered in another study (Selection and Classification Program) indicated that approximately fifteen percent of the ewe herd could be expected to have reproductive problems and be incapable of producing a lamb. Since presence of a lamb was criteria to be selected for the subsample these infertile animals were not candidates to be included.

Fifty-seven percent of the lambs present at the initiation of the study were born in the Spring '85 period. Thirteen percent of the lambs were born in the Fall '84 period and thirty percent were born in the December '84 period. Ninety-three percent of the ewes in the subsample gave birth again during the study. Four percent of these second lambs were born within eight to ten months after the previous lamb. Fifty percent were born twelve months after the initial study lamb. Thirty-eight percent to as much as forty-five percent were born fourteen to sixteen months later, and one to a maximum of eight percent (if all ewes in the subsample lambed again) were born at least eighteen months after the first lamb. Numbers of second lambs born during the

spring, winter, and fall periods were in similar percentages as the original lambs. Percentages of ewes, whose original lambs were born in the spring, winter, and fall periods, that lambed again within a twelve month period were 46%, 3% and 82% by period, respectively (Table 2.1). The data indicate that only approximately half of the ewes in the subsample (the productive group) produced a lamb on an annual basis during the study. When the entire ewe population is considered, the percentage of ewes producing lambs on an annual basis was even lower. This low productivity is a major problem facing Moroccan livestock producers.

Table 2.1. Lambing intervals and number of lambs born during each interval in the Midelt area sample.

PAIRS BY PERIOD OF LAMBING AT COMMENCEMENT OF THE STUDY	EWE LAMBING INTERVAL DURING THE STUDY MONTHS 8	10	12	14	16	18	TOTALS
FALL - 84 13 PAIRS (13%)	0 (0%)	0 (0%)	6 (6%)	4 (4%)	2 (2%)	1 (1%)	13 (13%)
DECEMBER-84 30 PAIRS (30%)	0 (0%)	1 (1%)	0 (0%)	22 (22%)	2 (2%)	*	25 (25%)
SPRING - 84 57 PAIRS (57%)	2 (2%)	1 (1%)	44 (44%)	8 (8%)	*	*	55 (55%)
TOTALS 100 PAIRS (100%)	2 (2%)	2 (2%)	50 (50%)	34 (34%)	4*(4%)	1*(1%)	93 (93%)

() Percent of the number of ewe-lamb pairs is shown in parentheses.
* The study ended prior to these lambing intervals.

Information on expected animal death loss percentage was acquired through interviews with the producers. The middle income producers reported that approximately three percent of the breeding herd and seven percent of the lambs (less than nine months of age) died annually. The low income producer said that losses varied with the availability of forage, but that death losses could be expected to be as high as thirty percent of the breeding herd and fifty percent of the lambs annually during a harsh year. Infertile ewes, low annual lambing rates, and death losses combined to produce a limited lamb crop for the Midelt region. The lamb crop, calculated as the number of lambs raised to a marketable age annually divided by the number of ewes in the breeding herd, was determined to be 42% for the middle income producers and 35% for the low income producer in the Midelt sample.

The majority of the middle income producers' lambs that were sold from the subsample were born during the Winter '84 and Spring '85 periods, and sold during July and August, 1985. That period corresponded to Aid El Kbir when prices generally rise. One producer sold 5 one year old rams per week between late June and late August to benefit from the price increase. Smaller numbers of animals were sold throughout the remainder of the year, as income was required. As a result of high lamb death loss (Table 2.2), and the need to replace lost ewes to maintain herd size, the low income producer did not sell or slaughter any animals during the period in which the study was conducted.

Table 2.2. Distribution of sales, slaughters and deaths of lambs and ewes in the Midelt area sample. [Numbers of animals are shown by data collection periods (28-day intervals). The study began April 4, 1985 and ended March 6, 1986.]

		LOW INCOME PRODUCER IN MIDELT AREA PERIODS LAMBS WERE BORN							
STUDY PERIOD	ACTIVITY	FA-84 (0)	WI-84 (1)	SP-85 (4)	SU-85 (1)	FA-85 (6)	WI-85 (0)	SP-86 (5)	EWES (17)
FIRST	DIED		0	0	0	0		0	0
	SOLD		0	0	0	0		0	0
	ABATTOIR		0	0	0	0		0	0
SECOND	DIED		0	0	0	0		0	0
	SOLD		0	0	0	0		0	0
	ABATTOIR		0	0	0	0		0	0
THIRD	DIED		0	0	0	0		0	0
	SOLD		0	0	0	0		0	0
	ABATTOIR		0	0	0	0		0	0
FOURTH	DIED		0	0	0	0		0	0
	SOLD		0	0	0	0		0	0
	ABATTOIR		0	0	0	0		0	0
FIFTH	DIED		0	1	0	0		0	0
	SOLD		0	0	0	0		0	0
	ABATTOIR		0	0	0	0		0	0
SIXTH	DIED		0	0	0	0		0	0
	SOLD		0	0	0	0		0	0
	ABATTOIR		0	0	0	0		0	0
SEVENTH	DIED		0	0	0	0		0	0
	SOLD		0	0	0	0		0	0
	ABATTOIR		0	0	0	0		0	0
EIGHTH	DIED		0	0	0	0		0	0
	SOLD		0	0	0	0		0	0
	ABATTOIR		0	0	0	0		0	0
NINTH	DIED		0	0	0	0		0	0
	SOLD		0	0	0	0		0	0
	ABATTOIR		0	0	0	0		0	0
TENTH	DIED		0	0	0	0		0	0
	SOLD		0	0	0	0		0	0
	ABATTOIR		0	0	0	0		0	0
ELEVENTH	DIED		0	0	0	0		0	0
	SOLD		0	0	0	0		0	0
	ABATTOIR		0	0	0	0		0	0
TWELTH	DIED		0	0	0	0		0	0
	SOLD		0	0	0	0		0	0
	ABATOIR		0	0	0	0		0	0

		MIDDLE INCOME PRODUCERS IN MIDELT AREA PERIODS LAMBS WERE BORN							
STUDY PERIOD	ACTIVITY	FA-84 (13)	WI-84 (30)	SP-85 (57)	SU-85 (0)	FA-85 (11)	WI-85 (23)	SP-86 (28)	EWES (100)
FIRST	DIED	0	0	0		0	0	0	0
	SOLD	0	0	0		0	0	0	0
	ABATTOIR	0	0	0		0	0	0	0
SECOND	DIED	0	0	0		0	0	0	0
	SOLD	0	0	0		0	0	0	0
	ABATTOIR	0	0	0		0	0	0	0
THIRD	DIED	0	1	0		0	0	0	0
	SOLD	0	0	0		0	0	0	0
	ABATTOIR	0	0	0		0	0	0	0
FOURTH	DIED	0	0	0		0	0	0	0
	SOLD	0	2	0		0	0	0	0
	ABATTOIR	0	0	0		0	0	0	0
FIFTH	DIED	0	1	0		0	0	0	0
	SOLD	0	5	1		0	0	0	1
	ABATTOIR	0	0	0		0	0	0	1
SIXTH	DIED	0	0	0		0	0	0	0
	SOLD	0	22	0		0	0	0	2
	ABATTOIR	0	1	0		0	0	0	0
SEVENTH	DIED	0	2	0		0	0	0	0
	SOLD	0	1	1		0	0	0	0
	ABATTOIR	0	0	0		0	0	0	0
EIGHTH	DIED	0	0	0		0	0	0	0
	SOLD	0	0	1		0	0	0	0
	ABATTOIR	0	0	0		0	0	0	0
NINTH	DIED	0	0	0		0	0	0	0
	SOLD	0	0	0		0	0	0	0
	ABATTOIR	0	0	0		0	0	0	0
TENTH	DIED	0	0	0		0	0	0	0
	SOLD	3	1	2		0	0	0	0
	ABATTOIR	0	0	0		0	0	0	0
ELEVENTH	DIED	0	0	0		0	0	0	0
	SOLD	0	0	0		0	0	0	0
	ABATTOIR	0	0	0		0	4	0	0
TWELTH	DIED	0	0	0		0	0	0	0
	SOLD	0	0	0		0	0	0	0
	ABATOIR	0	0	0		0	0	0	0

(Maximum number of animals in the subsample present for each category is shown in parentheses.)

Health Care

During the study, producers relied heavily on the health care provided by the Project. It is not known what practices would have been followed if the Project program had not been available. Treatment dates, treatments, and dosages provided the producers' sheep and goats were:

September	1985	Valbazen	(2.5 ml/kg of bodyweight)
October	1985	Enterovac	(adults and older lambs - 2 ml; less than 3 months - 1 ml)
November	1985	Ovipox	(0.5 ml to animals over 3 months)
February	1986	Valbazen	(2.5 ml/kg of bodyweight)

Sheep that were moved onto Plaine de l'Aarid Perimeter received Enterovac in June 1985. This treatment is required for all animals that use the perimeter and is provided at no cost to the producer. Two of the middle income producers provided other treatments at their own expense. One producer administered Panicur to his sheep for what he described as stomach problems in August, and the other producer treated his animals with Coglovax 8 in June and with Ranide in August. The low income producer treated his lambs and kids twice in January with Enterovac and Combiotic D to treat diarrhea. Death losses were high due to this illness. A list of medicines and their uses is shown in Table 2.3.

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Table 2.3. Medicines administered to sheep and goats owned by producers in the Producer Study.

NAME	TREAMENT FOR	TREATMENT MEANS	PREVENTIVE /CURATIVE
ANTELVETE	Lung Parasites	Oral	C
COGLOVAX 8	Enterotoxemia	Injection	P
COMBIOTIC D	Antibiotic	Injection	C
ENTEROVAC	Enterotoxemia	Injection	P
ENTEROVAL	Enterotoxemia	Injection	P
EXHELM II	Internal Parasites	Oral	C
MATELVELE	Enterotoximia	Injection	P
MULTIVAC	Enterotoxemia	Injection	P
OVIPOX	Smallpox	Injection	P
PANICUR	Gastrointestinal/Resp. Parasites	Oral	C
RANIDE	Internal Parasites	Oral	C
RANIZOLE	Internal Parasites	Oral	C
VALBAZEN	Internal Parasites	Oral	C

Ram Fertility

During the course of the study in the Midelt region, nineteen rams were checked for fertility problems. Three of the nineteen rams (15.8%) were sterile. Two of these (10.5% of the rams examined) had epididymitis. Five other rams (26.3%) were considered to be of marginal fertility with low sperm motility (50 - 75% motility) and slow movement and/or poor sperm concentration. Eleven (57.9%) of the rams checked were sound with motility at 80 to 90 percent, and with good movement and sperm concentration.

Replacement and Cull Animals

Three of the five producers in the study selected young female lambs as replacement ewes based primarily on the criteria of survivability. The other two indicated that overall appearance influenced their choice with weak lambs being eliminated. One producer said thickness of tail and amount of meat on the backbone, signs of a healthy animal, were the criteria he used. As a result of these selection criteria, and a desire to increase herd size, most female lambs were kept and placed in the breeding herd.

Age appeared to be the chief criteria for culling animals. Weak animals may first be given supplements to improve their vigor, and if improvement does not occur, they are sold. One producer listed his criteria for culling animals as age, lamb production, health, appearance, condition of teeth, and eating habits. Culled animals are usually sold at the local souk (market). Few if any producers weigh animals or keep written records.

Weight Gains for Ewes and Lambs

Ewes showed a tendency to gain weight during the period from

April through June and to lose weight during the other months. Weight fluctuations reflected the availability of forage. Contrary to what might be expected, ewes often lost weight throughout gestation (Figures 2.5 and 2.6). This nutritional problem no doubt at least partially explains why reproductive rates and weaned lamb production are so low. In addition, internal parasite load tends to amplify the problem.

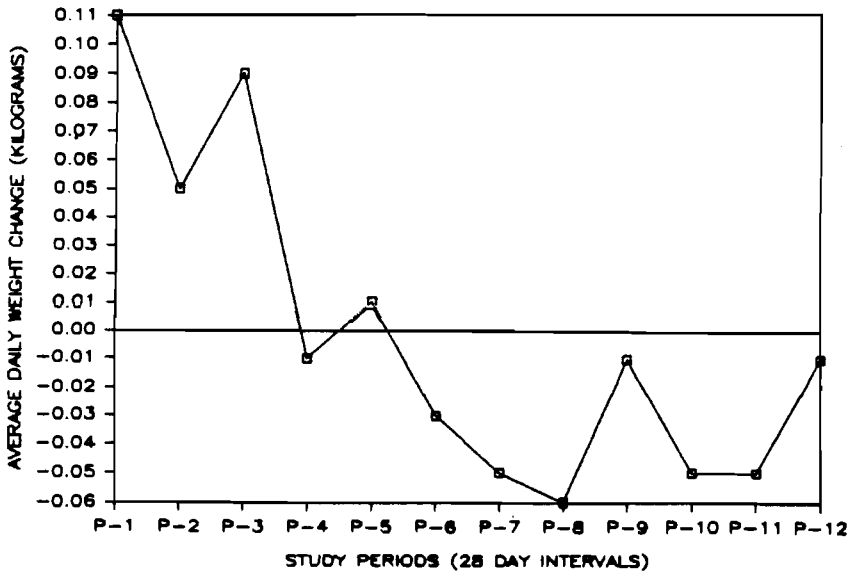

Figure 2.5. Average daily weight change during twelve, 28-day periods for ewes owned by the low income producer in the Midelt area sample.

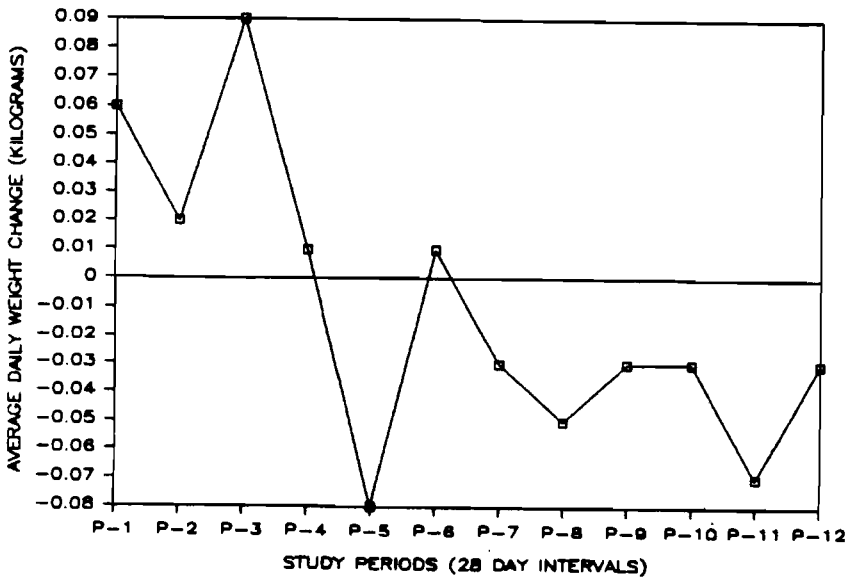

Figure 2.6. Average daily weight change during twelve, 28-day periods for ewes owned by the middle income producers in the Midelt area sample.

Weight changes were similar for both low and middle income producers' lambs though lambs belonging to the middle income producers were generally larger.

The original study lambs gained weight from the study inception until June. Weight gains stabilized from June to December, and then weights declined until February when slight gains were again seen. The low income producer had a summer lamb which failed to gain much weight after the first two months (a point when the ewe probably had little if any milk) and was soon surpassed by fall lambs. New lambs born to the ewes included in the subsample (fall, winter and spring periods) all showed gains during the study (Figures 2.7 and Fig. 2.8).

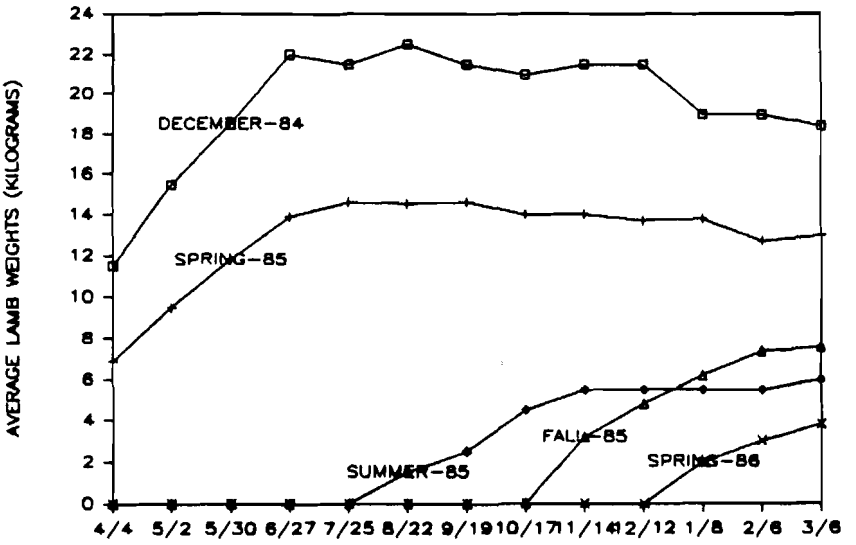

Figure 2.7. Average weights of lambs owned by the low income producer in the Midelt area sample (~28-day intervals; April 4, 1985 through March 6, 1986).

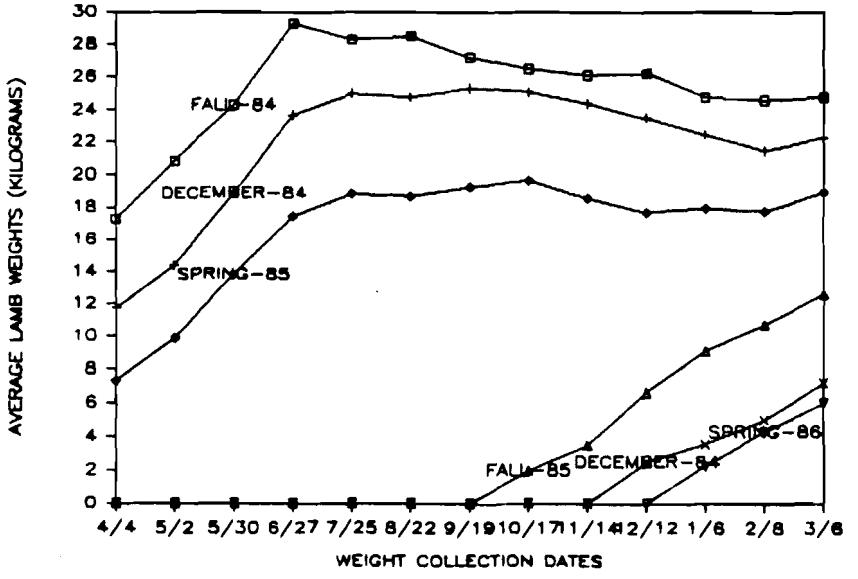

Figure 2.8. Average weights of lambs owned by the middle income producers in the Midelt area sample (~28-day intervals; April 4, 1985 through March 6, 1986).

Wool Production

Sheep were shorn in the Midelt region from mid May to late June. These periods corresponded to just before and after Ramadan. Average raw fleece weight was approximately 1.5 kg per ewe and 2.5 kg per ram, or about 1.6 kg per breeding animal.

Only ewe-lamb pairs in the subsample and rams were evaluated for wool quality and kemp presence. Spinning count wool grades ranged from 40 to 56 for the ewes and lambs (a spinning count of 50 is considered the lower limit of the fine wools). Ewes were evenly spread between the 40, 44, 50 and 54 grades. The majority of lambs and all of the rams fell in the 40 and 44 grade ranges. Kemp was present on 26% of the ewes (Table 2.4), 34% of the lambs (Table 2.5), and 36% of the rams (Table 2.6). No difference in wool quality was observed between the low and middle income producers' sheep. Therefore, the results were aggregated to present the results.

Table 2.4. Ewe wool quality and presence of kemp in the Midelt area sample (0 is no kemp and ++ is abundant).

KEMP RANKING	WOOL GRADES 40	42	44	46	48	50	52	54	56	TOTAL ANIMALS
++	0	0	0	0	0	0	0	0	0	0
+	5	0	1	0	0	0	0	0	0	6
-	8	0	4	0	0	8	0	5	0	25
0	16	0	30	1	1	21	0	17	2	88
TOTAL ANIMALS	29	0	35	1	1	29	0	22	2	119

Table 2.5. Lamb wool quality and presence of kemp in the Midelt area sample (0 is no kemp and ++ is abundant).

KEMP RANKING	WOOL GRADES 40	42	44	46	48	50	52	54	56	TOTAL ANIMALS
++	3	0	0	0	0	0	0	0	0	3
+	1	0	1	0	0	0	0	0	0	2
-	23	0	7	0	0	0	0	0	0	30
0	46	0	11	1	0	6	0	3	1	68
TOTAL AMIMALS	73	0	14	1	0	6	0	3	1	103

Table 2.6. Ram wool quality and presence of kemp in the Midelt area sample (0 is no kemp and ++ is abundant).

KEMP RANKING	WOOL GRADES 40	42	44	46	48	50	52	54	56	TOTAL ANIMALS
++	0	0	0	0	0	0	0	0	0	0
+	1	0	0	0	0	0	0	0	0	1
-	3	0	0	0	0	0	0	0	0	3
0	6	0	1	0	0	0	0	0	0	7
TOTAL ANIMALS	10	0	1	0	0	0	0	0	0	11

The majority of wool produced is kept for domestic use (blankets, sleeping pads, djellabas). Only one producer regularly sells wool, selling half and keeping half for domestic use. Wool sold was marketed at local souks. Another producer indicated that he sold wool when he had extra, and felt the quality was sufficiently good to draw a high price. He judged quality by weight, the heavier the fleece the higher the price. When wool is sorted in the souks prior to being resold, weight is often used as the criteria for quality.

Current Livestock Production

Three producers participated in the Producer Study at Timahdite (Azrou). Categorized according to wealth and resources, all three producers would be considered to be in the middle income range for the Timahdite region. All had access to communal land, owned and leased cropland, and utilized crop residues as a forage source. The size of the land holdings ranged from 20 to 53 ha of dryland, and 9 to 71 ha of irrigated cropland. All producers grew wheat and barley. Areas planted to wheat in 1985 ranged from 8 to 12 ha. Land planted to barley which was grown primarily for livestock consumption ranged from 10 to 14 ha. Flocks owned by producers in the Producer Study ranged in size from 215 to 349 sheep in the fall of 1985.

Herd Characteristics

Sheep account for most of the livestock in the Timahdite region (Figure 2.9). Goats, equines, and cattle are also owned, but in considerably smaller numbers. Numbers of animals for each age group are fairly consistent for both sexes (Figure 2.10). Although, by animal number count, the ram to ewe ratio is approximately one to twenty-nine, the producers claim that during the breeding season the ratio is one ram for every 32 to 40 ewes. Rams remain with the ewes throughout the year.

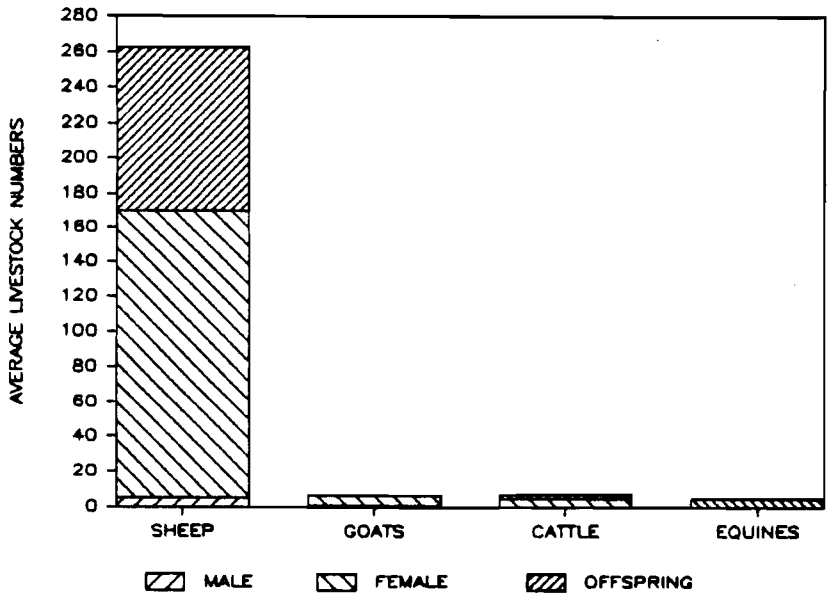

Figure 2.9. Livestock species, class, and average numbers owned by the producers in the Timahdite area sample.

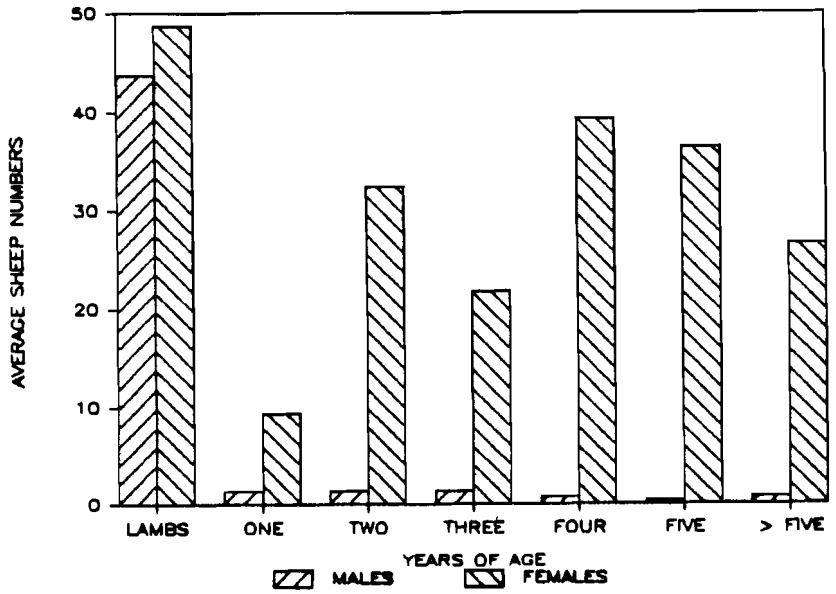

Figure 2.10. Average age and sex distribution of sheep owned by the producers in the Timahdite area sample.

The average weight for rams throughout the year in the Timahdite region was 34.7 kg, the average weight for ewes was 29.9 kg, and the average weight for ram lambs and ewe lambs at nine months of age were 23.6 and 21.6 kg, respectively.

Flock Movement and Management

Sheep are corralled at night in an enclosed area next to or in the producer's house, or in a corral constructed next to the herder's tent. From April through July, the producers kept their sheep at their houses and grazed communal land within a 3 to 5 kilometer radius. In August the flocks were split, with lactating ewes and old, poor condition ewes being kept at the house, fed supplements, and allowed to graze crop residues. The lambs were separated from the ewes during the day and placed with the ewes at night. As the lambs developed they were selected on an individual basis to graze with the ewes. Weaned spring lambs were often kept with this herd. The other animals were moved away from the house and corralled next to tents.

During the study, two of the producers herded their flocks away from the house on crop residues. They had moved their sheep in order to have easier access to the fields. The third producer moved his animals to a mountain range in order to take advantage of sagebrush and thymus (*Thymus capitatus*) range that was still relatively high in forage availability. The mountain range was depleted by early August and the flock was returned to the house to join the other sheep on crop residues. In late fall, the producers returned their herds to communal land and grazed the regrowth of native vegetation. Late gestating and lactating ewes were kept separate from the rams, dry ewes, and older lambs. From January through March, the animals were kept indoors at night, fed supplements and allowed to graze communal land, as weather permitted.

Rams received approximately 0.4 kg of barley per day throughout the year. Salt blocks are available year round in the corrals. Starting in late summer, spring lambs and old ewes are fed supplements. The rates and kinds of supplements fed varied among producers. For example, one producer fed lambs alfalfa free choice and 0.16 kg of Granulant 90 (Granulant 90 is a commercially prepared protein supplement) per lamb per day with some barley. Another producer fed only those lambs that were eventually to be sold daily rations of 0.1 kg of barley and 0.2 kg of Cicalim per animal. Old ewes received 0.2 kg of barley each day. The third producer fed lambs and old ewes 0.2 kg of barley per head per day. As the producer prepared to sell the old ewes, he would increase their barley ration to 0.8 kg/day. In late fall, all of the producers began to feed those ewes that had lambs 0.15 to 0.3 kg of barley per ewe per day. Once the weather became severe, producers supplied hay to the entire herd.

Natality, Mortality and Marketing

The producers reported that most lambs were born between October and November, or between March and May, though lambs could be born at any time during the year. As in the Midelt area, all ewes selected to be in the study subsample had lambs at the time that they were tagged. Twenty-five percent of the initial lambs were born in the fall period (October - November), 27% of the lambs were born in the winter period (December - early January) and the remaining 48% in the spring period (March - May). Eighty-seven percent of the ewes in the subsample produced lambs again during the study. Forty-five percent of the ewes lambed within six to ten months of their previous lamb. Thirty-two percent lambed twelve months after the initial study lamb. Ten percent to as many as 23% lambed fourteen to sixteen months post the first lamb, and one to a maximum of 15% (if all ewes in the subsample lambed again) lambed at least eighteen months after their previous lamb. Percentages of ewes whose original lambs were born in the fall, winter, and spring periods, that lambed again within a twelve month period, were 71%, 68% and 83% by period, respectively (Table 2.7).

Table 2.7. Lambing intervals and number of lambs born during each interval in the Timahdite area sample.

PAIRS BY PERIOD OF LAMBING AT COMMENCEMENT OF THE STUDY		EWE LAMBING INTERVAL DURING THE STUDY MONTHS 6	8	10	12	14	16	TOTALS
FALL - 84	14 PAIRS (23%)	0 (0%)	4 (7%)	0 (0%)	6 (10%)	2 (3%)	1 (2%)	13 (22%)
WINTER-84	16 PAIRS (27%)	1 (2%)	0 (0%)	6 (6%)	4 (7%)	3 (5%)	*	14 (23%)
SPRING-85	30 PAIRS (50%)	0 (0%)	12 (20%)	4 (7%)	9 (15%)	*	*	25 (42%)
TOTALS	60 PAIRS (100%)	1 (2%)	16 (27%)	10 (17%)	19 (32%)	5*(8%)	1*(2%)	52 (87%)

() Percent of the number of ewe-lamb pairs is shown in parentheses.
* The study ended prior to these lambing intervals.

The Timahdite producers reported that approximately 4% of the breeding herd died annually, and that an annual lamb death loss of approximately 9% could be expected. The lamb crop was estimated to be 57% for the producers in the Timahdite sample.

Lambs are primarily sold between June and November. Older lambs are sold first. Old, and a few young ewes, with or without a lamb, are sold between August and October. Livestock will also be sold throughout the year, as the producer's need for additional income dictates. One producer felt that prices for animals were directly related to available forage. Speculation on Aid El Kbir is also a factor affecting the sale of lambs. One producer saved most of his male lambs in order to sell them when prices were high prior to Aid El Kbir. Another producer bought spring lambs in May and sold them in August prior to the festival (Table 2.8).

Table 2.8. Distribution of sales, slaughters, and deaths of lambs and ewes in the Timahdite area sample. [Numbers of animals are shown by data collection periods (28 day intervals). The study began April 6, 1985 and ended February 11, 1986.]

		MIDDLE INCOME PRODUCERS IN AZROU AREA PERIODS LAMBS WERE BORN							
STUDY PERIOD	ACTIVITY	FA-84 (14)	WI-84 (12)	SP-85 (30)	SU-85 (5)	FA-85 (17)	WI-85 (13)	SP-86 (3)	EWES (60)
FIRST	DIED	0	0	0	0	0	0	0	0
	SOLD	0	0	0	0	0	0	0	1
	ABATTOIR	0	0	0	0	0	0	0	0
SECOND	DIED	0	1	0	0	0	0	0	0
	SOLD	0	0	0	0	0	0	0	0
	ABATTOIR	0	0	0	0	0	0	0	0
THIRD	DIED	0	0	0	0	0	0	0	0
	SOLD	0	0	0	0	0	0	0	1
	ABATTOIR	0	0	0	0	0	0	0	0
FOURTH	DIED	0	0	0	0	0	0	0	0
	SOLD	0	1	2	0	0	0	0	2
	ABATTOIR	0	0	0	0	0	0	0	0
FIFTH	DIED	0	0	0	0	0	0	0	0
	SOLD	6	0	2	0	0	0	0	3
	ABATTOIR	0	0	0	0	0	0	0	0
SIXTH	DIED	0	0	0	0	0	0	0	0
	SOLD	1	1	0	0	0	0	0	3
	ABATTOIR	0	0	0	0	0	0	0	0
SEVENTH	DIED	0	0	0	0	0	0	0	0
	SOLD	0	0	0	0	0	0	0	3
	ABATTOIR	0	0	0	0	0	0	0	0
EIGHTH	DIED	0	0	0	0	0	0	0	0
	SOLD	1	0	2	0	0	0	0	0
	ABATTOIR	0	0	0	0	0	0	0	0
NINTH	DIED	0	0	0	0	0	0	0	0
	SOLD	0	0	0	0	0	0	0	0
	ABATTOIR	0	0	0	0	0	0	0	0
TENTH	DIED	1	0	0	0	0	0	0	0
	SOLD	0	0	0	0	0	0	0	0
	ABATTOIR	0	0	0	0	0	0	0	0
ELEVENTH	DIED	0	0	0	0	0	0	0	0
	SOLD	0	0	0	0	0	0	0	0
	ABATTOIR	0	0	0	0	0	0	0	0

(Maximum number of animals in the subsample present for each category is shown in parenthesis.)

Health Care

One producer belonged to the local ANOC (National Sheep and Goat Association) and received health care for his animals

through their program. The ANOC animal health program is designed to prevent diseases and control parasites that are inherent in sheep. Treatment dates and treatments provided by ANOC to the producers' sheep and goats that were in their program were:

May,	1985	Panicur
		Matelvele
		Coglovax
September,	1985	Ranizole
		Valbazen
November,	1985	Enteroval
February,	1986	Valbazen

The producers not in the ANOC program purchased medicine as required. Veterinarians from Azrou routinely examine their animals and prescribe treatments. One producer administered Panicur throughout the year to sick and poor condition animals and to 3 to 6 month old lambs. Treatment dates and treatments administered to sheep and goats belonging to the producers outside of ANOC were:

1)	June,	1985	Multivac
			Antelvete
	September,	1985	Valbazen
	February,	1986	Valbazen
2)	May,	1985	Panicur
	June,	1985	Exhelm II
	September,	1985	Valbazen
	October,	1985	Enterovac
	March,	1986	Valbazen

Refer to Table 2.3 for a list of medicines and their uses.

Ram Fertility

Thirteen of the rams in the Timahdite area were examined for fertility problems. Two of these (15%) were sterile, and one (7.5%) had epididymitis. Two rams (15%) were marginal with average sperm motility (80 to 85%) and good to excellent movement but poor sperm concentration. Nine (70%) of the rams checked were sound, with motility of 90 to 95 percent, with good to excellent sperm movement and concentration.

Replacement and Cull Animals

Replacement ewes are selected from within the flock according to phenotype, (the preferred being that of the Timahdite breed) and size. Approximately 25-30% of the female lamb crop is retained for replacement of ewes in the flock. Additional ewes, usually two to three years old, are purchased if they are considered inexpensive, if adequate forage is available and if their phenotype is acceptable.

Old age is the primary reason for culling animals. If a ewe is sick or thin, she may be sold along with her lamb. Ewes are culled if they have not had a lamb in two years, have lost

considerable weight or if their phenotype is unacceptable. Few if any producers weigh animals or keep written records. Producer members of ANOC are provided record keeping assistance through that organization. Unfortunately, ANOC has been using only phenotype as the selection criterion for replacement. Culled animals are sold at the local souks.

Weight Gains for Ewes and Lambs

The ewes in the study decreased in weight from April through June. Generally the ewes either continued to lose weight or their weight stabilized during the rest of the year. Ewes often lost weight throughout gestation (Figure 2.11).

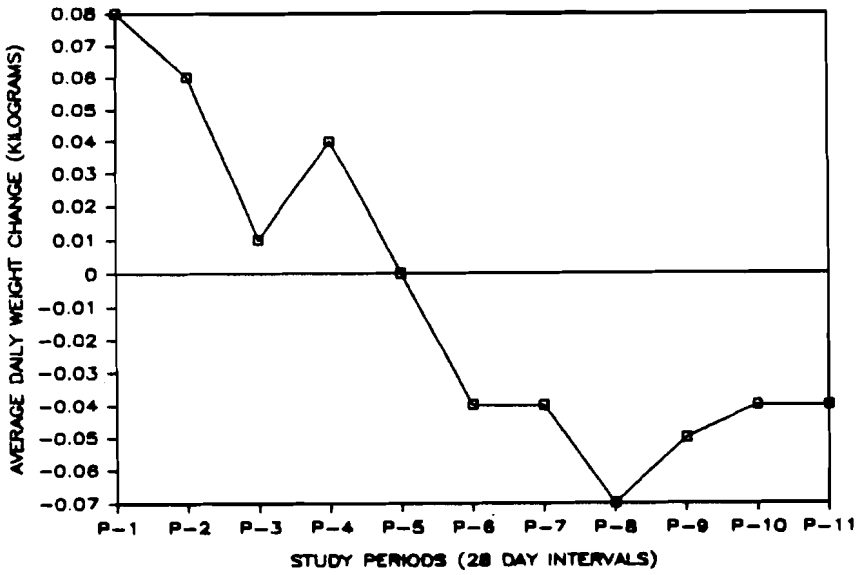

Figure 2.11. Average daily weight change during eleven, 28-day periods for ewes owned by producers in the Timahdite area sample.

The fall and winter lambs that were born prior to the onset of the study gained weight from the study inception until June or July. After these initial gains, the lambs lost weight until the end of the study. Lambs born in May '85 gained weight through December, then lost weight in January and February. Fall '85 lambs also gained weight through December, lost weight in early January, then weights stabilized. During the short period that new winter lambs were monitored, they gained weight, though not as rapidly as their spring and fall counterparts during their first three months post parturition. Reductions in lamb weights generally corresponded to reduced forage availability and/or reduced milk production by the ewe (Figure 2.12).

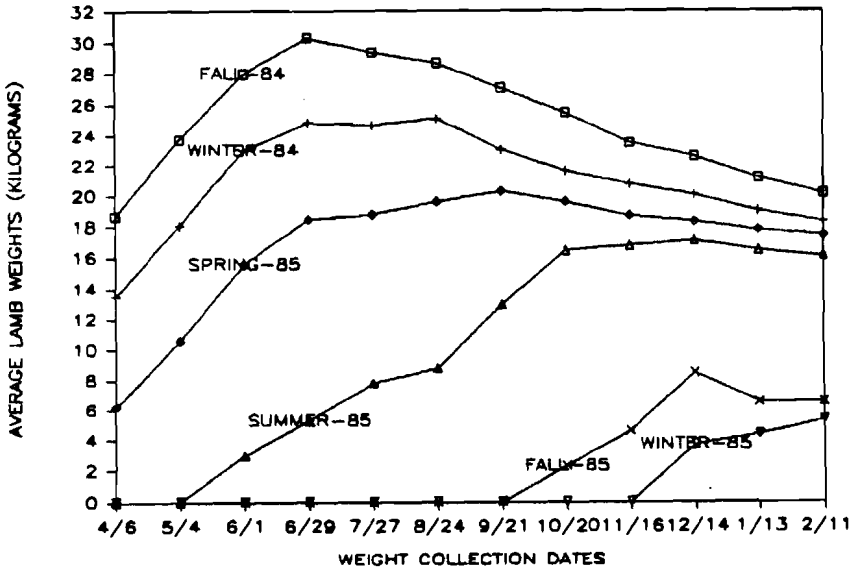

Figure 2.12. Average weights of lambs owned by the producers in the Timahdite area sample (~28-day intervals; April 6, 1985 through February 11, 1986).

Wool Production

Sheep were shorn in the Timahdite region from mid May to mid June. The average raw fleece weight for breeding animals was approximately 1.6 kg. The total production of wool that producers realized from their sheep flocks varied between 189 to 422 kg, depending on the number of animals owned.

Only ewe-lamb pairs in the subsample and rams were evaluated for wool quality and kemp presence. Wool grades ranged from 40 to 50 for the ewes. The majority of the ewes, and all the lambs and rams fell in the 40 and 44 grade range. Kemp presence was found on 17% of the ewes (Table 2.9), 8% of the lambs (Table 2.10), and 27% of the rams (Table 2.11).

Table 2.9. Ewe wool quality and presence of kemp in the Timahdite area sample (0 is no kemp and ++ is abundant).

KEMP RANKING	WOOL GRADES 40	42	44	46	48	50	52	54	56	TOTAL ANIMALS
++	0	0	0	0	0	0	0	0	0	0
+	1	0	4	0	0	0	0	0	0	5
-	4	0	1	0	0	0	0	0	0	5
0	31	0	15	1	0	1	0	0	0	48
TOTAL ANIMALS	36	0	20	1	0	1	0	0	0	58

Table 2.10. Lamb wool quality and presence of kemp in the Timahdite area sample (0 is no kemp and ++ is abundant).

KEMP RANKING	WOOL GRADES 40	42	44	46	48	50	52	54	56	TOTAL ANIMALS
0	0	0	0	0	0	0	0	0	0	0
-	2	0	0	0	0	0	0	0	0	2
+	3	0	0	0	0	0	0	0	0	3
++	40	0	14	0	0	0	0	0	0	48
TOTAL ANIMALS	45	0	14	0	0	0	0	0	0	58

Table 2.11. Ram wool quality and presence of kemp in the Timahdite area sample (0 is no kemp and ++ is abundant).

KEMP RANKING	WOOL GRADES 40	42	44	46	48	50	52	54	56	TOTAL ANIMALS
++	0	0	0	0	0	0	0	0	0	0
+	0	0	0	0	0	0	0	0	0	0
-	2	0	1	0	0	0	0	0	0	3
0	6	0	2	0	0	0	0	0	0	8
TOTAL ANIMALS	8	0	3	0	0	0	0	0	0	11

Wool was kept to be used in the home to make wool products and sold. The wool that was sold, was marketed at local souks and brought 12.5 to 20 DH per fleece. ($1.00 US was approximately equivalent to 9 Moroccan Dirhams; April, 1986.)

Current Livestock Production

Four producers participated at various times in the study at Beni Mellal. Only one participated from the inception of the study until the conclusion. At the study outset, two producers were involved. One dropped out after a few months and two new producers agreed to participate (the maximum number of producers to participate at any given time was three). The majority of the information presented in the report was derived from the three producers involved at the conclusion. The producer who cooperated throughout the study was considered fairly wealthy, while the other two producers were at low income levels.

Only the wealthy producer was in the business of fattening lambs for sale. He had more resources than the other two in terms of land and money, and therefore was capable of investing more in his livestock. The two low income producers were herders in an association relationship, that is, herding sheep which for the most part belonged to someone else. They provided the access to the perimeter, being right-users, and received a share of the production as payment. They sold animals when they needed money and bought sheep if they had surplus cash.

Herd Characteristics

The average age of sheep flocks in the Beni Mellal region was relatively old. This was exemplified by low numbers of one and two year old ewes (Figure 2.13), and may be attributed to the recent drought. The ram to ewe ratio is approximately 1:40. One producer, however, had fourteen yearling rams in his flock to be sold. Since they were to be sold, their numbers were not included in the calculations for the ram to ewe ratio. Rams remained with the ewes throughout the year.

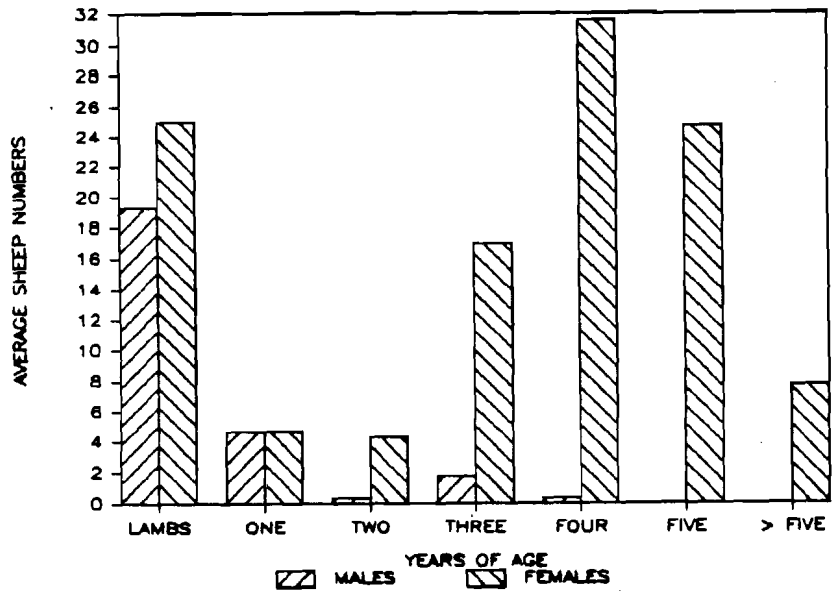

Figure 2.13. Average age and sex distribution of sheep owned by producers in the Beni Mellal area sample.

Flock Movement and Management

All three producers grazed their animals on the Ait Rbaa Perimeter from November to May. Following the harvest, animals returned to the producers' farms and grazed crop aftermath throughout the summer. Ait Rbaa Perimeter is the only collective rangeland area remaining in the region for producers to utilize. The area is used by some as a place to feed animals supplements while wheat and barley crops are grown on the private land resources. However, many people with the right to use the perimeter prefer not to do so, and keep their animals in other areas rather than incur the cost of hauling supplements and water to animals on the perimeter. One of the low income producers leased cropland on which to graze his animals during the summer. It is a common practice to rent fallow fields or harvested wheat or barley fields to serve as a source of forage. Often livestock remain around the house, grazing what forage they can find and are fed supplements until returned to the perimeter in November. Livestock in the area are generally not separated into different herds to allow for any intensive animal management practices.

One of the low income producers made no distinction between age or sex when supplementing animal diets. He fed barley, bran and beet pulp to all of his animals when no range forage or crop aftermath was available. The other low income producer fed supplements to pregnant ewes, rams and lambs that were to be sold. Barley, bran and beet pulp were fed between September and December. Hay was also fed during this period and this practice was continued on into February. The wealthy producer restricted supplemental feeding to lambs for fattening, except during periods of crisis. Barley, bran, beet pulp and beet leaves were used by the wealthy producer for supplemental feed.

Health Care

The two low income producers had not been treating their animals, though they acknowledged familiarity with treatments for diseases. They chose to invest what available funds they had on supplemental feed for their livestock instead. The richer producer may receive health care for his livestock from the Service de l'Elevage in Kasba Tadla. He rarely practices preventive treatments, and treats animals only when necessary. Little attention is given to parasite control.

Ram Fertility

Six rams were checked for fertility problems in the Beni Mellal region. One of these six rams was found to have testicles that had not properly developed resulting in sterility. The other five rams were found to be normal and capable of reproduction.

Replacement and Cull Animals

The wealthy producer claims to have practiced a selection program based on animal quality in the past. In the recent drought years he has neglected to practice selection based on any criteria. The two low income producers selected replacements on

the animal's outward appearance of strength and health. None of the producers based selection on a breed phenotype.

Old animals, and those with disease or anomalies, were culled. The animals' reproductive histories were rarely taken into consideration. Few if any producers weigh animals or keep written records of animal productivity. Culled animals were sold at the local souks. Producers often purchased replacement ewes from outside the region because locally raised sheep develop problems in teeth and bone formation due to high levels of fluorine in the local environment.

Wool Production

Sheep were shorn in the Beni Mellal region during late May and early June. Average raw fleece weight for breeding animals was approximately 1.5 kg.

Only ewe-lamb pairs in the subsample and rams were evaluated for wool quality and kemp presence. Ewe wool grades ranged from 40 to 58. The majority of the ewes fell in the 50 and 54 grades. Wool grades for lambs ranged from 40 to 56, with the majority in the 40, 50, and 54 grades. Only three rams were evaluated for wool quality and all three were in the 54 grade with kemp present. Kemp was present on 37% of the ewes and 56% of the lambs (Table 2.12 and Table 2.13).

Table 2.12. Ewe wool quality and presence of kemp in the Beni Mellal area sample (0 is no kemp and ++ is abundant).

KEMP RANKING	WOOL GRADES										TOTAL ANIMALS
	40	42	44	46	48	50	52	54	56	58	
++	0	0	0	0	0	0	0	0	0	0	0
+	1	0	0	0	0	2	0	0	0	0	3
-	1	0	0	0	0	6	0	3	0	0	10
0	2	0	0	0	1	6	0	10	2	1	22
TOTAL ANIMALS	4	0	0	0	1	14	0	13	2	1	35

Table 2.13. Lamb wool quality and presence of kemp in the Beni Mellal area sample (0 is no kemp and ++ is abundant).

KEMP RANKING	WOOL GRADES										TOTAL ANIMALS
	40	42	44	46	48	50	52	54	56	58	
++	0	0	0	0	0	0	0	0	0	0	0
+	7	0	1	0	0	1	0	1	0	0	10
-	5	0	0	0	0	4	0	1	0	0	10
0	2	0	2	0	0	5	0	4	3	0	16
TOTAL ANIMALS	14	0	3	0	0	10	0	6	3	0	36

The low income producers sold a portion of their wool and kept the rest for domestic use. One producer said it was his wife who made the decision on the amount to be retained for domestic use. The wealthy producer kept all of his wool. Wool marketing was generally carried out at the local souks.

ALTERNATIVE LIVESTOCK MANAGEMENT PRACTICES

Improved Herd Management Techniques

The Producer Study identified several areas in animal production where improvements which promised quick results could be made. Areas identified included animal nutrition, culling and selection to improve livestock performance, health care, indiscriminate breeding, synchronization and timing of lambing, and the more efficient use of the available resources.

The second component of the animal production aspect of the Morocco Range Management Improvement Project consisted of applied research efforts in cooperation with producers to identify methods to implement improved management. The methods explored were generally those that had been proven successful in other countries. The primary purpose of these investigations was to see if the improvements were acceptable within the religious and cultural framework of Moroccan rural society. Investigations were implemented in a manner that allowed the producers to see the results on their own animals.

The short scrotum technique was introduced as a means to address the problem of indiscriminate breeding in Moroccan sheep flocks as an alternative to separate herding. The "Classification and Selection Program" was a demonstration of a method to eliminate the poorly performing animals in sheep flocks, to improve meat and wool production, and to improve wool quality. The "Goat and Sheep Production on Limited Resources Study" was conducted to introduce to the producers the potential for increased small ruminant production by changing livestock management systems.

Method to Control Indiscriminate Breeding in Sheep Flocks

Indiscriminate breeding makes selection for genetic improvement impossible and hinders flock management, since lambs are born throughout the year. The establishment of a breeding program would enable lambs to be sired by high quality rams, and to be born at times when forage was readily available. Due to religious/culturally motivated preferences to avoid "mutilation" of the animal, the methods available to sterilize males are restricted. The best alternative to control breeding is to segregate all male animals from the females. Under systems where animals are herded, such as in Morocco, the expense of an additional shepherd can be prohibitive especially when livestock numbers are relatively small.

An alternative approach is to use a non-surgical sterilization method. The short scrotum method was chosen because it is a "bloodless" technique and it does not require extensive anatomical knowledge or exotic chemical products. This simple technique consists of forcing the testicles up along the abdominal wall and affixing an elastic band around the scrotum to hold them in position. The ring prevents blood circulation into the scrotum which becomes necrotic, dries, and falls off. The shortened scrotum prevents the testicles from descending and increased body heat affects the viable sperm producing

capabilities of the animal. This procedure is also thought to increase testosterone production (Ruttle et al., 1974). The method has been shown to cause sperm immotility within eight days of the operation (Ruttle et al. 1975).

Prior to recommending the short scrotum method to sheep producers in Morocco, Project technicians wanted to ascertain that it would not hinder meat production. There was also a concern that the short scrotum technique would inhibit market acceptance by altering testicle and horn development. The majority of meat is sold from carcasses with testicles intact. To determine if meat production could be enhanced, a mineral supplement was made available to half the animals. The study purpose, therefore, was to determine if sterilization via short scrotum would hinder meat production or alter masculine characteristics, and whether mineral supplements would enhance meat production in treated animals.

The study was conducted on the Ain Beni Mathar Perimeter (Fritiss Perimeter) with the cooperation of the Ain Beni Mathar "El Fath Cooperative". Ain Beni Mathar is located in the northeastern corner of Morocco. A 300 ha exclosure of the Artemisia herba-alba vegetation type which had been deferred from grazing since 1979 was used for the study.

The Ain Beni Mathar "El Fath Cooperative" provided lambs for the experiment. All cooperative lambs were weighed and tagged, and animals were ranked according to their weights. Fifty-six ram lambs between 5.5 and 6.5 kilograms were used in the short scrotum study. Fifty-six ewe lambs were included with these rams to carry out the experiment with mineral supplement. Lamb ages ranged from six to nine weeks. Lambs were randomly selected for each treatment group and the treatments were replicated twice. Animals to be sterilized via the short scrotum technique were treated on February 14, 1985 and returned to the herd.

All study lambs were weaned and weighed on April 12, 1985 and placed within their respective treatment groups: short scrotum, minerals; short scrotum, no minerals; no short scrotum, minerals; and no short scrotum, no minerals. During the day, flocks (one for each replication) were herded separately, though in the same area so that available forage was the same for both. At night lambs were penned by replication and mineral treatment. Mineral blocks were available for lambs that received the mineral supplement and all animals had free access to water while penned. Lambs were weighed at twenty-one day intervals, with final weights being collected on August 16, 1985. Unfortunately, equipment for fertility testing was not made available. Horn length and circumference, also criteria for market acceptance, were measured. Circumference was taken at the horn base, and the outside curve of the horn was measured for length. Four lambs were randomly selected from the largest ten lambs in the short scrotum and non-short scrotum treatments, and were slaughtered on August 17, 1985. Larger lambs were desired to assure that puberty had been reached. Live weights with no shrink were recorded just prior to slaughter. Carcass weight was recorded with the head intact. Chest measurements were taken across the hump. Carcass length was measured from the base of the tail to the beginning of the neck. Testicular measurements included circumference at the widest point, length from tip to tip, and the distance that the testicles descended from the abdominal

wall. Analysis of variance at the .05 probability level was used to determine if significant differences occurred between treatments for changes in weight. Testicular, horn and carcass measurements were compared using the students "t" test at the .05 level of probability.

No difference in weight gains was found (Figure 2.13). Average lamb gain for short scrotum and non-short scrotum treatments were 3.8 and 3.5 kg respectively for the first three weeks of the study. Prior to the study the lambs grazed similar areas (Artemisia herba-alba) although forage availability was different. The amount and variety of available forage was much greater on the study exclosure than on the areas grazed by the cooperative herd outside the exclosure, therefore gains were rapid when the animals were first introduced to the area. Weight gains were fairly constant for the next four periods. The average gain was between 1.1 and 1.6 kg during each of the three week intervals for all treatments. Weight losses occurred during the last period. That interval coincided with hot dry weather, when forage was less readily available and nutritive value had declined.

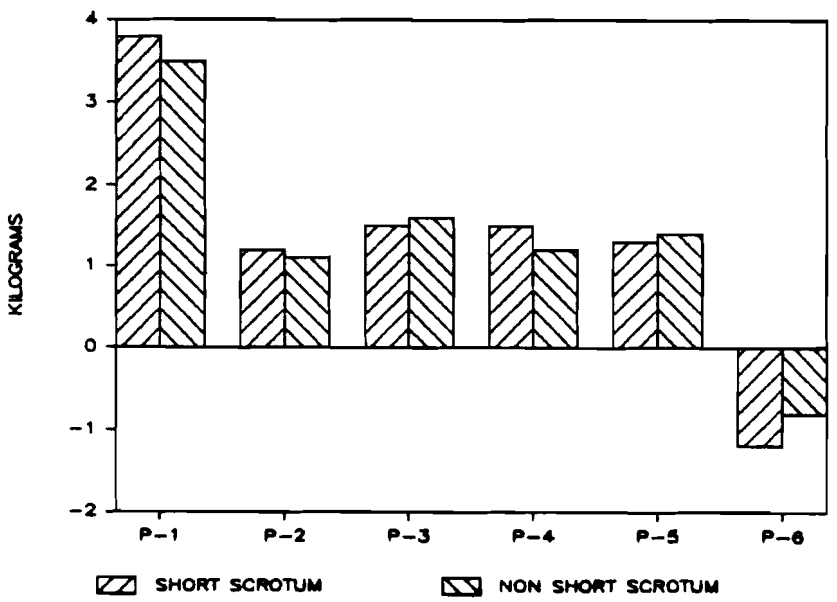

Figure 2.13. Statistical means for weight changes over twenty-one day intervals to show effects of the short scrotum technique on lamb weight.

