International Center for Agricultural Research in Dry Areas

ICARDA North Africa Regional Program

TUNISIA/ICARDA ANNUAL REPORT 2003-2004

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ICARDA

ICARDA North Africa Regional Program

Contents

Forword

This annual report (2003-2004) presenting main achievements of ICARDA North Africa Regional Program in Tunisia reflects the strong ties between ICARDA and Tunisian Agricultural Research System. These achievements have been possible because of the commitments and the dedication of IRESA, ICARDA and all National Institutes partners.

Since its establishment in 1977, ICARDA has played a key role in strengthening agricultural research and development in North Africa, particularly in Tunisia through the implementation of research and development projects involving many research and academic institutions. The partnership with Tunisia started with cereal and legumes breeding programs, which led to the development of large number of varieties and production packages that farmers are applying to increase productivity.

During recent years ICARDA widened its scope of activities in the country to address issues related to key priority problems of increasing agricultural productivity, sustainable management of natural resources, alleviating poverty and developing human resources. ICARDA – Tunisia collaboration covers now some 18 projects involving many national research/academic institutions. These projects cover biotechnology, promotion of durum wheat low-cost technologies, scarce water management in rainfed agriculture, management of rangeland, and improving livelihoods of rural communities in mountains and rangeland areas. This has been possible because of the valuable support of many donors, who worked closely with ICARDA: IFAD, AFESD, IDRC, SDC, BMZ, USDA, and FAO.

The tripartite collaboration between Tunisia NARIs, USDA and ICARDA should be highlighted. This collaboration aims at improving the livelihoods of rural communities, build human capacities, and exchange experiences in arid and semi-arid regions of Tunisia. Six projects are implemented and involve more than 10 research institutes and universities in Tunisia and USA (IRESA, IRA, INAT, INRAT, ARS, Purdue University, Mississippi University, University of Minnesota) in fruitful partnership with ICARDA. Within this framework, important issues were tackled as "the sustainable water management in the arid regions of Tunisia", the "biological diversity, cultural and economic value of medicinal, herbal and aromatic plants in southern Tunisia", "Improvement of oats productivity", "Improvement of the rural livelihood in North Africa and West Asia through strengthened teaching and research on sheep and goat production", "biological control of weeds with plant pathogens". In addition, ICARDA in collaboration with USAD launched an initiative to develop Maghreb biotechnology capability.

ICARDA and IRESA would like to thank all donors, ICARDA Management/scientists, NARP Tunisia Management/scientists for their efforts to make all these achievements possible.

Dr. Mohammed El Mourid
ICARDA North Africa Program
Regional Coordinator

Prof. Abdelaziz Mougou
President IRESA

REGIONAL INITIATIVE FOR DRYLAND MANAGEMENT (RIDM)

History of RIDM

The Regional Initiative for Dryland Management (RIDM) grew out of the multilateral working group on the environment, an element of the Middle East Peace Talks. It was created in 1995 to promote technical cooperation between 4 Arab Nations (Tunisia, Egypt, Jordan, and Palestine).

Phase I (1996- 1999): ***Initiative of collaboration for combating natural Resources degradation in MENA Regions.***

The work program was based on Regional support programs in 5 areas

- Germplasm in arid lands
- Economic Forestry and orchards
- Rangeland Management
- Marginal water and saline soils
- Capacity Building

Phase II (2000-2003), the Initiative would have to operate with a different title: ***Regional Initiative for dryland management in MENA Regions***, and took place in three component:

- Watershed Management;
- Treated Wastewater and Biosolids use.
- Socioeconomics and Policy.

Extension of Phase II (July 2003 – June 2005).

The Initiative RIDM took place with 20 sub-projects which differ from one country to another and from which Tunisia has 4 sub-projects:

- Sub-project 1-3: Conservation of Genetic resources.
- Sub-project 1-4: Development of Improved Management for soils, water, and germplasm.
- Sub-project 2-3: Technologies and guidelines for the safe use of treated wastewater.
- Sub-project 2-4: Technologies and Policy options for the use of Bio-solids in dry agriculture.

The total cost of the Tunisian project is estimated at 354,000 $ US.

Sub-project 1-3 (S/P 1-3): Conservation of Genetic Resources

Background

The vascular flora of Tunisia is composed of more than two thousand species, twenty of them disappeared completely, hundreds of others species would disappear in the next years, what would represent a real ecological disaster and a real genetic erosion.

