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PROJECT COMPLETION REPORT

CENTRAL TUNISIA RURAL DEVELOPMENT PROJECT

RANGE DEVELOPMENT AND MANAGEMENT SUBPROJECT

(664-0312.8) 1981-1989

(A.R. BURGETT)

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I. INTRODUCTION

The Range Development and Management project (RDM) (664-0312.8), was a subproject of the Central Tunisia Rural Development Project (CTRD) (664-0312). The latter was amended on seventeen occasions.

The tenth amendment(1) of the CTRD established the RDM on June 5, 1981. After three years, the thirteenth amendment(2) provided for rangeland reseeding prior to the introduction of improved management systems.

The design change brought about a change in project activities:

II. PROJECT DESCRIPTION

Background

The Government of Tunisia (GOT) included strengthening of rangeland management capability in its program for development of Central Tunisia. The Range Development and Management Subproject assisted the Ministry of Agriculture (MOA) to launch an experimental effort to design and implement socially and technically sound approaches to improve rangeland management.

During the life of the subproject 25 experimental sites were planned to be developed. The sites were selected in order to account for the variety of micro environmental settings as well as the principal land tenure arrangements (collective and private rangeland) found in Central Tunisia. Interventions at each site included improved range utilization and stock raising techniques. The subproject was implemented by the MOA's Office of Pastures (OEP) in coordination with the Central Tunisia Rural Development Authority (CTRDA) and other departments within the MOA.

At the community level, technical assistance was to be channeled through range management committees, organized with the help of local leaders into socially acceptable formats. However, a major project weakness was that these committees did not play an important role in project implementation.

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(1) Amendment 10, June 5, 1981
(2) Amendment 13, July 13, 1985

Almost 50% of the total livestock population is located in Central Tunisia where 200,000 project beneficiaries live. In the past 20 years livestock numbers increased fourfold. Livestock raisers (eleveurs) have made a transition to sedentary farming and present flocks are poorly managed. The local farming system consists of a small flock (less than 50 head) on a 10-15 ha farm. About 2-3 ha of the farm are in olive and almond trees, 2-3 ha in cereal crops and the rest left fallow.

There has been an expansion of cereal crops and fruit trees (olives and almonds) into the most fertile grazing areas. Grazing areas have been reduced. Little attention has been given to forage crop management and natural vegetation. Overgrazing and low rainfall have caused serious erosion problems and current rangeland productivity has decreased. After 3 years of implementation, the project had to be amended to resolve fundamental technical problems of rangelands that are depleted of original seed and plant material. Before range improvements could be made, reseeding was necessary.

Goal of the Subproject

The goal of the subproject was to increase income and improve the quality of life in Central Tunisia.

Purpose of the Subproject

The purpose of the subproject was to improve rangeland and range use practices in Central Tunisia.

Project elements were the following:

I. Livestock improvement (Nutrition, Health, Genetics)
II. Range improvement, management and reseeding (Water Basins)
III. Extension Program
IV. Applied research
V. Seed production and plant materials (see Annex A)

Nutrition

The World Bank report (1) indicated that in 1983 there were 354,000 farmers, 106,000 cattle farmers and 180,000 sheep farmers. A large number of livestock is located on small farms that lack forage. Medium and large farms raise less animals per hectare. Small farms under 10 hectares raise 3.6 times as many cattle and 2.4 times as many sheep per unit of area as large farms over 50 hectares. Thus a large proportion of livestock is located on small farms with a structural forage deficit.

The relatively low level of area under forage crops combined with low yields of rainfed forages and encroaching agricultural tree production are some areas that caused nutritional problems in sheep and other animals. For more details see Annex A.

(1) Report No. P 4368-TUN, Sept 3, 1986

Concentrate

Raw materials and imported components are maize, soybean cake, sorghum and millet. There was a rapid rise in concentrate feed production between 1972 and 1982 (32,000 to 474,000 tons). There are 187 concentrate feed production plants with a total capacity of 2,1 million tons a year. Thus the sector is over-equipped and operates at only 20-30% of its production capacity.

Project technicians developed a forage calendar in order to advise farmers what interventions and allocations of resources to use for their sheep during the feed deficit period. Some interventions were seeding of medic, straw ammoniation, forage production (oats).

Health

Eradication programs of animal diseases reach relatively small proportions of animals because of limited resources, wide dispersion of certain diseases, high cost of the farmer's lack of organization, discipline and small resources.

The project built dipping pools and dipped 63,000 head of sheep for external parasites. The project vaccinated over 29,500 sheep (see Annex A).

Genetic Improvement

Tunisian productive indicators of livestock are low because of inadequate fertility, lack of precocity, low milk yield, irregular forage supply, parasitic infestation and sterility, and genetic improvement, selection of native breeds adopted to their environment. At the PACD the project has distributed 390 rams to over 870 stockmen or sold to farmers (see Annex A).

Discussion

Project activities changed drastically after the first 3 years (1981-1984). Project staff decided that rangelands were too depleted to establish improved rotation and range management systems. Reseeding of rangelands was required before management changes were introduced. However, reseeding required relatively large amounts of seed and there were no seed production activities included in the original project. The project was amended, therefore, to establish a foundation seed unit. Other major changes occurred in project implementation:

1. GOT field staff increased from 26 to 36 agents.
2. Training of GOT supervisory level staff expanded from 12 to 20 participants.
3. Number of hectares of range improvement decreased from 36,000 to 25,000. Number of pilot sites increased from 12 to 25.
4. A foundation seed farm was established and the number of hectares to be reseeded increased.
5. Extension education became a priority.

III. FUNDING AND EXPENDITURES

The RDM was originally funded by a loan of 2,3 million and a grant of 300,000 US dollars for total of 2,6 million US dollars. However, the project was amended to provide for a total of $5.6 million US dollars of which $3.42 million were loan and $2.18 million grant.