Weight gains in the mineral supplementation treatments followed a pattern similar to those in the short scrotum treatments (Figure 2.14). There was a significant difference in gain during the third period. Lambs receiving mineral supplements gained 1.8 kg while those without gained 1.3 kg. No differences were found for the other periods. The reasons for a greater gain during an intermediate period and not the others are unknown. Lambs did not appear to readily utilize the mineral supplements. The results might have been different if a training period to encourage the lambs to consume the minerals had

preceded the experiment.

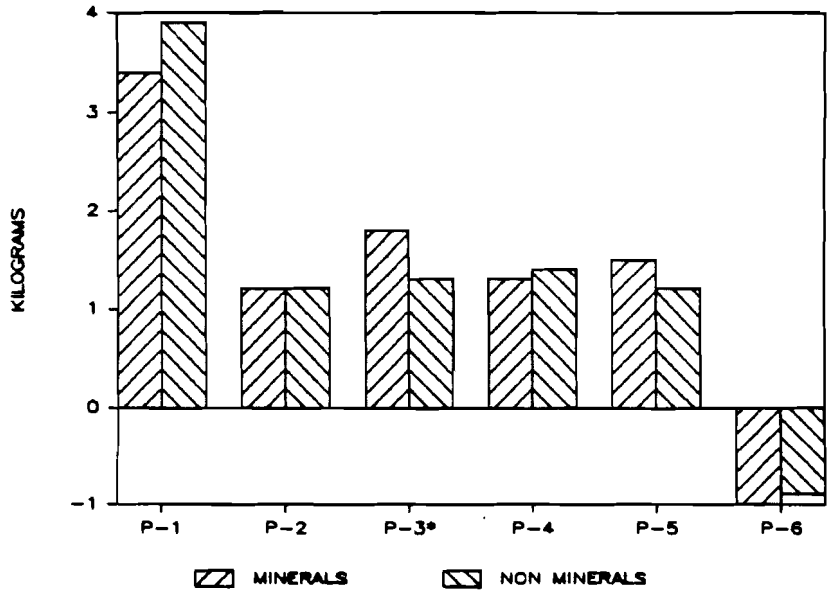

Figure 2.14. Statistical means for weight changes over twenty-one day intervals to show effects of mineral supplementation on lamb weight.

The study incorporated early weaning in its procedure, a management technique seldom practiced among Moroccan livestock producers. The positive weight gains on all treatments (early weaned study lambs) demonstrated that no ill effects resulted from the weaning of the lambs. Though no data was collected that compared lambs weaned and not weaned, visual observations indicated that the weaned lambs were healthier and gained more weight than their counterparts. Visual assessment of ewe condition appeared to favor early weaning as well.

Horn development was not influenced by short scrotum treatments (Figure 2.15). Horn circumference was 12.5 and 12.3 cm for animals in short scrotum and non-short scrotum treatments, respectively. Horn length was measured to be 17.9 and 18.2 cm for the same treatments.

Carcass development as measured by weight, chest size and length was not found to be altered by the short scrotum technique (Figure 2.16). Live weights were 26.0 kg for short scrotum and 25.4 kg for non-short scrotum treatments, and carcass weights were 12.5 and 12.0 kg, respectively. Therefore, viscera material does not appear to be influenced by application of the short scrotum technique either. Chest sizes were almost identical, 69.3 cm for short scrotum and 69.5 cm for non-short scrotum lambs. Carcass lengths were 54.0 and 52.5 cm, respectively, for the same treatments.

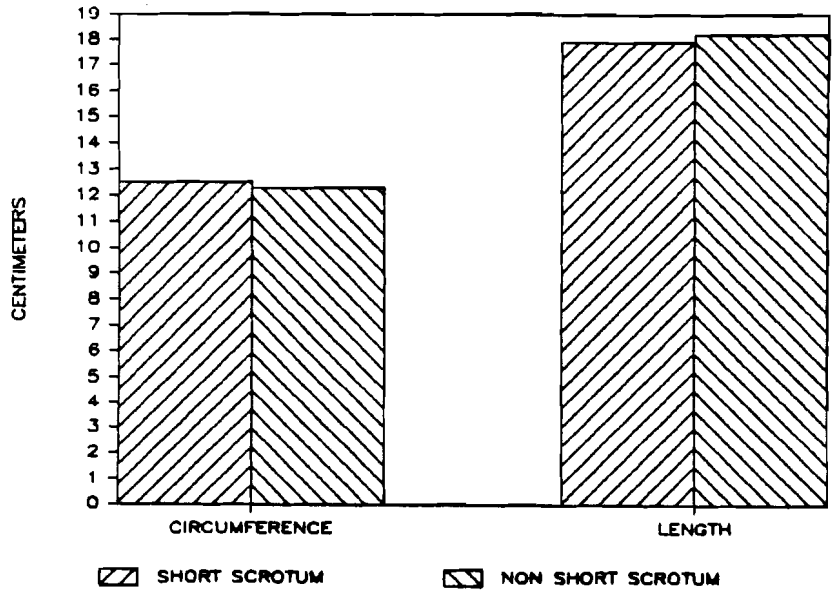

Figure 2.15. Statistical means for measurements of horn circumference and length to show effects of the short scrotum technique on horn development.

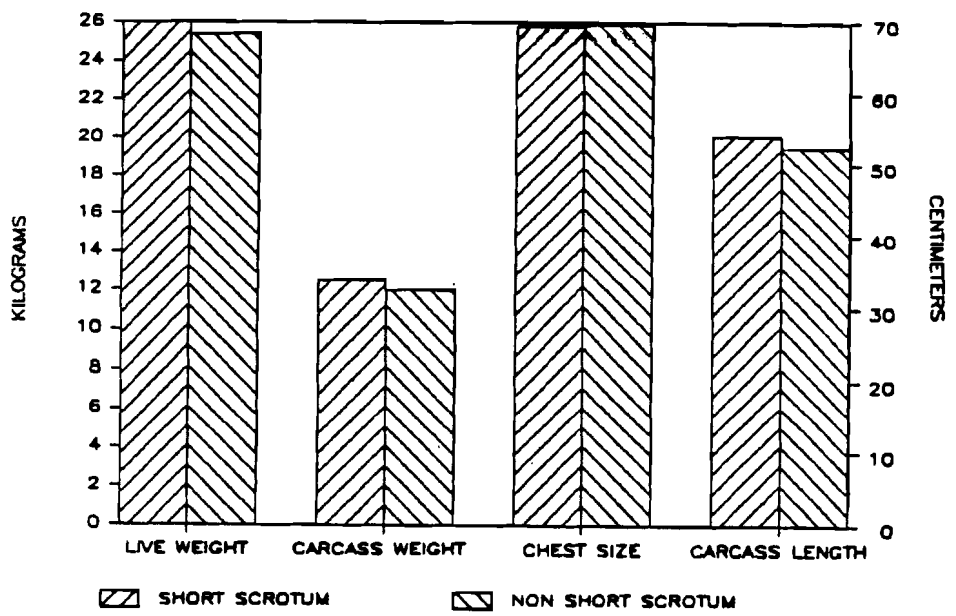

Figure 2.16. Statistical means for measurements of live weight, carcass weight, chest size, and carcass length to show effects of the short scrotum technique on carcass development.

When side-by-side comparisons were made, testicle circumference and length both visually appeared to be reduced by the short scrotum technique. However, at the .05 probability level, no significant difference could be detected (Figure 2.17). Short scrotum testicles averaged 8.9 cm in circumference and

5.1 cm in length. Non-short scrotum testicles averaged 10.9 cm in circumference and 7.0 cm in length. The distance that the testicles descended from the abdominal wall to the tip of the farthest testicle was found to be significantly different (Figure 2.17). Short scrotum testicles descended an average of 5.2 cm. Non-short scrotum testicles descended an average of 13.3 cm. Vas deferens and connecting tissue had not elongated having been restricted in the body cavity.

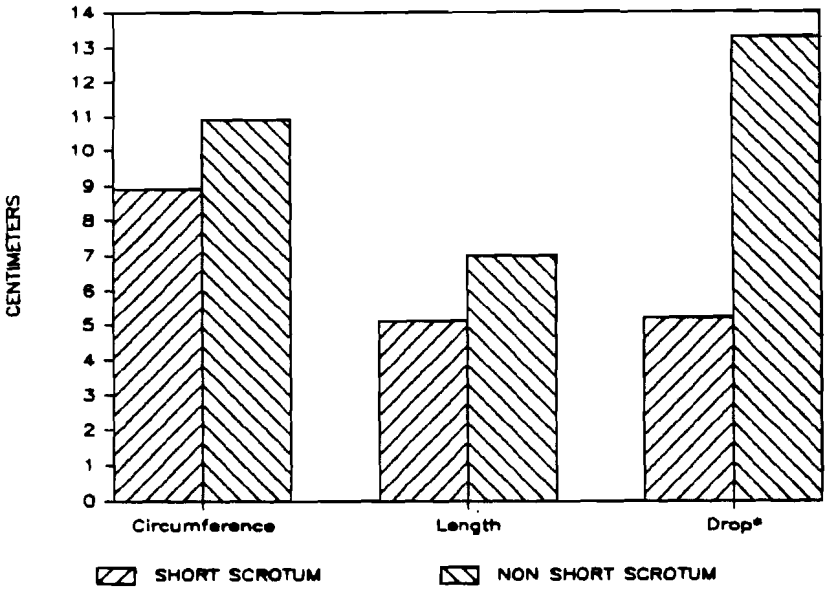

Figure 2.17. Statistical means for measurements of testicle circumference, length and drop to show effects of the short scrotum technique on testicle development.

In summary, indiscriminate breeding inhibits genetic improvements by allowing lambs to be sired by low quality males. If sterilization to reduce indiscriminate breeding is desired by sheep producers, the short scrotum technique is a feasible method. A survey is being conducted among the area sheep producers to find out their willingness to accept the short scrotum technique as a management tool. The short scrotum technique does not adversely affect animal gains. Testicles may be reduced in size, but given the variability that exists, it is doubtful that this reduction is enough to hamper market acceptance. Carcass development was not affected by the short scrotum technique. Benefits derived from mineral supplementation were limited but could possibly be increased with a training period.

Classification and Selection to Improve Herd Performance

Unproductive and poor quality sheep are common in Moroccan sheep herds. An animal selection and classification program initiated by the Project introduced a management approach to producers that enabled them to improve herd quality without costly investment. The program also provided data regarding the

composition of Moroccan sheep herds and the percentages of defective animals encountered.

An evaluation of sheep across Morocco found that fifteen percent of the breeding animals were incapable of reproduction. The cost, on a national scale, to feed these unproductive animals barley or the forage equivalent is over a billion dirhams annually. The elimination of this cost, combined with the additional income generated through the superior animals, would be a tremendous boost to the livestock sector. The potential of wool (considered by most livestock producers as only a by-product of animal production), could be greatly exploited to provide an additional source of income for the producers, and provide a needed raw product to Moroccan industry. At present, Morocco imports 20,000 tons of wool annually to weave Moroccan carpets and other textiles for export.

Approximately four thousand sheep were classified using selection criteria based on animal health and age, animal reproductive history and physical problems, body size, wool quality and fleece characteristics, and breed phenotype. Sheep ages were determined and recorded as one to four years or older. All classification criteria were recorded to be used as a reference to show improvements achieved over time. Technicians previously exposed to the grading system improved their skills and gave full explanation of the selection criteria and grading techniques to producers. Producers assisted project technicians in classifying and sorting the animals initially, and were soon participating in the actual grading and classifying.

The specific criteria for selection in order of priority were:

1) DISEASE. All animals were checked for signs of chronic external and internal parasites and/or diseases. Diseased animals were marked for culling.

2) ABILITY TO REPRODUCE. Ewes were checked for udder development, damaged udder, vaginitis, and deformities of the genitalia. Rams were checked for testicular development, epididymitis and deformities of the genitalia. Problem animals were marked for culling.

3) ABILITY TO FORAGE. All animals were examined for tooth development, deformities such as overbite and underbite, broken mouths or missing teeth and soundness of legs and feet. Problem animals were marked for culling.

4) SIZE. All animals were evaluated for size relative to age. Small, undersized animals were marked for culling.

5) WOOL QUALITY. The fleece of each animal was graded for quality based on the spinning count system. Hair and kemp in the fleece (defects causing wool to be downgraded heavily in the international wool market) were rated from 0 to 6, with 0 being none and 6 being abundant.

6) BREED PHENOTYPE. At one site, of the animals having met all the above production related requirements, only those expressing the characteristics of the local breed, Beni Guil, were placed in flock number one. This coordinated the selection process introduced by the Project and that of ANOC. The aim of this particular cooperative was to gradually create a highly productive pure Beni Guil flock through selection.

Animals were classified and grouped as follows:

Flock 1. This flock was made up of the highest quality animals that would comprise a breeding group from which the majority of future replacements would be selected. Only those sound animals (criteria 1-4) exhibiting a spinning count of 50 (the lower limit of the fine wools) or better qualified for this flock. Ewes were selected for Flock #1 only if the amount of kemp and/or hair was 2 or less. Rams were selected for flock one only if the amount of kemp and/or hair was 1 or less. Meeting a phenotypic criterion was required in some areas.

Flock 2. This flock was formed from animals meeting selection criteria one through four but with wool quality low or, at one site, if they did not exhibit the Beni Guil breed phenotype characteristics.

Flock 3. This flock was formed from those animals not meeting the criteria for flocks 1 or 2. These animals were considered the culls and were to be sold.

Data recorded during the initial selection process serves as the baseline for annual comparisons of the herd characteristics and as a measure of herd improvement progress. These data, the herd composition, age and sex ratio, wool quality and the occurrence of undesirable animal attributes indicate that the current level of management is low. Even in an ANOC herd that was included in the program, animal quality and productivity were found to be quite low.

After the sheep were classified and grouped according to the selection criteria, 745 ewes of the 3763 total (20%) qualified for Flock #1. Twenty-nine of the 179 rams examined (16%) met all the requirements for this primary breeding flock. An additional 2097 ewes (56%) and 59 rams (33%) met criteria that placed them in Flock #2. A total of 921 ewes (24%) and 91 rams (51%) did not meet the selection criteria, and it was recommended that they be sold.

Five hundred and forty-eight of the 921 ewes that failed to meet the selection criteria (15% of the ewes examined) were considered to be animals incapable of reproduction. One hundred and eighteen of the unproductive ewes were sterile. The other 430 ewes were considered unproductive as a result of physical problems, such as bad udders (84 ewes) that inhibited milk production, broken mouths (298 ewes), poor teeth (37 ewes) or poor health (11 ewes) that inhibited the animals from consuming adequate forage to meet nutritional requirements for reproduction

and lactation.

An additional 373 ewes (9% of the ewes examined) were culled for traits that did not render them incapable of reproduction, but that did make them undesirable animals to be kept in the herds. Twenty-two were recommended to be culled because they were dwarfs. Horn presence, an undesirable genetic trait that is an indication of hormonal imbalance, eliminated 103 ewes. Five ewes that had severe skin infections, one ewe that was blind and another that was crippled were also recommended to be culled. A poor fleece (a grade less than 46 and a kemp/hair rating of 5 or 6) was the reason that another 241 ewes were culled (see Table 2.14 for details of culling).

Table 2.14. Reasons and numbers of ewes that were culled in the Classification and Selection Program.

REASONS CULLED	NUMBER CULLED	PERCENT OF CULL	PERCENT OF EWES
REPRODUCTIVE PROBLEMS	118	12.81	3.14
BAD UDDER	84	9.12	2.23
BROKEN MOUTH	298	32.36	7.92
POOR TEETH	37	4.02	0.98
SICKLY	11	1.19	0.29
BLIND	1	0.11	0.03
BAD LEGS	1	0.11	0.03
SKIN INFECTION	5	0.54	0.13
POOR FLEECE	241	26.17	6.40
DWARFS	22	2.39	0.58
HORNS	103	11.18	2.74
TOTALS	921	100.00	24.48

Ninety-one (51%) of the 179 rams examined were identified for culling. Thirty-five (20% of the rams examined) were eliminated because they were considered incapable of reproduction. Twenty-two were found to be sterile. Problems ranged from epididymitis to a cryptorchid ram. The other 13 rams that were eliminated were considered unhealthy (nine with broken mouths, two with poor teeth and two that were sick) and incapable of meeting their required nutritional needs for reproduction. Fifty-six rams (31% of the rams examined) were eliminated because of a poor fleece (a grade less than 48 or a kemp/hair presence rating of 5 or 6) (see Table 2.15).

Wool grades ranged from 40 to 60. The majority of the fleeces of ewes (95%) and rams (92%) fell between the grades of 44 and 50. Kemp was present on 73% of the ewes (Table 2.16) and 65 percent of the rams (Table 2.17).

Table 2.15. Reasons and numbers of rams that were culled in the Classification and Selection Program.

REASONS CULLED	NUMBER CULLED	PERCENT OF CULL	PERCENT OF RAMS
REPRODUCTIVE PROBLEMS	22	24.18	12.29
BROKEN MOUTH	9	9.89	5.03
POOR TEETH	2	2.20	1.12
SICKLY	2	2.20	1.12
POOR FLEECE	56	61.54	31.28
TOTALS	91	100.00	50.84

Table 2.16. Ewe wool quality and presence of kemp in the Classification and Selection Program sample (0 is no kemp and 6 is abundant).

KEMP RANKING	WOOL GRADES											TOTAL ANIMALS
	40	42	44	46	48	50	52	54	56	58	60	
6	0	1	259	51	17	3	0	0	0	0	0	331
5	1	2	90	62	37	17	8	0	0	0	0	217
4	2	3	212	80	38	17	10	2	0	0	0	364
3	4	5	227	111	89	37	5	3	0	0	0	481
2	4	1	318	248	164	59	9	1	0	0	0	804
1	2	0	158	152	122	85	13	5	2	0	0	539
0	1	1	156	215	326	233	41	31	20	0	0	1027
TOTAL ANIMALS	14	13	1420	919	793	451	86	42	22	0	0	3763

Table 2.17. Ram wool quality and presence of kemp in the Classification and Selection Program sample (0 is no kemp and 6 is abundant).

KEMP RANKING	WOOL GRADES											TOTAL ANIMALS
	40	42	44	46	48	50	52	54	56	58	60	
6	0	3	8	2	0	0	0	0	0	0	0	13
5	0	0	4	3	4	2	0	0	0	0	0	13
4	0	2	10	5	0	0	0	0	0	0	0	17
3	0	0	13	2	3	0	0	0	0	0	0	18
2	0	0	10	8	7	3	0	0	0	0	0	28
1	1	0	6	6	6	7	0	1	0	0	0	27
0	0	0	5	10	19	21	2	0	1	0	5	63
TOTAL ANIMALS	1	5	56	36	39	33	2	1	1	0	5	179

In summary, poor quality animals are common in Moroccan sheep herds. Fifteen percent of the animals in the breeding herds were found to be incapable of reproduction. If these

numbers are expanded to the estimated 12 million breeding ewes in Morocco, a total of 1.8 million unproductive ewes are present in the country. These animals contribute to the consumption of a limited forage resource with little or no return. An average of thirty kilograms of barley or its forage equivalent is required to support a mature ewe monthly. In order to support the unproductive animals, over one billion dirhams worth of feed is required annually. A selection program established country wide could quickly reduce the number of poor quality animals and greatly improve herd performance. Further, wool quality, a highly heritable trait, could be improved through the same program and generate additional income for the livestock producers and provide a valuable resource for Morocco.

Goat and Sheep Production on Limited Resources

Low income producers often lack funds and other resources to invest in their livestock. Animals are inadequately nourished and receive limited and often ineffective health care. Low income producers' animals are generally restricted to grazing native vegetation throughout the year. The middle income producers' animals utilize crop residues during the summer and early fall, when native vegetation is scarce and its nutritive value is low. Livestock owned by low income producers generally consists of small numbers of sheep and goats. Sheep are recognized as being more valuable and are therefore the source of more pride of ownership.

When given a choice in forage selection, sheep and goat diet overlap is generally small at most. Goats prefer browse, while sheep select grass and forbs (Squires, 1982). Goats achieve higher reproductive rates and digestive and biological efficiency than sheep (Devendra, 1981). Thus, they may have a comparative advantage on range dominated by woody vegetation. Biological efficiency is defined as a measure of the ability of the species to reproduce, survive and maintain its numbers in a given environment (Blaxter, 1968). Native vegetation consisting of low lying shrubs with sparse dispersion of grass and forbs would therefore favor goat production. Dr. Jack Ruttle, a TDY specialist in sheep production, stated in his TDY report, "It is interesting to note that in all flocks seen, the goats appeared to be healthier and to be reproducing better than sheep. The reason for this is obvious as the goats are living on browse and do not compete with sheep for grasses. Consequently, the goats are by comparison well fed in areas where other animals are malnourished". Given these advantages, it may be better to direct the low income producer to raise goats rather than expend their limited resources in sheep production. A study conducted by Project technicians sought to determine if goats, though of lower value and status, have an advantage over sheep in terms of survival and production potential under a management system dictated by limited resources.

The sheep and goat flocks of a single low income producer in the Midelt region were monitored over the course of a year to determine their production levels. At the study inception, the producer owned equal numbers of sheep and goats; 17 ewes and does, and one ram and buck. All animals were identified with ear tags and weighed every twenty-eight days. Lambs and kids born

during the study had their birth dates recorded, were weighed and ear-tagged, and included in the periodic weight checks. All animals were herded together throughout the year.

The producer herded his flock within a two to three kilometer radius of his house on native vegetation year round. Sagebrush (Artemisia herba-alba) and alpha-grass (Stipa tenacissima) sites were both used. Sagebrush areas were used predominantly from early spring to early fall and alpha-grass areas were used the remainder of the year. Sheep were supplemented with 0.5 kg barley per head (ram, ewes and lambs) per day starting in November and continuing through February. During January the sheep were also provided approximately 0.3 kg of straw or alfalfa per head per day. Kids also received 0.5 kg barley per head per day during January in an effort to build up their strength and resistance to a diarrhetic illness that struck the flock. The goat does and buck did not receive any supplemental feed during the study.

The ram and buck did equally well during the study. They both weighed 19.5 kg at the start of the study (April 4, 1985) and concluded the study within 0.5 kg of each other. The buck weighed 25.0 kg and the ram 24.5 kg. Both animals showed significant gains during the first three months of the study and then maintained or lost weight during the rest of the time (an exception being that the buck gained weight during the fifth month of the study). The major breeding periods occurred for the buck while vegetation was readily available (April and May) and for the ram after available vegetation had begun to decline (June and August). Poor performance by the ram or buck might have indicated an unhealthy or unproductive animal, however, fertility had been proven in previous lamb/kid crops. Poor ram or buck performance might have caused production variances between the two species as a result of that individual's performance, unrelated to the species potential under the management system in question.

Ewes and does had similar weight fluctuations. Weight increased from April through June and then was lost as available forage declined (Figure 2.18). Five of the 17 ewes had lambs when the study started. All five produced another lamb during the study. One of the goats had a kid at the study inception and it gave birth to another kid the next fall. One ewe and three does died (six and eighteen percent, respectively) during the study. One doe was killed after it broke a leg. The reasons for the other deaths are unknown. The other 16 ewes and 14 does produced a total of 12 lambs and nine kids prior to the conclusion of the study. A 75% lambing rate for the ewes and a 64% kidding rate for the does occurred during the study. No twins were born to either species.

One kid and five lambs were present when the study began. Though the lambs were heavier, weight gains appeared to be similar for the two species. Weights fluctuated in much the same way as they did for the adults, with gains being made early in the study, leveling off and then declining as forage became less available.

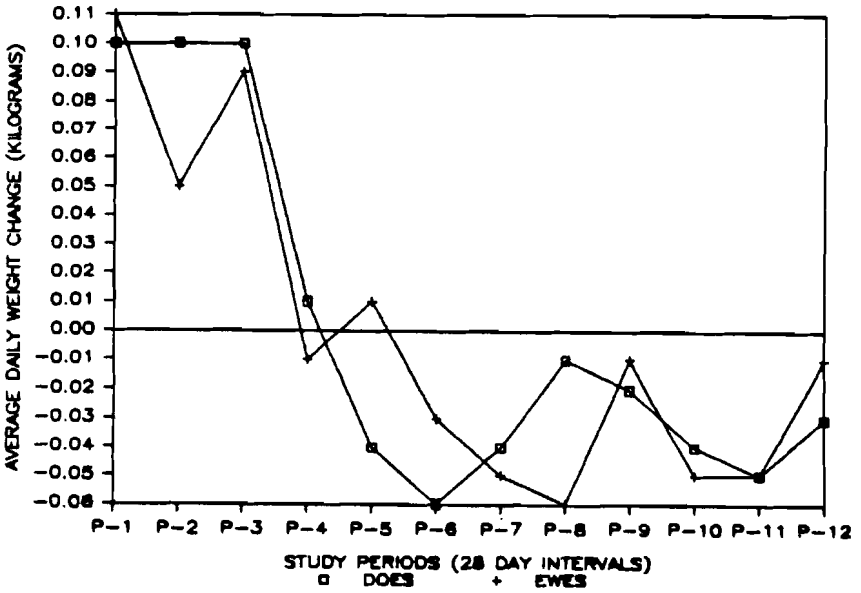

Figure 2.18. Average daily weight change during twelve, 28-day periods for ewes and does owned by a low income producer in the Midelt area.

Goats and sheep had three parturition periods during the study: summer (July and August), fall (October and November) and winter (December and January). Seven of the nine kids born during the study were born in the summer period and one was born in each of the other two periods. Only one of the lambs was born during the summer period. Five lambs were born in the fall and six were born in the winter period. Death losses for both lambs and kids born during the study were high. Fifty-six percent of the kids died; three of the seven born in the summer, and both of those born later. Two of the lambs born in the fall and three born in the winter died (40% of the lambs). One of the lambs present at the study inception also died. The causes of death were attributed to a diarrhetic illness. Low lambing rates and high death losses combined to result in low lamb and kid crop. The lamb crop was 35% and the kid crop was only 24%. Because of the deaths, comparisons of lamb and kid growth rates were not made.

Initially the study purpose was to determine if goats provided greater production than sheep under a management system with limited resources. Though neither species proved very productive, the results indicated the contrary, with sheep out producing the goats. Sheep produced more lambs than goats did kids and had a lower rate of death loss. However, the sheep were provided feed supplements at a cost to the producer that may have been higher than the potential income that could be derived from the additional lambs. At best, the results were not conclusive.

The study might be more useful for providing insight concerning the marginal production system of the low income livestock producer. The producer claimed that the year during which his animals were monitored was an "off" year. However, a

single kid and five lambs at the study inception April, 1985, indicated the previous year was hardly a success. Reproduction during the study period led to more offspring by April 1986 than were present by the same date in the previous year.

The producer incurred significant costs in obtaining the marginal results observed during the course of the study. He invested approximately 2200 DH in supplemental feeds and medicine to give his livestock. This expense is roughly equivalent to four months wages that the producer earned as a salaried worker for the government. No other income was available to offset these expenses. Wool produced by his sheep was worth slightly more than 200 DH at the local souk, but the producer kept all of his wool for domestic use. The goat hair was not clipped.

Livestock numbers represent wealth to the producer and provide him a sense of status. The man is holding what wealth he has in the form of livestock and surely feels that this form of wealth accumulation is his best alternative. Though this may be an extreme case, it is unfortunately not an unusual one for the low income producers.

CONCLUSIONS AND RECOMMENDATIONS

Small ruminant production systems and levels of production varied between and within the Project sites. However, similar problems and constraints in livestock production were reflected to some degree across the country. The purpose of this section of the report is to note these similarities and differences, discuss the problems identified, and suggest possible methods of ameliorating them. The recommendations are not meant to provide a final solution to problems faced by the livestock industry in Morocco, but rather to identify possible means that may be pursued to improve conditions and raise production levels for the Moroccan livestock producers. Most recommendations address problems that were found to occur country wide. However, individual site characteristics and conditions should be considered prior to the initiation of programs to improve the livestock sector at each location.

Herd Characteristics

Small ruminants, and sheep in particular, represent the majority of the livestock in Morocco. There is a tendency for the proportion of goats in a herd to increase as aridity increases and producer resource base or income level declines. Cattle and horses are generally owned by producers with relatively higher income and resource levels. Mules and donkeys are owned at all income levels and reflect a need for transportation and for draft. A producer who owns a tractor to provide these functions may own few or no donkeys or mules.

Ram to ewe ratios vary, ranging from 1:20 to 1:40. Invariably, when producers were questioned as to the number of ewes per rams, the number quoted was higher than the ratio calculated from the animal numbers counted in the herds. Variance may come from the presence of rams in the herd that are not considered as part of the active breeding stock, but are rather replacement breeding rams or animals to be sold later. At all sites, the rams remained with the ewes throughout the year. Separation of rams and ewes outside an established breeding season could lead to more timely lambing periods and increased lamb production.

More attention should be given to goats and their potential to produce protein and fiber, particularly among producers with limited resources. Though the "Goat and Sheep Production on Limited Resources Study" failed to demonstrate better performance by goats, it is still possible that goats will out produce sheep under the same severe conditions. Producers with limited resources to invest in their livestock may be well advised to raise animals that can produce on the resources available instead of attempting to raise animals that require supplemented resources at costs that are difficult to recover.

Flock Movement and Management

Corrals or enclosures are used throughout Morocco to pen

livestock at night. The facilities provide good protection from predators, but the permanence of the structures and negligence in keeping them clean results in health related problems. Problems incurred from corrals are discussed later in the animal health care section.

Types of forage resources and times of use varied between and within project sites. Animal movement and forages used were dictated by what resources were available. Producers used preferred resources first, then moved on to less desirable sites as the forage availability diminished. The more prosperous the producer, the more abundant and flexible were his opportunities to find adequate forage to meet his livestock forage needs. Middle and high income producers had access to crop residues and, if necessary, were able to haul or herd flocks to leased land to graze. Low income producers were limited to the forage available on communal land. Available forage was generally insufficient to meet the livestock's nutritional needs.

The intensity of livestock management often reflected income levels, with the higher income producers generally providing more intensive management. Dividing flocks to enable animals with different nutritional requirements to be managed separately requires additional labor input. Producers with limited resources, or insufficient livestock numbers to justify more than one herder, maintained only one flock and all animals were often treated equally. If animals were separated, it was generally to keep young lambs, old and weak ewes or late gestation and lactating ewes under close scrutiny; and to allow for ease in feeding supplements. Unfortunately, the general level of animal husbandry practiced was found to be quite low.

All producers fed supplements to their livestock during some time of the year. Barley was a common supplemental feed utilized by all producers. When feeding supplements to their livestock, the degree to which producers differentiated between animal species, class, and stage of reproduction, and the amount of supplements fed varied among producers.

Some producers in Morocco keep an excessive number of breeding rams in their flocks year round. This practice is unnecessary and results in inefficient use of forage and indiscriminate breeding, with lambs being born at various times of the year. It also results in little or no selection for genetic improvement. Separating rams from the ewes except during a specified breeding season would enable producers to better synchronize lambing periods and other critical nutritional periods with times of high forage availability, and to control which animals mate. Inferior rams need to be prevented from breeding so genetic improvements can be made. If separate herding is not possible, rams to be kept for market could be herded along with the ewes if some form of sterilization was practiced. The short scrotum technique for sterilization appears to be feasible and acceptable in the Moroccan system. When sufficient numbers of animals are present, the establishment of a superior breeding herd through a selection and classification program has the potential of greatly increasing livestock production and production efficiency. Banding of sheep into larger flocks proved to be an effective method of improving husbandry in one area.

Intentionally weaning lambs is a management practice rarely

utilized among Moroccan livestock producers. The study to determine the effects of the short scrotum technique incorporated early weaning and demonstrated that no ill effects were suffered by the lambs. Producers, therefore, could receive the health, nutritional, and reproductive benefits of weaning their lambs early without fearing a reduction in lamb growth. Improved forage quality was a factor in the performance of the lambs in the study, which demonstrated the potential benefits that might be achieved through a grazing management program coupled with early weaning. The combination would allow young lambs access to quality forage and reduce the time required to reach a marketable size. Ewes could be expected to remain in better condition and to rebreed more readly.

Communal land is decreasing in both size and productivity as ever-increasing demands are placed on it. As human pressure on communal assets increases, the dependency on private land, and crop residues in particular, increases. As the need for a land base becomes more important to livestock producers and more marginal land is farmed, the plight of the low income, and most often landless, producer worsens. The low income producers' flocks, due to limited availability of forage resources, rarely generate enough income to enable the producer to invest in the improvement of his flock, much less land. Direct subsidization programs benefit individuals at the moment, but do little to alleviate the problem of dwindling forage resources in the long run. Programs to increase herd productivity through improved animal husbandry methods will help, but cannot be entirely successful as long as the nutritional needs of livestock cannot be met. Perhaps the best means to improve the low income producers' situation, as well as that of the other producers, is to establish programs to increase the availability of forage through range development/improvement and grazing management while introducing improved animal husbandry practices.

A study conducted in 1970 showed that sheep grazing crested wheatgrass (Agropyron cristatum) in a rotational grazing system and involved in an improved health care program, produced five times as much meat per hectare as sheep grazing sagebrush (Artemisia herba-alba) under a traditional system (Graves et al., 1975). Partially as a result of the study, Plaine de L'Aarid Perimeter was established and developed. Researchers warned that improved management practices needed to be incorporated into any seeding program for proper forage exploitation. However, comparisons of producers who were involved in the Producer Study in the Midelt region and who used Plaine de L'Aarid Perimeter compared to producers without access to the perimeter, showed that only limited benefits were being derived from the improved rangelands due to low production efficiency and management problems. Lamb weight gains on and off the perimeter were similar. Ewes off the perimeter had lambing percentages better than or equal to ewes on the improved pasture. Thus, it appears that the lack of a functional management system does not allow for the potential benefits of the area to be fully realized.

In the future it may be more effective to improve forage resources after functional local producer organizations are formed and grazing management systems are established on native vegetation, than to incur extensive development cost and be unable to implement a grazing management system. Experience in

various regions of Morocco suggests that significant increases in forage productivity can be expected to result from the implementation of grazing management systems alone. Once a grazing system is established and recognized by the producers in the area, rangeland development projects such as seedings can be initiated where most needed during the periods of deferment established through the management system. In some areas of Morocco, livestock producers have recognized the value of formally organizing themselves to try and deal with range management and livestock production problems. Efforts of the range management professionals working in Morocco should be concentrated in areas where this climate of cooperation and concern exists. Given the limited number of professionals and the scarcity of funds for programs, it is essential that program resources be focused in areas where cooperation and participation by local livestock producers and officials is assured.

Natality, Mortality and Marketing

Across project sites, lambs were born throughout the year with a higher incidence of births occurring in certain periods. The majority of lambs were born during periods that occurred in the spring, fall and winter months. Higher percentages of ewes (82% in Midelt and 83% in Timahdite) that lambed in the spring period lambed again within twelve months. The percentages of ewes exhibiting lambing intervals of less than 13 months that initially lambed in the fall or winter periods were lower (46% and 3%, respectively, for the fall and winter periods in Midelt, and 71% and 68%, respectively, for the fall and winter periods in Timahdite). The high incidence of lambing intervals that exceeded 12 months was due (at least to a large extent) to insufficient forage availability for meeting the ewes' nutritional requirements for reproduction. Lamb crop percentages for Midelt were 42% and 35% respectively, for the middle and low income producers in Midelt. The Timahdite producers had a lamb crop percentage of 57%. Differences in lamb crop percentages may be partially attributable to higher average precipitation in the Timahdite region that increased the productivity from native vegetation and from cereal crops. None of the ewes in the Producer Study subsamples gave birth to twins during the study.

As expected, livestock death loss in the Producer Study subsample was lower than the 7% to 9% for lambs, and 3% to 4% for breeding animals that the producers had reported as normal. Nineteen of the 273 lambs (6.9%) that were ear-tagged and included in the subsample to be monitored died during the study. The number does not include aborted or still-born lambs to ewes in the subsample. Death losses occurred year round, but a higher incidence of deaths occurred during the late fall and winter when the weather was harsh and forage was limited.

The majority of lambs sold in the subsample were ram lambs over one year of age. Only 16 of the 57 lambs sold (28%) were female lambs and 13 of those were sold when a producer sold an entire flock. Lambs were sold throughout the year as the producers' need for income dictated. Producers with additional male lambs often speculated on a price increase prior to Aid El Kbir. Culled ewes were most often sold in the late summer or

early fall.

Lamb production and production efficiency could be increased if breeding and lambing periods were established to coincide with periods of high forage availability (spring period for Midelt and Timahdite), if unproductive ewes were culled to allow an increase in forage availability to productive animals, and if an appropriate animal health program was followed.

Health Care

Animal health care practices varied among producers, but most often treatments were curative rather than preventive. Vaccination to prevent enterotoxemia was an exception and a common practice. Since enterotoxemia is also called "overeating disease" and malnutrition is a primary health and production constraint in Morocco, a paradox seems to exist. This can be explained in two ways. First, enterotoxemia symptoms are very similar to symptoms of other diseases. Problems may often be diagnosed incorrectly especially if the dead animal is not posted. Second, hungry animals receiving periodic high levels of concentrated feeds such as grain supplements due to low forage availability are susceptible to enterotoxemia, a disease caused by microflora imbalance in the rumen resulting as the animal adjusts to a change in diet.

Animals treated for internal parasites are immediately returned to the same corrals and grazing areas used before treatment. The animals are, therefore, immediately re-exposed to parasite eggs and larvae becoming infested again. As a preventive measure, it would be better if treatments were scheduled when animals are moved to new pastures and corrals, thereby disrupting the parasite life cycles and maximizing the benefit of the practice. The establishment of extension programs to train producers in preventive animal health care, along with a description of cost and returns of such care, would be very beneficial to producers.

During discussions with producers throughout Morocco, a common concern was raised over the quality and effectiveness of the animal health care provided by the government. Why these concerns were voiced is unknown, and no effort was made to determine the reasons. Whether or not these concerns are valid, producer perceptions of the government program are important and measures should be taken to improve the program image. Government employees should ensure that all treatments are of high quality, administered at the proper dosage, and given on a timely basis.

Ram Fertility

Ram fertility problems were found at all project sites. Out of 217 rams checked for reproductive problems 48 (22%) were determined to be sterile or nearly so, and should be culled from the herds. Reproductive problems encountered ranged from low sperm motility and concentration to cryptorchidism in rams.

Technicians were trained to recognize ram reproductive problems, and a voluntary program for checking producers' rams is

in the initial phase. This program has the potential to greatly improve the quality of breeding rams retained in Moroccan sheep herds.

Replacement and Cull Animals

Criteria for lambs to be selected as replacement ewes were different at each site. Survivability was the main criteria in the Midelt region. Producers in Beni Mellal and Timahdite looked for signs of good health and strength (size). Phenotype was an important criteria in Timahdite but was considered of little importance in either Beni Mellal or Midelt. Aged, sick and weak animals were fairly well accepted as the animals to be culled at all project sites.

At present, the criteria used in Morocco to cull animals is such that vast numbers of undesirable animals remain in Moroccan sheep flocks. Out of 3942 breeding animals examined in the "Classification and Selection Program", 1012 head (26%) were rated as inferior animals. Five hundred and eighty-three of these animals (15% of all animals examined) were found to be incapable of reproduction. Unproductive animals require the same investment in forage resources, supplemental feed and medical care as productive animals, all at the cost of reduced profits to the producers.

Perhaps the single largest increase in livestock production and increase in producer profit could be realized simply by ridding herds of their unproductive members. A program established across the country similar to the "Classification and Selection Program" as introduced by the Project could vastly improve the quality of sheep in Morocco. The program demonstrated the ease in which it could be implemented, that it has the potential for rapid realization of benefits and that it is readily sought and accepted by the producers. Producers need to be encouraged to select for high quality productive animals, not just increased animal numbers.

Weight Changes

Lack of sufficient forage resources to meet livestock nutritional needs is a problem faced by most livestock producers in Morocco. Weight losses shown by animals were due to the lack of adequate forage. The low nutritional status that resulted severely depressed reproductive capacity. Few if any animals were allowed to express genetic potential for production. It was not unusual for ewes to lose weight the last trimester of gestation or even the entire gestation period. The normally expected weight changes in relationship to a ewe's reproductive cycle (Figure 2.19) are in contrast to the weight changes experienced by ewes in the Producer Study subsample (gaining weight in the spring and losing weight the remainder of the year regardless of the lambing date).

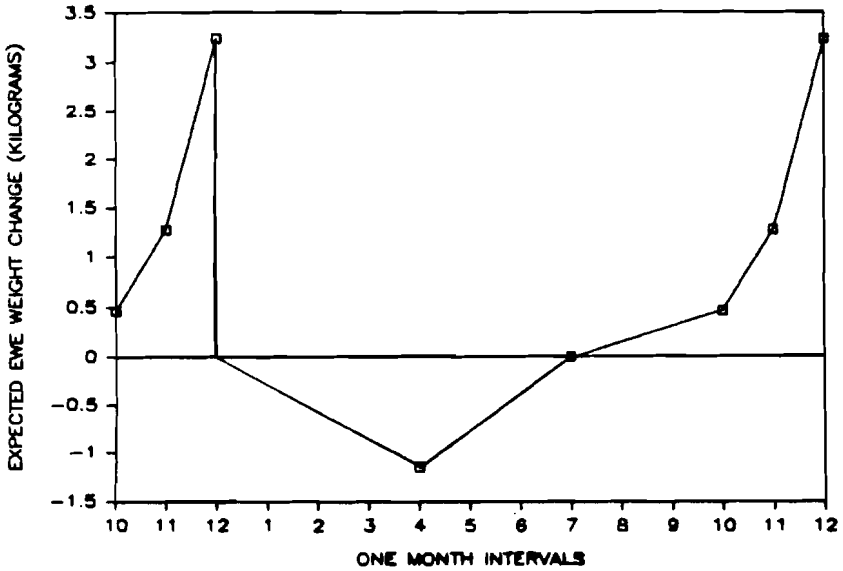

Figure 2.19. Weight changes normally expected over the course of a year for a twenty-eight kilogram ewe giving birth and rearing a lamb.

Timing lambing periods to coincide with periods of increased forage production could best utilize the available resources, improving the condition of the ewe and reducing the dependency on costly supplemental feed. A general problem found was inadequate forage availability to meet animal nutritional requirements for reproduction and weight gain. The improvement of forage resources in both productivity and management will be essential to stabilize or increase small ruminant production.

Wool Production

Wool grades in sheep at project sites were generally low. Fleece grades ranged from 40 to 60, with the majority of fleeces being graded between 40 and 50. Kemp and/or hair was present in roughly two-thirds of the sheep fleeces examined. Livestock producers generally consider wool a by-product of animal production and have little interest in its improvement because each individual producer deals with a relatively small quantity. Programmatic efforts in the areas of wool improvement and marketing could aid producers in realizing the benefits of wool improvement.

The Moroccan carpet industry creates a large demand for carpet grade wools; approximately 20,000 metric tons are imported annually. Wool quality, a highly heritable trait, could be improved through selection rapidly (a three to five year period). Herd selection for wool quality and improved marketing could allow Moroccan producers to meet the local demand for carpet grade wool within ten years. Extension programs targeted at

producers to create an interest in realizing the potential of their animals' wool production could feasibly lead to a situation beneficial to both producer and the carpet industry. Wool cooperatives with trained technicians in wool production would be a great asset to livestock producers in the grading, pooling and marketing of wool.

The economic impact of the adoption of a combination of improved livestock management practices (better nutrition and health care, culling of nonproductive animals and selection of animals based on production criteria) is discussed in Chapter 7 of this report.

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CHAPTER THREE: **APPLIED RESEARCH -- SOCIOLOGY**

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INTRODUCTION

The goals of the sociological research segment of the RMIP were:

- to determine the perceptions of producers of their needs and production constraints and,

- to identify social and cultural influences on the receptivity of new technologies.

The objective was to determined whether producers were **able** to implement suggested interventions, and whether they were **willing** to do so.

In the surveys, it was believed that qualitative data was as important as quantitative data. Secondly, since the project sought to better understand the system of range use, case studies appeared to be a viable method. Finally, studies were used to encourage contact with producers and the community in general to aid the extension function.

There were several constraints to the methodologies selected. Major project-wide systematic studies were only undertaken during the final eighteen months of the project. Further, the level of skills of the research staff was limited. Few of the Moroccan counterparts had any formal training in the social sciences.

A sociologist supervised the socio-economic component of the RMIP during the first 3 1/2 years of the project working primarily from the Meknes office. During the final 1 1/2 years of the project, the sociological research was conducted by a staff of about ten people. Two of these were Utah State University staff members, located in Rabat, who advised and assisted teams at each of the four sites. The site teams typically consisted of an Adjoint Technique or Ingenieur d'Application, assigned to the project from Service de l'Elevage, working with a Peace Corps Volunteer. This staffing arrangement allowed the Moroccan personnel to gain hands-on experience in conducting social research in relation to range management while providing input to the research from their experience in animal production.

The research teams undertook two major studies: 1) an on-going study of the souk or weekly market, and 2) case studies of a group of producers who were thought to represent the range of production systems found at each site. The following discussion will focus on the case studies, called the Agro-Pastoral Systems Study. This study employed ethnographic and participant observation techniques in order to describe the family system of production at three of the four project sites. Data collection to develop this description took place over a twelve month period of time from April 1985 through March 1986.

The first step of the Agro-Pastoral Study involved the selection of approximately twelve producers based on herd size, land holdings, and ethnic grouping (douar, fraction, or tribe), depending on the site. This selection was based on previous surveys conducted at each site. The second step involved the

collection of baseline data, obtained primarily through interviews with the heads of household of the families selected, though it was also supplemented through observations. This data described family membership, as well as crop and livestock production. The third phase consisted of periodic visits made to the family at approximately three week intervals. Researchers collected data on production and consumption as well as on issues that had been identified on previous visits.

SAMPLE SELECTION: **EL FAIJA**

The Ait Ben Yacoub are one of three fractions of the Ait Arfa de la Moulouya, a tribe of the Beni Mguild confederation. The people of these three fractions: the Ait Rahhou ou Ali, Ait Bassu, and the Ait Ben Yacoub, make their homes in the most arid region of the High Moulouya Plain. Farming practices such as fruit tree cultivation in enclosed fields are indicative of long-term sedentism. Seasonal migration, characteristic of many Beni Mguild tribes, has never been practiced by the Ait Arfa. Of the eleven participants in the Agro-Pastoral Production Systems Study, five were from the Ait Ben Yacoub, one from Ait Bassu, three from the Ait Sidi Ayad, and two from the Ait Serrochen. The latter two groups are tribes whose land is outside of the immediate region. With the exception of the two from the Ait Serrochen, producers claimed that tribes and fractions do not hold the importance they once did. Douar affiliation takes precedence.

The study sample population was selected in January 1985 on the basis of a socio-economic survey of El Faija (conducted by the Middle Atlas Project in the spring of 1982). This study selected 88 out of 100 producers from the Itzer Commune, who ostensibly belonged to the Ait Ben Yacoub. Seven douars are included in the fraction: Tafagourte, Tamayouste, Iztate, El Khokhat, Sehb Roua, Arvane, and Agoudim. Three families were chosen from Tafagourte, two families each were chosen from Tamayouste and Iztate, and one family was chosen from each of the four remaining douars.

The sample was selected to represent the range of land ownership and herd sizes found in the population according to the survey mentioned above. The sample represents anticipated ranges of producer resource sets. The distribution of the sample population in regards to these two variables is proportional to the 88 users included in the survey.

During the fifteen month period of the study (January 1985 through March 1986), changes were made to meet new circumstances and new information. Initial baseline data for the twelve producers were gathered during the first four months. After that, one family was replaced by another when the latter household began participating in the Animal Production Study. It was intended that those families participating in the Animal Production Study also be included in the Agro-Pastoral Production Systems Study if they belonged to the Ait Arfa fraction. The sample size became eleven when one producer discontinued his participation from lack of time. Dr. Henri Josserand, in his TDY report, suggested visiting producers every two weeks. The families were interviewed on a tri-weekly basis in order to contact and interview the respondents more effectively. Questionnaires were prepared as conversation guides. While eliciting information in a research interview by simply repeating what an informant has said or by commenting on the reply, it is nevertheless important to have a certain planned structure. Interviews were, for the most part, quite informal. This less formal approach worked fairly well.

CHARACTERIZATION OF PRODUCERS: **EL FAIJA**

A categorization of producers was necessary in order to analyze their agro-pastoral practices. Producers were placed into three categories derived from preliminary estimated production unit income statements. The five producers in category A had estimated gross returns in excess of 7,000 DH. Producers in category B had estimated gross returns of more than 10,000 DH. One of the producers in the B category was the elected representative of his douar to the Itzer Commune and received an unspecified amount of income for this activity. The three producers in category C had estimated gross returns of less than 10,000 DH. One received additional income from a small shop which he owned. Herd size and land ownership were also taken into consideration in producer categorization.

Type A

Although five producers were placed in this category based solely on their higher monetary returns, herd size and land ownership were also greater than in other categories. Herd size ranged from 290-806 and producers owned from 12 to 100 hectares of land. Whereas all 11 producers inherited land, only the wealthier have purchased land used for crop production. Labor needs were greater in this category. This was demonstrated by the fact that producers hired two or more herders or agricultural workers. These wealthier producers either owned capital equipment (trucks, tractors, irrigation pumps) or had the ability to rent such equipment. Major property improvements or repairs (installation of an irrigation pump or construction of a private mill, for example) were limited to Type A producers.

Type B

Herd sizes in category B ranged from 19 to 152 head. This broad range was partially a result of one producer not being dependent on livestock production for his livelihood because he represented his douar in the rural commune. He inherited about 50 sheep from his father. Some of these died and he felt it was not worth his while to replace them.

Herd sizes were not large enough to warrant hiring shepherds from outside of the family. Only one of the eleven producers in the entire study herded his own sheep, although he had sons capable of doing this. His explanation was that "These ewes and lambs are my life, how could I not be with them? When I die, my sons will be with them."

Producers owned from two to six hectares of land. One man employed a full-time agricultural laborer. Two heads of family in this category received agricultural credit loans. Type C producers claimed that they were not eligible for such loans during the previous year.

Type C

One producer was landless and also had the smallest return. However, as guardian of the range perimeter in the area, he received a salary of about 250 DH per month. He was responsible for a herd of 68 sheep and goats, at least half of which were held in association with another person. During the previous year, a second producer had sold his original herd of goats and purchased sheep (45 ewes and lambs), claiming goats do well in the forest but not in a farming region as they often destroy crops. When his father died, he inherited the goats, his brother the sheep. His brother had one ram which they shared between the two herds. This producer had two hectares of cropland. Although the third producer had ten hectares and a herd of 115 animals, he was placed in this category because of poor returns, a fact which becomes more important when the returns are divided among the 15 members of his family -- the third largest in the sample. This producer hired no labor, not even day laborers for the harvest. The other two producers did not hire herders. A khammes (sharecropper who receives one-fifth of the harvest for payment) was hired by one producer.

ASSESSMEMT OF PRODUCER RESOURCE SETS: **EL FAIJA**

Human Resources

Households in the sample were large, ranging from 8 to 29 members. One Type A producer had four wives, accounting for his large family of 29 people. Average family sizes for the categories were as follows: 18 members for Type A, and 11 members for Types B and C (Table 3.1).

Table 3.1. Family composition. Type A, B and C Producers--El Faija.

AGE	ACTIVE		INACTIVE		SCHOOL		TOTAL	
Type A	M	F	M	F	M	F	M	F
0 - 6			2	2			2	2
7 - 15		1	1	1			1	2
16 - 24	1	1			1		2	1
24 - 60	3	4					3	4
61 +	1						1	0
TOTAL	5	6	3	3	1	0	9	9
Type B								
0 - 6				1			0	1
7 - 15		1	1		1		2	1
16 - 24	1	1			1		2	1
24 - 60	1	2					1	2
61 +	1						1	0
TOTAL	3	4	1	1	2	0	6	5
Type C								
0 - 6			1	1			1	1
7 - 15	1			1	1		2	1
16 - 24	2	1					2	1
24 - 60	2	1					2	1
61 +							0	0
TOTAL	5	2	1	2	1	0	7	4

Residence was patrilocal after marriage with few exceptions. The head of household being the decision maker, livestock and land were considered his property, except in cases where the individual was extremely ill. Although traditional inheritance laws dictate that property be divided among males and females, among the families interviewed, this did not occur nor had written wills been made. In the instance of death, herds become the communal property of males of direct descent and decisions are jointly made.

Among the sample families, there was one instance of a woman owning her own sheep. She had inherited the ewes from her father two years previously. Since that time, the number had increased to 25. Proceeds from lamb sales from these ewes were not separated from proceeds from other livestock sales. There were no cases of a woman owning land (either inherited or purchased). Nor did they receive any crops, or money from the sale of crops, raised on land designated through inheritance as theirs. Among all eleven families, land to be distributed to women was divided among male family members. When a female was asked if she inherited any land, the response was always a laugh followed by, "That land will never be divided among women." This was true even in cases of the woman's husband residing in the same douar as the woman's family.

Referring to Table 3.2, the majority of household members in all three categories have had less than one year of schooling. Only one Type A producer sent a girl to school for an extended period of time (five years). Most boys of Type A families went to school at least through the secondary level. They then worked away from home and contributed to the family income, often accounting for the purchase of equipment and capital improvements. With the exception of one family, all sons of Type A producers have had some formal education. Producers in categories B and C sent one or two sons to complete, at least, primary school. At least one son remained at home to herd sheep or work the land. Type B and C producers received no income from children working full-time outside the farm, though they may hire out on a temporary basis.

Table 3.2. Level of schooling for three producer categories--El Faija.

Type A	0 - 1	2 - 5	6 - 9	10 - 13	14 +	TOTAL
MALES	6	1		2	1	10
FEMALES	9					9
TOTAL	15	1	0	2	1	19
Type B						
MALES	3	1		1		5
FEMALES	5					5
TOTAL	8	1	0	1	0	10
Type C						
MALES	5	1	1			7
FEMALES	5					5
TOTAL	10	1	1	0	0	12

Estimated Value of Production Unit Resource Sets

In terms of dirham value, land was the most valuable resource for all three categories of producers. (Dirham values by category: Type A--304,000 DH, Type B--94,000 DH, Type C--40,000 DH). Irrigated cropland was valued at 20,000 DH/ha while non-irrigated cropland was valued at 2,000 DH/ha. Estimated values of producer resource sets for the three categories of producers in the El Faija area are presented in Table 3.3.

Table 3.3. Estimated average value of producer resource sets. El Faija.

INVENTORY (Producer Category)	QUANTITY (units) A	B	C	VALUE (DHS) A	B	C
Land/Rights (ha/MAUMs)						
Irrigated Cropland	13.6	4.7	2	272000	94000	40000
Dry Cropland						
Private Range/Pasture	16.0			32000		
Grazing Rights						
Livestock (head)						
Sheep						
Ewes	240	48	25	108000	21600	11250
Rams	7	2	1	3850	1100	550
Replacement Ewes	40	8	4.2	16000	3200	1667
Replacement Rams	2	0.5	0.3	819	210	105
Speculation Animals	100	23		42000	9660	
Goats						
Does	42		17	12600		5100
Bucks	2		1	750		375
Replacement Does	7		2	1470		428
Replacement Bucks	0.3		0.3	79		60
Cattle						
Cows	3			9000		
Bulls						
Replacement Heifers	0.4			825		
Replacement Bulls						
Equipment (#)						
Tractors	1			30000		
Trucks	1			40000		
Farm Implements	2	1	1	6000	150	150
Buildings						
Tents	1		1	3000		3000
Pumps						
Draft Animals	4	3	2	10000	8400	5400
Other						
Subtotal				588393	138320	68085

Herds of sheep were the second most valuable resource next to land (dirham values by producer category: Producer A--170,690 DH, Producer B--35,770 DH, Producer C--13,572 DH). Prices used to estimate the value of livestock were based on ranges of prices prevalent at local markets (souks).

Livestock Production

Mixed herds of sheep and goats are common to pastoralists in this region. The majority of the herds were composed of sheep, which are more highly valued than goats for status, meat, and wool. Averaging herds to arrive at stock count charts (see Tables 3.4, 3.5 and 3.6) for the three categories resulted in goat ownership by the Type A and Type C producers. Producers in category B also own goats. However, the producers in the sample possessed virtually no goats. From observations and commonly held opinion, the goat is perceived as being a poor person's livestock. The low value relative to that of sheep enables a person with fewer economic resources to amass a larger herd of goats than sheep.