This is due to man's action "Over-grazing and non-adapted cultivation techniques", and to climatic modification.

This complex and alarming situation of the deterioration of the natural vegetation of the disappearance of palatable rangeland species incited the government to take the necessary measures aiming to protect the natural heritage such as:

- Establishment of a National Gene Bank which work with the collaboration of National Research Institutes, Agricultural Development Companies, nurseries, and co-financed projects such as RIDM.

Considering all above considerations, Sub-Project 1-3 has been installed at INRGREF Gabès station to create a local gene bank. Seeds are either collected from the Southern part of Tunisia aiming to revegetate Menzel El Habib region by propagation and delivery to rural communities.

Objectives of S/P 1-3

- Preservation and improvement of indigenous species that resist to drought and are able to fix moving sand.
- Gene bank constitution by collection, identification and treatment of indigenous species that will be used in the project area and the neighboring governorates that have similar climatic and edaphic condition.

Activities of S/P 1-3

- Survey, seed collection and establishment of demonstration site for in situ conservation of endangered seed varieties and range species. This activity is financed completely by RIDM for an amount of 20.100 US $.
- Conduct field days for farmers which is also financed by RIDM for 2000 US $.

Outputs of S/P 1-3

- Establishment of a list of indigenous species and constitution of a gene bank.
- Improvement of Farmers awareness on conservation of endangered arid land species.

Main achievements of S/P 1-3

- A Survey, description and in-situ conservation of endangered seed tree varieties and rangeland species in reclaimed arid land was undertaken, 20 species were concerned and the survey took place in the National Park of Bouhedma at about 200Kms North West of Gabès, Menzel El Habib and Henchir Snoussi and a herbarium of these species was constituted.
- 32 indigenous and exotic seed species were collected from the region of Menzel El Habib and Bouhedma National Park. INRGREF wishes to collect the maximum of seeds as much as possible from the southern part of the country where climatic conditions of this year were favorable for natural vegetation growth.
- Field days for farmers will be conducted during the first quarter 2005.

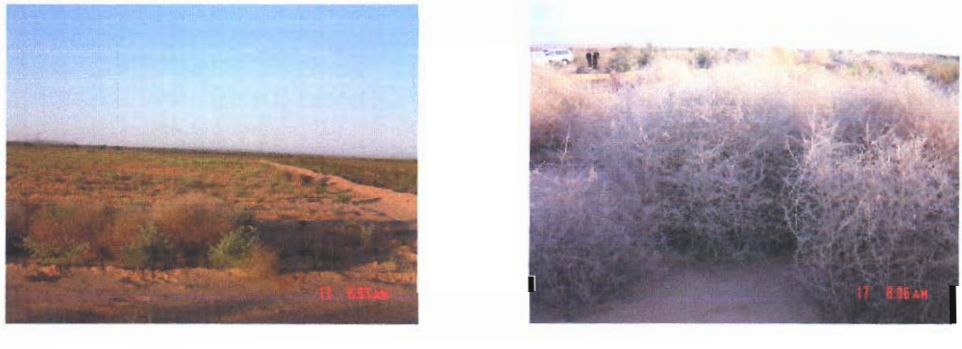


Figure 1. In situ conservation of endangered shrubs and tree varieties and rangeland species

Figure 2. Constitution of gene bank of endangered pastoral species

Sub-Project 1- 4 (S/P 1-4): development of improved management for soils, water, and germplasm

Background

In Tunisia, there are about 106.000 Km^2 of desertic and semi-desertic lands affected by desertification. This represents about 65% of the total country surface area. In the south, almost all lands are being desertified. The desertification process is induced by the retrogression of the vegetation cover which is in turn caused by over-use of natural rangelands and an irrational utilization of agricultural lands. Furthermore, the marginal physiographic conditions, unfavorable hydrological and climatological patterns, as well as socioeconomic factors affecting these lands contribute towards their degradation and ultimately their loss. This is especially true for those lands located below 200 mm annual rainfall which are jeopardized by ever-increasing erosion which is translated into lower soil fertility.

Since 1990, the government of Tunisia has undertaken an ambitious program in reforestation and combating desertification, however, it will be necessary to engage the rural communities through holistic pilot projects in order to demonstrate the utility of joint action: Menzel El Habib has been chosen as a pilot project in the south.