The financial status of the project is as follows:

USAID/TUNIS
FINANCIAL MANAGEMENT REPORT
AS OF SEPTEMBER 30, 1989

PROJECT No.: 664-0312.8 PROJECT NAME: RANGELAND DEVELOPMENT & MANAGEMENT

	OBLIGATED EARMARKED	COMMITTED	DISBURSEMENTS
TECHNICAL ASSISTANCE	5,226,964.00	5,226,964.00	4,934,700.65
- HOST CTRY CONTR - OSU (includes commodities of $1,102,725 and training of $1,277,322)	5,177,000.00	(5,177,000.00)	4,884,736.65
- RSSA-RONCO-W.O. No. 25	47,900.00	(47,900.00)	47,900.00
- EVALUATION	2,064.00	(2,064.00)	2,064.00
- COMMODITIES (includes vehicles, tractors, dozers, semi, dolly, AID excess property and locally procured commodities)	325,956.26	325,956.26	319,848.52
UNBUDGETED - UNEARMARKED	47,079.74	-	-
PROJECT TOTAL	*5,600,000.00	5,552,920.26	5,254,549.17
FINAL VOUCHER			46,660.76
			27,486.92
			3,209.00
			*5,331,905.85

*The difference is: 5,600,000.00-5,331,905.85 equals 268,094.15.

Project Inputs: GOT

GOT inputs by MOA/OEP were: 1) the core technical support staff of the Range management Unit (RMU) of OEP; 2) the OEP support of the regional offices and personnel of MOA/Forestry Service, Genie Rural and CTRDA; 3) the training of OEP/MOA staff by means of seminars, field days; 4) the costs for rangeland development on project sites, seed production and seed conditioning facilities; 5) the international travel costs of trainees; 6) the local transportation of short term TDY technicians; 7) locally purchased commodities such as 5 tractors, 4 trucks and other shelf items.

IV. ORGANIZATIONAL FRAMEWORK AND PROJECT ACTIVITIES

The life of this project was 8 years (1981-1989). It was implemented by the Government of Tunisia (GOT) through the Office de l'Elevage et des Paturages (OEP) in coordination with other Ministry of Agriculture (MOA) divisions and with technical assistance (TA) from Oregon State University. OEP's range management unit (RMU) implemented the project.

The original objective of the project was to introduce to stockmen resting and rotational grazing programs. In the three first years of implementation the project staff discovered that rangelands were too depleted to establish improved range management systems. Reseeding of rangelands had to be undertaken before range management systems could be improved. The reseeding activities called for the development and introduction of a seed production unit.

After the July 1984 evaluation the original PP was rewritten and approved on 5/2/85 and Oregon State University (OSU) was selected to implement the project (7/86). In addition, an extension of the life of the project (from 1986 to 1989) was approved.

In May 1988 an evaluation team recommended that the project should focus on 8 major activities. In the last 9 months of project life monthly meetings were held with OEP staff to implement the following activities:

1. Quarterly seminars to facilitate information exchange.
2. The hiring of a short term extension worker, agricultural economist and sociologist.
3. The expansion of the straw-ammoniation program.
4. The deobligation of OSU contract funds for reobligation to the Technology Transfer Project to permit completion of project long-term training beyond PACD.
5. The procurement of seed cleaning machines.
6. The repair of damaged equipment and provision of appropriate equipment storage facilities.

All of the above activities were completed at PACD except for the storage of equipment.

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All of the above activities were completed at PACD except for the storage of equipment.

Project Inputs: U.S.

1. Technical Assistance

OSU provided 2 resident advisors for 2 year tours of duty and 20 person-months of short-term technical assistance. One long-term advisor was a forage seed specialist to guide seed production and extension, the other a general range science advisor. Short-term advisors worked on special seminars and international symposia. They also studied and guided extension, range seeding, animal husbandry, seed processing, and agricultural economics activities. A sociological study was done by a Tunisian sociologist.

2. Training

One of OSU's inputs was training. The project called for a total of 30 months of language and academic training for trainees already in ongoing US academic programs and 30 months of the same training for 14 additional technicians (11 BS and 3 MS degrees).

LONG TERM TRAINING COMPLETED BEFORE PACD

Type of Training	Year Graduated	Number Participants Graduated	Participants Not Yet Graduated	Areas of Specialist
1. Long-term	1983-1990	23*)	1	Range Mgt sheep prod. seed prod. extension crop science agr. economics
2. Short-term training (6-8 wks)		57		Range mgt extension
3. Overseas training		10		USA, Syria Morocco France Australia

*) Thirteen participants completed their degrees after current PACD expires. Eleven participants were transferred to the Technology Transfer Project 664-0315 and Office of International Training (OIT), requiring additional 46 person months of financing under PIO/P.

In addition project staff received training at the International Center for Agricultural Research in the Dry Areas (ICARDA) in Syria, at the Jordan National Agricultural Development Project, and seed production training in Australia.

The project staff attended field trips, international symposia and several administrators of different ministries attended the 2 week range policy training in the USA. The training was held to improve and increase administrators' participation in bringing about policy changes in their sectors.

Five Tunisian professionals and administrators travelled to India, Jordan and Syria for training in new technologies. Important contacts were made and used for recruiting speakers for OEP's workshops, seminars and training sessions.

During overseas training the participants identified specific technologies which could be used and adapted to Tunisia i.e., (1) a single row shrub seeder developed in Jordan and (2) commercial milk production from range fed Awassi sheep, (3) ICARDA's frost tolerant Medicago regidula and drought tolerant varieties, (4) cultivation practices and grazing management for weed control which could also be tested in Tunisia. Participants also learned that phosphorus fertilization developed threefold increases in forage and medic production without need for reseeding.

Field days for sheep husbandry, range management and improvement and straw ammoniation were held in 41 locations. There were from 10-176 participants involved with each field day. The varied training activities strengthened and developed project staff's knowledge and skills, and changed attitudes.

3. Commodities

Commodity procurement included specialized range seeding, seed processing and ammoniation equipment. Before PACD the project purchased photocopy, stencil and other duplicating equipment for the extension education activities. A detailed list of commodities purchased under this project was developed by OSU.