Table 3.4. Stockcount chart. Type A Producer--El Faija.

	SHEEP								GOATS						CATTLE						
	Ewes 28.8 kg.		Rams 33.6 kg.		Lambs 23.9 kg.		Spec. Animals 30.0 kg.		Does 21.4 kg.		Bucks 25.8 kg.		Kids 13.5 kg.		Cows 250 kg.		Bulls 350 kg.		Calves 125 kg.		Total MAUMs Required
MONTH	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	
JAN.	240	230	7.00	7.8	24	19	100	100	42	30	2.00	1.7		0.0	3	25		0.0	1.0	4.2	418
FEB.	240	230	7.00	7.8	35	28	85	85	42	30	2.00	1.7	15.0	6.8	3	25		0.0	1.0	4.2	419
MAR.	240	230	7.00	7.8	65	52	51	51	41	29	2.00	1.7	22.0	9.9	3	25		0.0	1.0	4.2	411
APR.	245	235	7.00	7.8	49	39	30	30	41	29	2.00	1.7		0.0	3	25		0.0	1.0	4.2	372
MAY	249	239	7.00	7.8	89	71		0	48	34	2.00	1.7		0.0	3	25		0.0	1.0	4.2	383
JUNE	250	240	7.00	7.8	70	56		0	48	34	2.00	1.7	5.0	2.3	3	25		0.0		0.0	367
JULY	250	240	8.00	9.0	55	44		0	48	34	2.00	1.7	13.0	5.9	3	25		0.0		0.0	359
AUG.	247	237	8.00	9.0	50	40	4	4	46	33	2.00	1.7	12.0	5.4	3	25		0.0		0.0	355
SEPT.	245	235	8.00	9.0		0	88	88	46	33	1.00	0.9	12.0	5.4	3	25		0.0		0.0	396
OCT.	242	232	8.00	9.0		0	86	86	42	30	1.00	0.9	12.0	5.4	3	25		0.0		0.0	389
NOV.	230	225	8.00	9.0		0	90	90	42	30	2.00	1.7		0.0	3	25		0.0		0.0	384
DEC.	238	228	7.00	7.8		0	108	103	42	30	2.00	1.7		0.0	3	25		0.0	1.0	4.2	405
TOTAL		2807		99.7		347		642		377		18.9		41.0		300		0.0		25.0	4658

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Table 3.5. Stockcount chart. Type B Producer--El Faija.

	SHEEP								GOATS				CATTLE			
	Ewes 28.8 kg.		Rams 33.6 kg.		Lambs 23.9 kg.		Spec. Animals 30.0 kg.		Does 0.0 kg.		Bucks 0.0 kg.		Kids 0.0 kg.		Cows 0 kg.		Bulls 0 kg.		Calves 0 kg.		Total MAUMs Required
MONTH	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	
JAN.	48	46	2.00	2.2	0	0	26	26		0		0.0		0.0		0		0.0		0.0	74.3
FEB.	48	46	2.00	2.2	6	5	14	14		0		0.0		0.0		0		0.0		0.0	67.1
MAR.	48	46	2.00	2.2	12	10	11	11		0		0.0		0.0		0		0.0		0.0	68.9
APR.	47	45	2.00	2.2	15	12	6	6		0		0.0		0.0		0		0.0		0.0	63.3
MAY	47	45	2.00	2.2	25	20		0		0		0.0		0.0		0		0.0		0.0	57.2
JUNE	45	43	2.00	2.2	12	10		0		0		0.0		0.0		0		0.0		0.0	55.0
JULY	45	43	2.00	2.2	12	10		0		0		0.0		0.0		0		0.0		0.0	53.0
AUG.	43	41	2.00	2.2	12	10		0		0		0.0		0.0		0		0.0		0.0	53.1
SEPT.	43	41	2.00	2.2	10	8	16	16		0		0.0		0.0		0		0.0		0.0	67.5
OCT.	48	46	2.00	2.2	10	8	20	20		0		0.0		0.0		0		0.0		0.0	76.3
NOV.	48	46	2.00	2.2	0	0	20	20		0		0.0		0.0		0		0.0		0.0	68.3
DEC.	48	46	2.00	2.2	0	0	22	22		0		0.0		0.0		0		0.0		0.0	70.3
TOTAL		536		26.9		91		135		0		0.0		0.0		0		0.0		0.0	788.2

Table 3.6. Stockcount chart. Type C Producer--El Faija.

	SHEEP								GOATS						CATTLE						
	Ewes 25.0 kg.		Rams 28.5 kg.		Lambs 19.0 kg.		Spec. Animals 0.0 kg.		Does 22.0 kg.		Bucks 28.0 kg.		Kids 16.0 kg.		Cows 0 kg.		Bulls 0 kg.		Calves 0 kg.		Total MAUMs Required
MONTH	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	
JAN.	25	21	1.00	1.0	3	2		0	17	12	1.00	0.9	1.0	0.5		0		0.0		0.0	37.6
FEB.	24	20	1.00	1.0	3	2		0	17	12	1.00	0.9	1.0	0.5		0		0.0		0.0	36.8
MAR.	24	20	1.00	1.0	3	2		0	17	12	1.00	0.9	1.0	0.5		0		0.0		0.0	36.8
APR.	22	18	1.00	1.0	3	2		0	16	12	1.00	0.9	1.0	0.5		0		0.0		0.0	34.4
MAY	17	14	1.00	1.0	7	4		0	16	12		0.0	1.0	0.5		0		0.0		0.0	31.8
JUNE	17	14	1.00	1.0	9	6		0	15	11	1.00	0.9	3.0	1.6		0		0.0		0.0	34.4
JULY	16	13	1.00	1.0	15	10		0	14	10	1.00	0.9	5.0	2.7		0		0.0		0.0	37.7
AUG.	16	13	1.00	1.0	14	9		0	13	10	1.00	0.9	5.0	2.7		0		0.0		0.0	36.3
SEPT.	17	14	1.00	1.0	14	9		0	13	10	1.00	0.9	7.0	3.7		0		0.0		0.0	38.2
OCT.	19	16	1.00	1.0	14	9		0	17	12	1.00	0.9	3.0	1.6		0		0.0		0.0	40.7
NOV.	23	19	1.00	1.0	14	9		0	17	12	1.00	0.9	3.0	1.6		0		0.0		0.0	44.0
DEC.	25	21	1.00	1.0	1	1		0	18	13	1.00	0.9	2.0	1.1		0		0.0		0.0	37.6
TOTAL		204		11.4		63		0		139		10.3		17.6		0		0.0		0.0	446.1

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Lambing was sporadic throughout the year. A few producers reported August lambing. However, the most frequently cited months for lambing were October and December through March. Producers claimed that their least favorite time for lambing was the winter, yet December and January had the highest lambing rate. Type A and B producers cooperating in the study indicated that they sold the majority of their speculation rams in January and February while Type C producers said that they prefered to sell in May and June to offset harvest costs. Time of sale is often coordinated with periods of peak demand around Ramadan and associated religious holidays, if possible. As herd sizes, and resource sets in general, became larger, the production strategy became more market oriented, with production being sold according to demand characteristics. Nevertheless, the sale of livestock tended to be mostly dependent upon the producers' periodic needs for money.

Land ownership apparently had little relationship to the number of animals owned, though it may plat an important role in herd production. All producers grazed at least some of their animals on collective land throughout the year, keeping herds closer to the home in the winter months when they also fed supplements. A few producers in the area grazed some of their animals on government forest land for the summer months. There was more grass in the forest because of higher rainfall. This grazing alternative did not appear to be an avenue open to many producers. Access to communal range is becoming more limited, thereby increasing the importance of access to private pasture or crop aftermath.

Tables 3.7, 3.8 and 3.9, indicate that the feeding of supplements generally corresponds to periods of higher nutritional need and the levels differ among categories. Producers began supplementing in early fall and used a variety of sources of feed. Barley was the most universally fed supplemental feed. In addition to that produced, barley and straw were also purchased. Amounts of forage reported as supplied from collective rangeland are thought to be substantially overestimated. These estimates were derived mathematically by subtracting the more easily estimated amounts of forage derived from non-collective land sources from an estimate of animal forage (dry matter) requirements. The fallacies associated with such an assumption are recognized, however, under the circumstances, this procedure provides the best estimate of collective land forage productivity available. Animal production levels and measured weight changes indicate that nutritional requirements of the animals were not being met, therefore, it is highly likely that collective rangelands provide much less forage than forage balance charts indicate.

The level of supplemental feeding reported varied according to the class of animal and the resource sets of the producers. Average amounts of feed given to various categories of sheep per day for the whole sample were: rams - 650 g, ewes - 400 g, and lambs - 198 g. Using January levels of supplemental feed as a guide, category averages were: Type A - 230 g, Type B - 430 g, and Type C - 300 g. Type B and C producers had smaller herds and could not afford to transport them to distant grazing areas. Essentially their entire herds grazed wheat and barley stubble after harvest. Type A producers grazed a larger portion of their

animals on stubble during late summer.

Table 3.7. Forage balance chart. Type A Producer--El Faija.

SOURCES OF FEED

MONTH	Source #1 Coll. Range		Source #2 Dom. Range		Source #3 Pvt. Range		Source #4 Fallow/Stub.		Source #5 Hay/Straw		Source #6 Feed Grains		Source #7 Cr. By-Prod.		Source #8 Com. Supple.		TOTAL MAUMs AVAIL.	TOTAL MAUMs REQUIRED
	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs		
JAN.		171		0		0		0	4.41	163	2.00	74		0	0.27	10	418	418
FEB.		172		0		0		0	4.41	163	2.00	74		0	0.27	10	419	419
MAR.		164		0		0		0	4.41	163	2.00	74		0	0.27	10	411	411
APR.		327		0		0		0		0	0.95	35		0	0.27	10	372	372
MAY		373		0		0		0		0		0		0	0.27	10	383	383
JUNE		367		0		0		0		0		0		0		0	367	367
JULY		359		0		0		0		0		0		0		0	359	359
AUG.		176		0	0.42	16	4.14	153		0		0		0	0.27	10	355	355
SEPT.		217		0	0.42	16	4.14	153		0		0		0	0.27	10	396	396
OCT.		92		0	0.42	16	4.14	153	2.18	81	1.00	37		0	0.27	10	389	389
NOV.		219		0		0		0	2.18	81	2.00	74		0	0.27	10	384	384
DEC.		159		0		0		0	4.37	162	2.00	74		0	0.27	10	405	405
TOTAL	75.5	2795	0.0	0	1.3	47	12.4	460	22.0	813	11.9	442	0.0	0	2.7	100	4658	4658

Table 3.8. Forage balance chart. Type B Producer--El Faija.

SOURCES OF FEED

MONTH	Source #1 Coll. Range		Source #2 Dom. Range		Source #3 Pvt. Range		Source #4 Fallow/Stub.		Source #5 Hay/Straw		Source #6 Feed Grains		Source #7 Cr. By-Prod.		Source #8 Com. Supple.		TOTAL MAUMs AVAIL.	TOTAL MAUMs REQUIRED
	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs		
JAN.		26		0		0		0	0.71	26	0.60	22		0		0	74	74.3
FEB.		13		0		0		0	0.71	26	0.60	22		0		0	67	67.1
MAR.		27		0		0		0	0.71	26	0.41	15		0		0	69	69.9
APR.		65		0		0		0		0		0		0		0	65	65.3
MAY		67		0		0		0		0		0		0		0	67	67.2
JUNE		55		0		0		0		0		0		0		0	55	55.0
JULY		55		0		0		0		0		0		0		0	55	55.0
AUG.		1		0		0	1.40	52		0		0		0		0	53	53.1
SEPT.		1		0		0	1.80	67		0		0		0		0	68	67.5
OCT.		10		0		0	1.80	67		0		0		0		0	76	76.3
NOV.		27		0		0		0	0.71	26	0.40	15		0		0	68	68.3
DEC.		22		0		0		0	0.71	26	0.60	22		0		0	70	70.3
TOTAL	10.1	375	0.0	0	0.0	0	5.0	195	3.6	131	2.6	97	0.0	0	0.0	0	788	788.2

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Table 3.9. Forage balance chart. Type C Producer--El Faija.

SOURCES OF FEED

MONTH	Source #1 Coll. Range		Source #2 Dom. Range		Source #3 Pvt. Range		Source #4 Fallow/Stub.		Source #5 Hay/Straw		Source #6 Feed Grains		Source #7 Cr. By-Prod.		Source #8 Com. Supple.		TOTAL MAUMs AVAIL.	TOTAL MAUMs REQUIRED
	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs		
JAN.		12		0		0		0	0.50	19	0.20	7		0		0	38	37.6
FEB.		11		0		0		0	0.50	19	0.20	7		0		0	37	36.8
MAR.		13		0		0		0	0.50	19	0.15	6		0		0	37	36.8
APR.		31		0		0		0		0	0.10	4		0		0	34	34.4
MAY		28		0		0		0		0	0.10	4		0		0	32	31.9
JUNE		31		0		0		0		0	0.10	4		0		0	34	34.4
JULY		34		0		0		0		0	0.10	4		0		0	38	37.7
AUG.		1		0		0	0.91	34		0	0.05	2		0		0	36	36.3
SEPT.		0		0		0	0.92	34		0	0.10	4		0		0	38	38.2
OCT.		3		0		0	0.92	34		0	0.10	4		0		0	41	40.7
NOV.		22		0		0		0	0.40	15	0.20	7		0		0	44	44.0
DEC.		12		0		0		0	0.50	19	0.20	7		0		0	38	37.6
TOTAL	5.3	196	0.0	0	0.0	0	2.8	102	2.4	89	1.6	59	0.0	0	0.0	0	446	446.1

Type A producers may have been less dependent upon supplements than producers in the other categories because of their larger land base which served as a forage alternative to the ranges. Type A producers also tended to utilize a broader range of feed and forage sources than Producers B or C.

Crop Production

According to the respondents, all of their crop land is irrigated. They claimed that no one has practiced dryland farming since the onset of recent droughts, though the occurrence of dryland farming may be observed in the region. This discrepancy between their responses and observations may be related to the reticence that local producers showed in providing information about their land holdings. If dryland farming has in fact declined in recent years, this may be a positive yet short-lived trend in light of what appears to be ever increasing pressure for moving cultivated agriculture onto rangelands which are not capable of sustaining such land use practices. Fruit cultivation for commercial purposes has increased during the last seven to ten years. During the period if study, the trees of two producers in the sample were bearing fruit which was sold.

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Tables 3.10, 3.11 and 3.12 indicate that the two prevalent crops were barley and wheat. All three types of producers planted more than 50% of their land in these two crops. Wheat was used in the home and for seeding. Type A producers prefered to plant fields with their own wheat, claiming they then know it is good seed. Secondary crops were beans, potatoes, corn, and alfalfa. The latter two were used as livestock feed. Most producers had a very small bean harvest during the study year. Farmers complained that their cycle of irrigation water did not coincide with the flowering of the plants (when irrigation was critical) and that most of the plants died.

Type A producers who hired herders paid them with cash, products of the herd and grains. Type B producers did not hire sharecroppers nor herders. One producer in category C hired a sharecropper who received one-fifth of the harvest.

Producers of Types A and B fertilized most crops but Type C producers reported no use of fertilizer except manure on plots used to raise vegetables. Manure is said to produce much sweeter potatoes than do commercial fertilizers, which are believed to be too harsh.

Land was prepared for wheat and barley in October and early November. The fields were plowed after the first rains when the soil was soft and more easily worked with animal traction. It is important to have the seed in the ground by mid-autumn in order to reap the full benefit of the winter precipitation, which falls November through February. Vegetables were planted in May and June after the harvest of grains. Larger producers with more hectares allowed land to remain fallow for one year. Other irrigated fields were not replanted after the grain harvest, probably due to the limited amounts of irrigation water available in mid-summer. Two producers, with only two hectares each (Type C), planted cereals in the same fields each year. This practice, according to the producers, accounts for low yields. Two producers owned tractors. One used his to plow the fields, the other did not, indicating that his fields were too small and more efficiently plowed with draft animals. He may have rented the tractor out or had use agreements with other family members. Tractors are commonly used for transportation as well as for field work. All producers had at least two draft animals. Fields were worked with these animals and the traditional plow.

Barley was harvested before wheat in all cases. The fact that some large producers seemed in no hurry to complete the harvest unusual. One producer in particular reported that though the barley harvest took only five work days, the work was spread over a three-week period. (He blamed this on the unreliability of day laborers who often do not arrive for work.) Threshing took place after both crops had been harvested. The two producers who had tractors used them to thresh grains, producing straw which is very fine and thought to be excellent forage because of higher digestibility. The remaining eight producers used a combination of horses, mules and donkeys. A reciprocal arrangement existed between neighbors who borrowed each other's animals to complete the threshing.

Table 3.10. Crop production. Type A Producer--El Faija.

Crop Production by Field or by Crop

Plot	Crop	Area ha	Seed "Var."	Seed Amt. qx	Seed Rate qx/ha	Fert.	Fert. Amt. qx	Fert. Rate qx/ha	Herbi.	Herb. Amt. liters	Herb. Rate l/ha	Pesti.	Pest. Amt. liters	Pest. Rate l/ha	Water Amt. units	Water Rate u/ha	YIELD Tons	Yield Rate T/ha
		Input Levels/Rates															Output L/R	
D1					0.0			0.0			0.0			0.0		0.0		0.0
D2					0.0			0.0			0.0			0.0		0.0		0.0
D3					0.0			0.0			0.0			0.0		0.0		0.0
D4					0.0			0.0			0.0			0.0		0.0		0.0
D5					0.0			0.0			0.0			0.0		0.0		0.0
D6					0.0			0.0			0.0			0.0		0.0		0.0
D7					0.0			0.0			0.0			0.0		0.0		0.0
D8	Fallow				0.0			0.0			0.0			0.0		0.0		0.0
D9	Straw,etc																	0.0
D10	Stubble																0.0	1.2
I1	Wheat	4.2	Local	4.6	1.1	Unknown	2.5	0.6			0.0			0.0	?	0.0	1.6	0.4
I2	Barley	4.8	Local	5.1	1.1	Unknown	2.5	0.5			0.0			0.0	?	0.0	1.7	0.4
I3	Corn	1.8	Local	0.4	0.2	Unknown	0.2	0.1			0.0			0.0	?	0.0	0.7	0.4
I4	Veg.	0.7	Local	0.5	0.7	Unknown	0.3	0.4			0.0			0.0	?	0.0	0.3	0.5
I5	Fruit	1.4	Apples		0.0			0.0			0.0			0.0		0.0	3.0	2.1
I6					0.0			0.0			0.0			0.0		0.0		0.0
I7	Forage #1	0.7	Alfalfa		0.0			0.0			0.0			0.0	?	0.0	0.8	1.1
I8	Forage #2				0.0			0.0			0.0			0.0		0.0		0.0
I9	Straw,etc	10.8															3.0	0.3
I10	Stubble	11.5															13.8	1.2

Input Totals Seed 11 Fertilizer 5 Herbicide 0 Pesticide 0 Water 0

Total Dryland 0
Total Irr. Land 14
Total Cropland 14

Total Fallow & Crop Residue Forage Yield from Dry Cropland 0
Rate of Fallow & Crop Residue Forage Yield from Dry Cropland 0.0
Total Forage & Crop Residue Forage Yield from Irr. Cropland 16
Rate of Forage & Crop Residue Forage Yield from Irr. Cropland 1.3
Total Fallow & Crop Residue Forage Yield 1[illegible]

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Table 3.11. Crop production. Type B Producer--El Faija.

Crop Production by Field or by Crop

Plot	Crop	Area ha	Seed "Var."	Seed Amt. qx	Seed Rate qx/ha	Fert.	Fert. Amt. qx	Fert. Rate qx/ha	Herbi.	Herb. Amt. liters	Herb. Rate l/ha	Pesti.	Pest. Amt. liters	Pest. Rate l/ha	Water Amt. units	Water Rate u/ha	YIELD Tons	Yield Rate T/ha
		Input Levels/Rates															Output L/R	
D1					0.0			0.0			0.0			0.0		0.0		0.0
D2					0.0			0.0			0.0			0.0		0.0		0.0
D3					0.0			0.0			0.0			0.0		0.0		0.0
D4					0.0			0.0			0.0			0.0		0.0		0.0
D5					0.0			0.0			0.0			0.0		0.0		0.0
D6					0.0			0.0			0.0			0.0		0.0		0.0
D7					0.0			0.0			0.0			0.0		0.0		0.0
D8	Fallow				0.0			0.0			0.0			0.0		0.0		0.0
D9	Straw,etc																	0.0
D10	Stubble																0.0	1.2
I1	Wheat	1.0	Local	1.0	1.0	Unknown	0.8	0.8			0.0			0.0	?	0.0	0.6	0.6
I2	Barley	1.6	Local	0.8	0.5	Unknown	0.8	0.5			0.0			0.0	?	0.0	0.8	0.5
I3	Corn	1.0	Local	0.3	0.3	Unknown	0.3	0.3			0.0			0.0	?	0.0	0.2	0.2
I4	Veg.	1.0	Local	2.5	2.5			0.0			0.0			0.0	?	0.0	0.9	0.9
I5					0.0			0.0			0.0			0.0		0.0		0.0
I6					0.0			0.0			0.0			0.0		0.0		0.0
I7	Forage #1	0.1	Alfalfa		0.0			0.0			0.0			0.0		0.0	0.1	1.0
I8	Forage #2				0.0			0.0			0.0			0.0		0.0		0.0
I9	Straw,etc	3.6															4.0	1.1
I10	Stubble	3.6															4.3	1.2

Input Totals Seed 5 Fertilizer 2 Herbicide 0 Pesticide 0 Water 0

Total Dryland 0
Total Irr. Land 5
Total Cropland 5

Total Fallow & Crop Residue Forage Yield from Dry Cropland 0
Rate of Fallow & Crop Residue Forage Yield from Dry Cropland 0.0
Total Forage & Crop Residue Forage Yield from Irr. Cropland 8
Rate of Forage & Crop Residue Forage Yield from Irr. Cropland 1.8
Total Fallow & Crop Residue Forage Yield 8

Table 3.12. Crop production. Type C Producer--El Faija.

Crop Production by Field or by Crop

Plot	Crop	Area ha	Seed "Var."	Seed Amt. qx	Seed Rate qx/ha	Fert.	Fert. Amt. qx	Fert. Rate qx/ha	Herbi.	Herb. Amt. liters	Herb. Rate l/ha	Pesti.	Pest. Amt. liters	Pest. Rate l/ha	Water Amt. units	Water Rate u/ha	YIELD Tons	Yield Rate T/ha
		Input Levels/Rates															Output L/R	
D1					0.0			0.0			0.0			0.0		0.0		0.0
D2					0.0			0.0			0.0			0.0		0.0		0.0
D3					0.0			0.0			0.0			0.0		0.0		0.0
D4					0.0			0.0			0.0			0.0		0.0		0.0
D5					0.0			0.0			0.0			0.0		0.0		0.0
D6					0.0			0.0			0.0			0.0		0.0		0.0
D7					0.0			0.0			0.0			0.0		0.0		0.0
D8	Fallow				0.0			0.0			0.0			0.0		0.0		0.0
D9	Straw,etc																	0.0
D10	Stubble																0.0	1.0
I1	Wheat	1.1	Local	1.2	1.1			0.0			0.0			0.0	?	0.0	0.5	0.5
I2	Barley	1.7	Local	1.7	1.0			0.0			0.0			0.0	?	0.0	0.7	0.4
I3	Corn	0.3	Local	0.2	0.5			0.0			0.0			0.0	?	0.0	0.2	0.5
I4	Veg:	0.6	Local	0.8	1.3			0.0			0.0			0.0	?	0.0	0.3	0.5
I5					0.0			0.0			0.0			0.0		0.0		0.0
I6					0.0			0.0			0.0			0.0		0.0		0.0
I7	Forage #1	0.3	Alfalfa		0.0			0.0			0.0			0.0	?	0.0	0.3	0.9
I8	Forage #2				0.0			0.0			0.0			0.0		0.0		0.0
I9	Straw,etc	3.1															2.4	0.8
I10	Stubble	3.1															3.1	1.0

Input Totals Seed 4 Fertilizer 0 Herbicide 0 Pesticide 0 Water 0

Total Dryland 0
Total Irr. Land 4
Total Cropland 4

Total Fallow & Crop Residue Forage Yield from Dry Cropland 0
Rate of Fallow & Crop Residue Forage Yield from Dry Cropland 0.0
Total Forage & Crop Residue Forage Yield from Irr. Cropland 6
Rate of Forage & Crop Residue Forage Yield from Irr. Cropland 1.4
Total Fallow & Crop Residue Forage Yield 6

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Labor Use

Activities in the month of October required the greatest number of person hours for all three categories of producers (see Tables 3.13, 3.14 and 3.15). This was because of the large amount of time devoted to the harvest of vegetables and the plowing and seeding of fields for cereal crops. March had the fewest number of labor hours for Types A and B producers. For Type C producers, December required the least labor partly as a result of decreased hours of grazing on rangeland.

Table 3.13. Labor use in person/days per month. Type A Producer--El Faija.

ACTIVITY	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
Perimeter grazing	25.0	25.0	25.0	40.0	40.0	40.0	20.0	20.0	40.0	40.0	20.0	25.0	360.0
Stubble grazing							20.0	20.0			20.0		60.0
Supplemental feeding	15.0	15.0	15.0							10.0	15.0	15.0	85.0
Shearing					2.7								2.7
Breeding													0.0
Lambing	3.3	3.3								1.7	1.7	2.5	12.5
Barn cleaning				25.0					15.0				40.0
Maintenance				15.0									15.0
Health tasks				2.7					2.7				5.3
Domestic activities	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	960.0
Plowing/Seeding						13.3	2.7			25.0	2.7		43.7
Irrigation						4.2	4.2			8.3	2.7		19.3
Fertilization						2.7	1.7			8.3	1.7		14.3
Harvesting					33.3	33.3			16.7	16.7			100.0
Transportation						6.7	6.7		4.0	4.0			21.3
Threshing						16.7	16.7				16.7		50.0
Small Animal Husbandry	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	60.0
Sales/Marketing	1.3	1.3	1.3	4.0	4.0	1.3	1.3	4.0	1.3	1.3	1.3	1.3	24.0
													0.0
TOTAL	129.7	129.7	126.3	171.7	165.0	203.2	156.2	129.0	164.7	200.3	166.7	128.8	1873.2

Table 3.14. Labor use in person/days per month. Type B Producer--El Faija.

ACTIVITY	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
Perimeter grazing	25.0	25.0	25.0	40.0	40.0	40.0	20.0	20.0	40.0	40.0	20.0	25.0	360.0
Stubble grazing							20.0	20.0			20.0		60.0
Supplemental feeding	5.0	5.0	5.0								5.0	5.0	25.0
Shearing					1.3								1.3
Breeding													0.0
Lambing	1.7	1.7								0.8	0.8	1.7	6.7
Barn cleaning				16.7									16.7
Maintenance				8.3									8.3
Health tasks				1.3					1.3				2.7
Domestic activities	80.0	80.0	80.0	80.0	80.0	60.0	80.0	80.0	80.0	80.0	80.0	80.0	960.0
Plowing/Seeding						8.3	3.3			8.3	3.3		23.3
Irrigation						5.0	2.7			5.0	2.7		15.3
Fertilization						2.7	2.7			5.0	2.7		13.0
Harvesting						13.3	2.7			13.3	2.7		32.0
Transportation						4.0	4.0			6.7	3.3		18.0
Threshing							10.0				6.7		16.7
Small Animal Husbandry	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	60.0
Sales/Marketing	1.3	1.3	1.3	4.0	4.0	1.3	1.3	4.0	1.3	1.3	1.3	1.3	24.0
TOTAL	118.0	118.0	116.3	155.3	130.3	159.7	151.7	129.0	127.7	165.5	153.5	118.0	1643.0

Table 3.15. Labor use in person/days per month. Type C Producer--El Faija.

ACTIVITY	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
Perimeter grazing	25.0	25.0	25.0	40.0	40.0	40.0	20.0	20.0	40.0	40.0	20.0	20.0	355.0
Stubble grazing							20.0	20.0			20.0		60.0
Supplemental feeding	5.0	5.0	5.0								5.0	5.0	25.0
Shearing					1.3								1.3
Breeding													0.0
Lambing	1.7	1.7								0.8	0.8	1.7	6.7
Barn cleaning				16.7									16.7
Maintenance				5.0									5.0
Health tasks				1.3					1.3				2.7
Domestic activities	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	960.0
Plowing/Seeding						5.0	2.7			6.7	2.7		17.0
Irrigation						2.7	2.7			5.0	2.7		13.0
Fertilization						2.7	2.7				2.7		8.0
Harvesting						10.0	5.0			11.7	1.3		28.0
Transportation						4.0	4.0			6.7	3.3		18.0
Threshing							10.0				10.0		20.0
Small Animal Husbandry	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	60.0
Sales/Marketing	1.3	1.3	1.3	4.0	4.0	1.3	1.3	4.0	1.3	1.3	1.3	1.3	24.0
TOTAL	118.0	118.0	116.3	152.0	130.3	150.7	153.3	129.0	127.7	157.2	154.8	113.0	1620.3

Small animal husbandry was performed exclusively by women. Both rabbits and chickens provided an additional protein source, and one producer sold rabbits. The preparation of wool for sale and home use was also done by female family members. In this region, men do not prepare wool nor do they weave. Among the families interviewed, women did not herd or work in the fields at any time.

Hired agricultural labor appeared to be divided into four categories: day laborers, "individual field labor" (gorja), workers who live in the household working year-round, and the khammes. Most producers hired day labor for the harvest. Wages ranged from 17 to 22.50 Dirhams per day. The gorja is an interesting arrangement wherein one man is hired to complete all the production tasks for one piece of land. A set fee is quoted to him and he decides if the price is appropriate for the time involved. This same individual may work for several producers, spacing out his activities. Only one producer of Type A made use of this type of labor.

Type A producers had two to four laborers who lived with them year-round, receiving room and board, and a salary of 3,550 DH per year. One producer employed a khammes. This was a "one-fifth" arrangement whereby the laborer, contracted for one year, received one-fifth of the harvest as payment. This type of arrangement is what others have referred to as a "leveling mechanism" for access to resources between the landowners and the landless a practice that some producers say is becoming too expensive (especially in years of poor crop yields). Furthermore, workers are increasingly reluctant to be bound to one place for that length of time.

Several types of arrangements existed between producers and herders. Large producers who separated their animals in the summer, hired an additional herder at that time, paying him half of the "profits" from sales of that particular herd. The monetary wage for a year-round herder ranged from 3,000 to 4,000 dirhams. In addition, the herder received the products of seven

to ten ewes, a lamb for Aid El Kebir, a djelleba and sandals. Some producers also gave partial payment in grain or flour. Two producers held their animals in association. These animals were actually owned by another producer. One of these herders who cared for small herds of a number of producers, received 1,250 DH a year and some grain. The other received half of the "profit" of livestock sales.

TIMAHDITE

The Timahdite Rural Commune is composed of the Ait Arga du Guigou tribe. This tribe is divided into four fractions, which comprise the principal administrative units. These fractions are the Ait Ben Yacoub, Ait M'hamed, Ait Ben Hcine and Ait Hcine ou Hand. The majority of the population of Timahdite practice small-scale agriculture and livestock production. Most of the dwellings are in the Timahdite village or in the Guigou river valley. The Ait Arfa du Guigou are now permantly settled on what used to be their summer pastures. Winters in Timahdite can be severe, and there is often snow. Most animals are confined and fed supplements during the winter. In the warmer months they are taken out to graze the communal lands in the valley and in the mountains. Each fraction has rights to particular areas of the communal rangeland, and recently these boundaries were marked in order to control trespassing and potential conflict.

SAMPLE SELECTION: **TIMAHDITE**

Twelve families were chosen for the Agro-Pastoral Systems Study from information from the 1982 Moyen Atlas Project survey. Producers were chosen from each of the four tribal fractions, and from three herd size categories. The herd size categories were: under 100 sheep, between 100 and 200, and over 200 sheep. At the end of the study, the sample consisted of nine producers in four categories. The wealthiest producer, with approximately 1000 sheep, had a management system different enough from the others that he warranted a category of his own.

CATEGORIZATION OF PRODUCERS: **TIMAHDITE**

Type A

The one Type A producer in the sample was by far the wealthiest. He owned 700 more sheep than any other producer in the sample, and was the only one to own a motor vehicle. He and his two brothers owned 600 hectares of private rangeland. Access to this land may be the single most important factor which set him apart from the rest of the producers, and allowed him to accumulate such a large herd of sheep. While there are not many producers in Timahdite who are quite so well off, work in the area has shown that these few Type A producers owned the majority of the sheep which grazed on the collective lands.

Type B

The Type B producer had between 200 and 500 head of sheep. These producers were interested in modern ideas and production

techniques, and possessed the resources enabling adoption. The only members of the Association Nationale des Ovins et Caprins (ANOC) sampled were in this category. One of these two producers was actively involved in developing a certified herd of sheep of the Timahdite breed.

Type C

The Type C producers had between 100 and 200 head of sheep. They seemed to be working at the subsistence level. They did not appear to have the real options of expanding their operations or of intensifying production.

Type D

The two Type D producers had less than 100 head of sheep and were considered marginal producers. One was probably on his way out of livestock production, being a retired military officer and dependent on his military pension for the majority of his income. The other was a young man just beginning to develop his first herd, whose family performed nearly all tasks with their own labor and who grew potatoes for cash.

Sheep were the basis for the producer characterizations. However, numbers of goats and cattle and amount of land generally decreased proportionally to sheep numbers. While livestock and cropping activities varied according to the amount of resources available to the producer, there was no evidence of major differences in basic production strategies. Those with more resources were simply better able to carry out the strategy.

The apparent basic goal of production was to have as large a herd as possible, to be able to produce enough wheat to feed the family for the year, and to produce enough barley and oats to feed the animals. This goal was rarely attained (only one producer in the sample managed to produce all of his barley needs) and producers used a variety of methods to come up with the difference. Most purchased supplemental feeds, often selling sheep to do so. Some tried to raise cash by growing potatoes. Many cut wood in the mountains and sold it. Some depended on outside sources of income such as pensions or remittances from family members working in the cities or abroad.

An important thing to keep in mind is that none of these categories are static. Given some luck and enough rain, a producer could raise his fortunes substantially. Conversely, an event such as the bad hailstorms in the spring of 1985 could set production back far enough that it could take a family years to recover. History has shown many drastic changes in the fortunes of Berber families.

Human Resources

Type B producers in the study averaged 14 family members, which was at least twice as many as for the other categories (Table 3.16). Because of the small sample size, this difference may be completely spurious. However, it does make sense when one considers that an increased resource base allows one to support more people. That the Type A family only had five members was also rather unexpected. This is only one example of a particularly wealthy family in the area, however, and others could have a quite different family structure.

Table 3.16. Family composition. Type A, B, C and D Producers--Timahdite.

AGE	ACTIVE		INACTIVE		SCHOOL		TOTAL	
Type A	M	F	M	F	M	F	M	F
0 - 6							0	0
7 - 15	1				1		2	0
16 - 24					1		1	0
24 - 60	1	1					1	1
61 +							0	0
TOTAL	2	1	0	0	2	0	4	1
Type B								
0 - 6			1	2			1	2
7 - 15	1	2			1		2	2
16 - 24	1	2					1	2
24 - 60	2	2					2	2
61 +							0	0
TOTAL	4	6	1	2	1	0	6	8
Type C								
0 - 6				1			0	1
7 - 15		1			1		1	1
16 - 24							0	0
24 - 60	1	1					1	1
61 +							0	0
TOTAL	1	2	0	1	1	0	2	3
Type D								
0 - 6			1				1	0
7 - 15							0	0
16 - 24	2	1					2	1
24 - 60		1		1			0	2
61 +	1						1	0
TOTAL	3	2	1	1	0	0	4	3

All three sons in the Type A family have been educated (Table 3.17). Two are still attending school. This is a major difference between the categories. The Type B and C families typically send one or two sons through primary school as a minimum. Neither of the Type D families had any members with more than one year of schooling. In Timahdite, going beyond

primary school means studying in Azrou. Only families with the financial resources, or a strong desire to educate their children, do so. Even in Timahdite itself access to schools is often difficult. Many douars are simply too far for the children to walk back and forth. There are also language problems which cause high attrition. The first language of the majority of these children is Tamazight (Middle Atlas Berber), and school is often their first introduction to Arabic. Any child who fails a grade twice is out of school for good, and the number of these drop-outs is growing.

Table 3.17. Level of schooling. Type A, B, C and D Producers--Timahdite.

Type A	0 - 1	2 - 5	6 - 9	10 - 13	14 +	TOTAL
MALES	1	2	1			4
FEMALES	1					1
TOTAL	2	2	1	0	0	5
Type B						
MALES	4	1	1			6
FEMALES	8					8
TOTAL	12	1	1	0	0	14
Type C						
MALES	1		1			2
FEMALES	3					3
TOTAL	4	0	1	0	0	5
Type D						
MALES	4					4
FEMALES	3					3
TOTAL	7	0	0	0	0	7

Estimated Value of Producer Resource Sets

Table 3.18 indicates that the value of the resource sets for producer Types A through D become progressively smaller. The value of the 600 hectares of private rangeland owned by the Type A producer was estimated at 2,000 DH/ha. With land being the most valuable resource that producers owned in the study, it placed him high above the others in terms of wealth.

As noted above, the differences between the other producers in terms of resources do not seem to create major differences in management strategies. One factor which may partly account for this is the size of the Type B family. The per capita value of resources for this category was estimated at near 37,000 Dhs. For the Type C family, estimated value of resources on a per capita basis was approximately 55,000 DH. Keeping in mind that the majority of the people in the Type B family are small children, this dampens the advantage of the Type B in terms of resources. The relationship between family size and the value of resources is obvious. What is not so clear is whether one is caused by or logically follows the other.

Table 3.18. Estimated value of producer resource sets. Timahdite.

INVENTORY (Producer Category)	QUANTITY (units) A	B	C	D	VALUE (DHS) A	B	C	D
Land/Rights (ha/MAUMs)								
Irrigated Cropland	17	10.9	12.8	11.4	212500		160375	142250
Dry Cropland	1	16.7	3.8	5	7500	136500	28725	37500
Private Range/Pasture	600				1200000	125025		
Grazing Rights								
Livestock (head)								
Sheep								
Ewes	390	243	112	60	175500	109350	50400	27000
Rams	17	12	5	2	10200	7200	3000	1200
Replacement Ewes	190	60.8	28		81320	26022	11984	
Replacement Rams	4.5	2.4			2475	1320	550	
Speculation Animals	40	47	1		14000	16450		
Goats								
Does		104	4			36400	1400	
Bucks		4	1			1600	400	
Replacement Does		26	0.8			5850	180	
Replacement Bucks		0.8	0.2			240	60	
Cattle								
Cows	3	4	2	2	13500	18000	9000	9000
Bulls								
Replacement Heifers	0.4	0.5	0.3	0.3	760	1000	500	500
Replacement Bulls								
Equipment (#)								
Tractors								
Trucks								
Farm Implements	1	1	1	1	2500	150	150	150
Buildings		0.33				6600		
Tents	2	1			6000	5000		
Pumps	1				3500			
Draft Animals	4	8	3	3	11600	16000	6501	6501
Other								
Total					1741355	512707	273225	224101

Land, again, is the most valuable resource. Land values acquired from the Centre du Travaux in Azrou were 7,500 Dhs/ha for dry land and 12,500 Dhs/ha for irrigated land. Animals were valued based on local market prices.

Livestock Production

Since the Timahdite Perimeter comprises the entire Rural Commune of Timahdite, grazing on that perimeter can occur year-round. Traditionally, what is now the Timahdite Rural Commune was the summer range for the livestock of the Ait Arfa du Guigou tribe. This tribe would spend their winters in the valleys of Azrou and Adarouch. Now, they are restricted to their summer grazing area. Higher mountain pastures are still grazed from about June until October, at which time animals are moved down to the lower-lying areas nearer the dwellings. A number of producers keep their animals in a barn all winter and feed them

hay or straw, barley and oats. In any case, because of the cold and frequent snow cover, all producers find it necessary to supplement the scarce forage found on the rangelands in the wintertime.

Most of the lambs are born between October and April, with peaks in late fall and early spring. Though mortality of winter lambing is high, producers rarely try to control breeding.

Estimated livestock numbers throughout the year are presented in stock count charts (Tables 3.19, 3.20, 3.21 and 3.22) to provide a basis for estimating forage requirements over the course of year.

Table 3.19. Stock count chart. Type A Producer--Timahdite.

	SHEEP								GOATS				CATTLE					
	Ewes 25.9 kg.		Rams 34.6 kg.		Lambs 22.6 kg.		Spec. Animals 30.0 kg.		Does 0.0 kg.		Bucks 0.0 kg.		Kids 0.0 kg.		Cows 250 kg.		Bulls 350 kg.		Calves 140 kg.		Total MAUMs Required
MONTH	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	
JAN.	565	544	17.0	19.6	20	15	25	25	0		0.0		0.0		3	25		0.0	1.0	4.7	633.6
FEB.	565	544	17.0	19.6	75	57	22	22	0		0.0		0.0		3	25		0.0	1.0	4.7	672.1
MAR.	570	549	17.0	19.6	130	98	20	20	0		0.0		0.0		3	25		0.0	1.0	4.7	716.3
APR.	575	554	17.0	19.6	185	139	20	20	0		0.0		0.0		3	25		0.0		0.0	757.9
MAY	580	559	17.0	19.6	260	196	15	15	0		0.0		0.0		3	25		0.0		0.0	814.2
JUNE	578	557	9.0	9.2	340	256		0	0		0.0		0.0		3	25		0.0		0.0	847.2
JULY	578	439	9.0	9.2	310	234		0	0		0.0		0.0		3	25		0.0		0.0	757.1
AUG.	535	486	9.0	9.2	270	203		0	0		0.0		0.0		3	25		0.0	2.0	9.3	723.4
SEPT.	533	485	9.0	9.2	260	196		0	0		0.0		0.0		3	25		0.0	2.0	9.3	724.0
OCT.	565	544	18.0	20.8	10	8	40	40	0		0.0		0.0		3	25		0.0	2.0	9.3	646.9
NOV.	565	544	18.0	20.8	5	4	35	35	0		0.0		0.0		3	25		0.0	2.0	9.3	633.1
DEC.	565	544	17.0	19.6	0	0	25	25	0		0.0		0.0		3	25		0.0	3.0	14.0	627.0
TOTAL		6400		196.1		1405		202	0		0.0		0.0			300		0.0		65.3	8563.8

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Table 3.20. Stock count chart. Type B Producer--Timahdite.

MONTH	SHEEP: Ewes 26.9 kg. Head	Ewes MAUMs	Rams 34.6 kg. Head	Rams MAUMs	Lambs 22.6 kg. Head	Lambs MAUMs	Spec. Animals 28.0 kg. Head	Spec. Animals MAUMs	GOATS: Does 23.0 kg. Head	Does MAUMs	Bucks 29.0 kg. Head	Bucks MAUMs	Kids 12.5 kg. Head	Kids MAUMs	CATTLE: Cows 250 kg. Head	Cows MAUMs	Bulls 350 kg. Head	Bulls MAUMs	Calves 140 kg. Head	Calves MAUMs	Total MAUMs Required
JAN.	304	293	12	13.8	47	35	43	40	130	100	4.00	3.7		0.0	4	33		0.0	1.0	4.7	523.6
FEB.	304	293	12	13.8	65	49	43	40	130	100	4.00	3.7	10.0	4.2	4	33		0.0	1.0	4.7	541.4
MAR.	304	293	12	13.8	75	57	43	40	130	100	4.00	3.7	17.0	7.1	4	33		0.0	2.0	9.3	556.5
APR.	304	293	12	13.8	125	94	47	44	130	100	4.00	3.7	30.0	12.5	4	33		0.0	2.0	9.3	603.3
MAY	300	289	12	13.8	153	115	45	42	130	100	4.00	3.7	36.0	15.0	4	33		0.0	2.0	9.3	621.2
JUNE	300	289	12	13.8	174	131	42	39	126	97	4.00	3.7	49.0	20.4	4	33		0.0	2.0	9.3	636.5
JULY	300	289	12	13.8	130	136	42	39	120	92	4.00	3.7	65.0	27.1	4	33		0.0	3.0	14.0	647.8
AUG.	295	284	12	13.8	171	129	6	6	120	92	4.00	3.7	70.0	29.2	4	33		0.0	3.0	14.0	664.7
SEPT.	293	282	12	13.8	166	125		0	130	100	4.00	3.7	58.0	24.2	4	33		0.0	2.0	9.3	591.4
OCT.	288	277	12	13.8	145	109		0	130	100	4.00	3.7	42.0	17.5	4	33		0.0	2.0	9.3	564.1
NOV.	304	293	12	13.8	80	60	20	19	130	100	4.00	3.7	22.0	9.2	4	33		0.0	2.0	9.3	540.0
DEC.	304	293	12	13.8	63	47	40	37	130	100	4.00	3.7	7.0	2.9	4	33		0.0	2.0	9.3	540.5
TOTAL		3460		166.1		1088		346		1178		44.8		169.2		400		0.0		112.0	6971.7

Table 3.21. Stock count chart. Type C Producer--Timahdite.

MONTH	SHEEP: Ewes 28.9 kg. Head	Ewes MAUMs	Rams 34.6 kg. Head	Rams MAUMs	Lambs 22.6 kg. Head	Lambs MAUMs	Spec. Animals 0.0 kg. Head	Spec. Animals MAUMs	GOATS: Does 23.0 kg. Head	Does MAUMs	Bucks 28.0 kg. Head	Bucks MAUMs	Kids 17.0 kg. Head	Kids MAUMs	CATTLE: Cows 250 kg. Head	Cows MAUMs	Bulls 350 kg. Head	Bulls MAUMs	Calves 140 kg. Head	Calves MAUMs	Total MAUMs Required
JAN.	140	135	5.00	5.8		0		0	4	3	1.00	0.9		0.0	2	17		0.0		0.0	161.3
FEB.	140	135	5.00	5.8	27	20		0	4	3	1.00	0.9	1.0	0.6	2	17		0.0		0.0	182.2
MAR.	140	135	5.00	5.8	35	26		0	4	3	1.00	0.9	1.0	0.6	2	17		0.0		0.0	188.2
APR.	140	135	5.00	5.8	47	35		0	4	3	1.00	0.9	1.0	0.6	2	17		0.0		0.0	197.3
MAY	135	130	5.00	5.8	50	38		0	4	3	1.00	0.9	3.0	1.7	2	17		0.0	1.0	4.7	200.5
JUNE	130	125	4.00	4.6	92	69		0	4	3	1.00	0.9	3.0	1.7	2	17		0.0	1.0	4.7	206.2
JULY	123	118	4.00	4.6	100	81		0	4	3	1.00	0.9	3.0	1.7	2	17		0.0	1.0	4.7	211.5
AUG.	115	111	4.00	4.6	82	62		0	4	3	1.00	0.9	3.0	1.7	2	17		0.0	1.0	4.7	[illegible]
SEPT.	140	135	5.00	5.8	50	38		0	4	3	1.00	0.9	3.0	1.7	2	17		0.0	2.0	9.3	[illegible]
OCT.	140	135	5.00	5.8	26	20		0	4	3	1.00	0.9	2.0	1.1	2	17		0.0	2.0	9.3	[illegible]
NOV.	140	135	5.00	5.8	15	11		0	4	3	1.00	0.9	2.0	1.1	2	17		0.0	1.0	4.7	[illegible]
DEC.	140	135	5.00	5.8		0		0	4	3	1.00	0.9	1.0	0.6	2	17		0.0		0.0	[illegible]
TOTAL		1563		65.7		401		0		37		11.2		13.0		200		0.0		42.0	2333.0

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Table 3.22. Stock count chart. Type D Producer--Timahdite.

	SHEEP								GOATS				CATTLE						
	Ewes 28.0 kg.		Rams 34.6 kg.		Lambs 22.6 kg.		Spec. Animals 0.0 kg.		Does 0.0 kg.		Bucks 0.0 kg.		Kids 0.0 kg.		Cows 250 kg.		Bulls 350 kg.		Calves 140 kg.		Total MAUMs Required
MONTH	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	
JAN.	60	50	2.00	2.3		0		0		0		0.0		0.0	2	17		0.0	1.0	4.7	81.4
FEB.	60	50	2.00	2.3		0		0		0		0.0		0.0	2	17		0.0	1.0	4.7	81.4
MAR.	55	50	2.00	2.3	10	14		0		0		0.0		0.0	2	17		0.0	1.0	4.7	90.2
APR.	55	50	2.00	2.3	30	23		0		0		0.0		0.0	2	17		0.0	1.0	4.7	99.2
MAY	55	50	2.00	2.3	30	23		0		0		0.0		0.0	2	17		0.0	1.0	4.7	99.2
JUNE	50	40	2.00	2.3	25	19		0		0		0.0		0.0	2	17		0.0	1.0	4.7	90.5
JULY	50	48	2.00	2.3	20	15		0		0		0.0		0.0	2	17		0.0	1.0	4.7	86.9
AUG.	48	46	2.00	2.3	20	15		0		0		0.0		0.0	2	17		0.0	1.0	4.7	84.9
SEPT.	58	56	2.00	2.3	8	6		0		0		0.0		0.0	2	17		0.0	1.0	4.7	85.5
OCT.	55	53	2.00	2.3	5	4		0		0		0.0		0.0	2	17		0.0	1.0	4.7	85.2
NOV.	60	58	2.00	2.3	3	2		0		0		0.0		0.0	2	17		0.0	1.0	4.7	83.7
DEC.	60	58	2.00	2.3		0		0		0		0.0		0.0	2	17		0.0	1.0	4.7	81.4
TOTAL		648		27.7		120		0		0		0.0		0.0		200		0.0		56.0	1043.9

Forage balance charts for producers in the Timahdite area are presented as Tables 3.23, 3.24, 3.25 and 3.26. These tables show the extent to which various sources of forage are thought to contribute in meeting livestock nutritional (dry matter) requirements. Again, the forage productivity of collective rangelands are thought to be substantially overestimated in most cases.

Table 3.23. Forage balance chart. Type A Producer--Timahdite.

SOURCES OF FEED

	Source #1 Coll. Range		Source #2 Dom. Range		Source #3 Pvt. Range		Source #4 Fallow/Stub.		Source #5 Hay/Straw		Source #6 Feed Grains		Source #7 Cr. By-Prod.		Source #8 Com. Supple.		TOTAL MAUMs AVAIL.	TOTAL MAUMs REQUIRED
MONTH	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs		
JAN.		5		0	5.00	185		0	2.44	90	9.53	353		0		0	634	623.6
FEB.		9		0	5.00	185		0	2.00	74	10.90	404		0		0	672	672.1
MAR.		124		0	15.00	556		0	1.00	37		0		0		0	716	716.3
APR.		123		0	17.00	630		0		0		0		0		0	753	737.3
MAY		703		0	3.00	111		0		0		0		0		0	814	814.0
JUNE		847		0		0		0		0		0		0		0	847	847.2
JULY		572		0		0	5.00	185		0		0		0		0	757	757.1
AUG.		511		0		0	6.00	222		0		0		0		0	733	733.4
SEPT.		502		0		0	6.00	222		0		0		0		0	724	724.0
OCT.		150		0	8.00	296	2.00	74		0	3.41	126		0		0	647	646.9
NOV.		141		0	8.00	296		0	2.00	74	3.41	126		0		0	638	638.1
DEC.		24		0	4.00	148		0	2.00	74	10.30	381		0		0	628	627.9
TOTAL	100.1	3717	0.0	0	65.0	2407	19.0	704	9.4	350	37.6	1391	0.0	0	0.0	0	8569	8568.8

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Table 3.24. Forage balance chart. Type B Producer--Timahdite.

SOURCES OF FEED

MONTH	Source #1 Coll. Range DM (T)	Source #1 Coll. Range MAUMs	Source #2 Dom. Range DM (T)	Source #2 Dom. Range MAUMs	Source #3 Pvt. Range DM (T)	Source #3 Pvt. Range MAUMs	Source #4 Fallow/Stub. DM (T)	Source #4 Fallow/Stub. MAUMs	Source #5 Hay/Straw DM (T)	Source #5 Hay/Straw MAUMs	Source #6 Feed Grains DM (T)	Source #6 Feed Grains MAUMs	Source #7 Cr. By-Prod. DM (T)	Source #7 Cr. By-Prod. MAUMs	Source #8 Com. Supple. DM (T)	Source #8 Com. Supple. MAUMs	TOTAL MAUMs AVAIL.	TOTAL MAUMs REQUIRED
JAN.		307		0		0		0	2.96	110	2.90	107		0		0	524	523.6
FEB.		324		0		0		0	2.96	110	2.90	107		0		0	541	541.4
MAR.		347		0		0		0	2.76	102	2.90	107		0		0	557	556.5
APR.		540		0		0		0		0	1.70	63		0		0	603	603.3
MAY		603		0		0		0		0	0.50	19		0		0	621	621.2
JUNE		625		0		0		0		0	0.30	11		0		0	637	636.5
JULY		637		0		0		0		0	0.30	11		0		0	648	647.3
AUG.		336		0		0	6.75	250		0	0.50	19		0		0	605	604.7
SEPT.		323		0		0	6.75	250		0	0.50	19		0		0	591	591.4
OCT.		296		0		0	6.75	250		0	0.50	19		0		0	564	564.1
NOV.		242		0	2.60	96		0	2.56	95	2.90	107		0		0	541	540.0
DEC.		242		0	2.60	96		0	2.56	95	2.90	107		0		0	541	540.5
TOTAL	130.2	4922	0.0	0	5.2	193	20.3	750	13.3	511	18.3	696	0.0	0	0.0	0	6972	6971.7

Table 3.25. Forage balance chart. Type C Producer--Timahdite.

SOURCES OF FEED

MONTH	Source #1 Coll. Range DM (T)	Source #1 Coll. Range MAUMs	Source #2 Dom. Range DM (T)	Source #2 Dom. Range MAUMs	Source #3 Pvt. Range DM (T)	Source #3 Pvt. Range MAUMs	Source #4 Fallow/Stub. DM (T)	Source #4 Fallow/Stub. MAUMs	Source #5 Hay/Straw DM (T)	Source #5 Hay/Straw MAUMs	Source #6 Feed Grains DM (T)	Source #6 Feed Grains MAUMs	Source #7 Cr. By-Prod. DM (T)	Source #7 Cr. By-Prod. MAUMs	Source #8 Com. Supple. DM (T)	Source #8 Com. Supple. MAUMs	TOTAL MAUMs AVAIL.	TOTAL MAUMs REQUIRED
JAN.		73		0		0		0	0.10	4	2.28	84		0		0	161	161.3
FEB.		94		0		0		0	0.10	4	2.28	84		0		0	182	182.2
MAR.		100		0		0		0	0.10	4	2.28	84		0		0	188	188.2
APR.		133		0		0		0		0	1.60	59		0		0	197	197.3
MAY		201		0		0		0		0		0		0		0	201	200.5
JUNE		226		0		0		0		0		0		0		0	226	226.2
JULY		232		0		0		0		0		0		0		0	232	231.5
AUG.		56		0		0	3.09	143		0		0		0		0	204	204.2
SEPT.		62		0		0	3.09	143		0		0		0		0	210	210.0
OCT.		44		0		0	3.09	148		0		0		0		0	191	191.4
NOV.		31		0		0	3.09	148		0		0		0		0	179	178.4
DEC.		117		0		0		0		0	1.21	45		0		0	162	161.9
TOTAL	37.1	1374	0.0	0	0.0	0	16.0	591	0.3	11	9.7	357	0.0	0	0.0	0	2333	2333.0

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Table 3.26. Forage balance chart. Type D Procucer--Timahdite.