Government protection programs were intensified in the late 1980's in this area to combat the movement of sand dunes and to provide alternatives for pastoral communities. In spite of this effort, there is a need to approach the problem with better techniques and communities involvement. In 1997, the Initiative <<RIDM>> took place in this project aiming to collaborate in matter of controlling natural resources degradation and encouraging communities' participation in combating desertification.

Menzel El Habib is located in Gabès province in the south east of Tunisia. This area covers approximately 120.000 Ha in the form of desertified plateau and coastal plain, the average annual rainfall is estimated at 80-100 mm. The population is estimated at 13.000 and its main activity is livestock where the number of animals is estimated at 50.000 heads of sheep and goat.

Objectives of S/P 1- 4

The main goal is to protect and conserve the natural resources and reestablish an ecosystem diversity by reversing the degradation through the introduction of community know - how,

the lands cape can be developed in such a way as to attain a sustainable quality of rural community life through economic use and steward ship of their natural resources.

Activities of S/P 1-4

- Establish a nursery for forest, orchards and other special purpose plants
- Sand dune biological fixation:
- Natural resources conservation and watershed management (plantation and revegetation, regeneration for grazing purposes:
- Establish demonstration areas
- Socio-economic assessment

The cost of this SP is estimated at 129.000 $US.

Out puts of S/P 1-4

- Establishment of Oued Zayed Nursery and production of 70.000 seedling / year for sand dune fixation and reforestation.
- Biological sand dune fixation on an area of 100 Hectares / year.
- Regeneration of rangeland species and enclosures of grazing areas for conservation purposes on an area of 500 HA / year. Agroforestry by olive plantation on an area of 50ha / year.
- Establishment of 5 demonstrations sites with suitable watershed management techniques, sand dune fixation and rangeland improvement techniques.
- Completion of socio-economic assessment.

Main achievements

(i) Nursery establishment and seedling production: Oued Zayed nursery created by RIDM since 1998 has been rehabilitated since July 2003 and seedling production during the season 2003- 2004 is estimated at 110.000 units.

(ii) Sand dune fixation : An area of 75 Hectares has been fixed by multipurpose species since November 2003 and irrigated either by flood irrigation and drip irrigation

(iii) Natural Resources conservation and watershed management (Plantation and vegetation, regeneration for grazing purposes):
- An area of 500 Ha is being closed for grazing with the agreement of target collectivities since October 2003. A compensation process has been applied by offering, gas cookers and bottles by the Initiative to 36 families.
- An area of 50 ha has been planted by olive trees since December 2003 with the participation of target population.

(iv) Establishment demonstration sites with suitable techniques to combat desertification and rangeland management.

(v) Socio-Economic Assessment

This activity has been committed to INRGREF and analysis is on going.

Sub-Project 2-3 (S/P 2-3): technologies and guidelines for the safe use of treated waste-water

Background

One of the most import natural resources for socio-economic development in arid and semi-arid areas is water. More than 75% of Tunisia is under arid and semi-arid condition. These

areas are facing two major obstacles to its continued development: a growing scarcity of water resources and degradation of soil productivity.

Water resources of arid area of Tunisia are characterized by low water quality, over exploitation of fossil resources and a high risk of coastal ground water Stalinization due to seawater intrusion. The average annual precipitation ranges between 50 and 220 mm/year, with 80% of the total area receiving less than 120 mm/year. Precipitation exceeding 180 mm/year principally occurs in mountain areas, where only a small portion percolates to become groundwater.

The need for providing good water quality for irrigation is urgent to meet the increasing demand of food. Simultaneously, the same water is needed to satisfy the other economic activities (domestic, industrial, tourism). Under such conditions low water qualities from wastewater treatment plants should be used to alleviate high water quality demand. However, protecting public health environment and soil degradation are the main concerns associated with wastewater reuse. The challenge is to reuse treated wastewater for crop production in a highly skill manner to minimize the risks.

Objectives of S/P 2-3

- To utilize treated wastewater in irrigation under controlled conditions which ensure minimum health risks to human and environment;
- To identify economic crop varieties that present the optimum mix of income and public safety;
- To determine design criteria for semi-tertiary treatment (sand bed) based upon local conditions and experience;
- To study public acceptance attitudes of agricultural purposes in arid area of Tunisia.