Project Inputs: GOT

GOT inputs by MOA/OEP were: 1) the core technical support staff of the Range management Unit (RMU) of OEP; 2) the OEP support of the regional offices and personnel of MOA/Forestry Service, Genie Rural and CTRDA; 3) the training of OEP/MOA staff by means of seminars, field days; 4) the costs for rangeland development on project sites, seed production and seed conditioning facilities; 5) the international travel costs of trainees; 6) the local transportation of short term TDY technicians; 7) locally purchased commodities such as 5 tractors, 4 trucks and other shelf items.

V. PROJECT OUTPUTS AND ACHIEVEMENTS

1. Extension

A major GOT achievement was the establishment of the seed production program, the seed processing facility and extension education in sheep husbandry; the latter gave to stockmen feeding demonstrations during lambing and breeding season and creep feeding lambs. Field days were planned around health care and nutritional requirements. From 1982-1988 the number of field days held by the project were 42 and the number of participants for this period was 1690, about 40 participants per field day.

The target of 10 bulletins by the third year of the project was set. However, it is not clear how many bulletins were produced by the project.

Project technicians had good relationships with the Cellules Territoriales de Vulgarisation (CTV).

2. Genetic Improvement

The program was focused on giving farmers information to upgrade the quality of stock through selective breeding. Farmers had the opportunity to purchase an OEP ram at a subsidized rate. Some information was collected on meat production, breeding and lambing rates and general animal health.

From 1982 to 1987 the project distributed 387 rams. In 1989 the final report of Dr. Tiedeman indicates that 390 rams were distributed to farmers.

3. Range Improvement, Management and Reseeding Component

The project target for improved rangeland was 25,000 hectares over 25 sites in Central Tunisia. This included reseeding, mechanical treatment and deferment. Range management systems were to be developed for each site. Local farmers were supposed to participate in development and management at all sites, whether land was collectively or privately owned. The original project paper indicated that the project would establish deferred rotational grazing systems on collective and private rangelands. Project staff discovered that rangelands and marginal croplands had been abused for a long time and the remaining plants were of poor quality while desirable plants were often absent. Reseeding was necessary before range management systems could be established. The project amendment and the revised project paper included rangeland reseeding or revegetation as target activities and deferred rotational grazing. The project target was 3,250 hectares of reseeded and deferred rangelands each year spread over 25 sites. Local committees at the delegation level or on-site committees were to manage the collective use of land. During and after project

development the management of these collective lands came under the authority and responsibility of the Forest Service. However, at PACD, Forestry Service had not taken over responsibility for these collective lands. OEP staff will continue after PACD to provide technical assistance and guidance to management committees and users of the rangelands.

Along with reseeding and other range improvement interventions, which require elaborate and expensive equipment, the project was designed to develop prototypes of equipment of simple design, which could be purchased and maintained by small farmers. (See Annex A)

4. Health

The project assisted farmers with vaccination against sheep pox (Clavelee) and enterotoxemia. Drenching for internal parasites and dipping for external parasites (scabies).

From 1982 to 1987 the project assisted over 8100 beneficiaries with the following activities:

Animal Vaccinations	Animal Drenching	Animal Dipping
181,244	168,467	45,493 (1982-87) 63,000 (1989)

Planned project interventions 1987-1989 indicated(1) that the drenching and vaccination target was 140,000 head of sheep. The project surpassed these targets in 1987. However, project design did not include clear objectives and statistical baseline to measure these activities and data is lacking.

5. Nutrition

The project was aimed at 3600 farm families on 25 sites. The final OSU reports indicate that 6000 farmers improved range production and sheep raising practices, 5000 farmers planted forages, cactus, acacia and shrubs. All these activities improved the nutritional status of the flock of participating farmers. In addition, these farmers also were to receive 3,400 tons of concentrate feed subsidy in return for project intervention on 6500 hectares for range improvements and resting activities. (At 200 kg concentrate per hectare the total project requirements for concentrate were 3,400 tons.) In 1985-1987 the project distributed 709 ton of concentrate. It was projected that the project would treat 1500 tons of ammoniated straw each year and a total of 3000 tons at the PACD. This costs 30 dinars per ton with 50% subsidy or a total cost to GOT of 45,000 Tunisian Dinars. The project actually produced 4500 tons of ammoniated straw which was used by 600 participating farmers to feed to their flock.

(1) Range Management in Central Tunisia, Volume II, Appendices Page 1-47

The project surpassed its farmer participating objectives for the nutrition activities of sheep, because it reached almost double the number of farmers and families. Project also produced 50% more ammoniated straw than was originally planned. However, project demand for subsidized feed concentrate was less than expected.

A large tank was procured before PACD, so that OEP could increase the quantity of treated straw by at least 33% or a total of 5000 tons. This is sufficient to feed 50,000 sheep during the critical 4 months.

Participation of farmers in nutrition activities is relatively high. This may be due to the relatively high subsidization of animal feed and concentrate, rather than the technology and motivation of farmers to use new technology when subsidies are removed. It was difficult to find statistical evidence that there was an expansion of meat and wool production or that animals were larger and of higher quality due to project interventions.

Private entrepreneurs started treatment of straw at a profit. However, the relatively high subsidization of ammoniated straw by the GOT has discouraged private entrepreneurs from contining this activity.

6. Training

The project was successful in strengthening the OEP/Range Management Unit by training to BS and MS degree level 23 of its staff members. One participant will complete his degree in 1990. This trained cadre will make OEP/RMU more sustainable and improve the quality of its program. RMU will be capable of continuing to introduce improved range and herd management systems to stock raisers.

In the last 2 years of this project OSU and OEP and the project staff insufficiently measured how many beneficiaries were affected. Also insufficient indicators were established and monitored and little statistical data was collected which measured project impacts.

VI. SELECTED SUMMARY RESEARCH FINDINGS

1. In order to prevent overutilization of parcels the project staff shifted from perennial grasses to Jemalong Barrel Medic and annual grasses. Perennial grasses remain green late in the spring when there are few other sources of green feed. Farmers will not let their sheep go hungry or spend money on feed if there is green forage free in the pasture.