SOURCES OF FEED

MONTH	Source #1 Coll. Range		Source #2 Dom. Range		Source #3 Pvt. Range		Source #4 Fallow/Stub.		Source #5 Hay/Straw		Source #6 Feed Grains		Source #7 Cr. By-Prod.		Source #8 Com. Supple.		TOTAL MAUMs AVAIL.	TOTAL MAUMs REQUIRED
	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs		
JAN.		29		0		0		0	0.11	4	1.29	48		0		0	81	81.4
FEB.		29		0		0		0	0.11	4	1.29	48		0		0	81	81.4
MAR.		39		0		0		0	0.11	4	1.29	48		0		0	90	90.2
APR.		39		0		0		0		0		0		0		0	99	99.2
MAY		39		0		0		0		0		0		0		0	99	99.2
JUNE		65		0		0	0.70	26		0		0		0		0	91	90.6
JULY		61		0		0	0.70	26		0		0		0		0	87	86.9
AUG.		22		0		0	1.70	63		0		0		0		0	85	84.9
SEPT.		22		0		0	1.70	63		0		0		0		0	85	85.5
OCT.		22		0		0	1.70	63		0		0		0		0	85	85.2
NOV.		24		0		0	1.60	59		0		0		0		0	84	83.7
DEC.		29		0		0		0	0.11	4	1.29	48		0		0	81	81.4
TOTAL	14.6	542	0.0	0	0.0	0	8.1	300	0.5	17	5.2	191	0.0	0	0.0	0	1050	1049.0

Crop Production

The common crops produced in Timahdite are wheat and barley, with wheat being grown on 42% of the cropland, and barley on 33%. Corn, oats and potatoes account for the majority of the remainder. The Type B producers reported the most oat production (Tables 3.27, 3.28, 3.29 and 3.30). Corn is grown in small quantities by most producers in the area. Potatoes are grown as a cash crop by many farmers of the Ait M'hamed fraction and some from the Ait Hcine ou Hand fraction. These farmers, who all live in the same area, have access to more water than do those of other fractions and are able to undertake intensive potato farming. Potatoes can either be harvested by the producer and sold afterwards, or the crop can be sold while it is still in the field, in which case harvesting becomes the responsibility of the buyer.

A hailstorm in June of 1985 did extensive damage to crops in the area. This is primarily why crop yields reported were low and inconsistent. The indication that some producers have lower net yields is, in this case, mostly a matter of luck (or lack of it).

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Table 3.27. Crop production. Type A Producer--Timahdite.

Crop Production by Field or by Crop

Plot	Crop	Area ha	Seed "Var."	Seed Amt. qx	Seed Rate qx/ha	Fert.	Fert. Amt. qx	Fert. Rate qx/ha	Herbi.	Herb. Amt. liters	Herb. Rate l/ha	Pesti.	Pest. Amt. liters	Pest. Rate l/ha	Water Amt. units	Water Rate u/ha	YIELD Tons	Yield Rate T/ha
		Input Levels/Rates															Output L/R	
D1	Barley	1.0	Local	1.5	1.5			0.0			0.0			0.0		0.0	0.3	0.3
D2					0.0			0.0			0.0			0.0		0.0		0.0
D3					0.0			0.0			0.0			0.0		0.0		0.0
D4					0.0			0.0			0.0			0.0		0.0		0.0
D5					0.0			0.0			0.0			0.0		0.0		0.0
D6					0.0			0.0			0.0			0.0		0.0		0.0
D7					0.0			0.0			0.0			0.0		0.0		0.0
D8	Fallow				0.0			0.0			0.0			0.0		0.0		0.0
D9	Straw,etc	1.0															0.4	0.4
D10	Stubble	1.0															1.2	1.2
I1	Wheat	9.5	Local	9.5	1.0			0.0			0.0			0.0	?	0.0	3.6	0.4
I2	Barley	7.5	Local	7.0	0.9			0.0			0.0			0.0	?	0.0	3.0	0.4
I3					0.0			0.0			0.0			0.0		0.0		0.0
I4					0.0			0.0			0.0			0.0		0.0		0.0
I5					0.0			0.0			0.0			0.0		0.0		0.0
I6					0.0			0.0			0.0			0.0		0.0		0.0
I7	Forage #1				0.0			0.0			0.0			0.0		0.0		0.0
I8	Forage #2				0.0			0.0			0.0			0.0		0.0		0.0
I9	Straw,etc	17.0															9.0	0.5
I10	Stubble	17.0															20.4	1.2

Input Totals Seed 18 Fertilizer 0 Herbicide 0 Pesticide 0 Water 0

Total Dryland 1
Total Irr. Land 17
Total Cropland 18

Total Fallow & Crop Residue Forage Yield from Dry Cropland 2
Rate of Fallow & Crop Residue Forage Yield from Dry Cropland 1.6
Total Forage & Crop Residue Forage Yield from Irr. Cropland 29
Rate of Forage & Crop Residue Forage Yield from Irr. Cropland 1.7
Total Fallow & Crop Residue Forage Yield 31

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Table 3.28. Crop production. Type B Producer--Timahdite.

Crop Production by Field or by Crop

Plot	Crop	Area ha	Seed "Var."	Seed Amt. qx	Seed Rate qx/ha	Fert.	Fert. Amt. qx	Fert. Rate qx/ha	Herbi.	Herb. Amt. liters	Herb. Rate l/ha	Pesti.	Pest. Amt. liters	Pest. Rate l/ha	Water Amt. units	Water Rate u/ha	YIELD Tons	Yield Rate T/ha
			Input Levels/Rates														Output L/R	
D1	Wheat	3.2	?	3.4	1.1			0.0			0.0			0.0		0.0	0.4	0.1
D2	Barley	4.8	?	9.7	2.0			0.0			0.0			0.0		0.0	1.3	0.3
D3	Oats	8.7	?	26.0	3.0			0.0			0.0			0.0		0.0	3.3	0.4
D4					0.0			0.0			0.0			0.0		0.0		0.0
D5					0.0			0.0			0.0			0.0		0.0		0.0
D6					0.0			0.0			0.0			0.0		0.0		0.0
D7					0.0			0.0			0.0			0.0		0.0		0.0
D8	Fallow				0.0			0.0			0.0			0.0		0.0		0.0
D9	Straw,etc	16.7															7.5	0.4
D10	Stubble	16.7															20.0	1.2
I1	Wheat	6.3	?	6.3	1.0	?	7.8	1.2			0.0			0.0	?	0.0	2.2	0.4
I2	Barley	1.7	?	3.0	1.8	?	2.5	1.5			0.0			0.0	?	0.0	0.6	0.3
I3	Corn	1.8	?	0.5	0.3	?	2.8	1.5			0.0			0.0	?	0.0	0.5	0.3
I4	Oats	0.7	?	1.3	2.0			0.0			0.0			0.0	?	0.0	0.5	0.7
I5	Potatoes	0.5	?	0.4	0.8	?	0.8	1.5			0.0			0.0	?	0.0	2.3	4.7
I6					0.0			0.0			0.0			0.0		0.0		0.0
I7	Forage #1				0.0			0.0			0.0			0.0		0.0		0.0
I8	Forage #2				0.0			0.0			0.0			0.0		0.0		0.0
I9	Straw,etc	10.4															10.0	1.0
I10	Stubble	10.4															12.5	1.2

Input Totals: Seed 51; Fertilizer 14; Herbicide 0; Pesticide 0; Water 0

Total Dryland 17
Total Irr. Land 11
Total Cropland 28

Total Fallow & Crop Residue Forage Yield from Dry Cropland 28
Rate of Fallow & Crop Residue Forage Yield from Dry Cropland 1.6
Total Forage & Crop Residue Forage Yield from Irr. Cropland 23
Rate of Forage & Crop Residue Forage Yield from Irr. Cropland 2.1
Total Fallow & Crop Residue Forage Yield 50

Table 3.29. Crop production. Type C Producer--Timahdite.

Crop Production by Field or by Crop

Plot	Crop	Area ha	Input Levels/Rates: Seed "Var."	Seed Amt. qx	Seed Rate qx/ha	Fert.	Fert. Amt. qx	Fert. Rate qx/ha	Herbi.	Herb. Amt. liters	Herb. Rate l/ha	Pesti.	Pest. Amt. liters	Pest. Rate l/ha	Water Amt. units	Water Rate u/ha	Output L/R: YIELD Tons	Yield Rate T/ha
D1	Wheat	1.8	?	1.5	0.8			0.0			0.0			0.0		0.0	0.1	0.1
D2	Barley	2.0	?	2.3	1.2			0.0			0.0			0.0		0.0	0.2	0.1
D3					0.0			0.0			0.0			0.0		0.0		0.0
D4					0.0			0.0			0.0			0.0		0.0		0.0
D5					0.0			0.0			0.0			0.0		0.0		0.0
D6					0.0			0.0			0.0			0.0		0.0		0.0
D7					0.0			0.0			0.0			0.0		0.0		0.0
D8	Fallow				0.0			0.0			0.0			0.0		0.0		0.0
D9	Straw,etc	3.8															0.8	0.2
D10	Stubble	3.8															3.8	1.0
I1	Wheat #1	9.3	?	9.6	1.2			0.0			0.0			0.0	?	0.0	4.5	0.5
I2	Wheat #2	1.3	?	1.3	1.0			0.0			0.0			0.0	?	0.0	0.5	0.4
I3	Barley #1	5.3	?	10.7	2.0			0.0			0.0			0.0	?	0.0	2.9	0.5
I4	Barley #2	1.3	?	2.7	2.0			0.0			0.0			0.0	?	0.0	0.5	0.4
I5	Corn	1.0	?	0.2	0.2			0.0			0.0			0.0	?	0.0	0.2	0.2
I6	Oats	0.8	?	0.3	1.0			0.0			0.0			0.0	?	0.0	0.1	0.1
I7	Forage #1				0.0			0.0			0.0			0.0		0.0		0.0
I8	Forage #2				0.0			0.0			0.0			0.0		0.0		0.0
I9	Straw,etc	13.1															14.4	1.1
I10	Stubble	13.1															13.1	1.0

Input Totals Seed 29.0 Fertilizer 0.0 Herbicide 0.0 Pesticide 0.0 Water 0.0

Total Dryland 4
Total Irr. Land 18
Total Cropland 22

Total Fallow & Crop Residue Forage Yield from Dry Cropland 5
Rate of Fallow & Crop Residue Forage Yield from Dry Cropland 1.2
Total Forage & Crop Residue Forage Yield from Irr. Cropland 27
Rate of Forage & Crop Residue Forage Yield from Irr. Cropland 1.5
Total Fallow & Crop Residue Forage Yield 32

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Table 3.30. Crop production. Type D Producer--Timahdite.

Crop Production by Field or by Crop

Plot	Crop	Area ha	Seed "Var."	Seed Amt. qx	Seed Rate qx/ha	Fert.	Fert. Amt. qx	Fert. Rate qx/ha	Herbi.	Herb. Amt. liters	Herb. Rate l/ha	Pesti.	Pest. Amt. liters	Pest. Rate l/ha	Water Amt. units	Water Rate u/ha	YIELD Tons	Yield Rate T/ha
		Input Levels/Rates															Output L/R	
D1					0.0			0.0			0.0			0.0		0.0		0.0
D2					0.0			0.0			0.0			0.0		0.0		0.0
D3					0.0			0.0			0.0			0.0		0.0		0.0
D4					0.0			0.0			0.0			0.0		0.0		0.0
D5					0.0			0.0			0.0			0.0		0.0		0.0
D6					0.0			0.0			0.0			0.0		0.0		0.0
D7					0.0			0.0			0.0			0.0		0.0		0.0
D8	Fallow	5.0			0.0			0.0			0.0			0.0		0.0	2.5	0.5
D9	Straw,etc																	0.0
D10	Stubble																0.0	1.0
I1	Wheat	3.0	?	3.0	1.0			0.0			0.0			0.0	?	0.0	1.1	0.4
I2	Barley	2.8	?	4.1	1.5			0.0			0.0			0.0	?	0.0	0.8	0.3
I3	Corn	0.1	?	1.0	2.5			0.0			0.0			0.0	?	0.0	0.1	0.3
I4	Oats	2.0	?	5.0	2.5			0.0			0.0			0.0	?	0.0	0.5	0.3
I5	Potatoes	3.3	?	0.7	0.2	?	1.6	0.5			0.0			0.0	?	0.0	1.3	0.4
I6					0.0			0.0			0.0			0.0		0.0		0.0
I7	Forage #1				0.0			0.0			0.0			0.0		0.0		0.0
I8	Forage #2				0.0			0.0			0.0			0.0		0.0		0.0
I9	Straw,etc	8.1															3.8	0.5
I10	Stubble	8.1															8.1	1.0

Input Totals: Seed 14; Fertilizer 2; Herbicide 0; Pesticide 0; Water 0

Total Dryland 5
Total Irr. Land 11
Total Cropland 16

Total Fallow & Crop Residue Forage Yield from Dry Cropland 3
Rate of Fallow & Crop Residue Forage Yield from Dry Cropland 0.5
Total Forage & Crop Residue Forage Yield from Irr. Cropland 12
Rate of Forage & Crop Residue Forage Yield from Irr. Cropland 1.0
Total Fallow & Crop Residue Forage Yield 14

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Labor Use

Unfortunately, information was not provided which would enable us to make a comprehensive analysis of person days needed for livestock and crop production tasks in Timahdite. Included here is a calendar of livestock and crop production activities (Figure 3.1). Though difficult to perceive from this calendar, June is again the month of highest labor demand. Also, October is quite busy, as the corn harvest almost coincides with cereal planting. Threshing happens somewhat later in this area. Because of the higher elevation and colder weather, most producers do not have all of their fields harvested and ready to thresh until August.

ACTIVITY	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
Mountain grazing						<--------	--------	--------	-------->			
Plains grazing	<--------	--------	--------	--------	-------->					<--------	--------	-------->
Stubble grazing								<--------	---->			
Supplemental feeding	<--------	--------	--------	-------->								
Shearing					<-------->							
Lambing	<-------->		<--------	-------->								
Barn cleaning	<--------	--------	-------->							<--------	-------->	
Maintenance	<--------	--------	-------->									<-------->
Health tasks			<-------->					<-------->				
Plowing/Seeding				<--------	-------->							
Irrigation	<--------	--------	--------	--------	-------->					<--------	-------->	
Fertilization			<--------	--------	-------->				<--------	-------->		
Harvesting						<--------	-------->		<--------	-------->		
Transportation							<--------	-------->				
Threshing							<--------	-------->				

Figure 3.1. Calendar of livestock production and agricultural activities in Timahdite.

The labor of women is not included in this calendar. No one has had the opportunity to thoroughly study the labor input of women to the family production unit. Were domestic activities added to this calendar, it would indicate year-round activity, increasing the labor needs of the household considerably.

AIT RBAA

Four rural communes have rights to use the Ait Rbaa perimeter: Ouled Yaich, Ouled Said el Oued, Guettaya and Semguett. Each rural commune consists of a number of fractions, which these producers identify as being equivalent to tribes. The pattern of use of the perimeter by fraction is highly variable. The fractions in the Semguett rural commune chose to plow their section of the perimeter and plant barley. Of the other three rural communes, the majority of the sheep (71%) are grazed by the Ouled Said el Oued.

Herders begin moving animals onto the perimeter in October, with the first rains, when cereal crops are planted. Their black, goat-hair tents are usually in evidence until sometime in May or early June, if it has been a good year. Recently, however, both forage and water have been scarce on the perimeter, and producers have found it necessary to transport both items to their animals if they wish to remain. Chances are that any producer with other forage resources available to him would forego grazing on the Ait Rbaa perimeter.

SAMPLE SELECTION: **AIT RBAA**

In the spring of 1985, when the study households were being chosen, there was neither a comprehensive list of names from which to draw a sample nor a Moroccan counterpart available to assist in locating possible participants. Selection was done by approaching perimeter users directly, forming social contacts, and then choosing from among those producers which seemed most cooperative and which fit into particular demographic categories. The characteristics defining these categories were number of sheep owned, amount of land owned, family composition and fraction affiliation. As research progressed, the Ait Rbaa perimeter users could be classified into three different types: 1) quite wealthy producers having their sheep herded for them in an association relationship, 2) producers who herd their own sheep, and 3) producers who hold sheep in association. A description follows of each type of producer.

CATEGORIZATION OF PRODUCERS: **AIT RBAA**

Type A: The Wealthy Producer

Three producers in the Ait Rbaa study would be considered wealthy even by the standards of the developed world. Great care must be taken in characterizing the Type A producer because he was often reluctant to share with the interviewer his exact holdings. The information gathered on these producers is therefore incomplete.

Sheep production was a secondary activity to the Type A producer. Two of these producers included a tribal official owning a large, diverse, modern farm and a service station. The other producer was a butcher/meat supplier.

The Type A producer owned a great deal of land and grew a variety of crops along with barley, hard wheat and soft wheat. His farm was mechanized and he owned a variety of equipment. He normally had livestock other than sheep such as dairy cattle. He had his own source of water and could afford to irrigate his own land. While his sheep were on the perimeter, he would haul water and supplemental feed as needed. His use of supplemental feed was more extensive than that of the Type B producer, often feeding from May until December. Herd health, from observation, tended to be better, and individual sheep weights heavier than herds of the independent herder. Vaccinations were administered twice a year.

Family size of the Type A producer was 13 family members. The Type A producer educated all of his children and was more likely to have an outside source of income through family members. Expenditures for family members was high and variable. A large portion of the weekly expense is believed to have gone to entertaining in order to maintain social standing. It is assumed, as well, that meat was purchased daily. Household expenditures also included utilities such as telephone and electricity, conveniences not utilized by the majority of producers.

The Type A producer was an employer, employing the Type C producer and other laborers. Decisions related to livestock production were made by one person who was the de facto family head. It is important to realize that though deference may publicly be made to an older male member of the family, real decisions can be made by someone else. Decisions regarding the herd may take place in one of two ways depending upon the nature of the contract between the Type A and C producers. One form of agreement will leave all decisions pertaining to the herd up to the herder. The passive Type A producer/owner may only infrequently see his sheep. The second form will be that of the Type A producer actively exercising his own judgement with regard to herd management. Both agreements involve a sharing of the profits from the herd, and this most commonly involves the herder receiving a percentage of the lamb crop. This percentage is commonly one-fourth of the lamb crop, but may be as high as one-half. A third type of agreement not under study is that between a Type A producer and a salaried herder. The herder is typically supplied with food and his wage depends on the number of sheep he is herding and the length of time he herds. The Type A producer was also an employer of farm labor.

Type B: The Independent Herder

The independent herder owned his livestock and herding was his primary activity. He tended to own some land and other livestock, usually goats and/or cows. In general, the independent herder's farm was non-mechanized, but he may have rented machinery to plow, plant, and harvest. He grew some combination of hard wheat, soft wheat, and barley, but how that

combination was derived by the producer was not determined.

Secondary sources of income did not exist, though family size averaged 13 among those studied. Most of the children in the families under study were too young for school, so it was difficult to make generalizations about education of children. Weekly household expenditures were primarily for food purchases and the biggest expense item was flour.

The independent herder spent less time on the perimeter than Type C producers since he relied more on existing sources for water and forage. All producers claimed to vaccinate yet animal losses from diseases having symptoms of enterotoxemia were common. There was also evidence of heavy parasite loads in animals including heavy nasal mucous discharge. During months spent away from the perimeter, water came from common wells. Supplemental feed was given as needed.

Decision making within the family unit was similar to that of the Type A producer, that is, the de facto decision maker may not have been the family head. In one family in the study, a woman was making the decisions for the family.

Type C: The Herder in Association

As discussed above, the Type C producer was employed by the Type A producer. The extent of the employer/employee relationship may have run the gamut from one of colleagues to one of a lord-serf nature. Herding was the primary activity and there were rarely secondary sources of income. He usually owned relatively little land, but generally owned some other livestock. His farm, if he had one, was non-mechanized.

The herder in association was on the perimeter a relatively short time if he had been given primary responsibility for the management of the livestock. The length of time he stayed depended upon the availability of water. He fed supplemental feed for a shorter period of time, and in this respect he was much like the Type B producer. However, if the Type A producer was active in livestock management, the herder in association would stay at the perimeter at the discretion of the owner. As long as the owner believed it economically feasible to bring feed and water to the perimeter, the association herder remained.

Vaccinations were purchased by the owner, and all producers in the study claimed that they were administered twice a year.

Family size of the herder in association also tended to be relatively large (13). However, ages of family members were generally younger. They seemed to be families starting out in the world. As with the Type B producer, many children were below school age, so decisions regarding education are unknown. Expenditures per person per week for food purchases were the same as those for the independent producer at approximately 15 dirhams per person.

Unfortunately, because of the diversity of the economic activities of the Type A producers and the nature of the interview methodology, data were not obtained which would allow development of a reasonably accurate profile for these producers. It was primarily the herders for these producers that were contacted, and in no case were the complete holdings or income of the Type A producer accurately ascertained. For example, in the case of the butcher, three of his herders were studied as Type C producers, but he had seven herders working for him altogether, and we have no information on the other four. The majority of the sheep on the perimeter are owned by these wealthy producers, and the association relationship is the primary means of perimeter exploitation at Ait Rbaa.

Human Resources

The average family composition of producer families studied in the Ait Rbaa area is presented in Table 3.31. Information on family size and composition for large scale producers with livestock using the study site (Type A producers) was not available.

Table 3.31. Family composition. Type B and C Producers--Ait Rbaa.

AGE	ACTIVE		INACTIVE		SCHOOL		TOTAL	
Type B	M	F	M	F	M	F	M	F
0 - 6			1	1			1	1
7 - 15		1			2	1	2	2
16 - 24	1				1		2	0
24 - 60	2	2					2	2
61 +		1					0	1
TOTAL	3	4	1	1	3	1	7	6
Type C								
0 - 6			2	2			2	2
7 - 15					2	1	2	1
16 - 24	2	1					2	1
24 - 60	1	2					1	2
61 +							0	0
TOTAL	3	3	2	2	2	1	7	6

Information on the levels of schooling reached by livestock producer family members which is reported in Table 3.32 shows that the Type B family averaged five people with more than one year of schooling while the Type C averaged only three. This is probably a function of the ages of the children in these families, and not a real difference in ideas about education. This information was unavailable for Type A producer families.

Table 3.32. Level of schooling. Type B and C Producers--Ait Rbaa.

Type B	0 - 1	2 - 5	6 - 9	10 - 13	14 +	TOTAL
MALES	3	2	2			7
FEMALES	5	1				6
TOTAL	8	3	2	0	0	13
Type C						
MALES	5	2				7
FEMALES	5	1				6
TOTAL	10	3	0	0	0	13

It should be noted that the figures for education in Ait Rbaa were substantially higher than those for Timahdite and El Faija. Perhaps because the population density of the Tadla region is higher, access to schools is much easier and more children are able to receive at least a primary school education.

Estimated Value of Producer Resource Sets

The disparity in the value of resources of the different producers in the Ait Rbaa region is immediately obvious, and much greater than that which exists in the Middle Atlas regions. Estimates of the values of resource sets for the Type B and C producers are presented in Table 3.33. Again, the item with the highest value was land. Although a reasonably complete inventory of production assets could not be developed for the Type A producers it was possible to determine that all of these producers owned tractors, two owned combines and each had some kind of motor vehicle. Each of these producers also owned buildings of undetermined value.

The large difference in the resource base between the B and C producers should not be surprising since, by definition, Type C producers did not own all of the sheep that they were herding.

There was also a large disparity in the amount and value of land owned by Type B and C producers. Type B producers owned approximately four times as much dry cropland as Type C producers, but that land was of higher value (an average of 23,333 DH/ha as opposed to 8,400 DH/ha). A small amount of valuable arable land that was irrigated to some degree was owned by the Type C producer.

Land prices in the Ait Rbaa area proved to be relatively high when compared with prices in the other areas studied. This is one more piece of evidence of the increased modernization and prosperity of the Tadla/Beni Mellal Region. Though the values are high, it is doubtful that land values were grossly overestimated considering the population density and agricultural development in the region.

Table 3.33. Estimated value of producer resource sets. Ait Rbaa.

INVENTORY (Producer Category)	QUANTITY (units) A	B	C	VALUE (DHS) A	B	C
Land/Rights (ha/MAUMs)	NA			NA		
Irrigated Cropland			1.7			42500
Dry Cropland		32.0	8.8		746656	73920
Private Range/Pasture						
Grazing Rights						
Livestock (head)	NA			NA		
Sheep						
Ewes		116	89		71108	54557
Rams		1	2		1000	2000
Replacement Ewes		19.3	17.9		11831	10973
Replacement Rams		0.3	0.5		188	375
Speculation Animals		18	20		8928	9920
Goats	NA			NA		
Does		17	7		4675	1925
Bucks		3	1		1125	375
Replacement Does		2.8	1.2		560	240
Replacement Bucks		0.8	0.3		165	55
Cattle	NA			NA		
Cows		1			4050	
Bulls						
Replacement Heifers						
Replacement Bulls						
Equipment (#)	NA			NA		
Tractors						
Trucks						
Farm Implements		1			1500	
Buildings						
Tents		1	1		3000	2000
Pumps						
Draft Animals		2	1		1600	500
Other						
Subtotal					856385	199340

Livestock Production

As mentioned above, the majority of the animals on the Ait Rbaa Perimeter were being herded in association. They grazed on the perimeter from approximately October through April or May. It has been noted that the perimeter resembles a feedlot more than it does a collective rangeland. Especially during the recent drought years, the forage produced on the perimeter has been grossly inadequate for the number of animals grazing there. Studies carried out on the area during the project on quanitity and quality of forage produced indicate that only a maximum of 30% of the dry matter and protein requirements of the livestock on the area were being met. Animals were brought to the perimeter by truck along with large quantities of feed and water was transported to them routinely.

During the summer, there is virtually no vegetation on the perimeter, with the exception of a thorny shrub (jujubier), and the animals are kept at home in the douar. They graze crop stubble and aftermath, and are supplemented with purchased feeds when necessary.

Stockcount charts (Tables 3.34 and 3.35) do not show large difference in animal numbers between Type B and C producers. However, Type B producers were likely to have more total livestock, perhaps even including a cow or two.

Table 3.34. Stockcount chart. Type B Producer--Ait Rbaa.

	SHEEP								GOATS						CATTLE						
	Ewes 35.0 kg.		Rams 45.0 kg.		Lambs 23.5 kg.		Spec. Animals 37.0 kg.		Does 25.0 kg.		Bucks 35.0 kg.		Kids 20.0 kg.		Cows 300 kg.		Bulls 375 kg.		Calves 140 kg.		Total MAUMs Required
MONTH	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	
JAN.	110	135	1.00	1.5		0	4	5	17	14	1.00	3.5		0.0	2	20		0.0	1.0	4.7	184.1
FEB.	110	128	1.00	1.5	12	17	4	5	17	14	1.00	3.5		0.0	2	20		0.0	1.0	4.7	194.2
MAR.	110	128	1.00	1.5	36	34	4	5	17	14	1.00	3.5		0.0	2	20		0.0	1.0	4.7	211.3
APR.	110	129	1.00	1.5	54	51	2	2	17	14	1.00	3.5	6.5	4.3	2	20		0.0	1.0	4.7	230.3
MAY	110	131	1.00	1.5	69	66	2	2	17	14	2.00	2.3	6.5	4.3	2	20		0.0	1.0	4.7	245.7
JUNE	112	131	1.00	1.5	17	16	0	0	16	13	2.00	2.3	6.5	4.3	2	20		0.0	1.0	4.7	193.0
JULY	112	131	1.00	1.5	18	17	0	0	16	13	2.00	2.3	5.0	3.3	2	20		0.0	0.0	0.0	153.3
AUG.	112	131	1.00	1.5	19	17	0	0	14	12	1.00	1.2	5.0	3.3	2	20		0.0	0.0	0.0	135.4
SEPT.	114	133	1.00	1.5	0	0	2	2	14	12	1.00	1.2	4.0	2.7	2	20		0.0	0.0	0.0	172.3
OCT.	114	133	1.00	1.5	0	0	6	7	14	12	1.00	1.2	9.0	6.0	2	20		0.0	0.0	0.0	190.7
NOV.	116	135	1.00	1.5	0	0	2	2	13	11	1.00	1.2		0.0	2	20		0.0	0.0	0.0	171.3
DEC.	116	135	1.00	1.5	0	0	1	1	13	11	1.00	1.2		0.0	2	20		0.0	0.0	0.0	170.1
TOTAL		1580		18.0		219		33		154		26.1		29.3		240		0.0		28.0	2326.9

Table 3.35. Stockcount chart. Type C Producer--Ait Rbaa.

	SHEEP								GOATS						CATTLE						
	Ewes 35.0 kg.		Rams 45.0 kg.		Lambs 29.5 kg.		Spec. Animals 35.0 kg.		Does 25.0 kg.		Bucks 30.0 kg.		Kids 19.5 kg.		Cows 0 kg.		Bulls 0 kg.		Calves 0 kg.		Total MAUMs Required
MONTH	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	
JAN.	107	125	2.00	2.7	24	24	3	4	7	6	1.00	1.0	3.0	0.0		0		0.0		0.0	161.4
FEB.	105	146	2.00	2.7	20	20	0	0	5	4	1.00	1.0	6.0	3.9		0		0.0		0.0	177.2
MAR.	114	133	2.00	2.7	25	25	0	0	7	6	1.00	1.0	6.0	3.9		0		0.0		0.0	171.0
APR.	103	123	2.00	2.7	50	49	18	21	9	8	1.00	1.0	6.0	3.9		0		0.0		0.0	205.4
MAY	92	107	2.00	2.7	69	68	18	21	10	8	1.00	1.0	6.0	3.9		0		0.0		0.0	212.1
JUNE	80	93	2.00	2.7	97	95	36	42	11	9	1.00	1.0	6.0	3.9		0		0.0		0.0	247.5
JULY	82	96	2.00	2.7	44	43	15	18	25	21	1.00	1.0	1.0	0.7		0		0.0		0.0	131.6
AUG.	95	111	2.00	2.7	20	20	15	18	38	32	1.00	1.0	1.0	0.7		0		0.0		0.0	191.9
SEPT.	101	118	2.00	2.7	16	16	14	16	41	34	1.00	1.0	1.0	0.7		0		0.0		0.0	158.4
OCT.	100	117	2.00	2.7	8	8	16	19	49	41	1.00	1.0	0.0	0.0		0		0.0		0.0	187.7
NOV.	107	125	2.00	2.7	0	0	9	11	44	37	1.00	1.0	0.0	0.0		0		0.0		0.0	175.7
DEC.	102	119	2.00	2.7	0	0	7	8	9	8	1.00	1.0	0.0	0.0		0		0.0		0.0	138.2
TOTAL		1409		32.0		375		176		213		12.0		21.5		0		0.0		0.0	2235.1

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Forage balance charts (Tables 3.36 and 3.37) for Type B and C producers give an indication of the levels of dependence on the various local feed sources. While it is doubtful that collective rangeland actually supplies the amount of forage indicated, these charts are reasonable estimates of the amounts needed in order to meet animal requirements.

Table 3.36. Forage balance chart. Type B Producer--Ait Rbaa.

SOURCES OF FEED

	Source #1 Coll. Range		Source #2 Dom. Range		Source #3 Pvt. Range		Source #4 Fallow/Stub.		Source #5 Hay/Straw		Source #6 Feed Grains		Source #7 Cr. By-Prod.		Source #8 Com. Supple.		TOTAL MAUMs AVAIL.	TOTAL MAUMs REQUIRED
MONTH	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs		
JAN.		123		0		0		0	0.04	1	0.28	14	0.62	23		0	161	161.1
FEB.		177		0		0		0		0		0		0		0	177	177.2
MAR.		171		0		0		0		0		0		0		0	171	171.0
APR.		205		0		0		0		0		0		0		0	205	205.4
MAY		212		0		0		0		0		0		0		0	212	212.1
JUNE		178		0		0	1.80	70		0		0		0		0	248	247.5
JULY		57		0		0	3.30	124		0		0		0		0	192	191.6
AUG.		44		0		0	4.00	149		0		0		0		0	192	191.9
SEPT.		162		0		0		0		0	0.30	11	0.41	15		0	188	188.1
OCT.		139		0		0		0	0.05	2	0.46	17	0.82	30		0	198	197.7
NOV.		137		0		0		0	0.05	2	0.46	17	0.82	30		0	176	175.7
DEC.		89		0		0		0	0.05	2	0.46	17	0.82	30		0	138	138.3
TOTAL	45.5	1654	0.0	0	0.0	0	9.3	343	0.2	6	2.1	76	3.5	130	0.0	0	2220	2220.1

Table 3.37. Forage balance chart. Type C Producer--Ait Rbaa.

SOURCES OF FEED

	Source #1 Coll. Range		Source #2 Dom. Range		Source #3 Pvt. Range		Source #4 Fallow/Stub.		Source #5 Hay/Straw		Source #6 Feed Grains		Source #7 Cr. By-Prod.		Source #8 Com. Supple.		TOTAL MAUMs AVAIL.	TOTAL MAUMs REQUIRED
MONTH	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs		
JAN.		73		0		0		0	3.00	111		0		0		0	194	194.1
FEB.		102		0		0		0	2.50	93		0		0		0	194	194.2
MAR.		137		0		0		0	2.00	74		0		0		0	211	211.3
APR.		156		0		0		0	2.00	74		0		0		0	230	230.3
MAY		172		0		0		0	2.00	74		0		0		0	246	245.7
JUNE		100		0		0	1.00	37	1.50	56		0		0		0	193	193.0
JULY		75		0		0	1.55	57	1.50	56		0		0		0	193	193.3
AUG.		69		0		0	1.59	59	1.55	57		0		0		0	185	185.4
SEPT.		55		0		0	1.22	45	1.00	37	0.27	10	0.69	26		0	173	172.5
OCT.		53		0		0	1.33	49	1.15	43	0.27	10	0.69	26		0	181	180.7
NOV.		96		0		0		0	1.00	37	0.35	13	0.69	26		0	171	171.3
DEC.		87		0		0		0	1.20	44	0.35	13	0.69	26		0	170	170.1
TOTAL	31.7	1176	0.0	0	0.0	0	6.7	248	20.4	756	1.2	46	2.7	132	0.0	0	2327	2326.3

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Crop Production

Most livestock producers in the area do not have access to irrigated land. The large irrigation developments in the region are generally controlled by the wealthy. Small producers with irrigated land are probably using areas that have been irrigated for many years. Tables 3.38 and 3.39 present estimates of crop productivity for Type B and C producers.

Ait Rbaa producers seemed more likely to work land in association with someone else. Typically this means that the various inputs to crop production (land, water, seed, labor and other production inputs) are provided by two or more individuals and the yield divided among them according to their input. Each association relationship is a private contract between the individuals involved, and the permutations on the basic model are indeed numerous.

The two major crops grown in Morocco are wheat and barley. In the Tadla Region, both hard wheat and soft wheat are grown in nearly equal proportions. In the other regions, only hard wheat is grown. Considerable quantities of oats are grown in Timahdite for forage, while corn is grown in both Timahdite and El Faija. The absence of these crops in the Tadla Region make the producers there more dependent on their barley production and on purchased supplements such as bran and beet pulp for livestock. There is a large sugar plant in the area and a plant which manufactures pulp pellets, so this supplement is readily available. During the recent drought years, purchase of these feeds was heavily subsidized by the GOM and distributed free of charge by the Service de l'Elevage.

Table 3.38. Crop production. Type B Producer--Ait Rbaa.

Crop Production by Field or by Crop

Plot	Crop	Area ha	Input Levels/Rates: Seed "Var."	Seed Amt. qx	Seed Rate qx/ha	Fert.	Fert. Amt. qx	Fert. Rate qx/ha	Herbi.	Herb. Amt. liters	Herb. Rate l/ha	Pesti.	Pest. Amt. liters	Pest. Rate l/ha	Water Amt. units	Water Rate u/ha	Output L/R: YIELD Tons	Yield Rate T/ha
D1	H. Wheat	2.5	?	3.4	1.3	?	0.8	0.3			0.0			0.0		0.0	2.6	1.0
D2	H. Wheat	2.5	?	3.4	1.4	?	0.8	0.3			0.0			0.0		0.0	2.6	1.0
D3	H. Wheat	2.0	?	2.0	1.0	?	1.0	0.5			0.0			0.0		0.0	0.6	0.3
D4	Barley	3.0	?	4.5	1.5	?	1.0	0.3			0.0			0.0		0.0	3.5	1.2
D5	Barley	5.3	?	5.8	1.1			0.0			0.0			0.0		0.0	5.1	1.0
D6	S. Wheat	5.0	?	6.8	1.4			0.0			0.0			0.0		0.0	5.3	1.1
D7	S. Wheat	14.0	?	19.6	1.4	?	14.0	1.0			0.0			0.0		0.0	5.7	0.4
D8	Fallow				0.0			0.0			0.0			0.0		0.0		0.0
D9	Straw,etc	34.3															38.1	1.1
D10	Stubble	34.3															41.2	1.2
I1					0.0			0.0			0.0			0.0		0.0		0.0
I2					0.0			0.0			0.0			0.0		0.0		0.0
I3					0.0			0.0			0.0			0.0		0.0		0.0
I4					0.0			0.0			0.0			0.0		0.0		0.0
I5					0.0			0.0			0.0			0.0		0.0		0.0
I6					0.0			0.0			0.0			0.0		0.0		0.0
I7	Forage #1				0.0			0.0			0.0			0.0		0.0		0.0
I8	Forage #2				0.0			0.0			0.0			0.0		0.0		0.0
I9	Straw,etc																	0.0
I10	Stubble																0.0	1.2

Input Totals: Seed 45; Fertilizer 18; Herbicide 0; Pesticide 0; Water 0

Total Dryland	34
Total Irr. Land	0
Total Cropland	34

Total Fallow & Crop Residue Forage Yield from Dry Cropland		79
Rate of Fallow & Crop Residue Forage Yield from Dry Cropland	2.3	
Total Forage & Crop Residue Forage Yield from Irr. Cropland		0
Rate of Forage & Crop Residue Forage Yield from Irr. Cropland	0.0	
Total Fallow & Crop Residue Forage Yield		79

Table 3.39. Crop production. Type C Producer--Ait Rbaa.

Crop Production by Field or by Crop

Plot	Crop	Area ha	Seed "Var."	Seed Amt. qx	Seed Rate qx/ha	Fert.	Fert. Amt. qx	Fert. Rate qx/ha	Herbi.	Herb. Amt. liters	Herb. Rate l/ha	Pesti.	Pest. Amt. liters	Pest. Rate l/ha	Water Amt. units	Water Rate u/ha	YIELD Tons	Yield Rate T/ha
		Input Levels/Rates															Output L/R	
D1	H. Wheat	1.0	?	1.0	1.0	?	?	0.0			0.0			0.0		0.0	0.6	0.6
D2	H. Wheat	1.0	?	0.9	0.9			0.0			0.0			0.0		0.0	0.7	0.7
D3	Barley	3.5	?	3.9	1.1			0.0			0.0			0.0		0.0	2.3	0.7
D4	Barley	0.6	?	0.6	1.0			0.0			0.0			0.0		0.0	0.2	0.3
D5	S. Wheat	1.4	?	1.5	1.1			0.0			0.0			0.0		0.0	0.8	0.6
D6	S. Wheat	1.4	?	1.5	1.1			0.0			0.0			0.0		0.0	0.8	0.6
D7					0.0			0.0			0.0			0.0		0.0		0.0
D8	Fallow	0.0			0.0			0.0			0.0			0.0		0.0		0.0
D9	Straw,etc	8.3															4.8	0.5
D10	Stubble	8.2															10.6	1.2
I1	Barley	1.3	?	1.3	1.0	NPK	0.7	0.5			0.0			0.0	13	10.0	0.7	0.5
I2	S. Wheat	0.4	?	0.4	1.0	NPK	0.2	0.5			0.0			0.0	4	9.5	0.2	0.5
I3					0.0			0.0			0.0			0.0		0.0		0.0
I4					0.0			0.0			0.0			0.0		0.0		0.0
I5					0.0			0.0			0.0			0.0		0.0		0.0
I6					0.0			0.0			0.0			0.0		0.0		0.0
I7	Forage #1				0.0			0.0			0.0			0.0		0.0		0.0
I8	Forage #2				0.0			0.0			0.0			0.0		0.0		0.0
I9	Straw,etc	1.7															1.4	0.8
I10	Stubble	1.7															2.0	1.2

Input Totals: Seed 11; Fertilizer 1; Herbicide 0; Pesticide 0; Water 17

Total Dryland 9
Total Irr. Land 2
Total Cropland 11

Total Fallow & Crop Residue Forage Yield from Dry Cropland 15
Rate of Fallow & Crop Residue Forage Yield from Dry Cropland 1.7
Total Forage & Crop Residue Forage Yield from Irr. Cropland 3
Rate of Forage & Crop Residue Forage Yield from Irr. Cropland 2.0
Total Fallow & Crop Residue Forage Yield 19

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Labor Use

Tables 3.40 and 3.41 indicate that June was by far the month with the highest labor demand for the Ait Rbaa Perimeter users. This is the month of the cereal harvest, so this is to be expected. The plowing season in the late fall/early winter also created a small rise in labor needs.

Table 3.40. Labor use in person/days per month. Type B Producer--Ait Rbaa.

ACTIVITY	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
Perimeter grazing	25.3	28.0	31.0	30.0	31.0	20.0				10.0	10.0	20.0	205.3
Stubble grazing	5.0					5.0	31.0	31.0	30.0	20.0	20.0	10.0	152.0
Supplemental feeding	1.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	1.3	1.3	1.3	1.3	9.0
Shearing					0.7	2.0							2.7
Breeding													0.0
Lambing													0.0
Barn cleaning													0.0
Maintenance								12.6		4.0			16.6
Health tasks													0.0
Domestic activities	83.0	75.0	83.0	80.0	83.0	80.0	83.0	83.0	80.0	83.0	80.0	83.0	976.0
Plowing/Seeding													0.0
Irrigation											10.6		10.6
Fertilization													0.0
Harvesting						61.0							61.0
Transportation	1.0		1.3			4.0			0.7	2.0	1.3	1.3	11.6
Threshing						13.0	8.0						21.0
Small Animal Husbandry													0.0
Sales/Marketing	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	60.0
TOTAL	120.6	108.3	120.6	115.3	120.0	190.3	127.3	131.9	117.0	125.3	128.3	120.7	1525.7

Table 3.41. Labor use in person/days per month. Type C Producer--Ait Rbaa.

ACTIVITY	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
Perimeter grazing	31.0	32.0	35.4	34.3	35.4	15.0			4.3	4.4	10.7	17.7	220.2
Stubble grazing	5.6					19.3	35.4	35.4	30.0	31.0	23.6	17.7	198.0
Supplemental feeding	1.9	0.4	0.4	0.4	0.4	0.4	0.4	0.1	2.7	3.0	3.0	3.0	16.3
Shearing					0.3	1.1	0.9						2.3
Breeding													0.0
Lambing													0.0
Barn cleaning	1.1	1.3	1.3	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	14.0
Maintenance			6.0						2.7				8.7
Health tasks													0.0
Domestic activities	113.0	102.0	113.0	109.0	113.0	109.0	113.0	113.0	109.0	113.0	109.0	113.0	1329.0
Plowing/Seeding													0.0
Irrigation										6.6	3.7	5.3	15.6
Fertilization													0.0
Harvesting						41.9							41.9
Transportation	0.4	0.1			0.9	7.0	1.8			0.4	0.9	0.9	12.4
Threshing						4.3	10.3						14.6
Small Animal Husbandry													0.0
Sales/Marketing	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	60.0
TOTAL	158.0	140.9	161.1	149.9	156.1	204.2	167.9	154.7	154.8	164.6	157.0	163.8	1933.0

Domestic labor comprised the largest portion of the difference in labor use for the B and C producers. Controlling for domestic labor, a difference of only 34.3 days existed between the two types. This difference in domestic labor occurred because Type B families averaged 2.6 productive women and Type C 3.6.

As a caution, it should be added that these numbers were not gathered or projected with the precision and consistency of the El Faija numbers. The departure of the Peace Corps Volunteers before the final data analysis prevented detection of errors and correction of inconsistencies.

AIN BENI MATHAR

Ain Beni Mathar is distinctly different from other project sites. The climatic features of the region are the most arid. Further, it is the only site that is populated by purely Arab tribes. These tribes show a structural strength and unity which is different from the other areas. The following report will differ from those of the other sites as well, since the Agro-Pastoral Systems Study was not implemented in this area due to the death of the Peace Corps Volunteer, Raymond Kruger.

The characterization of producers and categorization of producer resource sets were developed based on data collected in 1983 from records at the Ain Beni Mathar Centre de Travaux and a 1978 list of rights users (sample of 10% of the rights holders to communal land of each of the douars). The assessment of producer resource sets and perceptions draws upon theses written by Paul Bartel in 1985 and Mohammed Aissi in 1986, both of which were completed under the auspices of the Project.

CHARACTERIZATION OF PRODUCERS: **AIN BENI MATHAR**

Producer resource sets were described by the percentage contribution to gross annual income of the tribe from agricultural production. Because data were available only for the number of sheep, cattle, and hectares of irrigated land owned by a representative sample of the tribe, gross agricultural income was defined as the sum of the estimated gross income received from livestock production, plus the estimated gross income from crops on irrigated land. The gross annual income from livestock production per Moroccan Animal Unit (MAU) was calculated by determining average gross annual income from all livestock sources reduced to the MAU basis. A MAU, which served as a standard by which animal dry matter requirements could be compared on a metabolic weight basis, was defined as the equivalent of one 30 kg ewe with 8.33 MAUs equal to one 250 kg cow (this definition is based on the daily requirement for dry matter, which was estimated as 3% of the body weight). The estimated gross income of an MAU was determined as the average market value of offspring (lambs and calves) plus the major secondary products such as culled animals, fleeces, and milk products. The total estimated income was calculated for the sample and divided by the total number of MAUs. This yielded an average return per MAU of 175.60 DH based on the following equation.

$$\frac{\text{Total Income Sheep Production} + \text{Total Income Cattle Production}}{\text{Total MAUs}} = \text{Average Income/MAU}$$

The value of the gross annual income from irrigated land was defined as the gross annual income per hectare for land planted in wheat which was assumed to be the highest feasible use for crop production (330 DH/quintal of wheat and the average yield of

12 quintals per hectare) plus the value of the crop residue (1.5 x 12 quintals x 150 DH). (The yield per hectare of crop residue was estimated at 1.5 x grain yield.) Following this procedure, the highest value per hectare of irrigated land was estimated to be 6660 DH.

Categories were developed which divide the gross income of the tribe into thirds. Producers whose estimated gross income fell within of the range were catagorized as Type A, the middle third as Type B and the lower third as Type C. A Lorenz Curve of the total gross annual agricultural income (Figure 3.2) presents the distribution of assets by percentage among the population. The X axis represents the cumulative percent of the population and the Y axis represents the cumulative percent of assets. Figure 3.2 indicates that the lower third of the total assets are controlled by 67% of the population, the middle third are controlled by 23.6% of the population, and the upper third are controlled by 9.6% of the population. This distribution of income represents a relatively high level of concentration of resources (GINI coefficient of 0.48). The income described, however, is gross and only partial. A more complete calculation of net income could provide better descriptive information about the distribution of wealth. Nevertheless, it is apparent that resources, as reflected by income estimates, are concentrated in the hands of a few.

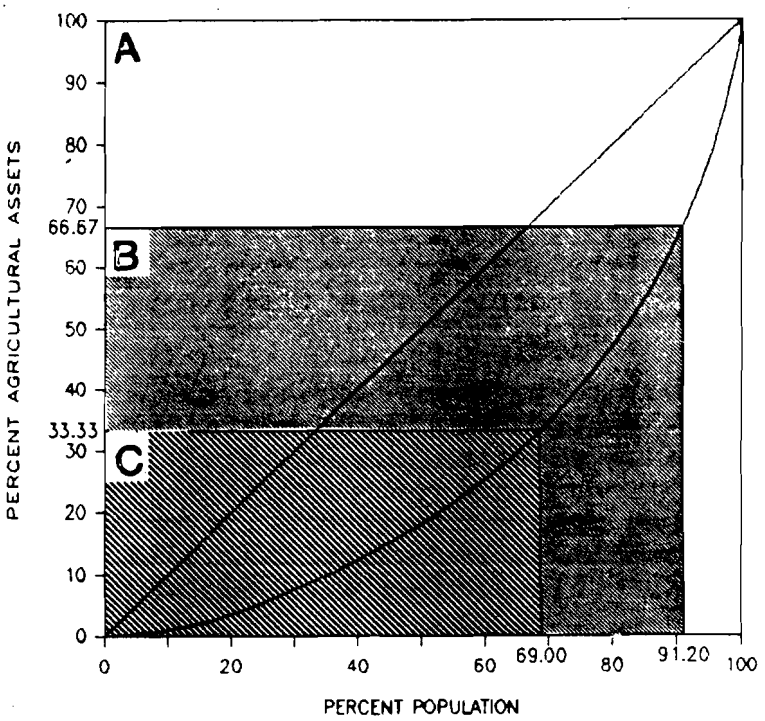

Figure 3.2. Distribution of gross annual income from livestock and irrigated land production activities among the Ain Beni Mathar tribal population.

In order to analyze the distribution of resources in terms

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of ranges of irrigated land and animals owned in each category, a crosstable was constructed (Figure 3.3). By applying the ratio of the gross income earned from 38 MAUs to the gross earnings from one hectare of land (equivalent values), the cells of the crosstable represent the exchange of a given range of animal units for a given area of land. With the total agriculturally active population equalling 100%, each cell would represent the percentage of the total falling within that range. In Figure 3.3, the established ranges are presented so that the income derived from that percentage falling within each of the nine cells comes from a mix of animal production and/or crop production activities. Note that the percentages of the populations in each of the three categories of the crosstable differ from 1.5% to 1.9% from Figure 3.2 because of the division of the population into separate groups for the crosstable.

CATE-GORY	MAX.GROSS INCOME PER CAT.*	MAUM RANGE CATEGORY	IRRIGATED LAND C 0TO2	B 2TO4	A 4MORE	PCT. ROW
C:	[illegible]	[illegible]	[illegible]	7.3	2.3	77.0
B:	26666	76 TO 152	[illegible]	1.9	2.3	17.6
A:	>26666	152&MORE	3.4	1.2	0.8	5.4
PERCENT COLUMN:			84.2	10.4	5.4	100.0
% IN CATEGORY: A = 10.7%, B = 20.7%, C = 67.4%						

* Adjusted for rounding errors in conversion factors

Figure 3.3. The distribution of gross annual income among the Ain Beni Mathar tribal population divided into ranges of resource sets. (Cell entries show the percent of the total tribal population, which equals 100%).

The upper left hand cell, which corresponds to Category C, accounts for 67.4% of the population. This portion of the population may have a maximum gross income of 13,333 DH (based on the price and yield assumptions previously defined) from some combination of livestock and crop production. The maximum number of MAUs required to achieve this level of gross income is 76 MAUs while the maximun number of hectares of irrigated land required is 2 hectares. Category B corresponds to the center left and upper center cells, representing 20.7% of the population. The maximum number of MAUs is 152 while the maximum number of hectares of irrigated land is 4 for this group. The maximum gross income derived from their production would equal 26,666 DH. Category A represents the portion of the population (10.7%) whose combined gross income from livestock and crops exceeds 26,666 DH.

Category A represents the broadest range of income sources, though the smallest percentage of the populaton. In the model, they have a range of gross income over 26,666 DH. The income of the lower left, upper right hand, and center cells are equal. Income increases in cells closer to the lower right, which has a

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value of annual gross income of 53,331 DH. Since this includes any income received from holdings of 152 MAUs or more, and four or more hectares of land, producers may exist beyond the boundaries of the model. The maximum gross agricultural income in the sample was 79,756 DH.

Several issues become important from this analysis. First, income from agricultural production is highly concentrated. The majority of agricultural income accrues to few people. It is apparent that the resource base of the vast majority is very limited. This greatly reduces the opportunities for their advancement.

This concentration of wealth also has ramifications in the setting of goals and objectives for programs oriented toward improving agricultural production. A choice exists in whether to emphasize increases in the productivity of the local resource base, in which case, the target population may be the upper segments of the population. If emphasis is to be placed on the greatest number of individuals, programs may be oriented toward improving production and income for producer families with a very small resource base. Though both goals are desirable and not necessarily mutually exclusive, it is important that in dealing with this population managers recognize that, while there are programs that are applicable to the entire population (such as the animal selection program), there is no panacea. It is important that a mix of programs aimed at different audiences be developed.

If crop production is to be addressed, the orientation should be toward relatively small landholdings and aimed at increasing the ability of the producer to meet the forage needs of his animals. This, coupled with the selection program mentioned above would provide quick returns to the producer and the extension effort.

The distribution of resources and size of the resource base has an effect on the introduction of new techniques and technologies. People in the middle income ranges seem the most likely to attempt to expand their production by adopting new techniques and technologies which are proven effective. The wealthy, on the other hand, may feel secure in their status and be less motivated to adopt new technologies when the old have proven suitable for their needs. The poor have limited resources to risk for possible increases in income.

In order to better understand this system of production in terms of income, it is necessary to look at net income rates for the population. Further, it is necessary to include dryland production since dry cropland is more extensive than irrigated land. Finally, the identification of interventions in this system according to the various resource categories may be achieved by reviewing their relative efficiency. An attempt will be made to address these issues in the following discussion.

ASSESSMENT OF PRODUCER RESOURCE SETS: **AIN BENI MATHAR**

Based on the preceding categorization of producers, examples

of production units were developed based on data collected in 1983 and 1984. The producers were assigned to the three categories based on the number of livestock and hectares of irrigated land they owned at the time of their interview. For the most part, quantities were averages of the subsamples. Management data, such as herd movements and sales, were based on general trends noted among the producers who fit that category. The production units described in the following discussion are composites of the producers for whom data was collected.

The value of producer unit resource sets was estimated based on the market value of all livestock, the productive value of cropland and the current value of facilities and equipment. It is clear that the estimated values of production unit resource sets, as shown in Table 3.42, are considerably greater than was estimated in the preceding discussion. This is primarily due to the inclusion of a considerably larger range of variables in the calculation. In the case of Producer C, the number of livestock owned is greater than would normally be accepted in that category. This producer was the smallest on which data was collected.

Table 3.42. Estimated value of producer resource sets. Ain Beni Mathar.

INVENTORY (Producer Category)	QUANTITY (units) A	B	C	VALUE (DHS) A	B	C
Land/Rights (ha/MAUMs)						
Irrigated Cropland	30	1		162000	8000	
Dry Cropland	5	35	10	40000	175000	60000
Private Range/Pasture						
Grazing Rights						
Livestock (head)						
Sheep						
Ewes	219	125	120	59130	33750	32400
Rams	6	5	2	4020	3350	1300
Replacement Ewes	23	23	5	5290	4600	1000
Replacement Rams	2			700		83
Speculation Animals	13	28	8	4940	10640	2800
Goats						
Does	16	28		2400	6300	
Bucks	2	2		350	500	
Replacement Does	2			250		
Replacement Bucks						
Cattle						
Cows	4	1		12800	2300	
Bulls						
Replacement Heifers	1			2250		
Replacement Bulls						
Equipment (#)						
Tractors	1			10000		
Trucks						
Farm Implements	2	2	1	10000	500	150
Buildings	3	2	1	15000	10000	5000
Tents	2	1	1	10000	4000	3000
Pumps						
Draft Animals	3	2	1	8400	3600	250
Other						
Subtotal				347530	262540	105983

Type A

The model producer in Category A had a family of eight; the head of the household, his wife, two sons, three daughters, and an unmarried sister. The sons both went to school and were available only part of the time to help with production tasks. He also had a son who worked in one of the large cities of Morocco, and who made occasional, but undetermined cash contributions to the family. The head of household acted primarily as a manager, due partly to his age and his status in the community. These roles, and particularly those of the male household members, required an outlay for hired labor to perform the menial production tasks.

The family lived in a douar near town. Their physical resources consisted of a rather large house with an attached storage building, barn and corral. They also owned a tractor, a motor bike and a horse. The horse was used primarily in fantasia ceremonies and was more of a status symbol than an actual part of agricultural production.

The irrigated land owned by the family was within easy walking distance of the house. Wheat and alfalfa were grown on the irrigated plots, along with a few fruit trees. These plots were used primarily to produce forage for the animals as well as wheat for family use.

The dry cropland lay a considerable distance from the house in communal grazing land traditionally used by the producer's fraction. The herds were often grazed in the vicinity and the tent of the hired herder was placed nearby so that he could also oversee the barley crop. The herd owner visited every week or so to check on the state of the herd and his crop, make management decisions and provide the herder with supplies. Occasionally, the herdowner or a member of his family stayed at the tent site in a guest tent kept for this purpose.

As can be seen in Table 3.43, this producer had a peak herd size of 232 adult sheep and 18 goats. The number remained rather constant with lambs being sold with some replacement of older ewes and rams. He also had four milk cows and their calves which were born the previous year. The cows were bred with a bull that was borrowed or rented.