2. Medic has done poorly on clay or gypsic soils. Sites with sand or sandy loam soils produced more than heavier soils. Project staff recommend that Jemalong Medic be seeded only in those areas that receive more than 300 mm of rainfall annually. Plant material staff has collected seed of Medics that can be used in regions of less rainfall 200-250 mm/year.

3. Atriplex plantations (Atriplex spp) are well adapted to arid and semi arid regions but the seedling stage is highly vulnerable to death and desication. The plant contains a high level of digestable protein (10-15%). However, the problems with this plant were: (1) direct seeding was not successful and (2) concentration of salt in the leaves increases water requirements for animals.

More research is needed on Atriplex semibaccata which has a good potential for direct seeding.

4. Ecological constraints are the timing of rainfall which is erratic and inconsistent once it starts. In order to take in account ecological and environmental constraints ideal plant characteristics should be the following:

a) Ability of seed to germinate rapidly over wide temperature range

b) A portion of the seed should be "hard" in order to resist germination in case there is a prolonged dry period, which can kill the seedling

c) The seed/plant should be fast growing and temperature independent as a seedling

d) The Seed/plant should be able to maintain viability for a long time while in the soil

Researchers should take the above mentioned factors in consideration in their breeding and testing programs.

VII. FINDINGS AND CONCLUSIONS

In August 1984, the first evaluation of the RMD project indicated that the most important problem in project implementation was of a technical nature. It was a weakness in the design of the project and the findings were the following:

1. Rangelands were more seriously depleted than had been assumed and required more reseeding and other forms of development before improved management systems could be introduced.

2. Management systems had to be adapted to individual farmers' cropping practices and social constraints.

After the August 1984 evaluation an Action Memorandum for the Assistant Administrator, Near East Bureau was prepared to amend the RDM. On 20 December 1984, it was approved and the following changes were proposed in the project:

a) Increase number of hectares to be reseeded
b) Increase TA and GOT personnel resources and

prioritize extension activities for farmers
c) Develop a foundation seed farm, organize and train private growers
d) Increase the number of sites (private land)
e) Increase training of senior level field technicians

The original target for range improvements was 36,000 hectares. However, the PP signed on 5/2/85 indicated that the project as amended would improve 25,000 hectares of rangeland over 25 sites in Central Tunisia.

The findings of the second evaluation which took place in April 1988 were the following:

1. Project is on track and overall progress in achieving most objectives is good.

2. Major activities of reseeding lands, planting forage resources and conducting animal health activities have been successful in meeting output targets.

3. Assumptions related to both purpose and output were generally valid. However, assumptions that staff activities and demonstrations would lead to long-term adoption of improved techniques by farmers were deficient due to the lack of an effective extension and follow-up program.

4. Land development appeared "technically" successful in collective land areas but social problems developed due to deficiences in extension and administration.

5. Because of the inherent long-term nature of rangeland development it was recommended that strong emphasis be placed on developing extension and sociology capability in the staff and tranferring more resource management responsibilities to local communities.

6. Key "Lessons Learned": Farmers must be fully involved in planning, decision-making and implementation activities if long-term development is to occur.

Project EOP targets were the following for 1987-1989:

	1987-1989 Targets (Hectares)	PACD Status (Hectares)
Cactus	2,700	10,000 spineless cactus
Cactus/Acacia	100	
Acacia/Atriplex	140	
Range seeding	5,000	Degraded Land 12,000
Intercropped Forage Reserve	(1987) 5,061	Annual forages 3,000
Grazing Management	15,000	
Scarify or Rip	100	
Improved Rangeland	15,000	27,000

End of Project Status (OEPS)

At the end of the project, a functioning Range Management Unit (RMU) was established within the MOA that had the capability to replicate the successful interventions of this pilot effort throughout Central Tunisia. In addition, improved range and herd management systems had been introduced and accepted by stock raisers on 25 perimeters. On at least three of the sites sufficient measurable progress: improved range conditions and increased flock productivity, had taken place for eleveurs to continue the recommended practices and encourage non-participating farmers to adopt them.

Sustainable changes caused by the project

The following are long term sustainable changes:

1. 24 OEP staff have completed their training in various specializations, (range management, extension, seed production, sheep husbandry) This cadre forms a solid foundation for OEP, if they stay with this office. Trained staff have been placed at different locations in Central Tunisia.

2. In order to correct the huge problem of overgrazed and poor rangelands, a seed production/marketing unit which can produce local high quality seed as well as import seed has been established.

3. Applied research especially in the first 3 years of the original project was successful. Project staff tested local varieties of seed and came up with a list of winners. Project staff also developed and created prototype farm equipment, which was used by the project and could be produced locally at relatively low costs.

4. Economic analysis in the first 3 years of the original project was strong. OSU computed IRRs, and cost return analysis of animal feed. In addition OSU completed a farm model, which will assist OEP to evaluate economic potential for various forage production technologies that have been made availabe to Central Tunisian farmers. These models can be altered and used for policy and planning purposes.

Weaknesses of the Project

The following weaknesses in the project should be strengthened in future livestock/range management projects:

1. Range committees and local participation in use and management of communual land, did not sufficiently materialize. The Forestry Service did not take over responsibility for these communal rangelands and there remains a lack of leadership necessary to establish a range management system and to maintain it.

2. In the last 2 years before PACD, there was no system of record keeping nor adequate data collection to measure project accomplishments toward targets.

3. The original social soundness analysis of the project stated that the women's role in decision making in use of rangelands, breeding and marketing of animals is limited. The number of female household heads in the project area was small and defined behaviour patterns limited their judgment on farming matters and favored allocation of resources to men. The Extension Service Support Unit of the Central Tunisia Rural Development Authority (CTDA) should have developed information packages tailored specifically for women. During project implementation very little participation of women occurred. Very little is known about women's participation in livestock raising and there is a great need for research in these areas.

4. Foundation seed production because of droughts and other circumstances did not materialize as was planned. Presently there is no efficient local forage production/marketing program. Unless there is a strong local forage seed production/marketing unit, the rangelands of Central Tunisia will remain and become increasingly more depleted. This in turn will create even more serious nutritional problems for flocks as the animal population grows. Lacking is a quality control program of seed. This should be of immediate concern.