Since the onset of the drought, the herds have been shrinking. During 1983 and 1984, approximately 100 ewes were sold annually. The herdowner tried to keep one breeding ram for every 30 to 40 ewes. In addition, he kept a few yearling males to fatten for sale during Aid El Kebir as well as provide replacements for aging breeding rams.

During the period of the study he tried to keep the number of ewes fairly constant. Six died during the fall and winter either lambing or from disease. These were replaced with a large purchase in the spring and by year-old female lambs in the fall. In addition, he kept a small number of goats. In the Ain Beni Mathar area, goats were not well regarded because they were considered to be more susceptible to disease and were thought to damage irrigated plots. The susceptibility to disease may have been because they were not highly valued, and unlike sheep, were

not usually vaccinated.

Table 3.43. Stockcount chart. Type A Producer--Ain Beni Mathar.

	SHEEP								GOATS						CATTLE						
	Ewes 27.0 kg.		Rams 45.0 kg.		Lambs 21.0 kg.		Spec. Animals 30.0 kg.		Does 22.0 kg.		Bucks 35.0 kg.		Kids 16.0 kg.		Cows 250 kg.		Bulls 350 kg.		Calves 163 kg.		Total MAUMs Required
MONTH	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	
JAN.	219	197	6.00	9.0		0	13	13		0	2.00	2.3		0.0	4	33	0.00	0.0	2.0	10.8	266
FEB.	221	199	6.00	9.0		0	13	13	16	12	2.00	2.3		0.0	4	33		0.0	2.0	10.3	279
MAR.	215	194	6.00	9.0		0	25	25	16	12	2.00	2.3	4.0	2.1	4	33		0.0	2.0	10.8	288
APR.	215	194	6.00	9.0	34	24	25	25	16	12	2.00	2.3	8.0	4.3	4	33		0.0	2.0	10.8	314
MAY	186	167	6.00	9.0	57	40	25	25	14	10	2.00	2.3	2.0	1.1	4	33		0.0	1.0	5.4	294
JUNE	186	167	6.00	9.0	41	29	25	25	14	10	2.00	2.3	2.0	1.1	4	33		0.0	1.0	5.4	283
JULY	186	167	6.00	9.0	37	26	0	0	14	10	2.00	2.3	2.0	1.1	4	33		0.0	1.0	5.4	255
AUG.	211	190	4.00	6.0	10	7	0	0	14	10	2.00	2.3	2.0	1.1	4	33		0.0	1.0	5.4	255
SEPT.	223	201	4.00	6.0	29	20	0	0	14	10	2.00	2.3	2.0	1.1	4	33		0.0	1.0	5.4	279
OCT.	223	201	6.00	9.0	2	1	13	13	16	12	2.00	2.3		0.0	4	33		0.0	1.0	5.4	277
NOV.	223	201	6.00	9.0		0	13	13	16	12	2.00	2.3		0.0	4	33		0.0	1.0	5.4	276
DEC.	219	197	6.00	9.0		0	13	13	16	12	2.00	2.3		0.0	4	33		0.0	1.0	5.4	272
TOTAL		2274		102.0		147		165		122		28.0		11.7		400		0.0		86.7	3336

The herd was divided during lambing. Pregnant and lactating ewes (representing 80% of the ewes) were brought in from the range to the home site in order to provide them with better forage. They were kept there until the lambs were weaned. The rest of the herd remained in the vicinity of the fields and most of the herd grazed the stubble on the dry cropland in the late summer or early fall. In the early stage of the drought, he rented land in the eastern part of the country. In 1983, he sent them south to land belonging to a neighboring tribe. In 1984, he kept them on the Beni Mathar land, possibly because it was more economically advantageous to sell sheep to meet forage needs rather than move them, or because the effect of drought was more general than in years past. A forage balance chart depicting the sources used and the amounts of forage required to meet animal requirements is presented as Table 3.44.

Since the onset of the drought, he has had to feed supplements to the herd year-round. Ordinarily, he only fed supplements during the winter and during periods of time when the ewes were nursing. He fed a mixture of barley or sugar beet pulp mixed with bran at a rate of one kilogram per ewe per day. This greatly increased his operational costs and was the primary reason for his shrinking herd. In essence, he subsidized livestock production heavily from profits from previous years, loans and crop income.

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Table 3.44. Forage balance chart. Type A Producer--Ain Beni Mathar.

SOURCES OF FEED

MONTH	Source #1 Coll. Range		Source #2 Dom. Range		Source #3 Pvt. Range		Source #4 Fallow/Stub.		Source #5 Hay/Straw		Source #6 Feed Grains		Source #7 Cr. By-Prod.		Source #9 Com. Supple.		TOTAL MAUMS AVAIL.	TOTAL MAUMS REQUIRED
	DM (T)	MAUMS	DM (T)	MAUMS	DM (T)	MAUMS	DM (T)	MAUMS	DM (T)	MAUMS	DM (T)	MAUMS	DM (T)	MAUMS	DM (T)	MAUMS		
JAN.	4.24	157		0	0.34	13	0.52	19		0	1.06	39	1.02	38		0	266	266
FEB.	4.59	170		0	0.34	13	0.52	19		0	1.06	39	1.02	38		0	279	279
MAR.	4.83	179		0	0.34	13	0.52	19		0	1.06	39	1.02	38		0	288	288
APR.	5.54	205		0	0.34	13	0.52	19		0	1.06	39	1.02	38		0	314	314
MAY	5.00	185		0	0.34	13	0.52	19		0	1.06	39	1.02	38		0	294	294
JUNE	4.70	174		0	0.34	13	0.52	19		0	1.06	39	1.02	38		0	283	283
JULY	4.35	161		0		0	0.52	19		0	0.67	25	1.35	50		0	255	255
AUG.	4.35	161		0		0	0.52	19		0	0.67	25	1.35	50		0	255	255
SEPT.	5.00	185		0		0	0.52	19		0	0.67	25	1.35	50		0	279	279
OCT.	3.51	130		0		0	1.89	70		0	1.06	39	1.02	38		0	277	277
NOV.	4.51	167		0	0.34	13	0.52	19		0	1.06	39	1.02	38		0	276	276
DEC.	4.40	163		0	0.34	13	0.52	19		0	1.06	39	1.02	38		0	272	272
TOTAL	55.0	2037	0.0	0	2.7	101	7.6	282	0.0	0	11.6	428	13.2	490	0.0	0	3338	3336

Sheep from the herd were sold during three major periods. The first sale occurred in the spring. At this time, fall lambs were sold along with ewes which had not lambed. Spring and winter lambs were sold during early- and mid-summer as they were weaned. From the sale of these lambs, he purchased twenty replacement ewes. Twenty-nine of the ewe lambs from the previous fall were kept as replacements for the ewes that were sold. The speculation animals were sold before Aid El Kebir. Ten of the older male lambs were also slaughtered during celebrations at the three major Moroccan holidays.

Three crops comprised the main part of Producer A's production; barley, wheat and alfalfa. The orchards had not born any fruit because of the drought and their young age. In fact, it was questioable whether or not the locale was suitable for commercial fruit production.

He devoted two hectares each to growing wheat and barley, and a half hectare to alfalfa. The land was irrigated every 20 days. Because of a dispute over payment of irrigation fees to the government, none of the tribal members paid their water fees during the year. The result was reduced production when the government eventually cut off the water. Crop residue on irrigated land was grazed by ewes nursing lambs.

The dryland was planted in barley. During the drought, production was greatly reduced. A large portion of his land was not planted. Though no measurable income was seen from this, a minimal value may have been obtained through grazing the scanty plant cover. All crops produced were used to meet family and livestock needs. The production was not adequate to meet his needs however, and he was forced to buy supplemental feeds on the market.

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Producer A received relatively low profits for his effort. A major profit-limiting factor was the high supplemental feed cost. In addition, the low crop yield contributed to this by reducing income. A third factor was his heavy dependence on hired labor. The willingness of Producer A to hire labor, enabling his sons to go to school, indicates a level of forward thinking in terms of his family, though this has significant costs during periods when the productivity of labor is low, such as during drought. His reluctance to further reduce his herd may reflect his desire to "weather the storm" of drought and be prepared to recover these losses during the better years which are expected to return.

The principal use of labor was for household tasks. Along with this, the level of labor used for transportation and herding remained relatively stable. There was a significant increase in the labor requirement for agricultural production in the summer and early fall months as fields were harvested, replanted and the herds separated. At this time, hired labor was relied upon.

Type B

Producer B had a family of twelve. He, his wife, three daughters and two sons lived in town. His married son, wife and their three children lived in a tent near the herd. His two younger sons went to school and provided part-time help with farming tasks. Producer B had a two-room house and an adjacent barn and corral.

Producer B differed from Producer A primarily in the size of his herd and amount of cropland. He did not possess several of the symbols which denote status: a horse and a large house. Further, he did not support members outside of his immediate family.

Producer B followed much the same production strategy as Producer A. The primary difference was the smaller set of resources in his possession which limited his flexibility. As with his wealthier counterpart, producer B had reduced his herd during the drought years but had tried to maintain the herd size during the year in study. He suffered losses of ewes during the lambing seasons which he replaced in the fall with yearling ewes kept over from the previous fall. He also kept thirteen yearling rams through the winter and spring for sale during Aid El Kebir. Producer B sold all but 23 ewe lambs during the spring and summer. Unlike producer A, he made no ewe purchases. All replacements came from his own lamb crop. A stockcount chart for Producer B is presented as Table 3.45.

The grazing pattern that Producer B followed with his herd marked another difference from Producer A. Since he depended on family members to herd his sheep, he had limited opportunity to herd his animals in separate groups based on animal requirements. He brought some animals in to graze irrigated land during the summer. They moved to his dry cropland in late-summer following the harvest. After this, essentially all animals were kept on communal rangeland. Some animals grazed the communal land in late-summer since his dry cropland lay within communal land and the barley crop was small due to the drought. A forage balance chart for Producer B is presented as Table 3.46.

Table 3.45. Stockcount chart. Type B Producer--Ain Beni Mathar.

MONTH	SHEEP: Ewes 27.0 kg. Head	Ewes MAUMs	Rams 42.0 kg. Head	Rams MAUMs	Lambs 11.0 kg. Head	Lambs MAUMs	Spec. Animals 35.0 kg. Head	Spec. Animals MAUMs	GOATS: Does 22.0 kg. Head	Does MAUMs	Bucks 25.0 kg. Head	Bucks MAUMs	Kids 8.5 kg. Head	Kids MAUMs	CATTLE: Cows 250 kg. Head	Cows MAUMs	Bulls 0 kg. Head	Bulls MAUMs	Calves 0 kg. Head	Calves MAUMs	Total MAUMs Required
JAN.	125	113	5.00	7.0		0	13	15	28	21	2.00	1.7		0.0	1	8		0.0		0.0	165.2
FEB.	125	113	5.00	7.0		0	13	15	28	21	2.00	1.7		0.0	1	8		0.0		0.0	165.2
MAR.	125	113	5.00	7.0		0	13	15	28	21	2.00	1.7		0.0	1	8		0.0		0.0	165.2
APR.	122	110	5.00	7.0	20	7	13	15	28	21	2.00	1.7	7.0	2.0	1	8		0.0		0.0	171.8
MAY	102	92	5.00	7.0	50	18	13	15	28	21	2.00	1.7	15.0	4.3	1	8		0.0		0.0	167.1
JUNE	102	92	5.00	7.0	52	19	13	15	28	21	2.00	1.7		0.0	1	8		0.0		0.0	163.6
JULY	102	92	5.00	7.0	24	9	13	15	28	21	2.00	1.7		0.0	1	8		0.0		0.0	153.3
AUG.	102	92	5.00	7.0	37	14		0	28	21	2.00	1.7		0.0	1	8		0.0		0.0	142.9
SEPT.	102	92	5.00	7.0	23	8		0	28	21	2.00	1.7		0.0	1	8		0.0		0.0	137.8
OCT.	102	92	5.00	7.0	23	8		0	28	21	2.00	1.7		0.0	1	8		0.0		0.0	137.8
NOV.	123	111	5.00	7.0		0		0	28	21	2.00	1.7		0.0	1	8		0.0		0.0	148.2
DEC.	121	109	5.00	7.0		0		0	28	21	2.00	1.7		0.0	1	8		0.0		0.0	146.4
TOTAL		1218		84.0		84		106		246		20.0		6.2		100		0.0		0.0	1864.5

Table 3.36. Forage balance chart. Type B Producers--Ain Beni Mathar.

SOURCES OF FEED

MONTH	Source #1 Coll. Range DM (T)	Source #1 MAUMs	Source #2 Dom. Range DM (T)	Source #2 MAUMs	Source #3 Pvt. Range DM (T)	Source #3 MAUMs	Source #4 Fallow/Stub. DM (T)	Source #4 MAUMs	Source #5 Hay/Straw DM (T)	Source #5 MAUMs	Source #6 Feed Grains DM (T)	Source #6 MAUMs	Source #7 Cr. By-Prod. DM (T)	Source #7 MAUMs	Source #8 Com. Supple. DM (T)	Source #8 MAUMs	TOTAL MAUMs AVAIL.	TOTAL MAUMs REQUIRED
JAN.		153		0		0		0		0	0.17	6	0.16	6		0	165	165.2
FEB.		153		0		0		0		0	0.17	6	0.16	6		0	165	165.2
MAR.		153		0		0		0		0	0.17	6	0.16	6		0	165	165.2
APR.		160		0		0		0		0	0.17	6	0.16	6		0	172	171.8
MAY		148		0	0.19	7		0		0	0.17	6	0.16	6		0	167	167.1
JUNE		144		0	0.19	7		0		0	0.17	6	0.16	6		0	164	163.6
JULY		129		0	0.19	7		0		0	0.17	6	0.30	11		0	153	153.3
AUG.		125		0	0.19	7		0		0	0.00	0	0.30	11		0	143	142.9
SEPT.		94		0		0	0.38	14	0.47	17	0.17	6	0.16	6		0	138	137.8
OCT.		94		0		0	0.38	14	0.47	17	0.17	6	0.16	6		0	138	137.8
NOV.		104		0		0	0.38	14	0.47	17	0.17	6	0.16	6		0	148	148.2
DEC.		134		0		0		0		0	0.17	6	0.16	6		0	146	146.4
TOTAL	43.0	1532	0.0	0	0.7	23	1.1	42	1.4	52	1.9	69	2.2	81	0.0	0	1865	1864.5

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As in the case of Producer A, Producer B provided supplemental feed all year. During a "normal" year, he only supplemented during the winter, if at all. As rangelands continue to deteriorate under current grazing practices, supplemental feeding may become the "norm" rather than the exception. During recent years, Producer B supplemented at higher levels than Producer A. This may be because he did not have the private forage resources at his disposal that Producer A did. This represented the greatest cost factor and, therefore limited profitability.

Producer B owned one hectare of irrigated land and farmed thirty-five hectares of dry cropland. He produced alfalfa and wheat on his irrigated land, and barley on his dry land. To some extent, he compensated for his lack of irrigated land by farming more dryland than Producer A. During a year of higher levels of precipitation, this activity may have been worthwhile. However, during the drought, his yields were low and, therefore, his returns per hectare were low. As in the case of Producer A, he plowed his barley field with a tractor. He did not own a tractor so he rented one. He hired most of the labor for his farming because his son was occupied with herding the sheep. His overall hired labor costs were lower than Producer A.

The returns from his alfalfa field were calculated based on five cuttings. This may be misleading since he actually made only one cutting and then turned the herd onto the field to graze subsequent production.

The allocation of labor by Producer B was similar to Producer A, with the exception of the amounts of time spent on each agricultural task. As in the case of Producer A, he hired labor for his cropping tasks and shearing. He did not hire a herder.

Type C

Producer C's agricultural operation differed in management from the other two. His family consisted of himself, his wife, two daughters and an older son. They had a small two-room house in his native douar. They also had a tent that they lived in when the herd was on communal land. He depended heavily on his family to supply as much of the labor for production tasks as possible. He rarely employed someone to do a job that he or his son were capable of doing.

The estimated value of Producer C's assets were less than half that of Producer B's and slightly more than one-quarter of Producer A's. This was reflected in his smaller herd, reduced dry cropland, lack of irrigated land and smaller house.

Whereas Producers A and B maintained essentially the same number of ewes throughout the year, Producer C's herd size fluctuated more (Table 3.47). Further, because of a die-off of goats, he had sold all of those surviving. Producer C lost six ewes during the spring and five in the fall. He also sold fifty of them during the spring and summer. He replaced five of these from his yearling ewe lambs.

Table 3.47. Stockcount chart. Type C Producer--Ain Beni Mathar

	SHEEP								GOATS				CATTLE			
	Ewes 30.0 kg.		Rams 45.0 kg.		Lambs 21.0 kg.		Spec. Animals 35.0 kg.		Does 0.0 kg.		Bucks 0.0 kg.		Kids 0.0 kg.		Cows 0 kg.		Bulls 0 kg.		Calves 0 kg.		Total MAUMs Required
MONTH	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	Head	MAUMs	
JAN.	120	120	2.00	3	0	0	8	9	0		0		0		0		0		0		132
FEB.	120	120	2.00	3	0	0	8	9	0		0		0		0		0		0		132
MAR.	109	109	2.00	3	21	15	8	9	0		0		0		0		0		0		136
APR.	109	109	2.00	3	46	32	8	9	0		0		0		0		0		0		154
MAY	109	109	2.00	3	54	38	8	9	0		0		0		0		0		0		159
JUNE	96	96	2.00	3	48	34	8	9	0		0		0		0		0		0		142
JULY	95	95	2.00	3	33	23	8	9	0		0		0		0		0		0		120
AUG.	61	61	2.00	3	5	4	8	9	0		0		0		0		0		0		77
SEPT.	81	81	2.00	3	5	4	8	9	0		0		0		0		0		0		97
OCT.	81	81	2.00	3	0	0	8	9	0		0		0		0		0		0		93
NOV.	80	80	2.00	3	0	0	12	15	0		0		0		0		0		0		98
DEC.	80	80	2.00	3	0	0	12	15	0		0		0		0		0		0		98
TOTAL		1141		36		148		124	0		0		0		0		0		0		1419

Besides his sale of ewes, he sold all but five of his surviving lambs (except for three which he slaughtered). He did not sell any speculative animals, but kept them to sell during the following year. This judicious sale of animals prevented him from suffering a net deficit in income during the year.

His lambing, and lamb survival rates, were lower than Producers A or B. This may have resulted from his late entry into a sheep breeding association which supplied all of the producers in the study with vaccinations. Had he vaccinated animals during the previous year, his lamb survival rate, and ultimately profits, may have been greater.

Unlike Producers A and B, who supplemented their herds with cereals and/or sugar beet pulp during the entire year, Producer C provided these only during the winter (Table 3.48.). During the spring, summer, and fall, he moved onto two hectares of rented pasture and cropland. The low rate of supplemental feeding may have also contributed to ewe and lamb losses. However, this low level of supplemental feeding was a significant factor in controlling livestock production costs.

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Table 3.48. Forage balance chart. Type C Producer--Ain Beni Mathar.

SOURCES OF FEED

MONTH	Source #1 Coll. Range		Source #2 Dom. Range		Source #3 Pvt. Range		Source #4 Fallow/Stub.		Source #5 Hay/Straw		Source #6 Feed Grains		Source #7 Cr. By-Prod.		Source #8 Com. Supple.		TOTAL MAUMs AVAIL.	TOTAL MAUMs REQUIRED
	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs	DM (T)	MAUMs		
JAN.	2.57	95		0		0		0		0	0.36	13	0.64	24		0	132	132
FEB.	2.57	95		0		0		0		0	0.36	13	0.64	24		0	132	132
MAR.	2.63	99		0		0		0		0	0.36	13	0.64	24		0	136	136
APR.	3.40	126		0		0	0.76	28		0		0		0		0	154	154
MAY	3.54	131		0		0	0.76	28		0		0		0		0	159	159
JUNE	2.16	80		0	0.92	34	0.76	28		0		0		0		0	142	142
JULY	2.59	96		0	0.92	34		0		0		0		0		0	130	130
AUG.	1.16	43		0	0.92	34		0		0		0		0		0	77	77
SEPT.	1.70	63		0	0.92	34		0		0		0		0		0	97	97
OCT.	1.59	59		0	0.92	34		0		0		0		0		0	93	93
NOV.	1.73	64		0	0.92	34		0		0		0		0		0	98	98
DEC.	1.65	61		0	0.00	0		0		0	0.36	13	0.64	24		0	98	98
TOTAL	27.3	1012	0.0	0	5.5	204	2.3	84	0.0	0	1.4	53	2.6	95	0.0	0	1449	1449

Producer C grew alfalfa for hay and pasture on the two hectares of rented land. The value and quantity of this production was calculated as if he had harvested five cuttings of alfalfa. This provided an important source of forage for his animals during all seasons of the year. He rented this land at a cost of 1050 DH per year.

He had ten hectares of dry cropland. This was planted in barley. However, since the crop was poor due to the drought, he did not harvest it but grazed the herd on the unharvested crop. It is likely that this crop would have gone to the herd anyway, so this decision was probably quite sound.

Labor costs were another major area where Producer C saved as compared to Producers A and B. He provided all of the labor for herding of the sheep. He and his son also sheared the sheep. The only major out of pocket labor cost was the plowing of the barley fields which required hiring of a tractor. During a normal year, he would hire one or two extra laborers to assist with the barley harvest depending primarily on his family to make up the bulk of the labor force.

Of the three examples discussed, Producer C seems to have followed the most sound strategy in the face of the drought. However, because of his small resource base, he did not have the flexibility that his wealthier counterparts had in buffering the effect of the drought. While they drew upon resources to subsidize their operations during the drought, he was forced to liquidate assets.

Conclusions

From the preceding discussion, it is apparent that the agricultural system of the Beni Mathar is very marginal. Though

it shows diversity between crop and livestock production as well as integration between these two activities, the returns from these activities were low. Once again, it should be emphasized that the data were collected during a period of severe drought and the potential returns from these activities should be much greater during "better" years. At least, this was the perception of the producers themselves.

There were major differences in the production system of producers in the three categories. The primary differences were differences in scale. The producers with larger sets of resources had more flexibility to diversify production and the resiliency in their production system to buffer the shock of failure in one of their sectors from catastrophes such as drought.

The amount of land owned by a producer is an important determining factor in this flexibility. Private land can provide a private forage reserve to be used during drought. It also increases the level of self-sufficiency in the provision of supplemental feed for the herds. This concept of self-sufficiency and the overall efficiency of crop production is brought into question given the low yield from crop production on marginal cropland.

Producers tried to maintain their levels of production at or above the break-even point during what they perceived as a short term period of low production. It is possible that they acted in a similar manner during periods of normal precipitation. As in other regions of Morocco, the possession of livestock may be a way in which producers are able to hold assets in a form that minimizes risk. This strategy may be quite sound considering the levels inflation common in recent years.

Several major issues may be identified from the analyses. First, livestock production in the area operates with a large forage deficit as indicated by the persistent use of supplemental feeds to meet animal nutritional requirements. This shows up clearly in this study of a drought situation. However, the situation probably exists to some extent during years of normal precipitation since the rangelands have been degraded extensively in the absence of management. If the level of production is to be maintained in the region and ranges are to continue to be considered as the major forage source that can substitute for high priced feeds and forages, steps should be taken to increase rangeland productivity. At the same time, interventions can be made to increase crop productivity, either through the use of more efficient cultural methods or the introduction of more productive forage crops.

Finally, improved livestock management techniques can be introduced. This may include more timely sale of cull animals, increased lamb offtake from improved nutrition and vaccination programs and the introduction of programs to improve the management of forage resouces.

The continuing need for involvement of extension and range specialists is clear. Further, experience gained through the Range Management Improvement Project indicate that sets of small interventions could lead to significant improvements in the level of production. Such interventions can be designed for the various groups of producers, thus reaching the majority of the population and affecting the majority of the local resource base.

Crop and livestock production activities are largely similar among producers. Differences in behavior are often a manifestation of a producer who views his herd as a business venture rather than simply traditional forms of livelihood or of holding wealth. Poorer producers living on the edge are generally not risk takers although resource constraints may result in relatively high levels of inherent risk in animal and crop production alternatives available to them.

Crop and herd production activities are intertwined. Much of the agricultural activity is directed toward forage and feed production, such as growing barley, oats and alfalfa. Wheat provides forage in the form of straw. Animals in turn, provide manure for fertilizer. The two main crops, barley and wheat, are planted in October or early November. Harvest time is usually in May or June. Producers in the Middle Atlas often plant corn, beans and potatoes which are then harvested in October. Type B and C producers do not sell much of their harvest. Rather, the wheat is used for human consumption and seed for the next crop while the barley is fed to the animals. Type A producers are the ones who are better able to get into lucrative cash crops such as cherries, pears and apples in the colder regions, and oranges, olives, cotton and sugar beets in the warmer areas.

The Ait Rbaa Perimeter is used at an entirely different time of year than the El Faija and Timahdite Perimeters. Ait Rbaa was traditionally a winter grazing area, and is used from October until May, during the time that the cereal crops are in the field. Timahdite and El Faija are both used on a continuous basis if weather permits. Historically, the El Faija Perimeter was a fall and winter range. During the times when animals are not on these perimeters, they are generally kept fairly close to home and fed supplements. In the past, reciprocal arrangements existed between tribes for the use of summer and winter ranges. Now, most of these arrangements have broken down and the seasonal lack of forage is compensated for with supplements. The supplements most commonly fed in El Faija and Timahdite are barley, straw, corn and alfalfa. Ait Rbaa producers also feed barley and straw, but are more likely to feed bran and sugar beet pulp than corn and alfalfa. Herds in all areas graze the grain stubble after harvest.

There are two livestock management strategies evident in the areas studied. Most Type B and C producers practice subsistence production in a fairly traditional manner. Surplus capital is invested in livestock, which are then sold to meet cash-flow needs. During the drought years, sheep were often sold in order to purchase supplemental feed for the remaining livestock. "The sheep eat each other," was a sentiment often expressed in area souks.

Though the lamb sales show seasonal increases, which indicate that the lamb crop tends to be sold during distinct periods, most lambs are kept for as long as possible in order to gain higher prices and to meet periodic cash needs. Three factors may account for the increased sales of old ewes and October lambs in May and June: harvest costs, repayment of agricultural credit loans, and a desire to sell lambs before summer when the forage supply decreases. Wealthier producers

claim that they never sell lambs in mid-summer or early fall. However, they will hold them for sale just prior to Aid El Kebir when it occurs during these seasons. These same producers fatten lambs marked for sale with barley or alfalfa.

Most lamb and young sheep purchases made by the families are to replace those that have died (other than those lambs which die just after birth). Two Type A producers in El Faija sold some young rams in the preceding June and replaced them with Timhadite breeding stock to improve their herds. Goats owned by Type A producers do not seem to be business investments in and of themselves. Rather, goats are purchased for slaughter to avoid slaughtering male lambs. Some poorer producers sell very young lambs in January rather than old ewes and support this decision by saying the ewes, unlike lambs, may lamb again in early spring. However, they then admit that due to inadequate feed, these lambs are frequently born weak and die, and the ewes often have little or no milk. This action is one manifestation of risk avoidance behavior of producers who have little, if anything, to fall back on in times of economic need except the herd and its potential for growth.

Researchers have noticed that a growing number of producers are becoming involved in livestock speculation. A producer with enough capital will often purchase a number of young lambs, fatten them on supplements and sell them for a profit. Even poorer producers will try speculation of this sort, albeit on a smaller scale. It is a good way to make some extra money as long as the profit on the sale exceeds the cost of feeding the animals and as long as one has the necessary cash to purchase both the animals and the feed.

Type A producers at El Faija sell speculative rams in January and February for two reasons. Prices are quite high at that time and sale of the yearlings will conserve supplemental feed resources, the cost of which, would probably not be offset by animal sales at a future date. These wealthier producers also watch the markets and, with their ability to rent trucks, often send lambs to distant souks to obtain higher prices.

These sales patterns seem to indicate that the wealthier producers are more integrated into the market. Since they have the resources to maintain their herds, particularly the lambs, during periods of low forage availability and to fatten them before sale, they can wait until the prices are higher and receive higher levels of income from sheep sold. On the other hand, smaller producers use the herd as a liquid asset whereby expenses may be met with the sale of a few head of sheep as the need arises. Behavior similar to that of the smaller herd owners is seen in the larger herdowners as well. The main difference is that the wealthier herd owner may be able to make better use of the market.

The production unit income statements were shown to two producers in El Faija, one Type A, and one Type B. The Type A producer agreed with almost all of it and did not express much surprise at what was done. The Type B producer, on the other hand, did not agree with his expenses or returns at all, insisting that he and his family were really far worse off than they had been portrayed. Where the discrepancies lay, he could not clearly say. The Type A producer is one who appeared to be

interested and cooperative. He was doing at least as well as his estimated returns suggested and had no argument with the conclusions. Most Type B and C producers expressed their belief that though crop and livestock production have generally improved during the past year, they themselves were not very successful. This attitude may simply be a disinclination to let any person outside of the family know whether or not they had a successful year. On the other hand, the Type B producer in question may not have been reporting his income accurately, and at the point in time in which he was asked, may have forgotten what information he had previously provided.

ASSESSMENT OF PRODUCER EXPECTATIONS

Most producers in this study (and others who often participated in discussions) seem aware of the adverse effects of heavy grazing on range which has suffered from drought. However, they offer no solution, except to hope for rain.

Producers and their wives often talk nostalgically of the past, of a period some twenty years ago when crop yields were high, forage was abundant, most ewes lambed, and when lambs thrived and were sold at high prices. According to them, the situation began to worsen eight to ten years ago. All producers interviewed seemed positive that the drought was passing and that both livestock and crop production would improve. Mortality of lambs in the last winter of the study decreased from the first year. Some producers had 60% to 80% of their ewes lambing, which they proudly admitted was an improvement over recent years.

Researchers were repeatedly told that sheep and goat production would improve with better supplemental feed. Poorer producers who were supplementing lambs in February with harvested alfa-grass and small amounts of barley, listed all the ingredients of a diet which would produce healthy lambs: barley, corn, straw, alfalfa, bran; and concluded by saying that they cannot afford to buy these feeds. In February, a Type A producer purchased two tons of a commercial feed which was cheaper than the current price of barley. He claimed that his sheep and cows were thriving on it and that it had contributed to increased milk production. Other producers took notice of this producer's actions, because his herd is healthy and the ewes produce strong lambs, and were very interested in the name and price of this feed. In Ain Beni Mathar, producers were skeptical of commercial feeds, saying they did not adequately meet the sheep's nutritional needs. Sales were low. A local feed plant went out of business and another did not sell much locally.

Public agencies have been involved in assisting farmers and livestock producers for many years. This assistance has taken the form of subsidies for agricultural products and supplemental feeds for animals. Government projects have built forage storage buildings, animal shelters, water points, and water collection devices. They have also excluded land from use and improved rangelands. Many, if not most, of these permanent improvements have been severly vandalized perhaps due to a lack of involvement by local people.

Producers expect government assistance to continue and may be willing to make group commitments ensuring their involvement. Producers in the Oujda area have been lobbying for help in the delimitation of ranges to be improved and in the formation of grazing cooperatives.

Producers' expectations of the success of governmental assistance may be varied, however. So far, few of these projects are viewed as successes.

ASSESSMENT OF PRODUCER PERCEPTIONS OF NEEDS, LIMITATIONS, ISSUES AND OPPORTUNITIES

Producers are unanimous in blaming low levels of production on the recent drought. On the survey performed in Timahdite in April 1985, when asked what was necessary for a suitable level of production, the answer invariably was rain. Finally, the drought seems to have broken and we may perhaps begin to have a better view of the other factors which limit production. Certainly an adequate amount of moisture would relieve the primary constraint to production. However, it must be remembered that Morocco is a country with a semiarid climate, which means it is and has been subject to frequent drought. People have short memories and tend to equate the good years of abundant rainfall with a normal year. Effective planning for improved livestock production in arid and semiarid regions requires planning for years of inadequate rainfall.

The second most common response to what is causing the range degradation is that there are too many sheep. Producers are well aware that the ranges are overstocked. The problem is that they do not see any real alternative to grazing on these ranges. El Faija producers say that even if they had the wherewithal to move their sheep to "greener pasture", someone else would just take their place on the range. Timahdite producers surveyed in 1985 agreed that animal numbers on the perimeter should be reduced. However, each group was adamant that it was the sheep of outsiders that were causing the problem, and that if entry rules could be enforced, legitimate rights-users would have plenty of room. The truth of such a statement is difficult to assess. The point is that, quite naturally, no one saw any benefit in reducing their own herd. Studies in Ain Beni Mathar during the drought found essentially the same situation and perceptions.

Among the four areas studied, the Ait Rbaa Perimeter suffers the most from this problem. The survey done in 1984 found more than 70,000 animals on an area of approximately 10,000 ha. Even worse, this survey was conducted in late spring after large numbers of animals had been removed from the perimeter. The survey found that one tribe, the Ouled Said el Oued, were the heaviest users of the Ait Rbaa Perimeter at the time of the survey, herding 71% of the sheep. However, they found only 224 households from this tribe on the perimeter. Since the tribal population was 21,174 according to the 1982 census, it is evident that perimeter users comprise only a small part of the tribe.

The dam at Bin el Ouidane in the mountains above Beni Mellal has played a major role in the expansion of modern agriculture in the region. This, in turn, has caused expansion of the human population. Only thirty years ago, there were only 100,000 people in the province of Beni Mellal. Now the population is nearing 700,000. Population pressure is turning the area into one of intensive irrigated agriculture, using modern farming methods and producing cash crops such as sugar beets, cotton, oranges, olives, and various kinds of vegetables. Traditional pastoral life is losing out. Evidence for this can be seen in the number of herders who do not own the animals they herd. Seventy-three percent of the animals using Ait Rbaa Perimeter are

owned by "absentee" owners and herded by producers with grazing rights. The three absentee owner/producers of this type (Type A) in the sociological study also happen to have grazing rights to the perimeter, but that is not always the case. In fact, a conflict which broke out in 1979 and resulted in tent burnings and massive property destruction was caused by non-rights-users having their sheep herded on the perimeter by people who did hold rights. However, considering that the population of the four rights-holding tribes is 65,404 (1982 census), there are enough people holding rights to keep the perimeter overstocked.

Though the communal grazing lands are still in existance throughout Morocco, the management system which traditionally governed their use is not. The jema'a, or tribal council, which used to make decisions about when certain areas could be grazed and which had the power to penalize trespassers has lost authority. As these traditional institutions have weakened, herdsmen have begun to perceive options to being bound by their authority. The effectiveness of a well-organized jema'a is demonstrated in Ain Beni Mathar where two tribes have been quite successful at implementing range management in their area, articulating needs, and garnering governmental assistance. Collective action can only be effective when everyone abides by the decisions. As soon as one person successfully breaks the rules to better serve his own interests, the system ceases to function. The state has attempted to take over this role but has found it difficult.

Ait Rbaa, again, suffers more than the other areas in this respect because of the diversity of the user population. Not only do these populations not have traditional ties, they are presently administered by three different caids, under two separate supercaids. To say that consensus is difficult would be an understatement.

Simple access to resources limits production among small producers. Property is, as everywhere, unequally distributed. Among the Ait Ben Yacoub in Timahdite, it was noticed that the alternative of providing every producer equal access to all of the fraction's ranges and managing it all as a common unit was endorsed by those groups whose grazing resources were limited, but opposed by those who had traditionally grazed the best lands. Those producers, not suprisingly, were much more apt to want to retain the status quo.

At all perimeters, the majority of the sheep are owned by only a few wealthy individuals who are able to manipulate resources and markets to great advantage. This makes it increasingly difficult for the subsistence level producer to continue. Certain producers in El Faija have expressed the belief that biases exist which favor wealthy producers in the allocation of water rights and the sale of land. This is a political issue, which cannot be directly addressed by range management. However, the realities of resource distribution are of utmost importance in formulating government policy and in identifying target audiences for extension. The GOM must first decide which people it plans to try to help by adopting an agency governing strategy before an effective program can be designed and implemented.

ASSESSMENT OF SOCIAL AND CULTURAL INFLUENCES ON LIVESTOCK AND CROP PRODUCTION AND THE ACCEPTANCE OF NEW TECHNOLOGY

The essential aspect of social science, regarding range management, is the ability to ascertain and assess cultural factors which bear on animal production and would influence the success of a potential innovation.

The Project has made recommendations in the areas of land treatments, grazing management, animal health, goat production, lamb marketing, controlled breeding, and animal selection for meat and wool production.

Experiments with land treatments and seedings were among the first of the project activities. There is now some information available about what kinds of treatments are most effective and which kinds of plants are best adapted. While producers do not have any problems with improving rangelands, they are understandably not very excited about turning over large areas of their already dwindling lands for protection, experiments, and unusable plantations. In most cases, they have yet to reap any benefit from these experiments. A better understanding of the goals of these experiments could be instilled in producers. For example, a clear understanding of the goals of adaptability trials and experimentation at El Faija does not seem to be widespread among producers. A few object outright to any fencing, arguing that if it continues, there will be no communal land left for grazing. When a new fence was constructed at the perimeter, the concern of some individuals was that their traditional route to move animals into the hills and fetch wood would be blocked. They were satisfied upon learning that this was not the case. Most producers visited were quite interested in perimeter development activities and were curious about soil preparation, seeding depth, and other methods used.

The Producer Study on animal production showed that animals on the improved rangeland at Plaine de l'Aarid were not producing substantially better than animals which did not have access to these areas. This points out that an improved grazing and animal management system is probably more important than an improved pasture. Such a system could work, but would be difficult to implement. First, the grazing resources in most places are scarce enough that excluding any section of them from grazing for extended periods of time and concentrating all the sheep on the remainder could be as detrimental as the present system. Secondly, there is the ever-present problem of arriving at a consensus in managing a collectively owned resource. If a central authority with the power to impose sanctions does not exist, or people feel that their interests are better served by not conforming to the consensus, people will break the rules. It takes only one person not following the rules to make the entire system break down.

Seedings on private land can result in increased forage resources which are more easily controlled than communal ranges. Their implementation is also problematic. Given the fact that producers plant more that 50% of their land in wheat and barley (of which the latter is used almost exlusively for feed), it is doubtful that producers could be persuaded to put some fields into forages unless the success of these efforts could be

assured. The production potential of barley is well known. If there is not enough to warrant harvesting, herds at the very least may graze the whole crop in the field. The support for improved pastures or seeding of private rangelands is stronger in El Faija and Plaine de l'Aarid than Timahdite; possibly because of the presence of a visual demonstration on the Plaine de l' Aarid Perimeter.

Animal health programs have proven to be acceptable and are generally perceived to be worthwhile. Producers are certainly aware of the various livestock diseases and the kinds of treatments which are available. The fact that a large number of them do not take advantage of these treatments is mostly a matter of economics. Either they simply do not have the money to purchase the medicines, or they have not seen the outlay result in a substantial increase in production. Other factors also effect the acceptability of vaccinations and other health treatments. As part of the Agro-Pastoral Systems Study and the Animal Production Study, herds were treated in the fall of 1985 against respiratiory/gastrointestinal parasites, small pox, enterotoxemia and ticks. The respiratory/gastrointestinal drench was repeated in February 1986. Some producers insisted that the small pox and enterotoxemia vaccinations of ewes had caused the deaths of winter lambs. When pressed, however, they admitted that not one of their animals had died of either disease, while untreated herds of neighboring producers had suffered some losses. These same producers preferred that the February drench not be repeated as one of its side effects is the temporary reduction of milk production. Even though they were supplementing ewes and giving young lambs finely gound barley mixed with a little milk, the idea of willfully decreasing milk production was unacceptable. This attitude was shared by some Type B and C producers as well. However, a few of them agreed to the drench with the belief that limiting the milk supply for a few days was preferable to loss of untreated ewes. These perceptions may be the result of a poor understanding of the purpose of these treatments. What becomes apparent in this discussion is that resistance to the treatments did not necessarily exist, but that the drench was proposed to be administered during an inappropriate time from the standpoint of milk needs.

The majority of animals in Morocco are infested with internal parasites. Though producers treat their animals with effective anti-parasite products, the sheep are routinely returned to a corral infested with the parasite larvae, thereby immediately re-exposing them. In order to interrupt the life cycle of the parasites, it is necessary to move the animals to clean ground long enough for the larvae to die. Most producers would be able to do this, although it would require building a new holding pen. They do not do it now because they do not have a clear understanding of these parasites and how they operate. If benefits were quantified, an extension effort devoted to this subject could be successful in convincing producers that the increased production of the healthier animals would be worth the expense of building a second corral.

Goats are often able to do better on poor quality range than sheep because of their preference for eating browse instead of herbaceous plants. However, producers prefer to invest in sheep

because they are preferred by consumers for both their meat and wool. Also, goats are purported to damage irrigated land and cause more range degradation. If producers could be shown that they could benefit from greater returns on their investment by raising strong goats rather than scrawny sheep, they may be willing to do so. However, the market will only bear so much goat meat. Goat production can occupy an important niche in the production system but will probably never achieve the importance of sheep production in Morocco.

The uncontrolled breeding and lambing periods in Morocco are considered by expatriot technicians to be a serious problem. Controlling the breeding and lambing seasons to coincide with seasons of high forage production could do much to improve lambing rates and lower mortality of lambs. Most other countries castrate male animals which are not specifically for breeding purposes. However, the preference for the meat of male animals and the prohibition against castration are among the few cultural features in Morocco limiting the acceptance of modern production methods. If castration is unacceptable, one option is to keep rams separate from the ewes except during the prescribed breeding season. This turns out to be economically infeasible for small (most) producers. They would have to hire another herder or feed the rams separately and they do not have the resources for this. The short-scrotum technique described in the Animal Production section is a good example of how technology can be adapted to be more acceptable to the culture.

Controlling breeding and lambing periods would enable the producer to better control his lamb marketing as well. At present, lambs are often sold in a situation of immediate cash needs. As was previously mentioned, some producers do practice market speculation but many sell lambs on a schedule dictated by cash flow needs. A well-organized marketing system could result in much higher revenues from sheep sales. This, however, may be impossible for those producers who sell sheep for the cash necessary to meet day-to-day expenses.

Moroccan rangelands are presently supporting large numbers of unproductive animals. Many reproductive problems were found in both ewes and rams. Technicians have recommended culling these animals to increase production and reproductive potential of the herd. Contrary to popular belief that wealth and status are closely connected with the numbers of animals owned, producers were very receptive to the project extension efforts aimed at animal selection for increasing animal production efficiency. Producers could readily see the reduction in production costs possible and the potential for production increases.

Higher revenues could also be obtained through increased production of high quality wool. The export carpet industry is of national economic importance. If care could be taken in the breeding and selection process to select for wool quality, major improvements could be made in a short time. There is a high potential for the success of extension activities involving wool production and marketing in Morocco. This is also an area where women could be directly involved.

The majority of the factors which inhibit the acceptance of new technologies are not mainly cultural--certainly not in the sense of adherence to traditional practices for their own sake.

Producers must first be financially able to implement a new practice before technicians wonder whether they would be willing to do so. They appear more than willing to change if they perceive the chances of benefit are high and if they are able to implement the change. Often they are not able to change and the reasons for this inability may not be evident to the outside extension agent. Most of the time the producer's resource base is simply not large enough or flexible enough to allow diversification. Producers who are just barely making ends meet cannot afford to take risks with their scarce resources. They do things the way they always have, not because they believe it is the best way, but because they believe it is the only thing they can do.

Limitations can be social as well. Often, a complicated system of contracts, agreements, and associations governs the use and ownership of land, water, and even animals. A producer in this case will not have complete control over his resources necessary for him to adopt a new practice.

Cultural and religious limitations are the hardest to change, but are fortunately few in number. Most technologies can be altered to adapt to these features as long as there is an awareness of what these limitations are.

CHAPTER FOUR: **APPLIED RESEARCH -- ECONOMICS**

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INTRODUCTION

Economics can be defined as the science which deals with the wealth-using and wealth-producing activities of man, or more succinctly phrased, the efficient allocation of scarce resources among competing uses. It is essential that economic analyses be included in any attempt to improve the well-being of people. Economics serves as an aid in the establishment of goals and the identification of activities that lead to attainment of goals. It also serves as a means by which goals and approaches to reaching goals can be appropriately evaluated.

Goals of the Economic Analyses

The primary goal of the economic analyses was to determine what products were produced by livestock producers, what resources were available to producers and what production practices were used. In addition, the goal included identification of alternative means of production based on consideration of the constraints affecting the production systems.

The project goals were to increase livestock production and production efficiency which would bring an increase in net income and improved well-being of Moroccan livestock producers. Thus, the project was focused on two important areas:

First, it was important to identify some economically feasible and appropriate alternatives (technological and operational strategies) that would increase production and production efficiency of the livestock/crop systems in Morocco and result in increased net income to producers.

Second, it was necessary to estimate the magnitude of production, production efficiency, and, ultimately, net income increases given a range of producer acceptance of alternative production strategies.

This chapter addresses the attainment of these goals.

Purpose of the Economic Analyses

The purpose of the project was to increase the institutional capacity of the Direction de l'Elevage to assist and lead in the accomplishment of the established goals. The purpose of the economic analyses was to demonstrate appropriate procedures for identifying needed biological and socioeconomic information and integrating this information into decision making. This information can then be used by decision-makers to plan programs and evaluate government investment alternatives that will help meet the goals identified for development of Moroccan livestock and crop production sectors.

Methods Utilized in the Economic Analyses

Two approaches were used in the economic analyses, partial

budgeting and budgeting. Partial budgeting refers to estimation of the outcome, in production parameters and net returns, resulting from individual production activities and was used to estimate the effects of various technical and operational alternatives such as range seeding, restructuring of livestock herds, and grazing management. Budgeting refers to estimation of the outcome, in production parameters and net returns, resulting from the combination of production activities included in the production systems as a whole and was used to estimate the cumulative effects of various production strategies for production systems.

A conceptual model based on the production parameters, the costs of resources used in production, and the prices of products of the production process was developed to aid in the integration of biological and socioeconomic information and to provide a consistent treatment of information. In order to establish an analysis format that could be easily applied and would provide a standard format for reporting the information, a micro-computer program was developed to aid in the computations required in the use of the model. This program, called "PROMO", was transmitted to DE, USAID, and others interested in livestock and crop production systems along with instruction manuals, questionnaires and data recording forms.

Biological and socioeconomic information was integrated through use of the economic analyses to allow identification of technical and operational alternatives that could be immediately applied. This information was then utilized to develop extension programs in the areas of high producer interest. Alternative range management practices were compared in terms of investment costs and the subsequent increases in forage production required to produce a given real rate of return on investment.

RESULTS

Range Livestock/Crop Production Systems Summary

Data pertaining to the components and productivity of several existing livestock/crop production systems were collected in each of four project areas as reported in Chapter 3. The information for the various producer categories was organized into models consisting of estimates of current production levels and economic characteristics. This was useful for comparison of resource availability and production characteristics of various groups of producers, for problem identification and for formulation of estimates of the effects of producer accaptance of alternatives. A summary of estimated production and economic characteristics (Table 4.1) serves as a basis for discussion of some of the more important production systems characteristics.

Herd Structure and Productivity

Male to female ratios of animals in livestock herds varied substantially by kind of livestock. Sex ratios tended to be low for sheep herds (1 ram to 33 ewes) and high for goat herds (1 buck to 9 does). It is important to have an adequate number of fertile males to successfully breed all females while excessive coverage adds nothing to reproductive rates yet requires more forage. If male fertility is relatively high, a ratio of 1 male to 25 females should result in enough males to breed all females in sheep and goat herds.

Female replacement rates tended to be low for sheep (19%) and goats (17%). This indicates that the average ewe is expected to be productive for a little over five years and that the average doe is expected to be productive for almost six years. These expectations appear to be somewhat optimistic if a high level of productivity is desired. A four-year productive life may be a more realistic expectation.

Lamb crops and kid crops were exceptionally low by most standards averaging 55% for sheep and 54% for goats. Inadequate nutrition and large numbers of animals that are functionally incapable of reproduction are thought to be major contributors to the low reproductive rates observed. An acceptable yet modest expectation of lamb and kid crop percentages for Moroccan livestock is 90%.

Adult death loss for both sheep and goats was relatively high (8.1% and 8.4% respectively) and is related primarily to inadequate nutrition and preventive health care. A reasonable expectation of maximum death loss for mature Moroccan sheep and goats is 5%.

Average weights of lambs and kids at six months of age were also relatively low (17.4 kg and 11.3 kg respectively) and reflect inadequate levels of nutrition for lactating females and young animals. Average weights of 23 kg for lambs and 17 kg for kids are reasonable weight expectations.

Table 4.1. Moroccan range livestock/crop production systems summary.

Parameter	Production System by Location and Category												
	Ain Beni Mathar			Timahdite				El Faija			Beni Mellal		Estimated Current Average
	"A"	"B"	"C"	"A"	"B"	"C"	"D"	"A"	"B"	"C"	"B"	"C"	
Livestock Production													
Sheep Herd													
# of Ewes	223	125	120	580	304	140	60	240	48	25	116	107	174
Herd Structure													
Rams/Ewes	0.027	0.040	0.017	0.029	0.039	0.036	0.033	0.029	0.042	0.040	0.009	0.019	0.030
Replacement Rate (#Repl. Ewes/#Ewes)	0.179	0.184	0.165	0.333	0.200	0.200	0.200	0.167	0.167	0.167	0.200	0.167	0.194
MAU Equivalents/Unit	1.280	1.234	1.324	1.323	1.368	1.239	1.222	1.523	1.701	0.982	1.465	2.012	1.389
Lamb Crop (%)	67.0%	40.0%	63.3%	68.1%	57.0%	62.1%	58.3%	49.6%	54.2%	35.0%	46.6%	56.1%	54.8%
Adult Death Loss (%)	9.0%	8.0%	8.3%	6.0%	6.0%	6.0%	6.0%	12.0%	12.0%	12.0%	6.0%	6.0%	8.1%
Annual Production (T)													
Young Animals	2.800	0.650	1.440	4.660	2.550	1.330	0.790	1.950	0.440	0.080	1.493	1.717	1.658
Adult Animals-Cull	0.790	0.450	0.390	4.240	1.170	0.540	0.230	0.320	0.070	0.030	0.517	0.317	0.755
Wool	0.340	0.195	0.180	0.955	0.506	0.239	0.099	0.400	0.080	0.040	0.234	0.218	0.291
Goat Herd													
# of Does	16	28	0	0	130	4	0	42	0	17	17	7	22
Herd Structure													
Bucks/Does	0.125	0.071			0.031	0.250		0.048		0.059	0.176	0.143	0.113
Replacement Rate (#Repl.Does/#Does)	0.125	0.286			0.200	0.200		0.167		0.120	0.118	0.171	0.173
MAU Equivalents/Unit	1.013	0.993			0.951	1.184		0.891		0.822	1.224	1.162	1.030
Kid Crop (%)	50.0%	64.0%			55.4%	65.0%		57.1%		24.0%	55.1%	57.1%	53.5%
Adult Death Loss (%)	7.0%	8.0%			6.0%	6.0%		10.5%		18.0%	6.0%	6.0%	8.4%
Annual Production (T)													
Young Animals	0.100	0.190			0.820	0.030		0.260		0.000	0.140	0.050	0.133
Adult Animals-Cull	0.050	0.090			0.400	0.010		0.050		0.000	0.060	0.026	0.057
Goat Hair	0.020	0.030			0.134	0.005		0.040		0.020	0.020	0.008	0.023
Cattle													
# of Cows	4	1		3	4	2	2	3			2		2
MAU Equivalents/Unit	9.688	8.333		10.278	10.083	9.850	9.873	9.028			11.167		9.788
Annual Production (T)													
Young Animals	0.170	0.075		0.300	0.350	0.140	0.150	0.090			0.136		0.118
Adult Animals-Cull	0.060	0.010		0.060	0.090	0.040	0.040	0.080			0.035		0.035
Forage Req. (MAUM)	3336	1865	1448	8570	6972	2223	1050	4660	788	446	2327	2238	2994
Forage Req. Origin													
Collective Range	81.2%	85.9%	69.8%	43.4%	69.2%	58.9%	53.1%	60.0%	47.7%	43.8%	50.4%	75.2%	61.6%
Other Range	4.0%	1.5%	14.1%	28.1%	2.8%			1.0%					4.3%
Crop Residue/Fallow	11.2%	2.3%	5.8%	8.2%	10.8%	25.3%	26.5%	9.9%	23.5%	23.1%	10.7%	15.3%	14.4%
Forage Crops/Straw		2.8%		4.1%	7.3%	0.5%	1.6%	17.5%	16.8%	19.8%	32.5%	0.3%	8.6%
Feed Supplements	3.6%	7.5%	10.2%	16.2%	9.9%	15.3%	18.8%	11.6%	12.0%	13.2%	6.4%	9.2%	11.2%
Avg. Cost per MAUM (Fee & crop sources)	3.33	5.74	10.13	8.69	8.51	11.42	13.65	10.36	12.70	13.25	8.60	7.81	9.52

Table 4.1 (cont'd.). Moroccan range livestock/crop production systems summary.

Parameter	Ain Beni Mathar "A"	Ain Beni Mathar "B"	Ain Beni Mathar "C"	Timahdite "A"	Timahdite "B"	Timahdite "C"	Timahdite "D"	El Faija "A"	El Faija "B"	El Faija "C"	Beni Mellal "B"	Beni Mellal "C"	Estimated Current Average
	Production System by Location and Category												
Livestock Revenue	46966	21336	22860	144365	92098	31667	18151	72579	16791	2627	36093	53670	46600
Livestock Prod. Costs	33656	19910	22255	104053	91104	31979	22460	103814	21062	6161	41795	49834	45674
Livestock Net Rev.	13310	1426	605	40312	994	-312	-4309	-31235	-4271	-3534	-5702	3836	927
Crop Production													
Cropland (ha)													
Dryland Surface	30.0	35.0	10.0	1.0	16.7	3.8	5.0				32.0	8.8	11.9
Irrigated Surface	3.0	1.0	2.0	17.0	10.9	18.0	11.4	13.6	4.7	4.0		1.7	7.3
Cereals													
Surface (ha)	13.5	35.5	10.0	18.0	25.4	20.8	7.8	9.0	2.6	2.8	34.3	10.5	15.9
Yield (Tons)	7.9	9.2		6.9	8.3	8.6	3.2	3.3	1.4	1.2	25.4	4.1	6.6
Rate (T/ha)	0.585	0.259	0.000	0.383	0.327	0.413	0.410	0.367	0.538	0.429	0.741	0.390	0.418
Forages and Aftermath													
Surface (ha)	30.0	36.0	12.0	18.0	27.1	21.8	13.1	11.5	3.7	3.4	34.3	10.5	18.5
Yield (Tons)	29.6	46.8	13.9	31.0	50.0	32.1	14.4	17.6	8.4	5.8	79.3	18.8	29.0
Rate (T/ha)	0.987	1.300	1.158	1.722	1.845	1.472	1.099	1.530	2.270	1.706	2.312	1.790	1.570
Veg., Corn, Other													
Surface (ha)					2.3	1.0	3.7	3.9	2.0	0.9			1.2
Yield (Tons)					2.8	0.2	1.4	4.0	1.1	0.5			0.8
Rate (T/ha)					1.217	0.200	0.378	1.026	0.550	0.556			0.327
Crop Revenue	28915	40840	12920	28085	47104	33117	16103	22843	8916	6080	93500	22076	30042
Crop Production Costs	15740	14560	7700	14708	14730	12008	6583	9910	2366	2640	28649	27279	13073
Crop Net Revenue	13175	26280	5220	13377	32374	21109	9520	12933	6550	3440	64851	-5203	16969
Other Sources of Net Income (DH)	112	56	136							3590			325
Inventory Value (DH)	331530	262540	105983	1741355	512707	273225	224101	588393	138320	68085	856385	199340	441830
Prod. System Net Rev.	26597	27762	5961	53689	33368	20797	5211	-18302	2279	3496	59149	-1367	18220
Return on Investment	8.0%	10.6%	5.6%	3.1%	6.5%	7.6%	2.3%	-3.1%	1.6%	5.1%	6.9%	-0.7%	4.1%
Per Capita Net Rev. (DH/family member)	5319	3966	1192	10738	2383	4159	744	-1017	207	318	4550	-105	1918
Forage Use Efficiency													
* Livestock Net Rev. (DH/MAUM)	3.99	0.76	0.42	4.70	0.14	-0.14	-4.10	-6.70	-5.42	-7.92	-2.45	1.71	0.31
* Animals (kg/MAUM)	1.190	0.786	1.264	1.081	0.772	0.940	1.152	0.590	0.647	0.247	1.023	0.943	0.920
* Fiber (kg/MAUM)	0.108	0.121	0.124	0.111	0.092	0.110	0.094	0.094	0.102	0.135	0.109	0.101	0.105

Feed and Forage Sources, Dependence and Average Cost/Moroccan Animal Unit Month of Forage (MAUM)

Feed and forage sources utilized by most producer groups included range forage, crop residue and fallow, hay and straw, grains, beet pulp and commercially prepared supplements. While categories of feeds and forage used were common among most producer categories, the level of dependence on the various sources varied. Most producers depended on rangelands to provide more than 50% of the dry matter required by livestock and average dependence was 61.6%. Grain and other supplement dependence ranged from a low of 3.6% to a high of 18.8% with a mean dependence of 11.2%. The level of dependence on the various sources of animal nutrients generally reflects differences in availability of range forage by location. However, it appears that the larger producers tend to have greater access to range forage. A possible explanation may be that larger producers with more financial resources (capital, land holdings and equipment) are not as constrained to graze their animals as near their private land holdings as are smaller producers.