5. Coordination between seed production unit, agricultural research and project implementation at all levels should be improved. Communication between seed growers and the extension services should become more efficient.
Seed marketing and multiplication could be privatized.

6. One weakness of this project is the lack of statistical data on numbers of eleveurs who are continuing recommended practices and who are encouraging non-participating farmers to adopt them.

Lessons Learned

1. A crucial short coming in the design of the original project was the assumption that range improvements and increased production could be achieved by means of deferment and resting of the rangeland. The design should have included an assessment of the rangeland conditions. It took 2 years for the implementation team of OSU to discover and turn this technical oversight around.

2. The project exceeded its target of 25000 hectares of improved rangeland by making improvements on 27000 hectares before PACD. However, the number of sites was overambitious. It was very difficult to manage and excute a research program and improved range activities on 25 sites, given the limited resources and equipment which had to be moved around. There are great differences in rainfall in Central Tunisia and soils and ecology at each site may require a unique set of production techniques, factors and packages. During the first 2 years the project staff had some tested recommendations for farmers. However, project staff had to test what would work locally and what did not.

3. Farmers on collectively used land were not organized in local committees at the delegation or site level. The Forest Service never took over management of collectively used rangeland. There seemed to be no leadership to establish a grazing calendar and open and close the rangeland. At PACD these issues were not completely resolved. A sociological study was completed to give OEP guidance on methods to use in the future.

4. The project designed prototypes of equipment which can be purchased and maintained by small farmers and is fabricated locally lacked a follow-up marketing program.

5. Fragmentation of land and relatively small size farms constrained the development of improved rangeland system of rotation. Competition with cereal and other income crops also hampered increased forage production.

6. On a large-scale the project staff used opening and closing of pastures rather than rotational or deferred grazing systems.

7. Social problems arose with the short intensity grazing management system. Shepherds had to split flocks between theirs and the landowners'. They had double work and no immediate benefits. This system did not work.

8. More research is needed to find technologies for grinding, blending and partially drying cactus for feeding.

9. Reseeding of the range technology required relatively large quantities of seed. The original project did not have a seed component. After 2 years when the strategy of implementation changed from resting rangelands to reseeding them, a seed production component was added to the project.

10. GOT and OEP had difficulties in accepting the seed component which never operated efficiently because of droughts, changes of sites each 3 years, insufficient support from research and extension. The lack of a good source of foundation seed caused the following problems for the reseeding activities:

a) Lack of appropriate varieties of Medic seed

b) Unreliable local seed production and untimely arrival of imported seed. Foreign currency expenditures.

Extension Programs included creep feeding, steaming, flushing nutrition, health, genetic improvement and management calendar.

ANNEX A

TECHNICAL COMMENTS

Applied Research

The Project's experimental sites were used to develop sound approaches to range management problems. They served as demonstration and research sites for the following activities and techniques:

1. Resting rangelands
2. Reseeding rangelands
3. Scarifying rangelands
4. Ripping rangelands
5. Establishing living forage reserves (Cactus, Acacia and Atriplex)
6. Establishing and demonstrating rotational grazing management systems
7. Promoting the use of annual forage crops
8. Demonstrating proper nutritional management of sheep flock through flushing, steaming and creep feeding programs
9. Establishing water catchment basins for animal use
10. Promoting proper flock health care through vaccination and the control of both internal and external parasites.

Livestock Improvement

The improved livestock management program included:

a) nutrition,
b) health practices, and
c) genetic improvement.

a) Nutrition

Supplemental feed is being imported to offset the reduction in the amount of forage and rangeland available and the withdrawal of areas reseeded. Supplemental feeding corresponded to the breeding and lambing season in order to improve lambing rates and lamb survivability and growth. Technicians demonstrated practices of supplemental feeding of ewes during breeding (flushing) and lambing (steaming) and the practice of creep feeding lambs to stockmen. Ammoniated straw (wheat + barley) was provided to farmers who

participate in the supplemental feeding program. The program started in summer 1985. Ammoniated straw is more highly digestible and has a higher nitrogen content than untreated straw. Ammoniated straw is not sold in the market. Ammoniation costs are 030 D/kg. Barley prices are controlled by the government and remained at 0120 TD/kg of grain. The price for forage and roughage is extremely high. Nutritional value of forage is not directly reflected in the cost. The grain prices are kept artificially low compared to fodder. The cost of alternative forage is so high that farmers will overgraze continually in order to save "out-of-pocket" expenses. Sheep numbers should be reduced to decrease demand on the forages and their costs. Off farm grazing on "communual range" is a major source of feed. However, the extent of farmer dependence on this source of feed is not well documented. The forage planner was developed to assist farmers to estimate their annual needs of units of forage (UF) and forage products.

The technique of treating straw with anhydrous ammonia was developed in Scandinavian countries and the United States of America. Cereal straw is treated by anhydrous ammonia (NH3). Analysis showed in Tunisia that straw ammoniated produced an increase of 5 to 11% of total crude protein. Digestibility of straw increased by 8-14% of total straw weight. Straw is stored in stacks and covered with mud rather than baled. Other forage resources on the farm are: Olive branches, olive pulp, almond shells, cactus and concentrate feeds or hay and straw which, purchased on the market, serve as a second feed source.

Forage Calender

During March-August feed is plentiful, however from September to February there is a feed deficit. The forage calender was developed by project staff it was a tool for technicians to advise farmers what interventions and allocation of resources to use for their flock (medic seeding, cactus plantation etc) during the feed deficit period. The forage calender spreadsheet which was used for analysis with personal computers was also developed by project staff. Late summer and fall (October/November) are the most critical periods in the annual forage calendar when severe nutritional stress occurs. It is possible to feed ammoniated straw during the lambing period (October/November). Research with different straw types was not completed and costs need to be calculated.

Annual Forage Production

The project promoted oats as an annual forage. Farmers received free seed and technical advice if they agreed to have the project manage part of their rangeland. Farmers preferred oats seed over barley; the latter was infected by insects.

In years of normal rainfall 300 mm, the forage availability on these farms does not meet the needs of the flock half of the year. Rangelands have been over utilized for a very long time and caused depletion of natural resources.

b) Health

Construction Of Dipping Pools
Project built 5 dipping pools in the gouvernorat of Kairouan the cost of each was 800 TD. A portable dipping pool (German) costs 50,000 TD and in addition a truck is needed to transport the dipping pool. Farmers should build their own dipping pools. Before PACD about 63,000 heads of sheep were dipped for external parasites by the project.

The project assisted farmers with vaccination against sheep pox (clavelee and enterotoxemia). Between 1985 and 1987, 29,659 sheep were vaccinated.

c) Genetic Improvements

Farmers received information to upgrade the quality of their stock through selective breeding. Farmers had the opportunity to purchase an OEP ram at a subsidized rate. In 1983 approximately 150 rams were distributed to 871 stockmen. At PACD, 390 rams had been improved through breeding and sold to farmers.

Range Improvement
Herders shifted their lifestyle from semi-nomadic to sendentary farmers. The best grazing lands are now used for cereal or tree crops or are settled. These changes brought about a decrease in individual flock size and grazing area. Remaining grazing areas are heavily and continuously utilized and eroded. Vegetative productivity is lost. Remaining plants on the range are of poor quality and desirable plants are generally absent or present in small numbers. The result is reduced plant productivity, chronic nutritional deficiences, reduced animal fecundity and increased mortality. Flocks are poorly managed.

Under traditional management, rangelands are used during the spring and fall seasons and anytime other forage sources are not available. There are three principle negative results of the traditional management scheme:

1. The vegetative productivity of ranges are reduced because of heavy continuous stocking.

2. Under collective grazing, native forage that could be saved for later critical periods is quickly used up.

3. The fecundity of the flock is reduced and fewer lambs survive because of chronic poor nutrition.

One of the overriding concerns of a stockman is to harvest as much of the spring growth as possible, before summer heat dries up the available forage, or before other stockmen use it up. Other forage resources are then used to bring livestock through the long dry summer season (5 months). Farmers use fat-tailed sheep adapted to the long dry and hot seasons. They use living fodder reserve such as cactus which stores water and remains as green feed throughout the summer months. On depleted ranges reseeding of rangelands had to proceed before resting of overgrazed rangeland could be introduced.

Water Retention Basins

Water Basins (WB) were designed to hold 60 m3 of water. They are important since there is no water available in many areas and cost of water is high. Basins cost approximately 3,500 TD with 50 TD annual maintenance costs. However, cost for basin maintenance and water can decrease as shown below:

Basin costs construction (TD)	Cost per liter water (TD)	Basins filled/emptied per year
3,500	003/004	Twice
	002/003	Three times

Another option for basin costs of construction is that project provides building materials/technical assistance and quality control and farmers provide the labor. In this case the construction cost of the basin could be 2000 TD with 20 TD for maintenance and 001 and 002 TD cost per liter of water. The project constructed 16 water basins of 60 cm3 each. Farmers should participate in construction of water basins in order to reduce cost. Some (WB) were filled with sediment and not maintained others were well maintained (demonstration WB). Private farmers built their own water basins.

Prototype Equipment Development

Scarification of crusted soils improves infiltration rates of rainfall and creates furrows where water nutrients and seeds collect. Project staff found that the scarifier received severe punishment on rocky sites and the locally purchased "Canadian spring toothed equipment" frequently broke. The project staff has built a modified pipe harrow, fabricated from 4 inch iron pipe, steel truck springs and chain and iron bars. Pipes were filled with concrete (for weight) and linked to a tool bar with chain and swivel made from iron bars. When pulled over the ground it cuts furrows that are approximately 3 cm deep. This implement costs 450 (TD). It can also be used to cover broadcasted seed, when a chain loop is added behind the pipes. It can scarify six ha/day pulled behind a 70 HP tractor. Thus the project accomplished development of prototype equipment.

Farming System
The destruction of perennial and beneficial annual vegetation and wide fluctuations in forage available for sheep are caused by irregular rainfall and land that is intermittantly tilled. These factors should be incorporated in future livestock/range management implementation activities. Research should take into account factors such as range seeding techniques of short duration; minimum costs in equipment; and the weather conditions.

Project Management Strategy
Project Management Strategy should be to "charge" the soil with seeds of beneficial annual and biennual plants, that will germinate over a period of years.

Seeding Techniques
Project staff experimented by reducing the internal rate of return on investment by cutting initial costs of seeding and time for establishment. In order to improve efficiency the project staff constructed a tandem cultivator-truax drill assembly. This tool performed two operations at one time in order to reduce initial costs and save time.

A combination of cultivation and drilling or tilling and seeding can increase the internal rate of return (IRR). Another factor to increase efficiency is to increase the lifespan of improved technology by means of maintenance and proper management.

Seed Adaptability and Germination Rates
Field trials indicated that the following annual grasses have the broadest adaptability and highest germination rates (GR):

Lolium rigidum (GR 86%) and Bromus mollis

Perennial Stipa Lagascal (GR 76%) has been successful across test sites and Plantago Albicans (GR 100%). Legumes such as the Medics and Hedysarums are adapted. However, Medicago polymorpha (GR 63%) and Hedysarum spünosissimum (GR 63%) do better on drier sites.

Browse Preference for Sheep and Goats
The preference of the following browse was observed by project staff:

Medicago arborea
Acacia cyanophylla
Atriplex halimus
Atriplex canescens
Atriplex nummularia

In controlled grazing, highly preferred shrubs were mixed with less preferred and grazing was not succesful.

Ripping Rangelands

Ripping was done with a D-8 caterpillar. Perimeters were ripped in order to build a berm at the edge of the parcel to plant the spiny cactus fence. Ripping also increased the effective depth of the soil, increased the infiltration of rain and breaks the soil crust. Furrows left by the ripper protected the emerging plants from dessicating winds. Costs of ripping 1 hectare was 95,000 TD, life of the rip is 10 years. If machinery is inefficiently used, or poorly maintained the economic loss can be substantial.