Average cost per Moroccan Animal Unit Month (MAUM) of forage (27 kg of dry matter - the estimated dry matter requirement for a 30 kg ewe) varied greatly among categories of producers from a low of 3.33 DH/MAUM to a high of 13.65 DH/MAUM with an average of 9.52 DH/MAUM. The level of dependence on feed grains and other supplements is sufficiently positively correlated with average cost per MAUM (correlation coefficient of .79) to make the generalization that low dependence on feed grains and other supplements leads to relatively low average feed and forage cost and vice versa. In other words, substituting low cost range forage for higher cost purchased forages can substantially reduce livestock production cost and increase profitability. The indication is that many producers substitute grains and other feeds for forage to meet basic maintenance requirements of animals rather than as supplements in the true sense, that is, to balance the forage base to meet specific nutritional requirements for reproduction, lactation, and growth.

Net Revenue from Livestock Production

The estimated net revenue from livestock production varied considerably among locations and producer categories. Certainly the low rates of productivity and production efficiency previously discussed limited livestock returns. Likewise, the relatively high costs of feeds and forage to support the livestock production enterprises resulted in high production costs. The average net return of 927 DH/producer family indicates little more than a break-even proposition. However, just as some groups showed relatively large losses from livestock production, some showed that profitable livestock production was possible.

Crop Productivity

Crop production activities centered primarily around cereals production although producers in some locations and categories engaged in the production of vegetables, forages, and fruit.

Barley was the most important cereal crop grown in terms of surface, commonality among locations, and groupings of producers. Most of the barley produced was used by producers to support livestock herds. In order to ensure that production costs and returns were properly treated, all crops and products produced and used in livestock production were considered at market value as returns to crop production activities and charged as costs to livestock production activities. Average yields were low, reflecting both drought conditions during recent years and inherently low land productive potential for much of the land cultivated. Shortages of irrigation water resulted in depressed yields on irrigated lands and nonirrigated lands were left fallow in some cases. Some fields had been damaged by hail in the Timahdite area, however, there is no reason to believe that such an occurrence is unusual. Use of commercial fertilizers was common, however, the data reported was not detailed enough to give any indication of whether or not the fertilizers used supplied the limiting plant nutrients. Use of improved crop varieties, herbicides or pesticides was not reported.

Net Revenue from Crop Production

Estimated net revenue from crop production was generally positive and varied primarily according to availability of resources. The estimated average net revenue from crop production was 16,969 DH/producer family.

Income from Other Activities

Some producers reported that they received income from sources other than crop and livestock production. The sources included military pensions; full or part-time employment; contributions from family members living and working outside the area; and small scale household enterprises such as weaving, vegetable production, or rabbit and poultry production. Information on these sources of income was difficult to obtain and was reported incompletely.

Production Systems Net Revenue

The average estimated annual net revenue/producer family from livestock production, crop production and other sources of income averaged 927 DH, 16,969 DH and 325 DH respectively resulting in an average total net revenue of 18,221 DH/family. Estimated net revenue on a family member basis was 1,918 DH, a relatively low value in comparison with the national average (estimated to be approximately 7,500 DH/capita).

While the contribution from crop production was approximately 17 times the contribution of livestock production, it is important to keep in mind that most of that income was derived through "marketing" of feed grains and forage through the livestock production enterprises. The opportunity for an individual producer to increase net income by selling barley in lieu of raising livestock does exist. However, without the livestock (on the national scale), the market value of many of the crops produced would drop dramatically. The interdependence of both the crop and livestock enterprises is very important

because few alternative crops offer viable alternatives on land currently dedicated to producing crops in support of the production of livestock.

Forage Use Efficiency

Net revenue from livestock production for each MAUM of forage (27 kg of dry matter) ranged from around 5 DH/MAUM to -8 DH/MAUM and averaged 0.3 DH/MAUM. This low level of efficiency results from relatively high production costs (primarily feeds and forages) and low productivity. Live animal production in kilograms per MAUM ranged from a high of 1.3 kg/MAUM to a low of 0.6 kg/MAUM and averaged 0.9 kg of live weight/MAUM. Animal fiber production per MAUM ranged from .135 kg/MAUM to 0.092 kg/MAUM and averaged 0.105 kg/MAUM. Since the wool and hair is clipped from mature animals, there is little correlation of fiber production and live animal production.

Production Systems Problems and Alternatives

The summary of production systems characteristics led to the identification of some basic problems in livestock production that affect the producers' economic welfare. These problems fell into two major categories: 1) high production costs and 2) low productivity. Although some basic information on crop yields and production practices was obtained, time constraints and staffing did not allow for analysis of the basic problem of low crop productivity. However, some work was done with producers in the Timahdite area to increase forage production on irrigated parcels with alfalfa and orchardgrass.

High Livestock Production Costs

Livestock production costs were high because of the relatively high level dependence on expensive sources of feeds for maintenance of animals and support of unproductive animals. Rather than using harvested forage, feed grains and commercial supplements to meet specific animal requirements for reproduction, lactation and growth of animals, these nutrient sources were commonly used to support weak and nonproductive animals. Nonproductive individuals were subsidized at the expense of productive animals by reducing the amount of nutrients available.

Two ways in which production costs can be reduced are by increasing livestock production efficiency and by producing low cost forage. Animal production efficiency can be increased by introduction of improved animal husbandry techniques including management of feed and forage resources to meet specific animal requirements for production, removal of nonproductive animals from the breeding herds coupled with selection of quality animals for replacement and adoption of higher replacement rates and adequate sex ratios of breeding animals. Range forage production can be increased in a number of ways but all require organization and management of grazing use. Therefore, improvement of range forage production is, in reality, dependent on the desire and commitment of producers to organize themselves, to control

grazing use and to improve their rangelands. Grazing management alone has the potential of dramatically increasing forage production from most Moroccan rangelands with little or no financial investment required. On some sites there is the potential to employ range improvement practices such as revegetation and water harvesting to increase forage production. These practices require various levels of investment depending on the particular practice or set of practices employed and the intensity of the treatments by land surface area.

Low Levels of Productivity

Animal and crop productivity estimates reported and measured were low as a result of drought, abusive land use practices that continue to degrade range and cropland, outdated animal management practices, and resource limitations.

Producers have reacted and adapted to recurring drought by reducing livestock numbers and increasing dependence on grains and supplements to support animals. However, the reduction in animal numbers has not been sufficient to reach a balance between animal requirements and forage supply and, although numbers were reduced, it appears that selection of animals for retention in breeding herds was done in the absence of production related criteria. Widespread use of feed supplement appears to have taken place with little or no production strategy in mind resulting in only marginally profitable use of expensive feed sources and low net revenues from livestock enterprises. The outcome of individual producer response to the recent drought has varied resulting in relatively high profits for some and relatively large losses for others. This may be due in part to factors such as differing levels of resource availability, differing perceptions of alternatives (opportunities) and differing expectations about future environmental conditions. Alternatives for dealing with recurring drought are essentially limited to managing animals, land and capital to reduce production costs while maintaining or improving production efficiency.

Abusive land use practices reduce the long-term productive potential of the land and lengthen the time period required for recovery from drought conditions to a new and lower level of productivity. The alternative to abusive practices on rangelands is to conserve the soil and increase forage production through development and management. Crop productivity can be increased through adoption of improved technology such as effective yet less destructive tillage techniques and improved crop varieties, production methods and cropping strategies. Crop production efficiency can be increased by adoption of alternative uses of marginal cropland such as range forage production.

Outdated animal management techniques seriously limit the potential for livestock producers to profit from livestock enterprises. The most obvious alternative for improving the profitability of animal production is to increase production efficiency through removal of inferior and nonproductive animals while selecting herd replacements based on production related criteria. Effective control of diseases and parasites through prevention (including regular and timely administration of vaccines and antiparasite drugs), adequate nutrition and animal

management (to limit the opportunity for treated animals to be re-exposed) reduces the depressing effect of these maladies on production thereby increasing profit. Attention to animal nutritional requirements based on animal function and physiological state (gestation, lactation, growth) and management of forage and feed resources to meet these requirements at relatively low cost increases production, production efficiency and, ultimately, profitability of livestock enterprises.

Little can be done to increase the amount of land resources available to individual producers. However, productivity of those resources can be improved. Productivity of collectively owned rangelands can be increased through organizing producers into functional groups that are capable of controlling land use, assisting these groups in defining appropriate management objectives and strategies, and developing rangelands through the use of range improvement practices. Resource limitations can also be overcome to some extent by increasing production efficiency through improved crop and animal production practices.

Estimation of Potential Benefits from Adoption of Alternative Management Practices

Production systems problems were identified in two major areas: low productivity (including low production efficiency and low overall production) and high production costs. While these problems were common to both livestock and crop production, emphasis in the search for alternatives was directed toward livestock production. This does not mean that the problems in crop production are not as important, rather, the emphasis on livestock production serves to balance other more widespread efforts in Morocco that are directed toward identifying and dealing with agronomic problems. Alternatives addressing productivity and production costs in livestock production enterprises were identified in two major areas: improved animal husbandry and management, and increased production of low cost forage as a substitute for high cost forages and feeds.

Potential Benefits from Improved Animal Husbandry and Management

Benefits from the low cost alternatives of improved basic animal husbandry and management can occur as an increase in total production and as an increase in production per breeding female, two closely related production parameters. However, in order to realize these benefits in Moroccan production systems, nutritional requirements of animals must be met. Indications are, that under current management, the low level of animal nutrition substantially suppresses reproduction and growth of animals. Estimates of the contribution of various sources of feeds and forages to the forage base (percent dependence, Table 4.1) were thought to seriously overestimate forage production on rangelands, possibly by as much as 30%. The estimates of forage contributions from rangelands were derived mathematically by subtracting the amounts of reported levels of animal nutrients derived from agronomic sources from the estimated amounts of nutrients required to meet animal requirements. It is important,

therefore, to give adequate attention to this animal nutrient deficit in considering the potential of alternative husbandry and management practices.

With adequate animal nutrition the potential for significant improvement in production and production efficiency is high. Lamb and kid crops could be expected to increase to a modestly respectable level of 90% (a 67% increase). Average weights at six months of age could reasonably be expected to increase to around 23 kg for lambs (a 34% increase) and to 17.5 kg for kids (a 57% increase). Average fleece weights could also be expected to increase to approximately 2 kg (a 24% increase). Wool quality as reflected by price could be expected to increase 33%. With improved husbandry and management, death loss of mature animals could be expected to decrease from an average of 8% to 5%. Total annual live animal and fiber production could reasonably be expected to increase 103% and 23% respectively. The magnitude of these estimates of potential benefits (changes) do not reflect exceptionally high expectations of performance but, more accurately, reflect exceptionally low current levels of animal performance.

Potential Benefits from Increase in Range Forage Production

There are many ways by which forage production from rangelands can be increased. These include investment intensive practices such as seeding, seedling transplanting and water harvesting as well as extensive practices such as grazing management. Each practice requires adequate grazing control and management for desired results to be realized. The degree to which employment of any of these alternatives (with the possible exception of grazing management) is appropriate is dependent on the potential of the local site to produce. Characteristics of the particular site such as climate, soil depth and texture, slope and aspect all interact to determine the site potential. In addition, each practice has unique requirements in terms of the combination of inputs involved affecting the magnitude of the investment required for implementation. As the amount of investment varies, different levels of production are required to defray the investment costs over the life of the project. A series of combinations of improvement practices and combinations of practices by measures of intensity of application are presented in Table 4.2 along with the estimated implementation costs. Treatments identified as having potential as economically viable practices for increasing forage production are described below.

Table 4.2. Estimated average implementation costs (DH/ha) for various range improvement practice combinations.

Treatment Combination	Distance between Contour Terraces (meters)								
	No Terraces (0)+	40m (2.5)+	35m (2.9)+	30m (3.3)+	25m (4)+	20m (5)+	15m (6.7)+	10m (10)+	5m (20)+
No Shrub Planting									
No Seeding (defer only)*	10	185	210	243	290	360	477	710	1410
Chisel 1/3 - w/o seeding*	37	212	237	270	317	387	504	737	1437
Chisel All - w/o seeding*	90	265	290	323	370	440	577	790	1490
Rangeland Drill 1/3	179	354	379	412	459	529	646	879	1577
Conventional Seeding 1/3	219	394	419	452	499	569	686	919	1619
Rangeland Drill All	499	674	699	732	779	849	966	1199	1899
Conventional Seeding All	619	794	819	852	899	969	1086	1319	2019
Shrub Planting @ 4m Intervals**									
No Seeding (shrubs only)	128	303	341	392	464	572	756	1114	2194
Chisel 1/3 - w/o seeding	155	330	368	419	491	599	783	1141	2221
Chisel All - w/o seeding	208	383	421	472	544	652	836	1194	2274
Rangeland Drill 1/3	288	463	501	552	624	732	916	1274	2354
Conventional Seeding 1/3	328	503	541	592	664	772	956	1314	2394
Rangeland Drill All	608	783	821	872	944	1052	1236	1594	2674
Conventional Seeding All	728	903	941	992	1064	1172	1356	1714	2794
Shrub Planting @ 3m Intervals***									
No Seeding (shrubs only)	158	333	377	434	512	637	839	1234	2444
Chisel 1/3 - w/o seeding	185	360	404	461	539	664	866	1261	2471
Chisel All - w/o seeding	238	413	457	514	592	717	919	1314	2524
Rangeland Drill 1/3	318	493	537	594	672	797	999	1394	2604
Conventional Seeding 1/3	358	533	577	634	712	837	1039	1434	2644
Rangeland Drill All	638	813	857	914	992	1117	1319	1714	2924
Conventional Seeding All	758	933	977	1034	1112	1237	1439	1834	3044
Shrub Planting @ 2m Intervals****									
No Seeding (shrubs only)	222	397	449	517	619	764	1006	1494	2969
Chisel 1/3 - w/o seeding	249	424	476	544	646	791	1033	1521	2996
Chisel All - w/o seeding	302	477	529	597	699	844	1086	1574	3049
Rangeland Drill 1/3	382	557	609	677	779	924	1166	1654	3129
Conventional Seeding 1/3	422	597	649	717	819	964	1206	1694	3169
Rangeland Drill All	702	877	929	997	1099	1244	1486	1974	3449
Conventional Seeding All	822	997	1049	1117	1219	1364	1606	2094	3569

+ Number of contour terraces per hectare.
* Seasonal deferment costs of 9.52 DH/ha (perennial species not planted), otherwise, deferment costs of 19.04 DH/ha.
** Shrub planting w/o terracing @ 62 plants/ha.
*** Shrub planting w/o terracing @ 82 plants/ha.
**** Shrub planting w/o terracing @ 125 plants/ha.

1. Contour Terracing

Contour terracing is a practice designed to slow, collect, and hold water as it runs over the sites. Since available water for plant growth is the most important limiting factor affecting range productivity, water retention and harvesting techniques such as contour terracing are often very effective means of altering microenvironmental conditions and increasing site productivity. The cost of contour terracing with a six month growing season deferment period were estimated for nine levels of intensity (from no terraces to terraces at 5 m intervals) and ranged from 185 DH/ha for terracing at 40 m intervals and a six month deferment period to 1410 DH/ha for deferment and terraces at 5 m intervals. Cost estimates were based on records of labor intensive nonmechanized construction of terraces.

2. Shrub Planting

Planting of seedling shrubs is a practice designed to increase forage production by introducing woody fodder species and by moderating local microenvironmental conditions. Shrubs plantings are often done in combination with water harvesting treatments such as contour terracing in order to concentrate water near the shrubs, increasing survival and production. The cost of planting shrubs at four linear intervals (0, 2 m, 3 m, and 4 m) at nine levels of intensity (from 0 lines or terraces to lines or terraces at 5 m intervals) ranged from 128 DH/ha for shrubs planted at a rate of 62 plants/ha to 2969 DH/ha for shrubs planted at 2 m intervals on lines 5 m apart. Figures included deferment costs during the establishment period which was estimated to be two growing seasons.

3. Chiseling

Chiseling is another means by which water can be harvested and retained on the site for increasing forage production. Chiseling can be employed to harvest water that falls as precipitation on the chiseled area and to slow and concentrate water flowing from unchiseled areas in "zones" by chiseling in strips on the contour. This not only reduces investment costs but also takes advantage of harvested run in water that originates on the nonchiseled area. Due to the water concentration effect, treatment efficiency (production/ha of area chiseled) can be expected to be greater than for complete chiseling of the area. Chiseling can be particularly appropriate in areas dominated by annual forage species but can also be effective in areas dominated by perennial plants such as *Artemisia herba-alba*. Although some plants are uprooted and killed (density is reduced), individual plant productivity and plant reestablishment may be high as a result of the increase in moisture available for plant growth. Costs of chiseling at two intensities, 33% of the surface area and 100% of the surface area were 37 DH/ha and 90 DH/ha respectively.

4. Seeding with the Rangeland Drill

Seeding with the rangeland drill reduces implementation

costs when compared to conventional seedbed preparation and seeding methods, while producing essentially the same results given the proper conditions. Cost reduction is realized by reducing the number of equipment operations (discing and seedbed firming operations are usually omitted). As a result, seedbed preparation is less effective. This can be a critical factor limiting seeding success during dry periods when seedbed preparation can make the difference between seedling establishment and seedling mortality. Just as chiseling 33% of the area reduces investment costs and capitalizes on harvested water, the same relationship can be expected in the application of practices such as seeding. Cost of seeding 33% of the surface area in contour strips with the rangeland drill were 179 DH/ha while costs of seeding 100% of the area with the rangeland drill were 499 DH/ha including estimated equipment costs, seed costs, and the cost of deferment for two growing seasons.

5. Seeding by Conventional Methods

Seeding by conventional methods includes plowing, discing, firming the seedbed with a series of packer wheels and seeding with a conventional grain drill. As indicated in the discussions of seeding with the rangeland drill, implementation costs are higher and risk of seeding failure is lower. This is not meant to imply that success is assured with this method since no degree of seedbed preparation will make much difference if moisture is insufficient to allow seedling establishment or if seed quality is low. Costs for conventional seeding of 33% of the area in contour strips were 219 DH/ha and 619 DH/ha for seeding 100% of the area. Costs include equipment costs, seed costs, and the cost of deferment for two growing seasons.

6. Combinations

The estimated costs associated with combination of various complementary practices are also presented in Table 4.2 and represent a broad array of investment costs ranging from investment extensive (low cost) alternatives to investment intensive (high cost) improvement alternatives.

With these investment costs in mind, it is now appropriate to discuss these alternatives for increasing forage productivity in terms of economic feasibility. Since efforts to quantify production levels resulting from various practices and combinations of practices in various locations were seriously limited by drought and other factors during the first 3.5 years of the project, it was not possible to implement trials designed to obtain preliminary estimates on which to base expectations until the last two years of the project. Therefore, the project ended prior to the opportunity to obtain preliminary estimates of forage production increases resulting from many of the treatments and treatment combinations. Ideally, forage production estimates over the defined life of the various improvement practices are needed to perform investment analyses for assessment of economic feasibility. This is especially important in an area such as Morocco where many of these practices have not been applied or, if applied, results have not been adequately quantified.

In view of these limitations and in order to make these analyses more meaningful to Moroccan technicians and others in the future, it is perhaps more useful to consider the investment costs presented in Table 4.2 in terms of the magnitude of forage increase (returns) required annually over the life of the project (set at 10 years in these analyses) in order to produce a given rate of return on investment. This approach follows the same line of reasoning as the one employed by Torell et al. (1986). In addition, although the array of investment costs presented are specific cost estimates for specific practices and combinations of practices, the income stream required to produce a given rate of return is specific only to the magnitude of the investment and the interest rate used. If the investment costs of other practices or combinations are known, the income streams and production levels required to produce these same rates of return can be approximated by matching the investment costs with cost values presented in Table 4.2 and considering the corresponding returns in Tables 4.3, 4.4 and 4.5. The returns in constant dirhams and increased forage production (valued at approximately 0.35 DH/kg of dry matter) required to produce a real rate of return of 2% on investment costs presented in Table 4.2 are presented in Table 4.3. The values required to produce real rates of return of 4% and 6% are presented in Tables 4.4 and 4.5. Real interest rates and the estimated average current (constant dirham or real) price of forage were used to provide consistency as suggested by various authors (Howe, 1971; Overton and Hunt, 1974; Hanke et al., 1975; Row et al., 1981; Workman, 1986). In order to be consistent, it is necessary to use either (1) real (inflation-free) rates of interest with projections of future returns based on real (current, unadjusted for inflation) prices or (2) the nominal (current borrowing) rate of interest with future projection of returns that are adjusted for inflation. In offering analyses using a range of real interest rates (2%, 4% and 6%) and real prices in estimating returns, the problem of trying to estimate future inflation and to adjust all future returns was avoided. A range of 2%, 4% and 6% real interest rates was used because the <u>real</u> interest rate relevant in Morocco was unknown. However, based on long-term estimates of a real interest rate of 4% in the U.S. discussed by Row et al. (1981), the range presented was thought to be appropriate for Morocco.

Table 4.3. Average annual returns (constant DH) and increase in forage production (kg dry matter/ha @ 9.52 DH/MAUM - in parentheses) required over a ten-year project life to produce a real rate of return on investment of 2%.

Treatment Combination	Distance between Contour Terraces (meters)																	
	No Terraces (0)+		40m (2.5)+		35m (2.9)+		30m (3.3)+		25m (4)+		20m (5)+		15m (6.7)+		10m (10)+		5m (20)+	
	DH	(kg)	DH	(kg)	DH	(kg)	DH	(kg)	DH	(kg)	DH	(kg)	DH	(kg)	DH	(kg)	DH	(kg)
No Shrub Planting																		
No Seeding (defer only)*	1	(3)	21	(60)	23	(65)	27	(77)	32	(91)	40	(113)	53	(150)	79	(224)	157	(445)
Chisel 1/3 - w/o seeding*	4	(11)	24	(68)	26	(74)	30	(85)	35	(99)	43	(122)	56	(159)	82	(233)	160	(454)
Chisel All - w/o seeding*	10	(28)	30	(85)	32	(91)	36	(102)	41	(116)	49	(139)	64	(182)	88	(250)	166	(471)
Rangeland Drill 1/3	22	(62)	44	(125)	47	(133)	51	(145)	57	(162)	66	(187)	81	(230)	110	(312)	197	(559)
Conventional Seeding 1/3	27	(77)	49	(139)	52	(147)	56	(159)	62	(176)	71	(201)	86	(244)	115	(326)	202	(573)
Rangeland Drill All	62	(176)	84	(238)	87	(247)	91	(258)	97	(275)	106	(301)	121	(343)	150	(425)	237	(672)
Conventional Seeding All	77	(218)	99	(281)	102	(289)	106	(301)	112	(318)	121	(343)	136	(386)	165	(468)	252	(715)
Shrub Planting @ 4m Intervals**																		
No Seeding (shrubs only)	16	(45)	38	(108)	43	(122)	49	(139)	58	(164)	71	(201)	94	(267)	139	(394)	274	(777)
Chisel 1/3 - w/o seeding	19	(54)	41	(116)	46	(130)	52	(147)	61	(173)	75	(213)	98	(278)	143	(406)	278	(788)
Chisel All - w/o seeding	26	(74)	48	(136)	53	(150)	59	(167)	68	(193)	81	(230)	104	(295)	149	(423)	284	(805)
Rangeland Drill 1/3	36	(102)	56	(159)	63	(179)	69	(196)	78	(221)	91	(258)	114	(323)	159	(451)	294	(834)
Conventional Seeding 1/3	41	(116)	63	(179)	68	(193)	74	(210)	83	(235)	96	(272)	119	(338)	164	(465)	299	(848)
Rangeland Drill All	76	(216)	98	(278)	103	(292)	109	(309)	118	(335)	131	(372)	154	(437)	199	(564)	334	(947)
Conventional Seeding All	91	(258)	113	(320)	118	(335)	124	(352)	133	(377)	146	(414)	169	(479)	214	(607)	349	(990)
Shrub Planting @ 3m Intervals***																		
No Seeding (shrubs only)	20	(57)	42	(119)	47	(133)	54	(153)	64	(182)	80	(227)	105	(298)	154	(437)	305	(865)
Chisel 1/3 - w/o seeding	23	(65)	45	(128)	50	(142)	58	(164)	67	(190)	83	(235)	108	(306)	158	(448)	309	(876)
Chisel All - w/o seeding	30	(85)	52	(147)	57	(162)	64	(182)	74	(210)	90	(255)	115	(326)	164	(465)	315	(893)
Rangeland Drill 1/3	40	(113)	62	(176)	67	(190)	74	(210)	84	(238)	100	(284)	125	(355)	174	(493)	325	(922)
Conventional Seeding 1/3	45	(128)	67	(190)	72	(204)	79	(224)	89	(252)	105	(298)	130	(369)	179	(508)	330	(936)
Rangeland Drill All	80	(227)	102	(289)	107	(303)	114	(323)	124	(352)	140	(397)	165	(468)	214	(607)	365	(1035)
Conventional Seeding All	95	(269)	117	(332)	122	(346)	129	(366)	139	(394)	155	(440)	180	(511)	229	(649)	380	(1078)
Shrub Planting @ 2m Intervals****																		
No Seeding (shrubs only)	28	(79)	50	(142)	56	(159)	65	(184)	77	(218)	95	(269)	126	(357)	187	(530)	371	(1052)
Chisel 1/3 - w/o seeding	31	(88)	53	(150)	59	(167)	68	(193)	81	(230)	99	(281)	129	(366)	190	(539)	374	(1061)
Chisel All - w/o seeding	38	(108)	60	(170)	66	(187)	75	(213)	87	(247)	105	(298)	136	(386)	197	(559)	381	(1081)
Rangeland Drill 1/3	48	(136)	70	(199)	76	(216)	85	(241)	97	(275)	115	(326)	146	(414)	207	(587)	391	(1109)
Conventional Seeding 1/3	53	(150)	75	(213)	81	(230)	90	(255)	102	(289)	120	(340)	151	(428)	212	(601)	396	(1123)
Rangeland Drill All	88	(250)	110	(312)	116	(329)	125	(355)	137	(389)	155	(440)	186	(528)	247	(701)	431	(1222)
Conventional Seeding All	103	(292)	125	(355)	131	(372)	140	(397)	152	(431)	170	(482)	201	(570)	262	(743)	446	(1265)

+ Number of contour terraces per hectare.
* Seasonal deferment only - returns received prior to the end of the first year following implementation.
** Shrub planting w/o terracing @ 62 plants/ha.
*** Shrub planting w/o terracing @ 82 plants/ha.
**** Shrub planting w/o terracing @ 125 plants/ha.

Table 4.4. Average annual returns (constant DH) and increase in forage production (kg dry matter/ha @ 9.52 DH/MAUM - in parentheses) required over a ten-year project life to produce a real rate of return on investment of 4%.

Treatment Combination	Distance between Contour Terraces (meters)																	
	No Terraces (0)+		40m (2.5)+		35m (2.9)+		30m (3.3)+		25m (4)+		20m (5)+		15m (6.7)+		10m (10)+		5m (20)+	
	DH	(kg)	DH	(kg)	DH	(kg)	DH	(kg)	DH	(kg)	DH	(kg)	DH	(kg)	DH	(kg)	DH	(kg)
No Shrub Planting																		
No Seeding (defer only)*	1	(3)	23	(65)	26	(74)	30	(85)	36	(102)	44	(125)	59	(167)	88	(250)	174	(493)
Chisel 1/3 - w/o seeding*	5	(14)	26	(74)	29	(82)	33	(94)	39	(111)	48	(136)	62	(176)	91	(258)	177	(502)
Chisel All - w/o seeding*	11	(31)	33	(94)	36	(102)	40	(113)	46	(130)	54	(153)	71	(201)	97	(275)	184	(522)
Rangeland Drill 1/3	25	(71)	50	(142)	53	(150)	58	(164)	64	(182)	74	(210)	90	(255)	123	(349)	221	(627)
Conventional Seeding 1/3	31	(88)	55	(156)	59	(167)	63	(179)	70	(199)	80	(227)	96	(272)	129	(366)	226	(641)
Rangeland Drill All	70	(199)	94	(267)	98	(278)	102	(289)	109	(309)	119	(338)	135	(383)	168	(476)	266	(754)
Conventional Seeding All	87	(247)	111	(315)	115	(326)	119	(338)	126	(357)	135	(383)	152	(431)	184	(522)	282	(800)
Shrub Planting @ 4m Intervals**																		
No Seeding (shrubs only)	18	(51)	42	(119)	48	(136)	55	(156)	65	(184)	80	(227)	106	(301)	156	(442)	307	(871)
Chisel 1/3 - w/o seeding	22	(62)	46	(130)	51	(145)	59	(167)	69	(196)	84	(238)	109	(309)	160	(454)	311	(882)
Chisel All - w/o seeding	29	(82)	54	(153)	59	(167)	66	(187)	76	(216)	91	(258)	117	(332)	167	(474)	318	(902)
Rangeland Drill 1/3	40	(113)	65	(184)	70	(199)	77	(218)	87	(247)	102	(289)	128	(363)	178	(505)	329	(933)
Conventional Seeding 1/3	46	(130)	70	(199)	76	(216)	83	(235)	93	(264)	108	(306)	134	(380)	184	(522)	335	(950)
Rangeland Drill All	85	(241)	109	(309)	115	(326)	122	(346)	132	(374)	147	(417)	173	(491)	223	(632)	374	(1061)
Conventional Seeding All	102	(289)	126	(357)	132	(374)	139	(394)	149	(423)	164	(465)	190	(539)	240	(681)	391	(1109)
Shrub Planting @ 3m Intervals***																		
No Seeding (shrubs only)	22	(62)	47	(133)	53	(150)	61	(173)	72	(204)	89	(252)	117	(332)	173	(491)	342	(970)
Chisel 1/3 - w/o seeding	26	(74)	50	(142)	56	(159)	64	(182)	75	(213)	93	(264)	121	(343)	176	(499)	346	(981)
Chisel All - w/o seeding	33	(94)	58	(164)	64	(182)	72	(204)	83	(235)	100	(284)	129	(366)	184	(522)	353	(1001)
Rangeland Drill 1/3	44	(125)	69	(196)	75	(213)	83	(235)	94	(267)	111	(315)	140	(397)	195	(553)	364	(1032)
Conventional Seeding 1/3	50	(142)	75	(213)	81	(230)	89	(252)	100	(284)	117	(332)	145	(411)	201	(570)	370	(1049)
Rangeland Drill All	89	(252)	114	(323)	120	(340)	128	(363)	139	(394)	156	(442)	184	(522)	240	(681)	409	(1160)
Conventional Seeding All	106	(301)	130	(369)	137	(389)	145	(411)	155	(440)	173	(491)	201	(570)	256	(726)	426	(1208)
Shrub Planting @ 2m Intervals****																		
No Seeding (shrubs only)	31	(88)	56	(159)	63	(179)	72	(204)	87	(247)	107	(303)	141	(400)	209	(593)	415	(1177)
Chisel 1/3 - w/o seeding	35	(99)	59	(167)	67	(190)	76	(216)	90	(255)	111	(315)	144	(408)	213	(604)	419	(1188)
Chisel All - w/o seeding	42	(119)	67	(190)	74	(210)	83	(235)	98	(278)	118	(335)	152	(431)	220	(624)	426	(1208)
Rangeland Drill 1/3	53	(150)	78	(221)	85	(241)	95	(269)	109	(309)	129	(366)	163	(462)	231	(655)	438	(1242)
Conventional Seeding 1/3	59	(167)	83	(235)	91	(258)	100	(284)	115	(326)	135	(383)	169	(479)	237	(672)	443	(1256)
Rangeland Drill All	98	(278)	123	(349)	130	(369)	139	(394)	154	(437)	174	(493)	208	(590)	276	(783)	482	(1367)
Conventional Seeding All	115	(326)	139	(394)	147	(417)	156	(442)	170	(482)	191	(542)	225	(638)	293	(831)	499	(1415)

+ Number of contour terraces per hectare.
* Seasonal deferment only - returns received prior to the end of the first year following implementation.
** Shrub planting w/o terracing @ 62 plants/ha.
*** Shrub planting w/o terracing @ 82 plants/ha.
**** Shrub planting w/o terracing @ 125 plants/ha.

Table 4.5. Average annual returns (constant DH) and increase in forage production (kg dry matter/ha @ 9.52 DH/MAUM - in parentheses) required over a ten-year project life to produce a real rate of return on investment of 6%.

Treatment Combination	Distance between Contour Terraces (meters)																	
	No Terraces (0)+		40m (2.5)+		35m (2.9)+		30m (3.3)+		25m (4)+		20m (5)+		15m (6.7)+		10m (10)+		5m (20)+	
	DH	(kg)	DH	(kg)	DH	(kg)	DH	(kg)	DH	(kg)	DH	(kg)	DH	(kg)	DH	(kg)	DH	(kg)
No Shrub Planting																		
No Seeding (defer only)*	1	(3)	25	(71)	29	(82)	33	(94)	39	(111)	49	(139)	65	(184)	96	(272)	192	(545)
Chisel 1/3 - w/o seeding*	5	(14)	29	(82)	32	(91)	37	(105)	43	(122)	53	(150)	68	(193)	100	(284)	195	(553)
Chisel All - w/o seeding*	12	(34)	36	(102)	39	(111)	44	(125)	50	(142)	60	(170)	78	(221)	107	(303)	202	(573)
Rangeland Drill 1/3	28	(79)	55	(156)	59	(167)	64	(182)	72	(204)	82	(233)	101	(286)	137	(389)	246	(698)
Conventional Seeding 1/3	34	(96)	61	(173)	65	(184)	70	(199)	78	(221)	89	(252)	107	(303)	143	(406)	252	(715)
Rangeland Drill All	78	(221)	105	(298)	109	(309)	114	(324)	121	(344)	132	(375)	151	(428)	187	(530)	296	(839)
Conventional Seeding All	96	(272)	124	(352)	128	(363)	133	(377)	140	(397)	151	(428)	169	(480)	206	(583)	315	(892)
Shrub Planting @ 4m Intervals**																		
No Seeding (shrubs only)	20	(57)	47	(133)	53	(150)	61	(173)	72	(204)	89	(252)	118	(335)	174	(493)	342	(970)
Chisel 1/3 - w/o seeding	24	(69)	51	(146)	57	(163)	65	(185)	77	(217)	93	(265)	122	(346)	178	(504)	346	(981)
Chisel All - w/o seeding	32	(91)	60	(170)	66	(187)	74	(210)	85	(241)	102	(289)	130	(369)	186	(528)	354	(1005)
Rangeland Drill 1/3	45	(128)	72	(204)	78	(221)	86	(244)	97	(275)	114	(323)	143	(406)	199	(564)	367	(1041)
Conventional Seeding 1/3	51	(145)	78	(221)	84	(238)	92	(261)	103	(292)	120	(340)	149	(423)	205	(581)	373	(1058)
Rangeland Drill All	95	(269)	122	(346)	128	(363)	136	(386)	147	(417)	164	(465)	193	(547)	248	(703)	417	(1183)
Conventional Seeding All	113	(320)	141	(400)	147	(417)	155	(440)	166	(471)	183	(519)	211	(598)	267	(757)	435	(1234)
Shrub Planting @ 3m Intervals***																		
No Seeding (shrubs only)	25	(71)	52	(147)	59	(167)	68	(193)	80	(227)	99	(281)	131	(372)	192	(545)	381	(1081)
Chisel 1/3 - w/o seeding	29	(82)	56	(159)	63	(179)	72	(204)	84	(238)	103	(292)	135	(383)	197	(559)	385	(1092)
Chisel All - w/o seeding	37	(105)	64	(182)	71	(201)	80	(227)	92	(261)	112	(318)	143	(406)	205	(581)	393	(1115)
Rangeland Drill 1/3	50	(142)	77	(218)	84	(238)	93	(264)	105	(298)	124	(352)	156	(442)	217	(615)	406	(1151)
Conventional Seeding 1/3	56	(159)	83	(235)	90	(255)	99	(281)	111	(315)	130	(369)	162	(459)	223	(632)	412	(1168)
Rangeland Drill All	99	(281)	127	(360)	134	(380)	142	(403)	155	(440)	174	(493)	206	(584)	267	(757)	456	(1293)
Conventional Seeding All	118	(335)	145	(411)	152	(431)	161	(457)	173	(491)	193	(547)	224	(635)	286	(811)	474	(1344)
Shrub Planting @ 2m Intervals****																		
No Seeding (shrubs only)	35	(99)	62	(176)	70	(199)	81	(230)	96	(272)	119	(338)	157	(445)	233	(661)	463	(1313)
Chisel 1/3 - w/o seeding	39	(111)	66	(187)	74	(210)	85	(241)	101	(286)	123	(349)	161	(457)	237	(672)	467	(1324)
Chisel All - w/o seeding	47	(133)	74	(210)	82	(233)	93	(264)	109	(309)	132	(374)	169	(479)	245	(695)	475	(1347)
Rangeland Drill 1/3	60	(170)	87	(247)	95	(269)	105	(298)	121	(343)	144	(408)	182	(516)	258	(732)	488	(1384)
Conventional Seeding 1/3	66	(187)	93	(264)	101	(286)	112	(318)	128	(363)	150	(425)	188	(533)	264	(749)	494	(1401)
Rangeland Drill All	109	(309)	137	(389)	145	(411)	155	(440)	171	(485)	194	(550)	232	(658)	308	(874)	537	(1523)
Conventional Seeding All	128	(363)	155	(440)	163	(462)	174	(493)	190	(539)	213	(604)	250	(709)	326	(925)	556	(1577)

+ Number of contour terraces per hectare.
* Seasonal deferment only - returns received prior to the end of the first year following implementation.
** Shrub planting w/o terracing @ 62 plants/ha.
*** Shrub planting w/o terracing @ 82 plants/ha.
**** Shrub planting w/o terracing @ 125 plants/ha.

There are several other important aspects of how the analyses were carried out that should be considered. Forage was valued at 9.52 DH for a Moroccan Animal Unit Month of forage (27 kg of dry matter) based on the estimated average feed and forage cost producers incurred in livestock production enterprises (Table 4.1). Additional forage produced can be valued at this rate because it can be directly substituted for some other feed or forage source currently used. This average value is a conservative estimate of the value of increased forage production since actual substitution would undoubtedly involve replacement of the most expensive feed source with a lower cost substitute if at all possible.

Annual returns were assumed to be received at the end of each year and some practices required longer deferment periods than others. For example, for practices in which establishment of perennial plants was not a factor and deferment was only seasonal, benefits were assumed to be realized at a constant rate at the end of each of the ten years of project life. The first three rows of table entries in Tables 4.3, 4.4, and 4.5 were based on this assumption because no seeding or planting of perennial species was involved. Conversely, for practices in which establishment of perennial forage species (both herbaceous and woody) was a factor, a longer deferment period was necessary and benefits were assumed to begin at the end of the second year of the project continuing to accrue at a constant rate at the end of each of the remaining eight years of project life. All entries in Tables 4.3, 4.4 and 4.5, with the exception of the first three rows, were derived based on a longer deferment period. There are important implications related to these assumptions that should be emphasized. The assumption that returns will begin at a certain magnitude and continue to accrue at an average and constant rate throughout the remaining life of the project is an oversimplification that has a great deal of bearing on the analysis. In reality, there is always variability in production from year to year and benefits such as production increases often peak in the early years and gradually decline over the remaining life of the project. Without production estimates over time, it is impossible to objectively take these production characteristics into consideration, therefore, average production values were used. The fact that higher returns in the early years of project life are more effective than the same returns in later years in covering investment costs (due to the time value of money) does, however, make use of estimated average returns a conservative approach.

The relationships among Tables 4.2, 4.3, 4.4, and 4.5 are important to understand in order to be useful and some discussion is warranted. This may best be done by contrasting the respective table entries for some specific improvement practice combination. For example, the practice of seeding perennial forage species in contour strips on 33% of an area with a rangeland drill is estimated to cost 179 DH/ha as noted in Table 4.2. In order for this investment to produce a 2% real rate of return, the average annual increase in benefits that begin to accrue at the end of the second year of the ten year project life must be worth 22 DH/ha (Table 4.3). At 9.52 DH/MAUM or .35 DH/kg of forage on a dry matter basis, an increase in dry matter forage production of 63 kg/ha is required. If a particular range

site under consideration is currently producing an average of 160 kg/ha of forage dry matter, then seeding of 33% of the area in contour strips with a rangeland drill must result in an average of 223 kg/ha of forage dry matter that is usable by the end of the second year after implementation of the practice in order to produce a real rate of return of 2%. In the absence of production measurements from which the manager can make comparisons, the manager must make a subjective assessment of whether or not that particular site has the potential to produce forage dry matter at the level required and either reject or accept that improvement alternative as feasible. If a real interest rate of 4% (Table 4.4) is appropriate, benefits must be valued at 25 DH/ha and the production increase must be 71 kg/ha of forage dry matter. The potential of the site to produce forage through implementation of the practice in question must be at least an average of 231 kg/ha of forage dry matter. If a real interest rate of 6% (Table 4.5) is appropriate, benefits must be valued at 28 DH/ha and production must be increased by 79 kg/ha of forage dry matter to an average level of 239 kg/ha.

In order to provide a dramatic contrast to the preceeding example, it might prove useful to discuss an investment intensive combination of practices for increasing forage production. A good example of such a combination of practices might be contour terracing at 5 m intervals, planting shrubs at 2 m intervals along the terraces, and seeding the entire area using conventional methods. Such a combination of practices requires the highest level of investment of any combination of practices considered in the analysis. The investment requirement was estimated to be 3569 DH/ha (Table 4.2). With this level of investment, the average annual returns required to provide a 2% real rate of return on investment was 446 DH/ha or an average dry matter forage production increase of 1265 kg/ha at a value of 9.52 DH/MAUM (Table 4.3). On a site currently producing 160 kg/ha of forage dry matter the new level of forage production required would be 1425 kg/ha of forage dry matter, an eight fold increase. To economically justify carrying out this combination of practices, the site must have a great deal of potential for producing forage. If the value of forage was greater than 9.52 DH/MAUM, the required amount of forage increase would be less. However, if the value of forage was less than 9.52 DH/MAUM, the amount of forage increase required to make this an economically feasible combination of improvement practices would be greater than 1265 kg/ha. If a real rate of return of 4% (Table 4.4) was the appropriate reflection of opportunity cost, average annual return would have to be valued at 499 DH/ha and a 1415 kg/ha increase in forage dry matter would be required to provide this value at 9.52 DH/MAUM. If the appropriate real interest rate was 6% (Table 4.5), average annual return would need to be 556 DH/ha and the required forage increase would be 1577 kg/ha of forage dry matter.

Several additional points should be made in order to complete the discussion of these analyses. First, the period of time for deferment required prior to the commencement of the realization of benefits dramatically affects the economic feasibility of improvement practices. Short periods of time between the point at which investment is made and the point when benefits are realized have a positive effect on the economic

feasibility and, as the time period lengthens, the required levels of returns rise. Therefore, it is important to use the forage produced as soon as possible. This not only reduces the deferment costs incurred but also speeds the flow of returns of the project whereby earnings can offset investment costs early. Second, as interest rates rise, project life becomes less important because benefits received far in the future are worth less and less. Therefore, an improvement practice with a relatively short life but relatively high returns may be economically advantageous to another improvement practice with identical investment cost, a relatively long life but relatively low returns, especially as interest rates rise. Third, if benefits other than forage production are expected to occur as a result of an improvement practices, they should be quantified if possible and added to the value of forage used in the analysis. Although difficult to quantify, benefits such as reductions in sediment production are real and should be considered, for reducing sedimentation rates increases the productive life of downstream reservoirs, and reduced erosion aids in preserving the productive potential of the site.

Potential Impact of Improvements on Production System

The wide spread adoption of new practices that will increase production and production efficiency and improve profitability for Moroccan producers represents the essence of project goal achievement. The potential impact of adoption of alternative practices on the range livestock/crop production systems is therefore important to consider in the assessment of the work done under the Range Management Improvement Project and in the planning of future efforts. Although the crop production problems and alternatives were not emphasized per se in the work done under this project, the importance of crop production enterprises was recognized in the context of the production systems as a whole. The assessment of the potential impact of adoption of range and livestock improvement practices is therefore only a partial assessment of the potential for improving production and producer welfare because it does not include the potential existing in the crop production area.

In any assessment of potential improvement in production it is necessary to establish some assumptions about the capacity for improvement. Levels of improvement in livestock production that may reasonably be expected, such as improvement in animal weight gains, were presented in detail in the discussion of alternative practices. Some conditions that must be met to achieve these benefits such as satisfying animal nutrition requirement deficits were also discussed. To receive the full benefit of a package of improvements for animal production and range forage production presented in these analyses, an additional investment in breeding animals of 7.4% is necessary. From the standpoint of rangeland forage production and improvement practices, it is necessary to make some estimates of the capacity of the land to produce forage. In these analyses, approximately 70% of the rangeland in Morocco was considered to have limited potential for production, primarily due to low precipitation. Therefore, these lands were considered to be candidates for improvement only through investment in extensive practices such as grazing management.

The expected average increase in available forage production was conservatively estimated to be 57%. The remaining 30% of the land was considered to have enough production potential to qualify as a candidate for more investment intensive improvement practices and the expected average increase was conservatively estimated to be 200%.

The impact of improvement in production systems is important at various levels of aggregation. It is important at the individual producer level; at the national level; and at intermediate levels such as the fractional, tribal, and regional levels. In this assessment, the potential impact on production systems will be considered at the individual producer and national levels.

1. Estimated Potential Impact of Adoption of Improvement Alternatives at the Individual Producer Level

The extent to which any new technology is accepted and adopted is rarely 100% due to the high degree of variability among individual producer's constraints and perceptions. Therefore, a range of levels of producer acceptance and adoption of alternative practices may be more useful, especially for establishing realistic expectations. Estimates of average producer family annual production and net revenue at five levels of producer acceptance are presented in Table 4.6. Even at a relatively low yet perhaps realistic level of producer acceptance of 25%, substantial improvement in average production and net revenue could be expected. Although the average increase in net revenue per family member is estimated to rise by 49%, the expected average increase for family members of those producers willing and able to adopt the new approaches to production at the levels of production specified would be 196%.

2. Estimated Potential Impact of Adoption of Improvement Alternatives at the National Level

If the range livestock and crop production systems throughout Morocco are similar in terms of production characteristics and resource sets, some generalization can be drawn about the potential impact of improvement at the national level. Estimates of average national annual production and product value for livestock/crop production systems based on various levels of producer acceptance are presented in Table 4.7. At low levels of producer acceptance (25%), substantial increases in product and product value could be possible. If these kinds of increases in production occurred at the national level, prices would be expected to adjust downward due to the increase in supply. However, it may be possible in the long term to reestablish export markets for meat and meat products and thereby strengthen the national economy by increasing international trade. Regardless, the people of Morocco would benefit in various ways from the increase in production and production efficiency of Moroccan range livestock/crop production systems whether it be from the increased supply of livestock and crop products or from more efficient use of resources.

Table 4.6. Estimated average annual production and net revenue per producer family for range livestock/crop production systems in Morocco by level of producer acceptance of range and livestock improvement technology.

Production System Parameter	Level of Producer Adoption and Percent Increase over Current Level of Production: Current	25% Adoption		50% Adoption		75% Adoption		100% Adoption	
	174 Ewes 22 Does 2 Cows	184 Ewes 24 Does 2 Cows	Increase over Current	194 Ewes 26 Does 2 Cows	Increase over Current	203 Ewes 28 Does 2 Cows	Increase over Current	213 Ewes 30 Does 2 Cows	Increase over Current
Estimated Average Annual Production (kg live weight)									
Sheep	2413	3188	32%	4164	73%	5040	109%	5915	145%
Goats	190	303	59%	416	119%	529	178%	642	238%
Cattle	153	228	49%	303	98%	378	147%	453	196%
Estimated Average Animal Production Efficiency (kg live wt./breeding female)									
Sheep	13.87	17.35	25%	21.52	55%	24.79	79%	27.77	100%
Goats	8.64	12.63	46%	16.00	85%	18.89	111%	21.40	148%
Cattle	76.50	114.00	49%	151.50	98%	189.00	147%	226.50	196%
Estimated Average Animal Fiber Production (kg grease weight)									
Wool	291	329	13%	367	26%	405	39%	443	52%
Hair	23	25.25	10%	27.50	20%	29.75	29%	32	39%
Estimated Average Animal Fiber Production Efficiency (kg/breeding female)									
Wool	1.67	1.79	7%	1.90	14%	1.99	19%	2.08	25%
Hair	1.05	1.05	0%	1.06	1%	1.06	1%	1.07	2%
Estimated Average Production System Net Revenue (DH)	18,220	27,156	49%	36,092	98%	45,027	147%	53,963	196%
Estimated Average Production System Per Capita Net Revenue (DH/family member)	1,918	2,858	49%	3,799	98%	4,740	147%	5,680	196%

Table 4.7. Estimated annual production and market value for national herd in Morocco by level of producer acceptance of range and livestock improvement technology.

Production/Market Parameter	Level of Producer Adoption and Percent Increase over Current Level of Production								
	Current	25% Adoption		50% Adoption		75% Adoption		100% Adoption	
	Ewes 12.00 Does 1.52 Cows .14 (millions)	Ewes 12.67 Does 1.65 Cows .14 (millions)	Percent Increase over Current	Ewes 13.32 Does 1.79 Cows .14 (millions)	Percent Increase over Current	Ewes 14.04 Does 1.93 Cows .14 (millions)	Percent Increase over Current	Ewes 14.64 Does 2.06 Cows .14 (millions)	Percent Increase over Current
Estimated Animal Production (Tons live weight)									
Sheep	166,440	219,866	32%	286,646	72%	348,052	109%	406,552	144%
Goats	13,109	20,902	59%	28,646	119%	36,404	178%	44,158	237%
Cattle	10,552	15,724	49%	20,896	98%	26,069	147%	31,241	196%
Estimated Animal Fiber Production (Tons grease weight)									
Wool	20,069	22,684	13%	25,308	26%	27,940	39%	30,451	52%
Hair	1,586	1,738	9%	1,898	20%	2,047	29%	2,208	39%
Estimated Market Value (Million Dirhams)									
Sheep @ 13DH/kg live wt.	2,163.72	2,858.26	32%	3,725.40	72%	4,524.68	109%	5,285.18	144%
Goats @ 10DH/kg live wt.	131.09	209.02	59%	286.46	119%	364.04	178%	441.58	237%
Cattle @ 15DH/kg live wt.	158.28	235.86	49%	313.44	98%	391.04	147%	486.62	196%
Wool @ 15DH/kg grease wt.	301.04	340.26	13%	379.62	26%	419.10	39%	456.76	52%
Hair @ 15DH/kg grease wt.	23.79	26.07	9%	28.47	20%	30.70	29%	33.12	39%
Total Estimated Market Value (Million Dirhams)	2,777.92	3,669.47	32%	4,734.39	70%	5,729.56	106%	6,703.26	141%

CONCLUSIONS AND RECOMMENDATIONS

The current levels of productivity and production efficiency of range livestock/crop production systems in Morocco are grounds for concern at the national level. Not only do the people involved in these agricultural production activities form one of the lowest income groups in society, but production practices employed by these people have serious negative long-term effects on land resources that serve the needs of society. Excessive erosion and related sediment production associated with the continual degradation of land reduce land productivity and render the land more xeric at the point of origin. In addition, the productive life of reservoirs and intensive agricultural developments downstream are substantially reduced.

The previous analyses have only addressed a portion of the problems. The externalities and long-term costs associated with the problems of current use have not been considered. In a country like Morocco that is so dependent on basic agricultural production, it appears critical that these problems be addressed.

Development of a National Strategy

A national strategy accompanied by clear statements of policy including concise role statements for employees is desperately needed in order to attack these problems. Such a strategy should be based on national goals and a series or set of programs to meet these goals that is characterized by high levels of producer interest and improvement potential. It is especially important that producer acceptance be high for the initial programs in order to make rapid progress, establish credibility and ensure broader acceptance for more difficult programs to be initiated later in the process.

Program Planning and Evaluation

A systematic approach to planning and evaluation of programs should be established to ensure that local programs are effective in addressing goals created under the framework of the national strategy. The development of annual workplans as introduced through the project can serve as the basis for development of local programs that adhere to guidelines set by the national strategy. A clear statement of work activities allows for effective evaluation of local activities in the context of the overall program and is useful in the development of financial budgets required to support programs. Production models, such as the PROMO model, can be useful in analyzing problems and alternatives that exist, thereby aiding in program development.

Investment Criteria for Development Efforts

Development efforts that directly and immediately increase production should be initiated. In terms of range developments,

investments in infrastructure such as buildings and roads should be of low priority since they rarely affect productivity. Investments should be economically feasible and efforts should be made to improve the land with the highest productive potential first unless forage increases on less productive sites are valuable enough in the context of the production system to yield greater value. In other words, investment opportunities should be considered in the context of production systems. When estimates of production characteristics are adequate to allow comparison of various alternatives, they should be compared on the basis of their "Present Net Worth" to ensure that the best alternatives are selected for implementation. Recipients of development assistance should be required to participate in the financing of developments. This should be done primarily to ensure their involvement and commitment to improve their situation. In doing so, there is much less likelihood of vandalism, abuse and disorganization among producers using the developments. Participation can occur in any form that will reduce investment costs.

Enlargement of the Information Base

Efforts to increase or enlarge the amount of information concerning production systems, such as range, livestock, and crop productivity; production efficiency and viable production alternatives should be continued. Improvement is a continuous process that constantly requires more and better information. Acceptance of the status quo is rarely an appropriate approach. Research efforts should be coordinated to address relevant production problems and research support should be increased. Lines of communication should be developed among professionals working in research, management and extension. A national commitment to continuing the search for better technical applications in semiarid and arid zones is needed.

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CHAPTER FIVE: **PROGRAM DEVELOPMENT -- EXTENSION**

INTRODUCTION

The Range Management Improvement Project was originally conceived as an "extension project", under the assumption that technology developed in other parts of the world could be installed into Moroccan range livestock production systems without further testing. This was incorrect. U.S. technicians and their Moroccan counterparts confronted resistance from Moroccan producers and administrators based on the argument that the necessarily generalized technology promoted was not pertinent to their situation. Faced with this, technicians at each site began a series of small research/demonstration trials in order to measure current production, condition and trend of the rangeland and to measure the effect of known practices in the range environments found in Morocco.

The redesign of the project formalized this adaptive research emphasis. Studies were established at each of the project locations that would provide baseline information about the local range resource. Results from these studies provided data that were transmitted to livestock producers in the form of direct interventions, such as seeding of denuded rangeland. Research trials themselves served as demonstrations for field days and teaching seminars.

TDY personnel were selected to provide information and training in specific subject matter areas. Guides were written, field days for technicians and producers were held and training seminars were given by several of these specialists. The result of this activity was the creation of an ongoing program which included: 1) the seeding of improved forage species on the private lands of local producers, 2) a program of sheep selection and flock improvement, and 3) the development of written educational materials directed toward extension workers, administrators and producers.

SUMMARY OF INFORMATION AND DEVELOPMENT INTO LIVESTOCK PRODUCTION SYSTEM MODELS FOR IDENTIFICATION OF INTERVENTION OPPORTUNITIES

There are essentially two extension audiences to be addressed in the extensive livestock sector in each region: 1) a small group of families who have most of the wealth and income producing capability, and 2) the majority of producers, who are in control of small resource sets and whose capability of producing income is low (see Sociological Research Section of this report). While not unexpected, this resource distribution pattern affects the design and implementation of range/livestock extension programs.