Grazing Management

Grazing management was the most important single factor of range development in this Project. All the land with good production potential has been tilled and the range provides only half the total nutritional requirements of the flock. Other forage sources such as green cereals, cactus, purchased hay, supplemental concentrates and olive leaves, make up the remainder. Fragmentation of land and sizes of flock that are much larger than the land can support remain problem areas. Stockmen move to rented fields in other regions when their own forages are used up. The project staff have not used rotational or deferred rotational grazing systems on a large scale but were forced to "open and close" pastures based on the vegetative standing crop.

A high intensity short duration grazing management system which accommodates 20 sheep for 3-4 months was tried. However, the shepherds complained. Their flock was composed of landowners sheep and their own. They had to split the flock, which posed labor problems (double work) and no immediate benefits. The landowner was viewed as a rich man from town. Local population often trespassed on his land, even after fences were built. This system did not work. However, the project could control the duration of grazing on those parcels (collective or private), also improve animal efficiency by encouraging use of available forages, vaccinations, control of internal and external parasites and teaching the principles of animal husbandry.

Strategies to improve grazing management need to be further tested particularly at the community level.

Cactus

Period for use of cactus is from end August to end December which coincides with the most critical forage shortage in Central Tunisia. Well managed cactus plantations in 150-300 mm rainfall zone can yield over 20 tons of green matter per year. Crop may build up to 90 tons of green matter with plant densities of 2000 plants/hectare.

During intense droughts shortage of animal fodder and forages occur. The price of straw and hay which are important components of animal diets increases significantly.

Spiny and Spineless Cactus

Spiny cactus (Opuntia ficus-indica) is common throughout Tunisia. Spineless cactus (Opuntia ficus-indica var inerma) is propagated vegetatively and used as a forage reserve plant in arid regions. Cactus conserves water. The roots are at less than 12 inches depth. Moisture is stored in the pads. Planting cactus with 5 meters between the rows and pads 1 to 2 meters apart creates plant density of 2000 plants/hectare. Cactus plantations cannot be used for at least 3 years. Pads can be fed to livestock and spines can be burned off. Applied research gave project staff a better insight in use of cactus as feed.

Cactus can be establised on a wide range of soil types. It is planted at up to 1000 M elevation and under a rainfall range from 150 mm to 1000 mm. Cactus is not well adapted to heavy clay soils. An animal can consume 10-15% of its body weight in cactus. Feeding cactus alone causes diarrhea and weight loss. It is recommended that farmers feed dry course forage such as straw for each kilogram of green cactus. Cactus pads contains 90% water and 10% dry matter. A cactus diet needs to be complemented with hay or high quality feed. In a drought year cactus may be used for 240 days. A farmer should feed 100 kg cactus dry matter per animal or one hectare for every 20 ewes.

More research is needed to find technologies such as grinding and blending partially dried cactus or feeding cactus with Atriplex spp. Also there needs to be more economical data.

Acacia (Acacia cyamphylla)

Leguminous plant, requires special care and irrigation and cost of establishment is high. It contains almost 17% digestible protein or a dry matter basis and provides supplementary protein at critical periods during "Steaming" for ewes and lambing in early fall.

Acacia planting dates are from end September to end November and from January 15 to March 15. Plant densities are 1000 plants/hectare.

RECOMMENDATIONS FOR THE FUTURE

1. OEP needs to take the lead in demons'rating perennial grasses or forage production as an alternative to cereal production. OEP needs to do this by testing and establishing demonstration trials on their own farms throughout the country. Preferably on a scale comparable to commercial operations by livestock producers.

2. The large-scale Medic seed production program needs to be focused in the Zaghouan region and expanded to include the UCP farms that plant Medics for forage production each year. These UCP farms need a special implement called a hearse-rotative. This implement should be made available to them. It should be used for forage Medic seedings and to prepare the seed-beds properly for seed production.

3. OEP needs to establish a National policy for rangeland intervention and usage. The development of this policy needs to be coordinated through the MOA in order to address the issue of alternative crop production programs which will depend on the demand created for these species.

4. OEP should coordinate its other donors projects, GTZ, PIETA and the FAO/RAB. These projects have similar activities to the Range Project Program. Coordination could be accomplished by scheduling semi-annual meetings.

5. The small-scale seed production program should be coordinated with Agriculatural Research and developed to produce experimental seed in quantities large enough to supply the range seeding multiplication activity by the RMU. This seed program should be developed in two phases at the El Grine Seed Center.

A. Phase one, would be for a plant materials program to collect, screen, select and test promising range forage species. This program should continue to use a back-up irrigation system to insure successful plant establishment.

B. Phase two, would develop a model for seed production to be used as a demonstration activity for future seed growers. The seed produced from this program would be breeder (Pre-Basic) Seed that could be used for a start of future commercial seed production.

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6. The Horwood-Bagshow harvesters should be stored and maintained at El Grine and distributed as follows for the harvest season:

A. One new harvester should be utilized at El Grine in the small-scale seed program. One reconditioned harvester should be used for the seed collections on local farms.

B. The other new harvester and any remaining reconditioned harvester should be assigned for use in the large-scale commercial production activity in Zaghouan. They will not be used every year, so proper storage is essential.

7. Train drill operators in the use and daily maintenance of the equipment, and provide them the essential tools.

8. Make future seeding equipment purchases locally.

9. Seed rugged land that would damage standard drill equipment with the rangeland drill or by broadcast seeding, and not with the Truax drill.

10. Produce appropriate varieties of medic seed in sufficient quantities at the right time. Seed should be ordered early by Grafoupast. Local production of seed was not reliable and appropriate varieties were not produced. Jamalog is used because it's the only seed variety available in large quantities. Local mix should be grown instead of Jemalog. Varieties of seed should be adequately tested. Site selection was a problem. Good land was seeded and then soon plowed by farmers to plant cereals.

11. The reseeded grasses, crested wheatgrass and orchard grass were less vigorous than when in environments where they are well adapted. Competition from Bermuda grass (CYNODON dactylon) killed the reseeded grasses. In general, medics did not establish when introduced in one year old grass stands, but when seeded with grasses they out competed them and dominated the stand.

Reseeding Rangelands

Recommendations for reseeding rangelands are:

1. Train drill operators in the use and daily maintenance of the equipment, and provide them the essential tools.

2. Select a variety of barley that is resistant to insect damage.

3. Continue to plant barley with medic in areas for annual forage but discontinue planting barley with the medic on sites selected for permanent range seedings.

4. Encourage farmers to harvest earlier than presently practiced in order to increase the quality of forage and achieve higher total yields.

5. Encourage farmers to plant annual forage as a rotation with cereals (wheat), if forage is needed or for marketing of hay.

6. Reduce government subsidies for wheat to make annual forage production more economically attractive.

7. Order forage seed well in advance and of appropriate varieties.

8. The varieties available need to be further tested in a plant material screening program on large fields.

9. Local medics or appropriate imported varieties need to be grown as a priority in the seed program.

10. Plant early in October before rains begin.

11. Clearly define the seeding program goals and permanent rangeland seeding for lay farmers.

12. Reduce the amount of compensation provided to participating farmers so that they will participate in the range improvement activities not only for the compensation.

13. Discontinue the practice of seeding the mixture of barley with medic for permanent range seedings, but continue the practice for the lay farming system.

14. Test the grazing of medic pods in early fall when forage is most needed as an alternative to spring grazing.

15. Seed rugged land that would damage standard drill equipment with the rangeland drill or by broadcast seeding, not with the Truax drill.

Shrub Plantation

The following are recommendations for shrub plantations:

1. Use manual labor with farmer involvement for plantation and limit the use of transplanters for large fields with gentle slopes.

2. Transplanting should take place late fall or early spring.

3. Use plants not older than 6 months. They need to be conditioned prior to transplanting.

4. Restrict Acacia plantations to the best soils in the higher rainfall regions, until more arid varieties are identified by research.

5. Continue field trials of direct seeding of Atriplex, particularly local varieties.

6. Plant shrubs with a wide row spacing in the less than 300 mm precipitation zone, on good but infrequently farmed land, as a wind break to protect both the crop and soil.

7. Use Acacia as an intercrop in cereal production and evaluate associated crops.

8. Conduct feeding trials in cooperation with INAT, INRAT and other institutions to determine the impact of the high salt of Atriplex on animal performance.

9. Continue relative palatability trials of shrubs and identify the appropriate species for the plantation program.

10. Determine the degree and frequency of defoliation that is optimum for the various shrub species. This needs to be determined either by observations of grazed plantations or by controlled research. The forage quality of Acacia regrowth should be compared to old growth.

11. Manage the range, if grazing can be controlled. Native forage produced between Acacia rows should be grazed. If grazing cannot be controlled, a minimum of two years regrowth is needed after cutting Acacia before it is regrazed. It should not be grazed during resprouting.

12. Place greater emphasis on management of plantations after establishment; use extension programs.

13. Establish national policy on the use of plantations for government and communual lands.

14. Compensate participant farmers on the number of the trees that survive rather than based upon the number of hectares planted.

Range Management

The following are recommendations for range management:

1. Acacia plantations should be restricted to the best soils in the higher rainfall regions.

2. If grazing can be controlled, annual forage which grows between the acacia rows should be used.

3. The Range Management Unit should continue to plant cactus, but only after evaluating if the plantation will help the farmer meet his individual farm needs.

4. More research is needed to determine the most appropriate methods of use, particularly grazing between rows, and direct grazing impacts.

5. Place a priority on management and control of grazing on improved rangeland. Test various approaches to grazing management of collective range.

6. Collective rangeland users should be given a voice in management decisions.

7. Use recently improved rangeland as demonstration sites for the benefits or rational grazing management.

8. Range technicians need to improve their assessment of carrying capacity with the assistance of the "duration of grazing spreadsheet".

9. An evaluation of the forage value of species used in the forage reserve plantation is needed.

10. Shift emphasis on shrub plantation to Atriplex halimus.

11. Practice controlled grazing of plantations in spring and fall and utilize grass and forbs between the rows.

12. Graze for short periods of Acacia or Medicago that are mixed with Atriplex for short periods at high stocking densities.

13. Grazing should not be used to control weeds of low palatibility, if they grow with palatable seeded species.

14. Seasonal changes in relative preference of the different shrubs needs further study.

15. Protect the plantation from grazing during the period of shrub sprouting.

16. More research is needed on the desired frequency of defoliation, alternate species and the forage quality of regrowth as compared to old growth.

17. The use of Acacia as an intercrop with cereal production needs to be encouraged, but also needs further evaluation as a windbreak, and for its positive or negative effects on the associated crop.

Cactus Plantation

Recommendations for cactus plantation are:

1. Use cactus as an intercrop with cereal production planted at wide row spacing (10 m) to provide protection of the crop and soil from wind erosion. Allow the farmer to continue to grow cereals.

2. The role of cactus as a source of water should be encouraged and tested on a broader scale.

3. The annual forage production and ability of cactus to build up a forage reserve for drought years needs further documentation.

4. The maximum and optimum quantity of cactus that can be fed to sheep under Tunisian conditions, during the annual dry season and during drought needs to be determined.

Water Retention Basins and Sheep Dips

Recommendations for water retention basins and sheep dips are:

1. OEP should assist farmers to construct water basins using locally available materials but discontinue building the expensive contractor built basins.

2. Future sheep dips should be contructed of local materials, either the permanent type or the portable unit.

Training

1. Include strong emphasis on leadership and management skills in future training programs since many trained at the masters degree level are assigned leadership positions upon return.

2. The strongest technical non-degree training needs to be provided to the field technician at the site level.

3. Further degree training is needed. INAT needs to develop a range training component and hire at least one faculty member in range management.

4. Professionals trained at the degree level need to be given greater decision making authority to best apply the skills they now have.

5. Short term training of field technicians in both technical and extension methods should be regularly scheduled.

6. Farmer training programs should continue and be scheduled annually.