Both audiences have divergent needs and varying abilities to respond to proposed interventions. Those few producers controlling most of the private land resources can benefit from programs which provide crop and rangeland improvements on private land, such as introduction of improved crop varieties and cultural practices, range seeding, terracing, water spreading, water development, herd improvement and animal selection. The

second group, who have less control over resources, must be organized to cooperatively improve the collective land to which they have access. Organizing this large body of producers into groups allows programs such as animal health, range improvements and record keeping and analysis to be implemented.

EXTENSION PROGRAM: DIRECT INTERVENTIONS

Seedings on Private and Communal Land

Midelt

An extension program to seed perennial grasses on the lands of private producers is now in its second year. Approximately 145 ha were seeded in the fall and winter of 1984-85 on private land of 15 producers in 6 different communities. In the following year (1985-86), 425 ha were seeded. These seedings were done on land owned by 18 different producers representing 10 communities.

Agropyron intermedium, *A. cristatum* and a small amount of *A. sibericum* were seeded in the 1984-85 program. These species were seeded either with a rangeland drill with no previous land preparation, or by a conventional grain drill after preparing the land by plowing and disking. *A. trichophorum* and *A. elongatum* were seeded in the 1985-86 program using the same planting procedures as the previous year.

DE/SP and the RMIP provided the seed, and the Service de l'Elevage in Midelt furnished the equipment and operators the first year. Producers provided the fuel for the machinery and, during the second year campaign, were required to furnish tractors, fuel and operators. Seed and drills were again provided by DE and the RMIP and sent to several locations where the local producers picked them up. A DE/SP technician trained by the project assisted the producers with the seedings and care of the equipment. Drills were pre-set to seed at relatively heavy rates.

The 1984-85 program was partially successful (see Table 5.1). Only five sites representing 41.5 ha produced significant stands of grass. Plant density varied widely. Since there was a noticeable lack of spring precipitation, most producers were not disheartened by the poor results. Technical reasons which may have contributed to the high failure rate were: 1) seeds were planted too deeply (seeds of *A. cristatum* are small, therefore planting depth is critical), and 2) use of the rangeland drill, which has not proven to be highly dependable during marginal rainfall years.

The 1985-86 program (Table 5.1) may be more successful, though production data for the 1985-86 program are not yet available. Preliminary indications were positive; germination was good to excellent. Spring rains should result in good growth and establishment of seedlings.

Table 5.1. Results of extension program seedings administered by the Midelt Office, Bureau des Parcours.

PERENNIAL FORAGE PLANTATIONS ON PRIVATE LAND: MIDELT

PRODUCER	FRACTION	SPECIES[1] PLANTED	DATE PLANTED	SEEDING RATE (kg./ha.)	FIELD SIZE (ha.)	GERMINATION DATE[2] DATE	PRODUCTION (kg./ha.)	DENSITY (#/ha.)
Akkaoui, L'Haj Moha	Aghbalou	Agcr	10/25/84	9.8	12 rge.[3]	04/03/85	10	1000
Akkaoui, Mohammed	Aghbalou	Agcr	10/24/84	9.8	7 rge.	04/03/85	N/A[5]	70000
Bekkri, Abdellah	Aghbalou	Agin	10/15/84	12.5	10 con.[4]	04/03/85	1226	125000
El Boustani, Ben Acca Lahcen	Aghbalou	Agcr	10/18/84	9.8	41 rge.	04/03/85	N/A	8000
		Agcr	10/18/85	12.2	4 con.	04/03/85	0	0
		Agin	10/18/85	12.5	15 con.	04/03/85	980	11000
Hakkoui, Lahabib	Aghbalou	Agcr	10/19/85	9.8	4.5 rge.	04/03/85	0	0
		Agcr	10/19/85	12.2	1.5 con.	none	0	0
Khantor, Lhousseine	Aghbalou	Agcr Agin mix.	none		2.0			
Oubessari, Ahmed	Aghbalou	Agin	10/25/85	11.1	12 con.	04/03/85	70	45000
Baba, Haj	Ait Ayach	Agin	01/22/85	11.1	3 con.	04/05/85	50	40000
Colonel	Ait Ayach	Agcr Agsi mix.	01/22/85	12.2	14 con.	04/05/85	0	0
Oumessahou, Ahmed	Ait Ayach	Agcr Agin mix.	01/23/85	11.8 11.1	2 con.	none		
Ait Azzi, Kassou	Ait Houssa ou Ali	Agin	11/02/85	11.1	1.5 con.	04/02/85	2298	320000
Bahmida, Mohamed	Boulabzous	Agin	10/09/85	12.5	2.5 con.	04/05/85	10	1000
Oukhouya, Moha	Tarougout	Agin	11/26/85	11.1	2.5 con.	04/02/85	N/A	8000
Oussid, Benacer	Boulabzous	Agin	10/09/85	12.5	3.5 con.	04/08/85	N/A	8500
Bazouki, Moha	Rae a Guercif	Agcr	12/11/85	heavy	7 hand-seeded	none		

[1]Species:
Agcr - Agropyron criscatum
Agin - Agropyron intermedium
Agsi - Agropyron sibericum

[2]Germination Date:
Date recorded for germination was the field trip date when germination was first present.

[3]rge.
Rangeland Drill was used to plant the seed.

[4]con.
Conventional method was used to plant the seed.

[5]N/A
Information is not available.

Timahdite

Approximately 18.5 ha of private land representing 17 producers and sites were seeded to numerous varieties from several species of perennial grasses in the genus Agropyron and a single legume, Vicia dasycarpa, in the fall of 1984/85 (see Table 5.2). Primary objectives for the seeding demonstration were to teach methods of revegetation, seeding rates, equipment calibration and pasture management techniques. By returning less productive cropland to perennial pasture the specific objective was to make additional forage available to livestock, either by grazing these seeded plots directly or by harvesting and feeding the cut forage or hay. If animal numbers remained constant, this additional forage production could reduce animal grazing pressure on collective rangelands. Seed was broadcast manually over plowed soil and then trampled it into the seedbed by running livestock over the plot. Broadcast seeding rates were increased somewhat above application rates for machine plantings and multiple species were added to the mixture of seed in order to reduce the risk involved in stand establishment. All seedings were completed by mid-November in order to take advantage of seasonal precipitation.

Germination and emergence occurred on all plots, though stand quality varied considerably. Weed competition, insects and frost contributed to the reduction of stand vigor and density. A. elongatum, A. intermedium and Vicia dasycarpa have been the most successful species to establish, and the most resistant to

Table 5.2. List of seeding demonstrations on private land in the Timahdite area - 1984-85.

PRODUCER	FRACTION	SPECIES[1] PLANTED	DATE PLANTED	SEEDING RATE (kg./ha.)	FIELD SIZE (ha.)	GERMINATION[2] DATE	PRODUCTION (kg./ha.)	DENSITY (#/ha.)
Allaoui, Moha	Ait Ben Yacoub	Agin	10/10/84	20	1.0	N/A[3]	N/A	45000
		Vida	10/10/84	15			N/A	N/A
Jouder, Mimoun	Ait Ben Yacoub	Agel	10/02/84	20	1.5	11/28/84	165	15000
		Vida	10/02/84	17		11/28/84	N/A	N/A
Feriesi, Hamou	Ait Ben Yacoub	Agin	10/17/84	16	1.5	11/25/84	34	10000
		Agin	10/17/84	9		11/25/84		
		Vida	10/17/84	15		11/25/84	N/A	N/A
Ouhadda, Abid	Ait Ben Yacoub	Agel	10/24/84	20	1.0	11/23/84	0	0
		Vida	10/24/84	20		11/23/84	N/A	N/A
Ouhadda, Mimoun	Ait Ben Yacoub	Agde	10/24/84	20	1.0	11/23/84	0	0
		Elju	10/24/84	22		11/23/84	N/A	N/A
Ouhadda, Mohamed	Ait Ben Yacoub	Agtr	10/24/84	20	1.0	11/23/84	0	0
		Dagl	10/24/84	22		11/23/84	0	0
Lahcini, Moha	Ait Ben Yacoub	Agtr	11/07/84	15.	1.0	N/A	19	7000
		Agde	11/07/84	20		N/A		
		Vida	11/07/84	20		N/A	N/A	N/A
Ouhaddi, Mohamed	Ait Ben Hcine	Agin	10/12/84	20	1.0	11/20/84	327	140000
		Vida	10/12/84	10		11/20/84	N/A	N/A
Assiouane, B. Youssef	Ait Ben Hcine	Agde	10/20/84	20	1.0	11/30/84	18	9000
		Vida	10/20/84	10		11/30/84	N/A	N/A
Moussaoui, Hadda	Ait Ben Hcine	Agtr	10/26/84	20	1.0	N/A	N/A	N/A
		Elju	10/26/84	22		N/A	N/A	N/A
Ajikhoune, Moha	Ait Hcine ou Hand	Agin	10/19/84	10	1.0	12/07/84	78	37000
		Vida	10/19/84	20		12/07/84	N/A	N/A
Daoui, Moha	Ait Hcine ou Hand	Agtr	11/30/84	22	1.2	N/A	0	0
		Agin	11/30/84	5		N/A	0	0
		Vida	11/30/84	20		N/A	N/A	N/A
Moussaoui, El Hachmi	Ait Hcine ou Hand	Agde	10/17/84	25	1.0	N/A	12	8000
		Vida	10/17/84	20		N/A	N/A	N/A
Bouhamed, Said	Ait M'Hamed	Agtr	10/15/84	20	1.0	12/05/84	0	0
		Vida	10/15/84	10		12/05/84	N/A	N/A
Ben Cherif, Ben Youssef	Ait M'hamed	Agin	10/18/84	22	2.2	12/04/84	325	135000
		Agsi	10/18/85	22		12/04/85		
Ou Ben Allah, Moha	Ait M'hamed	Agtr	10/15/85	30	1.0	11/17/85	0	0
		Vida	10/15/85	15		11/17/85	N/A	N/A
El Hamchaoui, Benaissa	Ait Ben Yacoub	Mesa[4]	04/27/85	15	1.5	05/11/85	07/27/85-660 09/01/85-1737	559000
		Dagl	04/27/85	13		05/15/85	0	0

[1]Species:
- Agin - Agropyron intermedium
- Vida - Vicia dasycarpa
- Agel - Agropyron elongatum
- Elju - Elymus junceus
- Agtr - Agropyron trichophorum
- Dagl - Dactylis glomerata
- Agsi - Agropyron sibericum
- Mesa - Medicago sativa

[2]Germination Date:
Date recorded for germination was the field trip date when germination was first present.

[3]N/A:
Information is not available.

[4]Mesa:
The Medicago sativa field has been irregated five times.

- 04/27/85 - Planted
- 04/29/85 - Irrigated
- 05/22/85 - Irrigated
- 06/12/85 - Irrigated
- 07/27/85 - Harvested
- 08/10/85 - Irrigated
- 08/05/85 - Production and density estimates taken

weed competition.

Producers' attitudes and perceptions towards their plots have been generally negative in the Timahdite area. Stands of perennial grasses planted during these demonstrations were generally poor and yielded less forage during the first year than did comparable plots of cereal crops. The majority of the private landholders involved in the demonstrations decided to replow the land for cereal production.

During the spring of 1985, a cooperative field demonstration was initiated with a private producer in order to assess producer attitudes toward the production of irrigated forage crops. A 1.5 ha plot of irrigated land was cleared of stones, cultivated and seeded to orchard grass (Dactylis glomerata var. Frondo) and alfalfa (Medicago sativa) (see Table 5.2). The field was fertilized with a commercially blended fertilizer (14-28-14) at the rate of 100 kg/ha. The seeding produced an excellent stand and was cut for hay twice the first year, yielding first and second cuttings of 1000 kg and 2000 kg respectively (a rate of yield of 2000 kg/ha). Three cuttings are expected in 1986.

Approximately 10.5 total hectares on seven sites belonging to four producers were seeded to several varieties of species from the genus Medicago, to Vicia dasycarpa and to A. tricophorum var. Topar in the fall of 1985 (see Table 5.3). Germination and emergence occurred on all plots. Barley was included in all alfalfa seedings to provide and overstory and thereby reduce frost damage. All plots received 100 kg/ha of fertilizer (14-28-14).

Table 5.3. List of seeding demonstrations on private land in the Timahdite area - 1985-86.

PRODUCER	DATE	LOCATION	NO. HA. SEEDED	SEEDING MIXTURE	kg/ha RATE	SEEDING TECHNIQUE	COMMENTS i.e. problems, success
JOUDAR Mimoun	12/08/85	AIt Ben Yacoub	1.5	Mesa var. Rhyzoma + barley	13,3 kg 66,7 kg	plow fertilized	dryland
	12/11/85	" " "	1.0	Vida + barley	12 kg 100 kg	plow seeded	dryland
CHIDA Said	23/11/85	" " "	1.5	Mesa var. Rhyzoma + barley	13,3 kg 66,7 kg	disced -tractor fertilized covercropped-tractor seeded-hand covercropped - tractor	dryland - medic seed planted too deep. Approx. 3-4cm inhibited post germination emergence. low density producer not satisfied w/ germination result
OUBAJA Abdelhamid	11/05/85	AIt Ben Heine	1.0	Mesa var cuf 101 + barley	10 kg 100 kg	disced-tractor fertilized covercropped seeded-hand broadcasted	irrigated / /85
	11/09/85	" " "	1.0	Mesa var Rhyzoma + barley	12 kg 150 kg		irrigated / /85 irrigated 08/12/85
	26/11/85	" " "	3.5	Vida +	20 kg 100 kg		producer pleased with past germination and emergence results.
OUCHRIF Mohamed	30/11/85	" " "	1,0	Agtr var Topar + vida	20 kg 10 kg	plowed-horse fertilized plowed - horse seeded-hand broadcasted	dryland

note which plots dryland and which are irrigated
time of irrigation

Participating producers anticipated additional high quality forage for early fall lambs and requested that future technical assistance programs reduce emphasis on wheatgrass plantations in favor of an increase in alfalfa plantings. The improved varieties of alfalfa established faster than perennial grasses,

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with less difficulty and provided adequate amounts of high quality forage even under dryland conditions in the Timahdite region.

Oujda

A two hectare pasture to be used for extension purposes was selected near the major highway along the northern boundary of Gouttitier Station. This pasture was seeded with a rhizomatous alfalfa species which germinated and is (at the time of this report) in the second leaf stage of development. This pasture will be irrigated at two week intervals.

This planting will be used for extension purposes to demonstrate a program of both pasture management and the introduction of a new variety of leguminous forage plant to the area. Many inquiries have already been received from local farmers asking for assistance in acquiring this variety of alfalfa.

Soil Treatments and Shrub Plantations on Communal Land

Observations at all work sites indicated that considerable precipitation was lost during each rain as a result of rapid runoff. This caused the level of effective soil moisture to be much lower than that implied from annual precipitation records. Drought conditions served to worsen the situation.

Denuded rangeland everywhere suffers from this problem. Loss of plant cover leaves the soil surface unprotected from the impact of raindrops and soil compaction resulting from extensive trampling by animals adversely affects infiltration of water. Capillary passages that promote water movement in soils are destroyed. Heavy crusting of the soil surface occurs and effectively prevents moisture penetration.

The 1984-85 workplan included demonstration trials of soil treatments at two locations. A fairly extensive trial was installed at Ain Beni Mathar and Gouttitier Station (Oujda Office), and a small trial was installed at Ait Rbaa (Beni Mellal Office). The treatment in each location included: 1) the construction of contour terraces to trap runoff moisture and reduce erosion, and 2) the plantation of fodder shrubs in the more mesic zone created above the terraces.

Survival and growth of planted fodder shrubs at Ain Beni Mathar and Goutitier was excellent. Shrub survival at Ait Rbaa was low because of late planting and poor quality plant material. Native vegetation responded extraordinarily well to the additional moisture on all treatment sites. The DE range staff at Oujda immediately saw the opportunity for improving rangelands and watersheds and began to conduct field days and tours with local producer groups, tribal leaders and government officials from the area. Two major field days for members of the Oulad Sidi Ali and Oulad Sidi Abdelhakim Tribes were held with about 40 persons attending each one. Local caids and other officials supported and attended each field day.

The result has been a classic extension program transmitting new technology through demonstration. The land area treated increased in 1985-86 to about 450 ha. The 1986-87 program is to

include work with the two tribes mentioned above, and will include 14 new producer groups treating 1,500 to 2,000 ha/yr. Total land area that will be involved in a management plan for range use as a result of this extension activity is approximately 128,000 ha.

Unfortunately, although the increased forage production of native range plants from contour terracing and deferment was just as dramatic at Ait Rbaa, the SE range staff at Beni Mellal did not take advantage of the demonstration opportunity. No data was collected to quantify the production differences, nor were any field days organized for local producers and leaders to explain the activity or the advantage of the technology.

Trials were initiated at El Faija during the fall of 1985 to assess the potential for improving alfa-grass dominated sites by contour terracing, planting shrubs near the terraces and seeding grasses and forbs in the interspaces between terraces. To date, shrub survival and emergence rates for seeded species have been high. Although production levels have not been quantified, large production differences are anticipated. At present the visual differences reflected in this trial serve as a positive demonstration of the utility of this technology in the alfa-grass zone, especially when the current low forage productivity of this zone is considered.

Shrub Plantations in Urban Areas

Because of the increased scope of the range rehabilitation program at Ain Beni Mathar, the Bureau de Parcours staff thought the local community needed a better understanding of the reclamation efforts. Several sites around the village were planted with *Atriplex nummularia* shrubs and various range grasses. The shrubs were produced at the local nursery, which alone has proven to be an excellent extension tool. Sites were selected for high visibility.

A long empty island that extends for two blocks in front of the newly completed mosque was transformed from a donkey parking lot into a garden of range plants. The site, which covers 1/3 ha, was planted with a hedge of *Atriplex nummularia* and seeded with several species of range grasses. Olive and acacia trees were planted in the center of the garden. A fence was built around the plantation to protect it.

A small hedge of *A. nummularia* was planted on either side of the main entry to the village hospital. This hedge is expected to be extended to enclose a newly planted garden where many species of range grasses are planted. In addition, about 100 *A. nummularia* shrubs were planted as a driveway hedge leading into the meterology station along the main highway to Oujda. A small hedge of *A. nummularia* was planted around both the Forest Service District office and residence, and around the two Ain Beni Mathar Service des Parcours residences.

Livestock Development Programs

Herd Health

The Agro-Pastoral Systems and Animal Production Studies performed as part of the applied research program of the project also served as an extension/demonstration activity with the cooperating producers. As an incentive to cooperate, vaccines and anti-parasite drench were purchased by the project and administered to the producers' sheep by SE, USU and PCV technicians. The treatments were administered twice during the data gathering period. Information was presented to the producers concerning the need for a regular flock sanitation program. About 30 producers with about 1,000 sheep participated in the program.

Control of breeding

Indiscriminate breeding makes selection for genetic improvement impossible and hinders flock management as lambs are often born throughout the year. The best alternative is to separate all male animals from the females except during a specified breeding season. However, the expense of additional herders can be prohibitive for many producers. Therefore, a non-surgical method of sterilizing the male lambs which are undesirable for replacement rams (the "short scrotum" technique) was employed. This technique is bloodless and requires no special knowledge of anatomy (see "Alternative Livestock Management Practices" in Chapter 2 for details).

The cooperative flock at Ain Beni Mathar was used to demonstrate the technique. Members of the cooperative assisted SE, USU, and PCV technicians in treating the male lambs used in the study. There was no resistance by the producers since there was no blood. The members have followed with interest the growth and slaughter of these animals, and agree that it is an acceptable technique.

EXTENSION PROGRAM: TEACHING REVEGETATION TECHNIQUES AND ANIMAL HUSBANDRY

Two fairly large scale extension programs are particularly noteworthy. These are: 1) the expansion of the program in the Oujda region, as a result of the demonstrations developed at the Ain Beni Mathar Perimeter, and 2) the sheep and wool selection program. These programs are valid indications that this type of activity can be fostered in Morocco, and that producers are interested in learning and applying new technology.

Using the knowledge gained from working with the Beni Mathar Tribe, and using the range and livestock improvement demonstrations on the perimeter, the Bureau de Parcours at Oujda expanded its efforts into two neighboring tribes. Keeping in mind that each tribe is structurally different and that each has a different resource base, specific development programs have been presented to the tribal members for approval.

Oulad Sidi Ali

Two perimeter systems are being constructed in the Merija area because of the split needs of the community. One, the Hasiane L'Diab, will be 30,000 ha in size. This perimeter is on very abused lands invaded with Anabasis anaphyla. Much work will be required to develop this land into a productive unit. A cooperative sheep herd will use the area. The second, the Rkiz, will include 19,000 ha of land. This land is situated on a plateau dominated by (Artemisia herba-alba) and alfa-grass (Stipa tenacissima).

After an intensive survey of the right-users by the Oujda BP staff and discussions with tribal leaders, this development program has been approved for the upcoming year. The initial investment by the GOM will be equivalent to $1.6 million for range and range livestock development. The Ouled Sidi Ali are in a transition phase from migratory pastoralism (transhumance) to a more sedentary lifestyle. The major priority of this work will be the implementation of a perimeter range resource management program.

Oulad Sidi Abdelhakim

Over time, the Oulad Sidi Abdelhakim Tribe has lost land along the frontier of Algeria. With no souk of their own and no paved roads to their tribal lands, access is very limited. Over 70% of the communal lands are rangelands dominated by alfa-grass. Selling the harvested grass for paper production accounts for much of the cash flow of the tribe.

A $3.2 million, five year development plan has been submitted to the Ministry of Agriculture for approval. The main focus is to declare the entire tribal land resource as the management perimeter. This perimeter is proposed to be divided into four management units, each consisting of three sheep cooperatives, each one corresponding to a douar. Each management unit will be controlled in a strictly enforced grazing management program.

The net result of this new program will include the formation of 12 new sheep production cooperatives based on the model of the highly successful co-op at Ain Beni Mathar. Formation of these cooperatives will serve two purposes, 1) it organizes the people into management units that will permit the BP staff to develop a grazing program to protect and improve the range resource, and 2) it will create combined sheep flocks that can be improved by applying the selection practices activity already programmatically institutionalized in the DE/SP program at Oujda. These cooperatives will include the producer families representing more than 2,500 tribal members and will be created from the present flocks comprised of about 150,000 sheep and goats. The size of the communal land base that will be involved in the program is about 32,000 ha.

Noteworthy is the fact that the tribes are interested and willing to make certain concessions in order to receive this program of aid and technical assistance. They have agreed to stop cultivating fragile rangeland and, wherever possible, to seed land presently being cultivated to improved forage species

according to appropriate procedures. The tribes have also agreed to pay a portion of the cost of the improvement work. The GOM has asked that the recipients of such activities pay 40% of the cost either in direct payment or by furnishing equipment, fuel, and labor to install improvements.

Selection Program for Sheep and Wool Quality

A program of sheep selection was planned with Dr. Jack Ruttle during a TDY visit to Morocco in 1985. A field day was held at the Ain Beni Mathar Perimeter in association with a seminar given for technicians at Oujda. The possibility of imposing a selection program for reproduction, growth performance and wool quality was discussed with the members of the cooperative attending the field day. Since producers expressed interest, arrangements to begin the program were made through local technicians.

At the present stage in the development of the Moroccan sheep industry, changes in basic animal husbandry techniques need to be instituted before improvements can be realized from breeding programs. Few producers in Morocco take the time to inspect their animals each year. A large percentage (about 25% based on data collected on 4,000 animals) are totally unproductive because of disease, advanced age, and/or congenital defect. Identification and removal of these unproductive animals immediately contributes to the improvement of the flock by increasing the annual lamb crop percentage and decreasing costs. Removal of these animals also improves the nutritional base of those remaining, and should, therefore, improve weaning weights and the ewes' capacity to rebreed. Based on a national sheep flock of about 12 million breeding age ewes, the annual maintanence cost for these unproductive animals in locally priced barley amounts to over one billion dirhams. Once a program of selection based on reproductive capability is institutionalized, selection pressure for other production traits can be applied. Wool quality is thought to be important because of the highly developed carpet and fabric industry in Morocco. Discussions with managers of local factories indicated that all raw wool used in the construction of carpets and fabrics produced for the export market is imported. Imported wool prices quoted at the time of the interviews was 55 DH per kilo, FOB the factory. The DE has stated that there are about 20,000 metric tons of wool imported into Morocco each year at hard currency costs to support the industry. Because the local wool industry is poorly organized and because wool quality is low and has many defects, domestic wool production cannot meet the needs of the export carpet industry. Improving technicians' and producers' knowledge of wool quality criteria and selection procedures is a first step in capitalizing on the opportunity to develop a strong domestic market. Substitution of locally produced wool for imported wool would not only save the hard currency costs of importation, but also would generate a net gain in hard currency receipts through the export of locally produced wool. The internal infrastructure needed to market, process and distribute the improved wool would be beneficial in creating additional employment in Morocco.

In the sheep selection program, each flock was reviewed,

animal by animal. The animal's age was determined, the animal was inspected for any diseases or defects and wool quality (Tables 5.4 and 5.5) and body conformation judged. The flock was divided into three herds based on quality. Flock A consisted of those animals free of any defects, with wool spinning count of 50 or better (the lower limit of the fine wools), with little or no kemp or hair and, in Oujda Province, with the phenotype of the local Beni Guil breed. This flock became the superior animal group from which all replacements will be selected in the future. Flock B was constructed from those animals having no physical defects, but not meeting the breed or wool qualities desired. Flock C consisted of those animals marked for culling.

The work was performed by a team composed of DE, USU and SR-CRSP technicians. The DE technicians were trained in the U.S. during one of the short-term training courses in the selection techniques. This activity served to reinforce that training. Members of the co-op assisted and soon began to judge and see differences in quality.

Table 5.4. The number of ewes by kemp/hair rating and wool grade, El Fath Co-op herd.

		WOOL GRADES								
		44's	46's	48's	50's	52's	54's	56's	TOTAL	
KEMP/HAIR CONTENT RATING	6	2	4	5	3	0	0	0	14	III
	5	4	10	17	15	8	0	0	54	
	4	3	14	18	14	10	1	0	60	II
	3	4	16	41	24	5	1	0	91	
	2	6	38	76	39	9	1	0	169	
	1	1	35	76	66	12	3	2	195	I
	0	2	31	138	125	38	9	4	347	
TOTAL		22	148	371	286	82	15	6	930	

308 ewes or 33% of the original CO-OP herd qualified for the top flock based on wool and fleece quality criteria.

490 ewes or 53% of the original CO-OP herd qualified for the intermediate level flock based on wool and fleece quality criteria.

132 ewes or 14% did not meet minimum wool and fleece quality standards.

Table 5.5. The number of rams by kemp/hair rating and wool grade, El Fath Co-op herd.

KEMP/HAIR CONTENT RATING	WOOL GRADES 44's	46's	48's	50's	52's	54's	56's	TOTAL	
6	0	0	0	0	0	0	0	0	
5	0	2	0	0	0	0	0	2	III
4	0	0	0	0	0	0	0	0	
3	1	0	3	0	0	0	0	4	II
2	0	2	5	1	0	0	0	8	
1	0	2	3	5	0	0	0	10	I
0	0	7	14	19	2	0	0	42	
TOTAL	1	13	25	25	2	0	0	66	

26 rams or 39% of the CO-OP herd qualified for the top flock based on wool and fleece quality criteria.

26 rams or 39% of the CO-OP herd qualified for the intermediate herd based on wool and fleece quality criteria.

14 rams or 21% did not meet minimum wool and fleece quality standards.

The result with the El Fath Cooperative has been the formation of a flock of quality Beni Guil sheep that has the potential for producing an annual percentage lamb crop of 100%. This is compared to lamb crop percentages for flocks measured throughout Morocco of about 35 to 40 percent on an annual basis. Recently, the commission from the ANOC (National Sheep and Goat Association) reviewed the flock. Thirty-five ewes were presented for breed certification. The commission accepted 31 and denied 4 because the wool quality was too high (a "problem" that would become a blessing if a strong domestic wool market were developed). The co-op flock has now been certified to produce purebred Beni Guil sheep for sale to the public.

This work caught the interest of many people. The report of the activity was sent to a recently returned RMIP degree participant working in Safi who had been trained in range management and sheep and wool production at the University of Wyoming. He organized a training/demonstration activity for Safi Province, and a one week program for Moroccan technicians and producers was conducted by the same team that had worked at Ain Beni Mathar.

Eleven Moroccan technicians from various provinces and 76 producers participated in the training/work portion and about 3,000 animals were classified using the selection criteria described above (with the exception of the breed phenotype criteria). The technicians felt very good about the training received and were of the opinion that valuable techniques and skills learned could be used to develop programs in their own work areas. They believed that the high producer interest rewarded them for their efforts and that they had achieved an important level of credibility.

The producers were also pleased with the effort. At the end of the first day, it was learned that many of the producers that had participated expected pharmaceuticals for their animals. There was concern that this might have been their only reason for participating. However, one team returned to this same work site the following day to find just as many producers waiting who knew exactly what the program was. Many of these producers waited around until after the work to discuss sheep management related problems. Technicians were gratified by the positive attitude and enthusiasm of the producers.

The technicians worked with herds of various sizes ranging from 15 to 300 ewes. Participating producers showed a high degree of interest and desired to see the defects encountered. They requested that explanations be given about how to avoid such problems and how they could get into a management program that would enhance production. One producer requested that the defective animals be coded when marked for culling so that he could return later and study them to better see the problems himself.

One team was stopped on the road into a douar by a producer not scheduled to receive assistance. When asked if he knew what the team was doing, he said, "Yes, you're the group that is doing the animal selection work. I know that I have problems with my herd but I don't know what they are". He was scheduled for a later visit. Another producer, when shown that many of his ewes had very high quality wool, mentioned that he had cross-bred his flock with some Ile de France stock in years past and that his shearing was in the bags if the technicians wanted to see the wool. The wool bags were dumped before Mr. Berger, a SR-CRSP livestock specialist, who sorted the fleeces into three quality groups. The differences were so dramatic that the producer re-bagged the wool according to quality, marked the bags, and indicated that with this new knowledge he intended to drive a harder bargain at the market.

Many producers, when shown the defects in their animals (particularly in wool quality), wanted to know the fastest way of improving their flocks. In general, there was a noticeable lack of high quality rams in the flocks. Discussions with producers about purchasing improved rams from outside the local genetic pool occurred frequently. Arrangements were made with a number of producers to meet at various breed development stations in Morocco to purchase rams of higher quality. There was not one case of expressed disinterest by any of the producers in attendance.

The value of this type of extension activity is obvious. In addition to fulfilling the goals of the project to increase the productive efficiency of sheep flocks in Morocco, technical staff receive additional training and are allowed to sharpen skills in a local setting. They are given the opportunity to utilize their training in the field. Producers are trained to see the wide range of differences in quality that are found in essentially every flock. Producers can understand immediately the impact of such an activity on their income from sheep products. Administrators are happy because such programs create positive responses from the producers and excellent information to report to superiors.

This type of activity is an extremely important extension

function. Producers can easily relate to quick improvements that can be achieved in their flocks. This creates confidence and trust in technicians which allows inroads to be made in more esoteric activities such as long-term range and pasture improvement programs. This type of "hands on" activity not only serves to make an improvement but becomes a vehicle to teach the methodology, and, obviously, raises the status of Moroccan technicians in the eyes of the producers.

Producers in Morocco are interested in improving their production systems if they can be shown a better way. The key word is "shown". This means demonstrating improvement practices for both range and livestock that work, in impressive scale and that are readily available for field days of "show and tell". The work at Oujda, Midelt, Timahdite and Safi are good starts, but it is not enough. Unless there is outside impetus to continue the research and refinement process in order to provide the technical backstopping for these new ventures with local producers; and in order to serve as the glue for this fragile, young, range management institution; the future of this development activity will surely be the same as for those programs that have come before. First there will be a stagnation of effort, then a gradual erosion back to the status quo. Technically, managerially and organizationally, the institution is not mature enough to survive and grow by itself.

DEVELOPMENT OF EXTENSION MATERIALS

The concepts of range resource management are relatively new. The Society of Range Management was only formed in 1948, and the first university range departments were created shortly thereafter. Therefore, the application of this science throughout the world, and in particular in lesser developed countries, is only now beginning to have any impact on resource management and conservation. Since the early 1970's, the primary development goals have been to form a cadre of trained range technicians who could teach, research and implement range management techniques. Only then can extension agents be trained to carry this information to the public.

This project has gone a long way towards developing a cadre of range technicians. As mentioned in the training section, 11 Moroccan technicians were trained to the master's level and many others were given intensive short-term training in range management, livestock management and extension methodology. However, the Moroccan Extension Service has not, for the most part, been exposed to range management principals or methodology. The Range Management Improvement Project has, however, developed numerous materials that can serve as informational guides, not only for extension workers, but for producers, administrators and the public at large.

These materials include:

- A handbook for International Range Management Extension which provides guidelines on extension theory and program planning procedures as they apply to range management in Morocco. This guide explains what extension workers must and must not do, how they should conduct themselves, how to motivate people, and how to plan, implement, and evaluate an effective range management extension program. A French version of this handbook will be distributed by the Direction de la Vulgarisation Agricole et de la Reforme Agraire to extension agents in the field.

- A Handbook of Basic Range Management presents basic information to extension workers, administrators, producers, and the public on most aspects of range and range livestock management. Particular attention has been given to make the information pertinent and applicable to Morocco.

- In addition, training information organized and presented in the form of handbooks treating specific topics was prepared in conjunction with TDY visits and in-service training seminars. Each participant in the two training seminars was given a packet of research and extension information including the papers presented. TDY personnel were asked to develop their reports so that they included "how to do it" type handbooks whenever applicable. In particular, both Dr. Ruttle (extension and animal production) and Mr. Graves (indigenous forage plants collection) prepared considerable amounts of information that was distributed to all persons attending the field days and seminars described above. These materials, applicable to Morocco, were incorporated into the extension handbooks discussed earlier in this section.

CONCLUSIONS AND RECOMMENDATIONS

Emphasizing the Appropriate Extension Program

If the government wishes to improve aggregate output, then the extension program must be directed toward those who control the most resources. Also, interventions directed toward the poorest agriculturalists may not lead to great changes in agricultual production statistics. This dichotomy creates a real dilemma for the extension program planner.

We now know that the principal production constraint for most producers is not simply a lack of technological knowledge or a desire to produce by traditional methods. The primary constraint is a resource base so small that it cannot produce income in excess of that required by the producer to try to

maintain a relatively meager standard of living.

The data also indicate that, in arid zones and most semiarid zones, small ruminants form the basis for the production system. In these zones, the potential for major increases in grain production is limited and of reduced local importance except in the context of its integration into the livestock production scheme. Therefore, extension in these drier zones should be directed primarily towards livestock production. Moreover, plant material development and soil and water conservation programs on marginal cropland in these areas should be directed toward improving forage crop production rather than increasing cereals. This would be a reversal of the present program in which the focus of extension is directed primarily on crop production for grain, often without due regard for the limitations set by the inherently low productive potential of the land and the climate.

Future work should be to train extension agents in range/livestock production and management, and to reinforce them with a national program directed at improving the production of the extensive livestock sector.

Organization of the Local Populations

A recurring theme in any extension program is to "identify the audience". Extension programs must be directed to a specific audience in order to be successful. This axiom is often violated when dealing with members of a communally held range resource. Trying to impose a management program on a collectively utilized rangeland has met with failure again and again because individual desires and motivations cannot be satisfied. Although the members may be looked upon as a common group with similar problems, they cannot manage the resource as one entity unless they are organized to work cooperatively. With organization, collective goals and motivations can substitute for those of the individual.

In particular, the formation of one or more cooperative flocks allows management systems to be established on the land and permits effective livestock improvement programs. There is little progress to be made in the improvement of collectively owned land resources until the members are willing to organize, elect representatives and impose the will of the majority to develop a management plan and utilize the resource in a cooperative manner.

Range Seedings

Inadequate rainfall has plagued the extension/demonstration program of seeding private land. However, the experience gained has created some guidelines for success in the future.

When seeding small dryland plots using traditional methods, avoid perennial species with small seeds. Animal traction plows cannot adequately prepare the seedbed to insure proper germination and survival of small seeded species. On the other hand, even with traditional seeding methods, large seeded annual species can compete with weeds, respond quickly to soil fertility programs and can emerge even when buried deeply. Oat-vetch

mixtures, for example, are excellent and produce large quantities of high quality forage.

In seedings using tractor drawn implements, extreme care should be taken when planting small seeded species, or they should be avoided. There are many excellent perennial plant materials with large seeds that increase the probability of success. Avoid small plots if possible. The equipment cannot express its potential if reasonably long runs cannot be made. Plan a complete tillage program. Any shortcuts will result in reduced success because of reduced survival and weed competition. Always plan for inadequate precipitation. Optimum conditions occur only about 20% of the time and the only defense against such odds is a well prepared seedbed, properly calibrated machinery and close supervision.

Livestock Extension Programs

This type of extension activity has implications for all of Morocco. It immediately creates credibility with the producers and gives the technician and producer common ground that allows discussion to begin about more esoteric and long-term activities (pasture and range programs). Present activity in this program indicates that the interest exists at the producer, technician and administrative level for continuation and expansion. This type of program could be implemented with relatively little investment in terms of training, equipment and operating expense, especially given the financial impact in the short-term that such a program can produce.

A future range project should build upon this foundation. It will generate quick interest in those concerned, create credibility that will allow the technician to expand the program into other topics and will produce fast financial rewards that can easily be quantified. In the meantime, continued training of Moroccan technicians in range management and sheep and wool production and marketing are needed to insure that the technical base is in place when a new range project is planned.

CHAPTER SIX: TRAINING

INTRODUCTION

Training of all types has been the backbone of the Project since its beginning, and is generally thought to be the element that will provide the greatest long-term effect in solving range and livestock problems in Morocco. A side benefit of the training program has been the improved English language capability of the participants. This has expanded their access to technical materials and to professional organizations worldwide that are working with similar problems. Morocco now has many talented technicians who have a desire to improve their skills. Their record of performance at many different institutions in the U.S. speaks for itself.

LONG-TERM DEGREE TRAINING

Eleven Moroccan technicians were sent to the United States to obtain Master's degrees during the life of the Project. These "participants" were jointly selected by Project and DE staff from varied locations around Morocco. All of these participants have returned to Morocco and are serving as technicians throughout the country. Table 6.1 presents summary information concerning this long-term training.

Table 6.1. Program of long-term participant training.

PARTICIPANT	DISCIPLINE	UNIVERSITY	RETURN DATE	WORK SITE	DEGREE
Mohamed Abbassi	Range Mgt./Extension	Montana State	July 1984	Ouarzazate	M.S.
Boujema Bourass	Range Mgt./Extension	Texas Tech	June 1984	Meknes	M.S.
Akka Oulahboub	Range Mgt./Extension	Univ. of Arizona	June 1984	Rabat	M.S.
Rahal Kouiri	Range Mgt./Extension	Humbolt State	Jan. 1985	Settat	M.S.
Mostafa Laadnani	Range Mgt./Extension	Univ. of Wyoming	Aug. 1985	Safi	M.S.
Mohamed El Kabbach	Range Mgt./Extension	Oregon State	Aug. 1985	Guercif	M.S.
Abdelkader Adila	Range Mgt./Extension	Utah State	Aug. 1985	Khemisset	M.S.
Ahmed Ait Hroch	Seed Prod./Range Mgt.	Washington State	Aug. 1985	Errachidia	M.S.
Mohamed Aissi	Rural Soc./Agri. Ext.	Univ. of Missouri	Jan. 1986	Oujda	M.S.
Mohamed El Manfalouti	Range Mgt./Extension	Univ. of Nevada/Reno	Jan. 1986	Khouribga	M.S.
Abdelkader Assal	Rural Sociology	Colorado State	June 1986	Marrakech	M.S.

SHORT-TERM TRAINING

Fourteen Moroccans (2nd Cycle and Adjoint Technique personnel) were sent to the United States in three groups for short-term training in range management/livestock production principles and practices. These individuals received 4 to 6 months of training comprised of three parts. First, the technicians were given an orientation program in range management principles at Utah State University. Next, theoretical training in range/livestock management and production, including extension techniques, was presented at New Mexico State University. This is a U.S.D.A. shortcourse presented by the range management teaching, research and extension staff at that institution. Last, practical work experience on ranches and field experiment

stations was presented at Utah State University. This allowed all participants to have "hands on" experience working with large and small commercial flocks of sheep, and gave them the opportunity to see firsthand how management is imposed in range livestock operations in the U.S. Visits to range experiment stations were designed to show the latest technology in range improvement techniques, and to allow interchange of philosophies between U.S. and Moroccan technicians.

In addition, two technicians from the Plant Materials Center were sent to the U.S. for training programs in farm management. These two special programs with a duration of four to five months were developed to expose PMC management staff to the rigorous management programs required for producing plant materials on a regular and efficient basis. These training programs included operation of seed cleaning and processing equipment.

A total of approximately 98 person-months of short-term training, including time at professional meetings, were provided (Table 6.2). This short-term training has been very effective. Returned participants have been enthusiastic and knowledgeable and have demonstrated increased skills. They have shown great interest in applying these skills to the range and livestock situation in Morocco. They quickly formed a cadre of qualified field staff capable of assisting Project personnel with the collection of field data or the implementation of extension programs. This is a quick and relatively inexpensive method of creating a trained staff to replace technicians lost to long-term degree programs or simply to bolster the existing programs. It is especially effective when rapid program expansion is desired.

Table 6.2. Program of short-term training.

PARTICIPANT	LENGTH OF TRAINING	DEPARTURE	SPECIALIZATION	WORK SITE
Mohamed Somoue	6 months	3/17/82	Range Management	Beni Mellal
Boujemaa Majrabi	6 months	3/17/82	Range Management	Taza
Essalah Dghoughi	6 months	3/17/82	Range Management	Azrou
Brahim Kabdi	6 months	3/17/82	Range Management	Oujda
Abderrahmane Amimar	6 months	3/17/82	Range Management	Meknes
Ahmed Boulahoual	6 months	3/15/83	Range Management	Meknes
Mohamed Baalla	6 months	3/15/83	Range Management	Meknes
Ali Nourddine	6 months	3/15/83	Range Management	Beni Mellal
Chouki Salah	6 months	3/15/83	Range Management	Midelt
Mohamed Tazi	4 months	4/8/84	Farm Management	El Jadida
Abderrachid Boutouba	4 months	29/3/85	Range Mgt./Repro.	Rabat
Hassan Dhassi	4 months	29/3/85	Range Mgt./Repro.	Meknes
Mohamed Driouich	4 months	29/3/85	Range Mgt./Repro.	Beni Mellal
Mohammed Hammoudi	4 months	29/3/85	Range Mgt./Repro.	Oujda
Lahcen Zougagh	did not complete *	29/3/85	Range Mgt./Repro.	Midelt
Abdelouhab Mesbah	5 months	13/5/85	Farm Management	El Jadida

* Returned to Morocco, lacked interest in program

ADMINISTRATIVE SHORT COURSE

Early in the Project, the need to improve Moroccan administrators' knowledge and awareness of range management was identified as important for the success of the Project. This was because range management concepts were relatively new to the country and these administrators were recognized as playing key roles in generating support and acceptance of programs and proposed interventions by the local administration and populace. Therefore, five Chefs de la Service de l'Elevage, the Sub-Director of the DE, and the Chef du Bureau of the Service des Parcours were sent to the U.S. to attend the course at Utah State University. However, while this training increased the understanding of range management needs by these administrators, the constraints under which these administrators functioned in Morocco were not removed. Further, as a number of other administrators in Morocco still do not have an awareness of the principals, goals and methodologies of range management, there remains a strong probability that progress will be retarded. The program of training for administrators undertaken by this project was too small. The program should be large enough to include all key administrators in the range areas where the Project is active, or concentrate on a continuing type of in-country training, or both. If the budget for this type of activity is small, it would be better spent training technicians. Additional information about the Administrative Short Course is presented in Table 6.3.

Table 6.3. Program of training for administrators.

PARTICIPANT	LENGTH OF TRAINING	DEPARTURE	SPECIALIZATION	WORK SITE
Mr. Bensouda	1 month	8/2/82	Range Mangement	Rabat
Mr. El Gharbaoui	1 month	8/2/82	Range Mangement	Rabat
Dr. Himeur	1 month	8/2/82	Range Mangement	Meknes
Dr. Hamid	1 month	8/2/82	Range Mangement	Khenifra
Dr. Bougnine	1 month	8/2/82	Range Mangement	Beni Mellal
Dr. Daoudi	1 month	8/2/82	Range Mangement	Oujda
Dr. Zouagui	1 month	8/2/82	Range Mangement	Missour

IN-COUNTRY SEMINARS

The redesign of the Project at mid-term included two formal training seminars, one presented in 1984 and another in 1985. These seminars included the Moroccan and American personnel working in range management in Morocco, and personnel from other agencies such as Eaux et Forets and Promotion Nationale. Information was presented as lectures, utilizing expertise from various agencies working on range livestock problems in Morocco. Classroom sessions were separated by field days and tours. Both seminars were for one week.

The first seminar was held at the C.R.A.F.A. agricultural school near Kasba Tadla. It was organized primarily by USU staff, and was used to present basic information on range

management in Morocco as well as the planning, organizational format that would be utilized for the remainder of the Project. There were approximately 50 persons in attendance. All DE/SP, USU, and PCV personnel assisted throughout the seminar.

The second seminar was developed by the Moroccan team and held in El Jadida. This seminar was devoted almost entirely to the presentation of research data from studies performed in Morocco on range or range livestock management and pastoral sociology. A tour of the Plant Materials Center that included training on calibration of farm implements was part of the session activities.

Both seminars were well attended. This was partly because of project financial support of the participants and guest speakers. Normally, DE personnel would pay expenses out of pocket. Honorariums helped promote the concept that Moroccan technicians presenting research data were considered professionals by their peers. Programs of the two professional seminars follow (Figures 6.1 and 6.2).

TDY personnel also provided timely and informative seminars as part of their activities while in Morocco. Drs. Ben Norton and Fred Provenza presented seminars to both Moroccan and Peace Corps technicians on sampling methods to measure range productivity and on statistical design and analysis of data. Dr. Jack Ruttle presented information on wool quality and grading, sheep husbandry and selection techniques, and sheep reproduction at numerous field days throughout the country. He conducted one formal seminar in Oujda for Moroccan technicians in the eastern region. Walter Graves organized and conducted a series of formal seminars on plant materials appropriate for revegetation programs in Morocco, and on the techniques of identifying, collecting, processing and evaluating native plant materials for rangeland rehabilitation purposes.

PROFESSIONAL MEETINGS

The Project has sponsored a number of trips to professional meetings with side trips to various locations of professional interest for both Moroccan and American technicians (Table 6.4). These trips included visits to ranches, state and federal experiment stations, and university research installations throughout the western U.S. to review new techniques and equipment and to exchange ideas with technicians and ranchers on shared problems.

The professional meetings provided an opportunity for Project technicians to present information generated in Morocco that included research data, historical information and philosophical approaches to the international range management community. Attendance gave the technicians exposure to the world range livestock profession, and provided valuable experience in the analysis, organization and presentation of information before an informed group of peers. A complete bibliography of papers presented during the life of the project is also presented in Table 6.4.

TEMPS	CONFERENCIER	ADMINISTRATION	SUJET
SEPTEMBRE 17,1984	LUNDI		
08:30-08:45	M.A.R.A.	DE/RABAT	INTRODUCTION
08:45-09:00	DR ROGER BANNER	USU	SUITE
09:00-09:45	DR JOHN WARME	COLORADO SCHOOL OF MINES	HISTORIQUE DE LA GEOLOGIE DU MAROC
09:45-10;00	REPOS		
10:00-10:45	DR. JOHN WARME	COLORADO SCHOOL OF MINES	HISTORIQUE DE LA GEOLOGIE DU MAROC
10:45-11:00	REPOS		
11:00-12:00	OMAR BERKAT	IAV/RABAT	ECOLOGIE DES PARCOURS DU MAROC
12:00-15:00	DEJEUNER	CRAFA	
15:00-15:45	DR FRED TROEN	MIAC-INRA/SETTAT	LES TYPES DE SOL AU MAROC
15:45-16:00	REPOS		
16:00-16:45	OMAR BERKAT	IAV/RABAT	IDENTIFICATION DES PLANTES PASTORALES
16:45-17:00	REPOS		
17:00-17:45	LORI BLODGETT	USU	TECHNIQUES DE PREPARATION D'UN HERBIER
SEPTEMBRE 18,1984	MARDI		
08:30-09:00	EL GHARBAOUI	DE/RABAT	SITUATION DE L'AMELIORATION DES PARCOURS AU MAROC
09:00-09:15	FAGOURI	DE/MIDELT	DEVELOPPEMENT DES PARCOURS DANS LA REGION DE MIDELT
09:15-0930	HARKOUSSE	DE/BENI MELLAL	DEVELOPPEMENT DES PARCOURS DANS LA REGION DE BENI MELLAL
09:30-09:45	LARAISSE	DE/OUDJA	DEVELOPPEMENT DES PARCOURS DANS LA REGION D'OUJDA
09:45-10:00	REPOS		
10:00-10:15	ATIQUI	RANCH ADAROUCH	DEVELOPPEMENT DES PARCOURS DANS LA REGION DE TIMAHDITE
10:15-10:30	EL MAGHRAOUI	ORMVA/OUARZAZATE	DEVELOPPEMENT DES PARCOURS DANS LA REGION DE OUARZAZATE
10:30-10:45	HARDING	CMSP/EL JADIDA	VUE SUR LE CENTRE DE PRODUCTION DES SEMENCES PASTORALES
10:45-11:00	REPOS		
11:00-12:00	DR. H. NARJISSE	ENA/MEKNES.	BESOINS NUTRITIONNELS SAISONNIERS
12:00-15:00	DEJUNER	CRAFA	
15:00-15:45	DR. H. NARJISSE	ENA/MEKNES	DEFICIENCES NUTRIONELLES USUELLES CHEZ LES OVINS
15:45-16:00	REPOS		
16:00-16:45	DR. M. PURVIS	USAID/RABAT	PLAN DE TRAVAIL: OUTIL DE PLANIFICATION
16:45-17:00	REPOS		
17:00-17:45	DR. M. PURVIS	USAID/RABAT	LE PROGRAMME D'EVALUATION: OUTIL D'AMENAGEMENT
SEPTEMBRE 19,1984	MERCREDI		
07:30-09:00	CHARLES GAY	USU	DEPART POUR LA FERME SR/CRSP DE TADLA
09:00-09:45	DR YVES BERGER	SR-CRSP/RABAT	RACES OVINES AU MAROC
09:45-10:00	REPOS		
10:00-10:45	DR YVES BERGER	SR-CRSP/RABAT	SYSTEMES DE SELECTION
10:45-11:00	REPOS		
11:00-12:00	DR YVES BERGER	SR-CRSP/RABAT	VISITE DE LA FERME SR-CRSP DE TADLA
12:00-14:00	DEJEUNER	LA FERME SR-CRSP DE TADLA	
14:00-14:45	DR YVES BERGER	SR/CRSP/RABAT	LES PRINCIPES D'AMENAGEMENT DES OVINS
14:45-15:00	REPOS		
15:00-16:00	DR YVES BERGER	SR-CRSP/RABAT	TABLE RONDE
16:00-17:30	CHARLES GAY	USU	RETOUR A BENI MELLAL
SEPTEMBRE 20,1984	JUEDI		
09:00-09:45	PAUL BARTEL	USU	ASPECTS SOCIOLOGIQUES DES PROJETS PASTORAUX
09:45-10:00	REPOS		
10:00-10:30	PAUL BARTEL	USU	LE SYSTEME DE VULGARISATION BASE SUR LA FORMATION ET LES VISITES
10:30-10:45	HASSAN DHASSI	DE/ MEKNES	RESULTATS PRELIMINAIRE DE L'ENQUETE SOCIOLOGIQUE A TIMAHDITE
10:45-11:00	REPOS		
11:00-12:00	DR. A. GLATZLE	GTZ/RABAT	PROJETS DE RECHERCHE DE GTZ
12:00-15:00	DEJEUNER	CRAFA	
15:00-15:45	ROD GALLACHER	FAO/RABAT	ESSAIS D'ENSEMENCEMENT DANS LA PROVENCE DES AZILAL
15:45-16:00	REPOS		
16:00-16:45	PAUL CRAWFORD	USAID/RABAT	EXERCISE DE DEMONSTRATION: DESSIN ET EXECUTION DU PROJECT
16:45-17:00	REPOS		
17:00-17:45	CHARLES GAY	USU	GROUPE SESSIONS
SEPTEMBRE 21,1984	VENDREDI		
08:00-08:30	CHARLES GAY	USU	DEPART AU PERIMETRE D'AIT RBAA
08:30-12:00			TOURNEE AU PERIMETRE D'AIT RBAA
12:00-12:15	CHARLES GAY	USU	CLOTURE DU SEMINAIRE

Figure 6.1. Shortcourse program organized by the Direction de l'Elevage and Utah State U., September 17-21, 1984, Kasba Tadla.

Lundi 6 Mai:	9:00 - 10:00	Séance d'Ouverture du Séminaire	DE/USU/Autorités
	10:00 - 10:15	Pause	
	10:15 - 11.00	Répartition des Principaux Types de Sol	Ousghiri (INRA)
	11:00 - 11.30	Bioclimatologie Marocaine	Hamoumi (INAV)
	11:30 - 12:00	Ecologie des Plantes Pastorales et Pâturages	Omar Berkat (INAV)
	12:00 - 15:00	Déjeuner	
	15:00 - 15:30	Quelques Techniques d'Evaluation et du Monitoring de la Veg^{on}	Akka Oulahboub
	15:30 - 16:00	Evaluation des Annuelles a Ait Rbaa	Harkousse DE/BM
	16:00 - 16:30	Evaluation de l'Armoise	Bourass/Laraisse
	16:30 - 16:45	Pause	
	16:45 - 17:30	Création des Périmètres d'Amélioration Pastorales: Méthodologie et Législation	El Gharbaoui
Mardi 7 Mai:	8:00 - 9:15	Aménagement de la Végétation	Consultant: Ben Norton
	9:15 - 10:00	Conduite et Gestion du Troupeau	SR-CRSP
	10:00 - 10:15	Pause	
	10:15 - 10:45	Les Principes de la Vulgarisation	USU
	10:45 - 12:00	Méthodes de Vulgarisation Appliquées par le Projet USAID	USU
	12:00 - 15:00	Déjeuner	
	15:00 - 15:30	Arbustes Fourragers dans l'Alimentation Animale	El Maghraoui
	15:30 - 16:00	Plantation d'Arbustes Fourragers dans la Région d'Ouarzazate	"
	16:00 - 16:15	Pause	
	16:15 - 18:00	Présentation de Diapositives sur la Désertification en Afrique	DE
Mercredi 8 :		Visite du Périmètre de Sidi Chiker	
Jeudi 9 Mai:	8:30 - 9:15	Bilan des Essais Entrepris par l'INRA sur les Espèces Pastorales	Bounejmate INRA
	9:15 - 10:00	Ensemencement des Parcours entrepris chez les Sociétés d'Etat	"
	10:00 - 10:15	Pause	
	10:15 - 10:45	Ensemencement du Périmètre de l'Aarid	Fagouri
	10:45 - 11:15	Ensemencement entrepris dans le cadre du Projet Loukkos	Oumekloul
	11:15 - 12:00	Conservation des Eaux : Travaux de Sol	USU (Kitts and Blodgett)
	12:00 - 15:00	Déjeuner	
	15:00 - 15:30	Technique de Fertilisation	Bourass
	15:30 - 16:00	Essais de Fertilisation entrepris à Timahdite	Chergaoui/Atiqui
	16:00 - 16:15	Pause	
	16:15 - 17:00	Projection de Diapositives du Centre de Semences Pastorales	Tazi et Harding
	17:00 - 18:00	Discussion	
Vendredi 10 Mai:		Visite du Centre de Semences Pastorales	

Figure 6.2. Shortcourse program organized by the Direction de l'Elevage, May 6-10, 1985, El Jadida.

Table 6.4. Professional meetings attended and papers presented during the life of the project (excluding attendance by MS participants in the U.S.).

PARTICIPATING STAFF	PROFESSIONAL MEETING	DATE	LOCATION	PAPERS PRESENTED
Dr. Richard Aro Mr. Mohamed Atiqi	Society for Range Management	February 1982	Calgary, Canada	No papers presented
Dr. Carl Goebel Mr. Akka Oulhaboub Mr. Boujema Bourass	International Society of Animal Science	August 1982	Ontario, Canada	Goebel, C.J., R. Kouriri, and M. Fagouri. 1982. Results of forage species selections from North American varieties applied in eastern Morocco for increased animal production.
Dr. Alan Gray Mr. M'barek Fagouri	Society for Range Management	February 1983	Albuquerque, New Mexico	Gray, A. and M. Fagouri. 1983. Evaluation and observations of range grasses on Plaine de l'Aarid in Morocco. Gray, A., M. Fagouri, and D. Nolte. 1983. For a better tomorrow - The story of range management in Morocco. (a slide-tape presentation) Fagouri, M. and A. Gray. 1983. Implementation of range management on collective lands at Plaine de l'Aarid in Morocco.
Dr. Conception del Castillo Mr. Mohamed Aissi	American Association for the Advancement of Science Symposium on the Political Ecology of Pastoral Peoples	May 1983	Detroit, Mich.	No papers presented
Dr. Alan Gray Mr. M'barek Fagouri Mr. A. Karmouni Mr. A. El Gharbaoui	Second International Rangeland Congress	May 1984	Adelaide, Australia	Artz, N.E., J.T. O'Rourke, J.L. Gilles, R.S. Aro, & H. Narjisse. 1984. The development implications of heterogeneity in a Moroccan communal grazing system. El Gharbaoui, A., E. Laraisse, A. Oumekloul, A. El Maghraoui, M. Atiqi, M. Fagouri, & M. Harkousse. 1984. Range management in Morocco-Doing our thing to help ourselves. Fagouri, M. and A. Gray. 1984. Initiation of range management activities in Morocco - A look back. Graves, W.L., B.L. Kay, A. Gray, J.T. O'Rourke & M. Fagouri. 1984. Long-term wheatgrass adaptation trials in the cold semi-arid Mediterranean type climates of California and North Africa. Gray, A. M. Fagouri, and K.L. Johnson. 1984. Range management in Morocco -- Taking it to the people. I. Extension Planning. Marsile, A. 1984. Private industry in Morocco - Range management hits the marketplace.
Mr. John Harding Mr. Mohammed Tazi	American Society of Agronomy	December 1984	Las Vegas, Nevada	No papers presented
Mr. Charles Gay Mr. Mhd Harkousse Mr. E. Laraisse	Society for Range Management	February 1985	Salt Lake City, Utah	Harkousse, M., C.W. Gay, A. Nourddine and L.J. Blodgett. 1985. Forage production of annual vegetation on two highly degraded range sites in Morocco following protection from grazing.
Mr. John Harding	International Grassland Congress	August 1985	Kyoto, Japan	No papers presented
Dr. Roger Banner * Mr. Charles Gay Mr. Paul Bartel Mr. Dale Nolte	Society for Range Management	February 1986	Orlando, Florida	Gay, C.W. and P. Bartel. 1986. Planning work to achieve project objectives. Nolte, D., J. Kitts, R. Banner and B. Kabdi. 1986. Possible method to control indiscriminate breeding in Moroccan sheep flocks. Visness, C.M. and P. Bartel. 1986. The study of agropastoral systems for technical assistance: Technology applied for use on Morocco's communal rangelands.

* Trip sponsored by Utah State University

The RMIP Project also sponsored a trip to Tunisia in April 1985 as part of a technical and administrative exchange with a sister project. John Harding and Roger Banner represented USU and A. Karmouni and A. El Gharbaoui represented DE during the exchange of visits. Representatives of the Tunisia Project, Mohamed Ben Ali and Mike Borman, visited Morocco in January 1985.

COMPUTER TRAINING SEMINAR

The project assisted in the establishment of the DE Microcomputer Room (Le Cellule Informatique) as a center for data processing to increase the number of DE personnel trained to use the computer and to take advantage of the four complete microcomputer work stations purchased by the RMIP. Computer Room staff gave a 30-minute presentation to DE administrators to introduce them to the capabilities of microcomputers and to announce training sessions which would be available to their technicians. This seminar was followed by nine, hour-long training sessions over a three-week period which allowed technicians and secretaries to use application programs and data of personal interest. After training, users were encouraged to utilize the facilities of the room at their convenience and freely seek aid from the staff.

The two Moroccan computer specialists, who supervise the Computer Room, trained seven technicians and four secretaries during and after the originally planned training period. The seminar that was directed toward DE administrators fell short of expectations; it was not attended by any of them due to scheduling conflicts. Training sessions attracted young, enthusiastic personnel who quickly adapted the software to their everyday tasks. After the training sessions, the Microcomputer Room staff continued to train interested personnel individually, upon request. This activity included three staff members from the PMC.

SHEEP SELECTION TRAINING AT OUJDA AND SAFI

In-country training activities directed at improved herd management and designed for both Moroccan technicians and livestock producers were conducted at Oujda and Safi. These activities built upon the sheep selection program designed by Dr. Ruttle during his TDY trip in May and June of 1985. The training has improved skills of about 15 technicians and over 100 producers. Technicians were able to practice their skills while classifying more than 4,000 animals. Detailed descriptions of the activity are found in the Extension section of this report.

CONCLUSIONS AND RECOMMENDATIONS

The total training program of the project has been an outstanding success. Virtually no attrition has occurred and all participants that have completed their training are in place in various MARA organizations around Morocco. The job is not yet complete, however. Many gaps still exist at many sites in Morocco. There is a serious need for trained people in range management and sheep and wool production. There is also continued need for short-term, in-country and U.S. training for

Adjoint Techniques and Engineers in production and extension. Hopefully, the end of this project will not signal an end to the opportunities for training of Moroccan technicians in the fields of range management and livestock production.

Present projections by DE/SP are to have 2 M.S. level technicians (one trained in range management/extension and one trained in range livestock management/extension) and 2 B.S. or Adjoint Technique level field assistants with short-term training in range and range ent, 29 range livestock management, and 12 rural sociologists will need training to the M.S. level. There will also be a need for 21 B.S. or Adjoint Technique field staff to receive short-term training.

Five-year projections include the opening of 10 new offices. Four will be regional offices in the Oriental Region, and six will be provincial offices in Tiznit, Marrakesh, El Kelaa des Sraghna and the Tangier area. These new offices will require 10 range management and 10 rent, 29 range livestock management, and 12 rural sociologists will need training to the M.S. level. There will also be a need for 21 B.S. or Adjoint Technique field staff to receive short-term training.

Five-year projections include the opening of 10 new offices. Four will be regional offices in the Oriental Region, and six will be provincial offices in Tiznit, Marrakesh, El Kelaa des Sraghna and the Tangier area. These new offices will require 10 range management and 10 range livestock management technicians trained to the M.S. level, and 20 B.S. or Adjoint Technique field staff trained through short-term practical courses.

CHAPTER SEVEN: **PROGRAM DEVELOPMENT - SEED PRODUCTION**

INTRODUCTION

Design Concept

A major problem hampering rangeland programs in Morocco has been the slow and irregular distribution of seed for trials and seeding programs. The need for quality range forage species seed on a large scale has long been recognized as a necessary ingredient to successful rangeland rehabilitation programs in some areas of the country. It was first identified with the Carter study in 1966, followed by the USAID Livestock and Rangeland Improvement Project (608-68-4) in 1968.

In October 1975, the Government of Morocco requested technical assistance for range management. When the GOM Five Year Plan (1978-1982) projected a demand for almost 1000 T of range forage species seed to be planted on 132,000 hectares, USAID followed in August 1977 by sponsoring a team of consultants from Washington State University to complete a study on commercial range forage species seed production. This team recommended that pilot seed production programs be established immediately. In 1977, a USAID document entitled "Technical Services and Feasibility Study for Forages and Seeds" (608-11-120-131) recommended the establishment of a Plant Materials Center (PMC) to test varieties and produce foundation (basic) seed. Thus, the ideas and concept were initiated with the Direction de l'Elevage to solve their perennial problem of seed supply and availability that were hindering the improvement of Moroccan rangelands.

The Project Identification Document (PID), prepared in July 1979, recommended that a seed production component be developed in two phases. Phase I (first 5 years) would concentrate on cool-season species with a center constructed in the Midelt region. Phase II (second 5 years) would specialize on warm-season species, with another center being constructed in a suitable region. Seed production would consist of forage species which have shown positive results in field adaptation and use trials, in terms of productivity, palatability, persistence, and ease of establishment.

The concept for the Seed Production Center was further defined in the "Basis for Project" paper, prepared by CID in December 1979. Objectives were clearly outlined for both the five year plan of activities and the responsibilities of the seed production specialist. Specific recommendations were made concerning a farm site, including location, soil types, climatic conditions, irrigation, building and equipment requirements.

In August 1980, the USAID Project Paper, reflecting the PID recommendation for two centers, clarified the purpose and established requirements of the Center. Expecting that the greatest seed demand would be for cool-season species, the Meknes area was recommended for the Phase I Center. Sites near Beni Mellal and El Jadida were suggested as alternatives, though it was noted that this would limit cool-season grass seed production. The program for the Center was completed during the Project Grant Agreement (PROAG) negotiations between the GOM and USAID.

Objectives

The initial objectives for the Center and staff, as defined in the USAID Project Paper and PROAG, were:

- forage species seed multiplication from breeder (pre-basic) seed to foundation (basic) seed,
- coordination of forage species evaluations with field staff at the various project sites,
- development of seed certification standards for range forage species seeds through INRA and SONACOS, and
- promotion of extension and demonstration activities for production and utilization of range forage species seeds.

These objectives for the PMC were quite ambitious, but not unreasonable. This program essentially followed the system of species development in the USA; seasonal accomplishments flow into the program for the next season.

The ultimate goal of the PMC was for Morocco to have a viable forage species seed production program, with the PMC producing the foundation seed for the private sector (SONACOS), which in turn would contract with private growers to produce all forage species seed requirements for Morocco. The demand for this seed existed, or was at least assumed to exist, since the projected need for GOM programs alone amounted to 1000 T of seed. The next logical step was to develop a seed-stock multiplication program for specialized forage species. All of the other PMC objectives (adaptability trials, seed certification, extension and education) supported this goal. The end result of these accomplishments was envisioned to create a "seeding" revolution (where appropriate) on Moroccan rangelands.

DEVELOPMENT AT THE PMC

Modifications to the Original Plan

The mid-project evaluation team (January 1984) recommended that the emphasis be switched from foundation seed production to noncertified seed production. This was for several reasons: 1) the quality standards for range forage species had not been developed through the Moroccan seed certification office, DPVCTRF. None of the introduced rangeland species utilized at the grazing perimeters were registered in the "official" catalogue. 2) The immediate demand was for noncertified seed to be planted on rangelands, not foundation seed production for certified seed production. And 3), results from the adaptability trial evaluations for the introduced species were inconclusive. The Foundation Seed Production Program required knowledge, based upon meaningful data, which pinpointed those species adapted to rangelands which were worth the initial investment required for production.

The Project Redesign (June 1984) and the amended contract between USU and DE clarified and redefined PMC goals: 1) forage species seed multiplication, to include certified seed production for SONACOS, 2) production of plants and seed of forage shrub species, 3) coordination of forage species evaluations and adaptability trials, including the distribution of seed and innoculant and the development of uniform evaluation procedures, 4) collection, research and development of native range forage and conservation species, and 5) promotion of seed production extension activities, to include a determination of forage species seed requirements in Morocco.

Species proven to be adapted from the previous USAID Range Management Project (begun in 1968), mainly cool-season grasses of the genus Agropyron, became the focal point for seed production. It had already been established, however, that seed production from these cool-season grasses may not be feasible at the Khemis M'touh farm location.

The physical development of the farm and the agronomic training in farm management necessary to complete seed production tasks were carried out on schedule. The first plantings included 26 varieties, both warm-season and cool-season grasses, as well as annual and perennial legumes.

From this first attempt in the fall of 1982 through the end of the project, annual management objectives were altered frequently to fit the capabilities of the staff, the PMC budget, and the demand for seed of various species from project field offices. However, the goals remained essentially the same -- seed and plant production for rehabilitation and development of collective rangelands.

Summary of the Process of Development at the PMC

1981-1982

California Agriculture Institute was subcontracted for four years to plan the development of the PMC. CAI specialists visited Morocco three times during the first year in order to: 1) review the current forage species seed production and marketing program, 2) outline the initial farm management program, 3) design the farm buildings, and 4) make recommendations for farm and seed cleaning equipment.

1982-1983

USU hired a resident Seed Production Specialist in 1982. The DE added support staff, including a farm manager and assistant. Seed production objectives were planned and the initial farm work was contracted to COMAGRI. The initial plantings consisted of 22 species on 25 ha (Table 7.1). The survival percentage was only about 10% due to weed contamination. The exercise did help identify many farm management mistakes. It helped to locate problem areas within the farm, such as heterogeneous soil types, poorly drained areas, and the operation of the irrigation system. Herbicide availability in Morocco was researched and visits were made to the technical departments of companies distributing chemicals. Some 200 demonstration plots

were also established.

The farm equipment was ordered and delivered. The construction of the PMC buildings was initiated and was to include a well and a cistern. Fences were built around the farm. The first formal tour was given in April 1983 to introduce Seed Certification officials from (DPVCTRF) and representatives from SOGETA, INRA, The World Bank, GTZ, and INAV Hassan II to the farm.

Table 7.1. Species planted at the PMC: 1982-1983.

Genus	Species	Variety	Area Planted (Ha)
Grasses			
Agropyron	elongatum	Largo	.73
Agropyron	intermedium	Oahe	1.07
Agropyron	desertorum	Nordan	.42
Agropyron	trachycaulum	Primar	.52
Bromus	marginatus	Bromar	.96
Bromus	inermis	Manchar	.56
Dactylis	glomerata	Berber	1.25
Ehrharta	calycina	Mission	.65
Eragrostis	curvula	Catalina	1.12
Festuca	ovina	Covar	1.17
Oryzopsis	hymenoides	Nezpar	1.02
Phalaris	tuberosa	Perla	1.18
Phleum	pratensis	Common	1.63
Poa	ampla	Sherman	1.58
Legumes			
Astragalus	cicer	Common	.24
Medicago	littoralis	Harbinger	.85
Medicago	sativa	Teton	.57
Melilotus	officinalis	Common	.24
Onobrychis	viccifolia	Common	.11
Trifolium	hirtum	Hykon	.53
Trifolium	incarnatum	Dixie	.48
Trifolium	subterraneum	Clare	1.28
Trifolium	subterraneum	Daliak	.51
Trifolium	subterraneum	Geraldton	.53
Trifolium	subterraneum	Trikkala	.48
Trifolium	subterraneum	Woogenellup	.51

1983-1984

An expanded seed production program was devised and, with improved farm management techniques, a total of 19 species were planted on 57 ha (Table 7.2.). Considerable time was devoted to redesigning field layouts, land leveling, seedbed preparation, and weed control. In addition, the shrub nursery was constructed

and planted with shrub species from the genus Atriplex for both seed and plant production.

The success rate for establishment improved to 60% and, as harvest time approached, there were plantings of 18 species on 45 ha. The total seed production was 6000 kg of uncleaned seed. These seeds were distributed to DE for demonstrations at field locations and plantings by local livestock producers.

Building construction continued with the completion of three houses and an equipment hangar. Important modifications to existing farm machinery and specialized equipment were engineered by the Peace Corps Volunteer assigned to the farm.

Table 7.2. Species planted at the PMC: 1983-1984.

Genus	Species	Variety	Area Planted (Ha)
Grasses			
Agropyron	cristatum	Fairway	4.50
Agropyron	desertorum	Nordan	1.50
Agropyron	intermedium	Oahe	3.00
Agropyron	trichophorum	Luna	5.85
Andropogon	gerardii	Common	2.40
Bromus	marginatus	Bromar	4.42
Bromus	mollis	Blando	2.76
Cenchrus	ciliaris	Experimental	.41
Dactylis	glomerata	Palestine	2.10
Elymus	junceus	Common	1.95
Eragrostis	curvula	Catalina	3.32
Lolium	rigidum	Wimera	1.96
Phalaris	tuberosa	Sirosa	2.00
Phalaris	tuberosa	Seedmaster	2.50
Poa	compressa	Reubens	.50
Legumes			
Medicago	rugosa	Paraponto	1.70
Medicago	rugosa	Sapo	1.20
Medicago	sativa	Rhizoma	1.93
Medicago	scutellata	Robinson	3.00
Medicago	scutellata	Sava	3.03
Medicago	truncatula	Cyprus	2.30
Medicago	truncatula	Jemalong	3.28
Melilotus	officinalis	Common	.50
Onobrichis	viccifolia	Common	.81
Ornithopus	compressus	Pitman	1.00
Vicia	dasycarpa	Lana	1.85

1984-1985

With each planting season, the staff gained experience and was better prepared for the new set of challenges. In 1984,

seeding started on September 14, and a total of 31 ha were planted with 7 species (Table 7.3). One hundred forty-four new demonstration plots were established. These included the introduction of Moroccan native species and other North African plant materials. In addition, 70,000 Atriplex species shrub plants were distributed to support local SE programs around Morocco. During the spring of 1985, 26 ha were planted with 8 species. A portable sprinkler irrigation system was used for the first time to produce certified Medicago sativa seed for SONACOS.

Both the Bureau Chef for the PMC and the Farm Manager attended specialized training courses for Farm Management in the US. An additional Farm Manager and a Farm Mechanic were assigned to the PMC.

After presentation of the PMC functions to other groups, the PMC received cooperation from scientists working with INAV (for genetic research and herbicide/weed control research in seed production), INRA (for native plant collections and germplasm storage), SONACOS (for certified seed production), and DPVCTRF (for certification standards for range forage species and field inspections).

The main building for offices and seed processing was completed along with an additional house for the staff. The seed cleaning equipment was designed and ordered.

Table 7.3. Species planted at the PMC: 1984-1985.

Genus	Species	Variety	Area Planted (Ha)
Grasses			
Agropyron	cristatum	Fairway	3.0
Agropyron	desertorum	Nordan	3.5
Agropyron	elongatum	Jose	6.2
Agropyron	trichophorum	Luna	2.2
Cenchrus	ciliaris	Higgins	1.2
Dactylis	glomerata	Berber	2.5
Dactylis	glomerata	Palestine	6.5
Elymus	junceus	Vinal	5.3
Eragrostis	curvula	Common	6.0
Festuca	arizonica	Redondo	1.8
Phalaris	tuberosa	Seedmaster	.5
Legumes			
Medicago	sativa	Moapa (SONACOS)	9.5
Onobrychis	viccifolia	Common	1.6
Vicia	dasycarpa	Lana	7.2

1985-1986

The fall seeding activities concentrated mainly on seed production of annual forage plants from the genus Medicago

(medics) in support of the MARA Ley Farming Program. A total of 90 ha, representing 7 varieties, were planted in 1985 (Table 7.4). Also, selective herbicide trials were conducted to solve weed control problems for this program. Results of the trials were presented at the INRA seminar on Ley Farming in May 1986.

Seed and shrub plant distribution continued with 6300 kg of seed and 127,800 plants being sent to local SE field offices. To overcome irrigation water problems, a well was drilled for sprinkler irrigation of both the shrub nursery and some seed production fields.

The other major fall activity was the establishment of over 550 plots for the multiplication of seed from native range plant species. This activity represented a change in the emphasis from the use of imported species for range revegetation to that of developing indigenous natural resource.

RESULTS

Status at Close of Project

With the current Moroccan government interest in the Ley Farming system, present production at the PMC represents the manner in which the farm can best function as a support entity for the MARA programs. Along with legume seed production, range forage species seed production will continue on a limited scale. This seed production, under DE control, assures that at least a portion of seed requirement for these range forage species is produced locally. This production also reduces the perennial problem of not having seed available on a timely basis for planting.

Approximately 51 ha still remain in seed production for range grass species, with 100 ha planted to legume species. The shrub production nursery was expanded and improved with the addition of an irrigation system. Presently, it has the capability to produce up to 300,000 shrub plants annually.

However, the PMC program emphasis on legume seed production answers only a portion of the country demand for these species. In 1985, around 764 T of annual legume seed was imported from Australia to support the Ley Farming Program. The PMC has the capability of producing approximately 60 T of legume seed annually. With the current focus on legumes rather than grasses, the seed production program addresses the most immediate need for seed. It should be noted that with the focus on production of medic seed, additional capital investment is required for the purchase and importation of specialized harvesting equipment.

If local demand for annual legume seed continues, the next step for the PMC would be to produce foundation (basic) seed in conjunction with an extension program for seed production by private seed producers. Certification standards are currently being developed for the anticipated local production of seed.

The primary goals of seed and plant materials production have been accomplished. The Project has provided DE with the capacity to produce range forage species seed locally. Since many of the exotic varieties requested annually by local SE

Table 7.4. Species in production at the PMC: 1985-1986.

Genus	Species	Variety	Area Planted (Ha) 83-84 Irr.	84-85 Irr.	85-86 Dry Land	85-86 Irr.	Total
Grasses							
Agropyron	cristatum	Fairway		3.0			3.0
Agropyron	desertorum	Nordan	2.0	3.5			5.5
Agropyron	elongatum	Jose		6.2			6.2
Agropyron	trichophorum	Luna	5.9	2.2			8.1
Dactylis	glomerata	Berber		2.5			2.5
Dactylis	glomerata	Palestine	2.1	6.5			8.6
Ehrharta	calycina	Mission	2.3				2.3
Elymus	junceus	Vinal	2.0				2.0
Eragrostis	curvula	Common		6.0			6.0
Lolium	rigidum	Wimera				2.0	2.0
Phalaris	tuberosa	Seedmaster	2.5	.5			3.0
Phalaris	tuberosa	Sirosa	2.0				2.0
Poa	compressa	Reubens	.5				.5
Legumes							
Medicago	sativa	Rhizoma	2.0				2.0
Medicago	sativa	Moapa		9.5			9.5
Medicago	truncatula	Cyprus			9.0	5.0	14.0
Medicago	truncatula	Paraggio			4.0	8.5	12.5
Medicago	truncatula	Jemelong			4.8	5.2	10.0
Medicago	scutellata	Sava			5.0	6.5	11.5
Medicago	littoralis	Harbinger			6.0	7.0	13.0
Medicago	rugosa	Paraponto			6.4	5.5	11.9
Medicago	polymorpha	Serena			4.0	9.0	13.0
Onobrychis	viccifolia	Common	.8	1.0			1.8
Vicia	dasycarpa	Lana				8.0	8.0
Shrubs							
Atriplex	spp.		3.0				3.0
Native Collections and Demonstration Trials				1.0		4.0	5.0
TOTALS			**25.1**	**41.9**	**39.2**	**60.7**	**166.9**

offices are no longer available on the international market, the PMC output assures Morocco access to limited quantities of these plant materials while superior native species and selections are being identified and brought into production.

ON SITE NURSERY OPERATION BY THE OUJDA OFFICE: A MODEL OF LOCAL CONSTRUCTION AND PLANT MATERIALS PRODUCTION

Ain Beni Mathar On Site Nursery (ABM OSN)

Rangeland reclamation efforts in the eastern region of Morocco have been severely constrained by the lack of dependable or adequate sources of plant materials. It seemed reasonable that production of locally adapted plant material near the plantation site would increase plant survival rate, reduce transportation cost and assure availability of plant material.

The Ain Beni Mathar ON SITE Nursery produced 150,000 shrubs of forage/fuelwood species for area plantations in 1985. These plant materials met the goal of supplying initial root stock for a Bureau des Parcours rangeland reclamation project, plantations by the Forest Service at two newly constructed dams and a village extension demonstration plantation. A local center for plant materials such as this has the potential to help small producers invest in forage and fuelwood species to increase rangeland production through conservation practices.

The ABM OSN was developed on a five hectare site provided by the local rural commune. The site was considered to be excellent because a water source bordered one side and adjacent trees provided protection from the wind. The Forest Service provided expertise and a large truck, while the Bureau des Parcours provided funding for labor and two guardians. The Range Management Improvement Project provided funds for fuel and construction materials.

Seedlings were raised in press mottes, the method most commonly used by the Moroccan Forest Service (mottes are small cups made of clay, straw, sand and manure). These cups were placed in rows and planted with 3-5 seeds/motte. Seeds had been soaked for 48 hours. Cane shades protected the newly germinated seedlings from wind and intense sunlight.

Atriplex nummularia plants accounted for 85% of the total production while *Atriplex halimus* and *Atriplex semi-bacata* plants accounted for part of the remainder. Two species of acacia trees were also raised for village plantations.

Nursery construction cost contributions were 23,068 DH from the RMIP, 60,000 DH from Bureau des Parcours and the use of a truck for two weeks provided by the Forest Service. At these production capacity and cost levels, there was an average cash investment cost of approximately 0.55 DH/plant. Annual labor costs for operation, figured for ten workers at six days per week, were 64,000 DH.

The development of this nursery has opened the eyes of the local people to the potential of rangeland reclamation. There have been many requests for plants including one request for 2000 trees and shrubs from the newly constructed high school. This

nursery has increased the potential for large scale rangeland improvement and inter-service cooperation in the region. The high visibility of the nursery has sparked interest throughout the community with one local tribe taking the initiative of requesting trees and shrubs for establishment of plantations on tribal land. This was an unsolicited request that stemmed from the desire of local people to address what they perceive to be major problems affecting the local environment and their livelihood.

Native Plant Species Research and Development

Program Development

The objective in establishing a native species development program was to identify productive forage plant species adapted to the environmental rigors of Moroccan rangelands. In some areas, annual species dominate the plant communities and provide large amounts of forage on a seasonal basis. These species are well adapted to the harsh conditions created by the highly variable and seasonal climatic extremes associated with the Mediterranean climate. In other areas, perennial shrub, grass and forb species dominate and provide forage and site protection on a more constant basis. These species are also drought resistant and are well suited to the areas where a more continental climatic regime is prevalent.

The potential for identifying forage and conservation species in Morocco that are economically important to Morocco and other regions of the world is indeed great. The International Board for Plant Genetic Resources (FAO) selected the Mediterranean Region as a priority area from which to collect and preserve valuable germplasm which is being lost at an increasingly rapid rate due to exploitive practices in cultivation, forestry and livestock grazing.

In 1983, Mr. Walter Graves (University of California, San Diego) and Dr. Mel Rumbaugh (Agricultural Research Service/US Department of Agriculture, Logan, Utah) conducted a collection/exploration trip to Morocco sponsored by the USDA. The urgency of the situation was indicated by the fact that only limited quantities of seed of the targeted genera and species were located. These two scientists acquired 852 accessions of seed of forage plant species from arid and semi-arid rangelands. (An accession is a collection of seed or plant material from a single species found in one location.)

Adaptability trials at various RMIP sites demonstrated that most introduced species are only marginally adapted to the conditions existing in Morocco at best, even under protection from grazing. In reaction to this realization, the RMIP began some cooperative work with Mr. Graves to establish a program of native plant species research and development in August of 1984. Mr. Graves provided 29 accessions of promising North African plant material collected on an earlier trip to the arid zones of Tunisia for testing. He also provided seed from 250 of the most promising accessions acquired on the trip he made in 1983 with Dr. Rumbaugh. (A complete inventory of native plant species

collected or provided with Mr. Graves assistance is available from DE on microcomputer diskette. See Chapter 8, Project Software Library.)

Collection Trip - 1985

In July 1985, Mr. Graves returned to Morocco as a RMIP consultant and collected 219 accessions of native plant material. During his stay in Morocco he presented training seminars at six local offices on the value of native forage species, collection techniques, plant identification, labeling and storage. Techniques for determining seed germination rates and for inoculating legume seed were demonstrated. Germination supplies, collection envelopes, regional maps, reference books and related literature were distributed to each of the local offices affiliated with the RMIP. A special seminar was given for the PMC personnel on processing, handling, cleaning and storage of valuable seeds. Mr. Graves compared the findings from the 1985 collection trip to data from collections he made in Morocco in the early part of the 1970's and noted the absence of many species previously collected. The assertion that native plant resources of the region are rapidly disappearing may very well be true.

On both of the collection trips made by Mr. Graves, valuable assistance was provided by Mr. Mustapha Bounjemate, Director Fourragere, Le Guich Station (Rabat), INRA. A complete seed inventory resulting from the Graves/Rumbaugh trip and the 1985 trip by Mr. Graves were donated to INRA.

Results of Project Efforts

Seed from the Graves/Rumbaugh collection made in 1983 and the Graves collection made in 1985 were planted for multiplication at the PMC in December 1985. There were 69 accessions of native grasses representing 15 genera, including *Dactylis glomerata* (29 accessions) and *Oryzopsis miliacea* (14 accessions). *Agropyron festucoides* was another species that appeared to have a great deal of potential. Unfortunately, seed of this species was not mature at the time collections were made so little if any viable seed of this promising drought and grazing tolerant species was collected. Technicians returned to locations where this species was noted only to find that the seed had ripened and fallen to the ground.

There were 353 accessions of leguminous forbs representing 21 genera planted at the PMC. This total included *Medicago laciniata* (35 accessions), *M. truncatula* (24 accessions), *M. aculeata* (24 accessions), *M. littoralis* (17 accessions), *M. minima* (16 accessions), *M. rigidula* (15 accessions) and *M. polymorpha* (15 accessions). Also included were experimental plant materials from Australia and Tunisia. The PMC staff also established a variety trial for annual species and varieties of the genus *Medicago* used in the GOM Ley Farming Program in an effort to support that program. A total of 422 accessions, representing 36 genera were planted in 552 plots and detailed observations of the germination and growth were recorded.

The native species evaluation and development program has only just begun. Limited initial collections have been made,

geographic areas for additional collections have been identified, and multiplication of seed has been initiated. Preliminary results indicate that the accession of Medicago laciniata from the Ait Rbaa Grazing Perimeter outproduces all other annual medics evaluated, including improved varieties from outside Morocco. This gives credence to the hypothesis that native species have a great deal of potential for meeting the needs of Morocco and other countries in the region as well as the world. Technicians at the Beni Mellal SE Office have completed the first phase leading toward field scale utilization of this accession, from collection through multiplication at the PMC to testing in the field. This accession is now ready to be produced on a larger scale at the PMC for use in large demonstration plantings.

In the coming years, more native plant seed accessions will be evaluated. Precise recordkeeping and meaningful data analysis will be essential. Ideally, one person should be given the responsibility for continuing and developing this program; from field collection to coordination of the recordkeeping, processing and storage of plant materials to evaluation of accessions at the PMC and field locations. In order for someone to carry out these program responsibilities it is essential that an adequate budget exist for transportation, per diem, equipment and necessary supplies for collecting. Testing should continue following the established program for adaptability trials. The key to success of a program such as this is timing. All aspects of collecting, planting and evaluation require that each be performed according to a well planned schedule. Success will only be achieved if there is good coordination between the PMC and field offices. It is essential that work be carried out in areas where vernalization of cool-season species will occur (in addition to work at the PMC) in order to evaluate many of the high potential species from the colder climatic regions of the country.

CONCLUSIONS AND RECOMMENDATIONS

Ultimate Goals for the PMC

The original goals set for the PMC primarily emphasized the use of cool-season forage grasses. After the mid-project evaluation, modifications were made to these goals. Once it was verified that cool-season grasses would not vernalize and produce seed economically at the Khemis M'touh location, seed production was directed toward legume species.

It is recommended that the original goals, however, still be applied to legume seed production activities. These goals are:

- Production of foundation (basic) seed.
- Development of seed certification standards.
- Promotion of an extension program for seed production.

Four additional recommendations are offered that would strengthen the role of the PMC in Morocco. These are:

- Continue the program for research and development of native plant species for forage and conservation use.

- Obtain financial autonomy in order to allow the flexibility required for the PMC to function in the role that has been identified.

- Use the PMC facilities to generate revenue by producing high quality seed of agronomic crops for which seed is in short supply.

- Integrate the PMC seed laboratory with the DPVCTRF.

- Develop a laboratory for inoculum production that will complement the program of research and development of native legume species.

Lessons Learned

Potential problem areas in seed production were adequately documented during initial studies, yet decision makers at the early stages of the Project were either unconvinced or inadequately informed of these issues. The only irrigated farm site available was in a climatic zone inappropriate for achieving the objective of cool-season grass seed production. The absence of an operating budget which was adequate in terms of amount and flexibility has been a chronic problem at the PMC. The budgeting procedures applied to normal government operations has not proved effective for operation of a facility (such as the PMC) that is involved in farming.

Moroccan rangelands still require seed of range forage species and the quantities requested increase yearly. It remains the responsibility of DE to fulfill this seed production need. No other MARA Division is projected to undertake seed production of these range forage species. If DE continues to require domestic production of range forage species, and if they continue to emphasize cool-season grasses, then another suitable location for seed production must be a priority. At least two locations are necessary to provide the range of environmental conditions necessary to achieve the seed production potential for most range species. The Khemis M'touh location could remain the center for coordination, processing, storage, some testing and quality control for cool-season species.

The Project Identification Document (PID) first suggested that a seed multiplication center be developed in two phases over a 10 year period. Phase II, according to the plan, has been successfully completed.

CHAPTER EIGHT: **PHYSICAL RESOURCE DEVELOPMENT**

INTRODUCTION

To facilitate project implementation while maintaining the goal of developing capability within DE of managing vast rangeland forage and livestock resources, substantial quantities of capital equipment and expendable supplies were purchased. In addition, basic informational resources such as libraries and base line data, which help administrators and technicians identify problems, were developed. The Project also undertook a number of small construction projects in order to overcome obstacles which blocked the realization of Project objectives. The goals, in the area of physical resource development, was to provide equipment and facilities which would make range management interventions possible in Morocco and to train individuals in the proper use of these materials. Some specific objectives were:

- the outfitting of the Plant Materials Center (PMC) for the task of production and processing of seed from plant species useful in the range environment.

- the purchase of microcomputers to facilitate analysis and reporting by DE/SP personnel.

- the purchase of vehicles, tools, and office equipment for field offices in order to carry on the planned program of research, extension and development at selected locations.

Staff began developing in-country resources at the outset of the Project, including: a Rangeland and Pastoral Sociological Library, a 4-language Lexicon for technicians working in rangeland development, and Plant Species Herbaria for field workers. Original staff members helped develop the Moyen Atlas sociological survey and saw the need to collect baseline market prices from local souks. During the final year of the Project, the arrival of four microcomputers and the emphasis on seed collection and multiplication of native species facilitated the creation of a computerized database of native plant species seed resources within Morocco. Other databases and database management programs followed this effort, leaving behind a sizable library of 5 1/4 inch diskettes for future use by DE and other interested agencies.

PROJECT COMMODITIES

Purchased Commodities

Purchased commodities were grouped into six general categories:

- machinery and tools.

- office equipment (typewriters, desks, furniture).

- field materials (seed, fertilizer, animal health products, feed supplements, etc.).

- vehicles.

- books for the project library.

- computer related material (hardware, software, and consumables).

PLANT MATERIALS CENTER

The following contributions were made by the Project in order to produce an operating center for the production and distribution of range plant materials:

		Cost in dollars
I.	Utah State University	
	A. Purchases in USA	
	1. Combine, Massey Ferg	43,113.00
	2. Rigid grain table, Massey Ferg	5,855.00
	3. Windrow pickup 82 Melroe	2,410.00
	4. Swather 18 FT Massey Ferg	6,221.00
	5. Precision Planter Nibex	3,969.00
	6. Tractor Frame for Planter Nibex	5,048.00
	7. Stubble Drill Nye	5,199.00
	8. 2 - Belt Threshers, 36 In	8,450.00
	9. Plot Planter Nibex	1,079.00
	10. Plot Sprayer Mater	2,317.00
	11. Plot Head Thresher	1,474.00
	12. M2B Seed Cleaner	2,015.00
	13. 2 - "Bag Closers" Sewing Machines	1,600.00
	14. Platform Scale 100 lb.	491.00
	15. Laboratory Equipment	
	a. Debearder Mat-OSU	2,310.00
	b. Germinator	723.00
	c. Seed Blower	1,056.00
	d. 2 - "Office Testers" Seed Cleaners	1,504.00
	e. Seed Counter (Count-A-Pak)	2,223.00
	f. Moisture Tester (Steinlite)	1,294.00
	g. Stereo Microscope	518.00
	f. Platform Scale 5 lb.	455.00
	h. Gram Scale (Seedburo)	112.00
	i. Refrigerator (GE)	565.00
	j. Freezer (Westinghouse)	418.00
	k. Seed Screens (40)	384.00
	l. Purity Work Board	125.00
	m. 7 - Aluminum Scoops	62.00
	16. Office Equipment	
	a. Typewriter Electric (Olivetti)	1,148.00
	b. Copier (Xerox 3103)	3,197.00
	c. Calculator (Texas Instruments)	130.00
	d. Camera (Canon AF-1) w/ 3 lenses and case	779.00

17.	Shop Equipment	
	a. Welder w/accessory kit (Dayton)	2,318.00
	b. Tool Kit (Craftsman)	1,750.00
	c. 1/2 inch w/ drill set	245.00
18.	Seed Cleaning Equipment	
	a. Design	5,000.00
	b. Processing Equipment, 16 pieces	85,520.00
	c. System for Dust Control and Seed Flow	29,190.00
	d. Manufacture and Assemble System	10,000.00
	e. Start-up Training Course, TDY Assistance	7,250.00
	Total (excluding shipping)	**247,517.00**
	Shipping and Handling (@ 40%)	**99,007.00**

B. Purchases in country, January 1983 to March 1985

1.	Farm equipment/parts	$ 3,300.00
2.	Tractor parts	1,800.00
3.	Shop supplies/tools	6,500.00
4.	Farm/nursery supplies	3,000.00
5.	Chemicals	2,600.00
6.	Bags	1,000.00
7.	Office equipment/supplies	4,500.00
8.	Irrigation pipe	14,400.00
	Total	**$37,100.00**

Grand Total of Project Expenditures for PMC $383,624.00

II. Direction de l'Elevage	Cost in dirhams
A. Buildings and Fences	
1. 4 Houses and Power supply	1,419,745.00
2. Offices, cleaning plant, equip shop	1,089,125.00
3. Fencing, roads	196,570.00
B. Water and Irrigation development	
1. Domestic well and pump	217,731.10
2. Portable pump	110,010.00
3. Drilling well for sprinkler irrigation	339,000.00
C. Shrub Nursery Irrigation	
1. Reservoir	38,914.98
2. Sprinkler system and pump	67,569.50
D. Farm Equipment	
1. 4 - Tractors	225,500.00
2. Moldboard plow	30,500.00
3. Disc plow	20,500.00
4. Cover crop	8,000.00
5. Fertilizer spreader (Centrifuge)	3,750.00
6. Fertilizer spreader (5 meters)	16,600.00
7. Hay baler	44,000.00
8. Hay rake	7,540.00

9.	2 - Cultivators	29,910.00
10.	Sickle-bar Mower	6,340.00
11.	Flail Mower	38,000.00
12.	2 - Rollers	30,000.00
13.	Sprayer (600 litres)	12,390.00
14.	Spike-tooth Harrow	3,150.00
15.	Blade	12,200.00
16.	Furrow maker	11,850.00
17.	Rototiller	31,900.00
18.	Rotavator	40,000.00
19.	2 - Trailers	41,000.00
20.	2 - Cisterns	32,412.00
21.	Chisel	10,000.00
22.	Fork Lift	179,205.25
E.	Vehicles	
1.	Truck	167,049.19
2.	3 - R-4's	117,588.24
F.	Shop Equipment and Tools	91,786.73
G.	Operating Supplies and Materials	
1.	Machinery repairs and spare parts	103,706.60
2.	Materials for farm fabrication	97,667.41
3.	Fertilizers and Chemicals	241,714.47
4.	Diesel/Gasoline	294,997.88
5.	Labor	657,489.26
6.	Fees for Irrigation Water	227,845.27
7.	Office Equipment and Supplies	33,535.00
	TOTAL	**6,346,774.88**

INFORMATIONAL RESOURCES

As pertinent information is often nonexistent or inaccessible in developing countries, the Range Management Improvement Project has attempted to gather as much useful information on the development of range management programs as possible. The following are the major information resources created in the Ministry of Agriculture.

Library Development

Throughout the life of the Project, documents on range management and pastoral production systems were acquired from Moroccan and US sources. Each office assumed the responsibility for organizing its own library. A large Project library in Meknes was organized by a trained librarian during the initial two years of the Project. Moroccan technicians in Meknes have continued to maintain this collection, cataloging all further acquisitions.

To make this documentation more accessible to DE/SP personnel, a computer program was written to catalogue and retrieve titles. This bibliography program ("BIBLIO") allows access to a data base containing specific information (i.e., citation data, keywords, location, etc.) on all documents maintained in Rabat or at Project sites. This data is being developed and catalogued by DE staff on a continuing basis. The DE technicians have adapted BIBLIO to catalogue all of their references and documents, as well.

Pastoral Lexicon

Extension activities are most effective when extension agents can speak with people and explain new methods in terms which are easily understood by the audiences involved. In Morocco a dialect is spoken which is quite different from Modern Standard Arabic. There are also large dialectical differences within the country, as well as many areas where Berber is more common than Arabic. For this reason, project personnel decided to create a Pastoral Lexicon. Local terms were collected by the DE/SP Sociological Counterparts and Peace Corps Volunteers throughout the life of the Project, sent to the main office and organized on index cards. In the fall of 1985, a format was developed using the new microcomputers and software which permitted printing and distribution of the Lexicon to all Project sites.

The Lexicon microcomputer "card file" lists all collected terms in French, English, Arabic and (when applicable) Berber. Words can be retrieved by entering the word itself in any of the languages by the subject or by the region of use (provided one's transliteration matches the one entered). Lists of words can be sorted alphabetically in either French or English. Printouts of the Lexicon were provided to all Project offices, and the diskette is available through the DE Microcomputer Room for future use, copying, and revision.

Souk Observations

Programs of range management, as is the case with all development programs, must consider the local economic environment. In Morocco, major market interactions take place at the local weekly market (souk). The Souk Study, performed at each Project site, enabled evaluation of the market trends of production inputs and outputs from the agro-pastoral production system.

The study consisted of weekly visits to major souks in each study area. Data were recorded on standard forms and periodically summarized and reported. These data were entered onto the computer using the LOTUS 1-2-3 program. The diskettes are available through the DE Microcomputer Room.

Socio-economic Analysis of the Ait Arfa du Guigou

In 1982, the Middle Atlas Project conducted a survey of all producers in the region. As of 1984, the collected data had received only a cursory analysis. This was primarily due to the lack of a well defined system of analysis and the absence of a computer with which to conduct the analysis. In 1984, the staff of the RMIP and the local staff of the Service des Parcours decided to analyze this data for their own use. It was decided that a survey of a smaller number of producers was necessary to corroborate and update the data from the previous survey.

Analysis was conducted at the level of the four tribal fractions. It identified differences between major population groups. The study concluded that the level of efficiency of small producers could be improved by better integrating crop production to meet the nutritional needs of local livestock. Further, the results indicated that improvements in herd management strategies could be made.

The raw data from both surveys were coded and entered onto magnetic tape. The copy belonging to DE is stored in an air-conditioned storage facility at the Institut National de la Statistique et de l'Economie Applique (INSEA). This tape is available for further analysis or reference. (A detailed report of this survey is available under separate cover. See list of Project documents.)

Project Software Library

All programs and data bases developed under the program are available at DE Rabat. They are accessible by IBM-PC compatible/MS-DOS systems. Copies can be obtained by sending a blank diskette to the "Cellule Informatique", DE, MARA, Rabat (tel. 640-22).

Range Livestock/Crop Production System Model: File name--PROMO. (1986), 1 diskette. This program uses LOTUS 1-2-3 to provide an easily understood and applied production system model that can be used at the individual and group producer levels. The model can be used to analyze production systems and enable the user to identify production problems and

opportunities at the individual, local, regional or national levels. It also can be used as a tool to aid decision makers in program evaluation and financial resource allocation by enabling them to identify the most beneficial programs.

Material Inventory Program: File name--INV. (1986), 1 diskette. This program was written using Dbase II to provide menu driven access to standard MARA material inventories. The program allows a user to build, retrieve, edit and print names of inventoried items, and print a completed MARA inventory form.

Library Program: File name--BIBLIO. (1986), 1 diskette. This program was written using Dbase II to provide access to all bibliographic materials at DE and Project sites. The program allows a user to add, edit, retrieve and sort bibliographic entries and print lists of available materials.

Pastoral Lexicon Program: File name--LEXICON. (1985), 1 diskette. This program uses PFS:File to provide access to Arabic and Berber terms concerning range production. The program allows a user to add, edit and retrieve lexical items, as well as to print alphabetically sorted lists.

Inventory of Plant Collections (Moroccan Indigenous Forage Plants Collection Program): File name--COLLECTIONS. (1985), 1 diskette. This program uses PFS:File to provide information on all native range forage species collected under the auspices of the Project in July and August 1985. This file was prepared as Annex 1 to the TDY report by Mr. Walter Graves. The program allows the user to add, retrieve and print sorted lists. (In French).

Inventory of the Moroccan Native Range Forage Species Collection: File name--MORESEED. (1986), 1 diskette. This program uses PFS:File to provide information on selected native range forage species collected in July and August 1983 and multiplied for seed production at the University of California, Riverside by Mr. Walter Graves in 1985. The original plant material was collected by Mr. Graves and Dr. Mel Rumbaugh, ARS-USDA/Logan, Utah. The program allows the user to add, retrieve and print sorted lists. (In English).

Herbaria

Knowledge of local vegetation in both scientific terms and local dialect is very important to the land manager or extension agent in the field. Collections of specimens of the local flora were made and prepared for display and reference at each of the Project sites. Specialists at INAV Hassan II in Rabat have been available on a continuing basis to provide assistance in the correct identification of species.

Ain Beni Mathar

The Ain Beni Mathar herbarium has 54 species identified with local Arabic names. Seventeen of these species have been positively identified. However, the durability of this collection is threatened by the lack of permanent mounting of the specimens, uncertainty of storage facilities, and lack of maintenance at the local level.

Beni Mellal

The majority of the Beni Mellal herbarium was collected on the Ait Rbaa perimeter during the first three years of the Range Management Improvement Project (RMIP). During the latter two years of the project, plants were collected in the surrounding areas. Mr. Nourddine and Mr. Driouich of the Bureau Pastoral are presently responsible for the collection, which is stored at the Range Management office in the Service de L`Elevage complex. To date, the herbarium contains 172 collected specimens. Of these, 63 have been identified with a total of 34 different species represented. There are 109 specimens that have not been identified (30 have not been mounted). The plants were identified by the staff at the INAV Hassan II in Rabat using Petite Flore des Regions Arides du Maroc Occidental by Mr. R. Negre as the source text.

Midelt and Timahdite

Herbariums were prepared for the Midelt and Timahdite areas. A detailed accounting of species has been completed for the Midelt herbarium with the assistance of Dr. Omar Berkat who aided in the correct identification of plant species.

CONSTRUCTION

Office Construction: **Beni Mellal**

In April, 1985 the Project financed the remodeling of an existing structure into a permanent office facility at the Beni Mellal Service de l'Elevage building. Although the contract stipulates that DE will provide office space and equipment, budgetary constraints forced the Project to finance these items in most cases. The Service de l'Elevage offices at Beni Mellal were never adequate to support the Project staff. An agreement was struck between the SE director and the Project to convert a garage space into an office and laboratory for Project staff, including USU, Peace Corps and SE personnel. The construction costs were approximately 20,000 DH. The office was completely furnished with office equipment and drafting supplies for SE personnel use.

Water Hook-up: **Ain Beni Mathar**

The Ain Beni Mathar Extension office was without water for the first four years of the project. This created many problems for DE/SP technicians, resident Peace Corps volunteers, visiting staff and TDY personnel. The hook-up, which cost US$1500, will allow technicians to live and work close to the perimeter and permit better use of an existing facility.

On Site Nursery: **Gouttitier**

Nursery Development Plan

The shortage of available shrubs is an acute problem hindering reclamation efforts of the Bureau des Parcours. Nurseries must be developed near future plantation sites to provide greater plant availability, to cut transportation costs and to increase shrub survival rates. To this end, a development plan has been created for a nursery at the Gouttitier Experimental Farm. This Nursery has a 280,000 plant capacity which will help range rehabilitation efforts but will still fall short of meeting needs.

The climatic zone in which the Project Plant Materials Center is located limits the production of seed for many of the important rangeland plant species adapted for use in the mountains and basins plateau areas of the interior of Morocco (see PMC, vernalization problem). Technicians at the Oujda office investigated the possibility of seed production at the Gouttitier Experimental Farm. In an effort to determine the biological feasibility, seeds from fifteen species were sewn in 10 X 10 meter plots. An additional 6 ha was seeded to a mixture of species as a demonstration activity.

These trials were installed on November 14 and 15, 1985. After two weeks an intense rainstorm occurred, accompanied by high winds which caused the soil to dry and crack in a short time. Grass seed germinated but could not break through the crust formed by the fast drying of the soil surface. The area has a history of extensive plowing which has adversely affected the soil structure. This is a problem that must be dealt with throughout the region as it represents much of the marginal croplands in the area.

Cane Plantation

Cane (*Phragmites australis*) is a very useful material in many construction projects. The cost of using cane for shading of nursery stock was a major expense in the development of shrub nurseries at Ain Beni Mathar and the PMC. For this reason, a small plantation of 500 cane plants was developed at the Gouttitier Experimental Farm.

The root stock was purchased for the same cost as single cane, 0.35 dirhams each. The shoots were planted in contours in a deep ravine near an irrigation source. Growth has begun on all of the transplanted shoots.

Seed Source Plantation

A source of seed for nursery stock has been a major concern for the Oujda reclamation efforts. To help alleviate the problem, 600 plants were planted in a site near the nursery (200 *Atriplex nummularia*, 200 *Atriplex halimus*, and 200 *Atriplex semibacata*). The Forest Service in Taourirt has agreed to supply 100 *Medicago arborea*. The latter species has shown good potential in rangeland plantings in similar areas.

Livestock Handling Facility and Dip Tank Redesign: **Ain Beni Mathar**

A modification of the existing Dip Tank was needed to allow total immersion of livestock for complete control of external parasites. This involved narrowing and deepening the existing tank. Incorporated into the tank system was a weighing station which consisted of a room for the scale and an inlet and outlet chute leading from a holding pen. The chute was constructed so that animals could be separated out of the line by the use of a small gate. A holding pen was also constructed for the dipped animals.

Some work is required on the scale room and the gates in order to complete this project. With the completion of this facility, the entire El Fath Cooperative herd could be treated in one day with the assurance of complete treatment for external parasites. This facility could also help reduce the labor required during herd separation and vaccination activities.

On Site Nursery: **Ain Beni Mathar**

A cooperative effort was mounted to develop a nursery for producing plant materials in Ain Beni Mathar. Details of this effort are presented in Chapter Three: Program Development - Seed Production.

MICROCOMPUTER ROOM

A goal of the RMIP was to establish the Microcomputer Room (Le Cellule Informatique) as a center for training, data processing, and computer consulting needs within DE. The DE/SP Central Office (MARA, Rabat) has functioned in strictly an administrative capacity; it has not been a center of expertise for the maintenance of field operations. Microcomputers offer the DE a method of input into field operations through the analysis of results of field activities and the distribution of conclusions. Objectives were to:

- purchase and install four complete work stations (microcomputer, printer, software, computer desks and diskette filing system).

- organize program diskettes to make them readily available to inexperienced users.

- offer training for interested personnel.

- promote the integration of application programs into DE/SP functions.

- begin applications consulting with at least one field station.

User proficiency was encouraged by providing basic hardware, offering only a small selection of versatile software with manuals in French (simple filing system, advanced data base management, spreadsheet, word processing, and statistics programs), and offering hands-on training in a central, supervised workspace.

The DE Computer Room received two microcomputer stations in November 1985, and one at the close of the project in June 1986 (the remaining microcomputer station went to the Oujda office). The room, which functions independently of Service administration, was supervised by two Moroccan specialists (one full-time, Abdellah Mdafri; one half-time, Dr. R. Azlaf, both of whom were trained in animal production and microcomputer applications), and one USU project staff member. Besides conducting training (see TRAINING: MICROCOMPUTERS), Computer Room staff conducted training and wrote programs that addressed needs within and outside the scope of the Project. At the close of the RMIP, a number of data bases had been developed and were routinely being used. (For a complete description of RMIP data bases and program diskettes [IBM-PC/MS-DOS] see INFORMATIONAL RESOURCES: RMIP SOFTWARE LIBRARY. For copies of diskettes please contact DE, MARA, Rabat/tel. 640-22.) Computer Room staff wrote French language menu driven programs to access data bases of the SP Library and SP Material Inventory. Contact with the Service de l'Elevage in Ouarzazate and the PMC was made based on the expressed interest at these locations for development of applications in the field.

Problems encountered during this activity were: 1) data scrambling and equipment malfunctions caused by the local power supply, and 2) difficulty in meeting French language requirements under the "buy America" policy. Purchase of heavy-duty power stabilizers with battery back-ups for each microcomputer is recommended. Conventional protective devices marketed in the USA were insufficient. Though high quality stabilizers/back-up power supplies are expensive, they can keep a microcomputer operating after assistance projects and associated funding have ended. Buying US computer equipment means having to substitute printer ROMS to print the French character set on daisy wheel printers, buying French keyboards, trying to buy French copies of equipment and software manuals, and French menu driven software. Buying a 24-pin near letter quality printer and software which will make French character conversions between program and printer (e.g. Micro-Soft Word) eliminates one problem. The solution is, however, for USAID to either develop a US based contact for French language equipment (a large percentage of French hardware and software is already

manufactured by foreign branches of US companies) or to relax the policy.

CONCLUSIONS AND RECOMMENDATIONS

Some of the initial equipment purchased was essentially unused throughout the life of the Project. This equipment was purchased at the onset of the Project based upon lists of equipment developed several years before project implementation began. It is recommended that projects purchase only for a short initial period, after which lists can be modified and major purchases can be made based upon current knowledge of program development needs and the constraints which are likely to be faced.

DE/SP must develop the means to plan budgets and manage operating expenses. The agency is young and staff are sorely lacking in that capability. Further assistance to DE should concentrate on developing skills in personnel which will support field offices in areas of planning, accounting, and inventory. These are areas in which DE/SP must develop in order to function as an agency. If the GOM is committed to development of the range/livestock sector, funding of programs must improve and continue after assistance from outside sources ends.

APPENDICES

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APPENDIX A

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APPENDIX B

LIST OF ABBREVIATIONS USED

ANOC	Association National des Ovins et Caprins
APSS	Agro-Pastoral Systems Study
BP	Bureau des Parcours
CAI	California Agriculture Institute
CID	Consortium for International Development
COMAGRI	Compagnie Marocaine de la Gestion des Produits Agricole
CT	Centre de Travaux
DE/SP	Direction de l'Elevage/Service des Parcours
DE	Direction de l'Elevage
DH	Dirham
DPA	Direction Provinciale de l'Agriculture
DPVCTRF	Direction de la Protection des Vegetaux, Controle Technique et de la Repression des Fraudes
ENA	Ecole National de l'Agriculture
FAO	Food and Agricultural Organization of the United Nations
GOM	Government of Morocco
INAV	Institut National Agronomique et Veterinaire, Hassan II
INRA	Institut National de la Recherche Agronomique
MARA	Ministere de l'Agriculture et de la Reforme Agraire
MAU	Moroccan Animal Unit (standard based on a 30 kg breeding ewe)
MAUM	Moroccan Animal Unit Month (the amount of feed required per month for maintenance and growth of one 30 kg ewe - estimated to be 27 kg dry matter)
ORMVA	Office Regional de Mise en Valeur Agricole
PC	U.S. Peace Corps
PCV	Peace Corps Volunteer
PID	Project Identification Document
PMC	Plant Materials Center
RMIP	Range Management Improvement Project
SE	Service de l'Elevage
SODEA	Societe de Developpement Agricole
SOGETA	Societe de Gestion des Terres Agricoles
SONACOS	Societe Nationale de Commercialisation des Semences
TDY	Temporary Duty
USAID	United States Agency for International Development
USDA-ARS	United States Department of Agriculture -- Agriculture Research Service
USU	Utah State University

APPENDIX C

ARABIC WORDS USED IN THE TEXT

Aid el Kebir	"The Big Feast". Moroccan holiday during which all families are expected to slaughter a sheep.
Dirham (DH)	Moroccan dirham. Approx. exchange rate - 1 DH:0.11 US Dollar
Djellaba	Long woolen cloak with hood.
Douar	Small village or hamlet. (lit. houses)
Gorja	Laborer who is responsible for all production tasks on a single field.
Khammes	Sharecropper. Works for a portion of the harvest.
Souk	Weekly market.

APPENDIX D

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