Activities of S/P 2-3

- Effect of tertiary treated wastewater on cash crop
- Effect of secondary treated wastewater on different crops
- Revision of Guidelines for treated wastewater reuse
- The final component is a socioeconomic study on the impact of TWW reuse.

Outputs of S/P 2-3

- Measurements of impact parameters of tertiary treated wastewater on cash crops (bacteriological quality of water, soil and plant, nutrient content of water).
- Measurement of impact parameter of secondary treated wastewater on cash crops (Bacteriological quality of water, soil, and nutrient content of water).
- Draft guidelines presented for adoption at the end of project (Guidelines on physical, chemical and biological parameters of treated wastewater).
- Socio-economic impact assessment of treated wastewater.

Main achievements

(i) Effect of tertiary treated wastewater on cash crops:

- Establishment (In November 2003) of a methodology and technical procedures for the monitoring of Treatment station and laboratory analysis (water, soil and plants).
- Cultivation of 3 commercial crops irrigated with TTWW is conducted in 2 different areas (Dissa perimeter and ONAS station).
- This experiment started in May 2004 with the collaboration of IRA Gabès.

(ii) **Effect of secondary treated wastewater on cash crops:**

- This activity is conducted in Dissa perimeter since the 2000 by 24 farmers. Actually 180 Ha of the total area (400Ha) are exploited by these farmers.
- Two fodder crops (alfalfa and Oats) are cultivated under 2 irrigation methods surface, sub-surface for alfalfa to minimize microbiological contamination and water efficiency.
- Fruit trees such as granates, pears, almonds and apricots are under drip irrigation system.
- Data are collected by <<IRA>> researcher with the collaboration of <<ONAS>> Gabès during the growing season by taking samples of water, plants, soils, and ground water.
- Periodical analyses (physical, chemical and biological) are made in the laboratories of << IRA>> Gabès and CITET.

(iii) **Revision of guidelines for TWW reuse**

- ***Socioeconomic impact assessment***

- Study of public acceptance attitudes of treated wastewater reuse for agricultural purposes in DISSA perimeter has been started by a Tunisian graduate student of the university of Montpellier <<France>> since last April 2004.
- The total cost of this SP is 107,000 $US.

Figure 3. View of waste water treatment plant

Figure 4. Gabès ONAS/ green pepper plot irrigated with TTWW (July 2004).

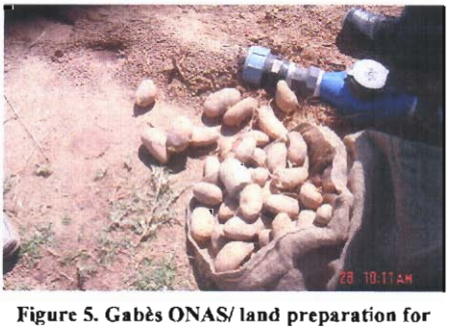


Figure 5. Gabès ONAS/ land preparation for potatoes cultivation under TTWW (Sept 2004).

Figure 6. Gabès ONAS/ tomatoes cultivation under drip irrigation with TTWW (Sept 2004).

Figure 7. Dissa perimeter/filtration percolation station constructed by IRA Mednine (2002). Up ground view.

Figure 8. Dissa perimeter/ Green pepper cultivation experiment under drip irrigation with TTWW from IRA filtration percolation station (July 2004).

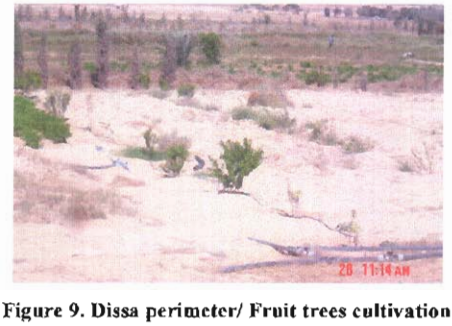


Figure 9. Dissa perimeter/ Fruit trees cultivation experiment under drip irrigation with TTWW from IRA filtration percolation station (July 2004).

Figure 10. Wali, Menzel Habib/ Solar energy for pumping water at low pressure for irrigation of cash crops (Sep 2004).

Sub-Project 2-4: Technology and poucy options for the use of bio-solids in dryland agriculture

Background

Tunisian soils often have organic-matter contents that are low for productive agriculture.

Consequently, there are needs for both water-resources development and soil-fertility improvement. One way to cope with these problems is to reuse wastewater sewage sludge (biosolids) in agriculture.

The sludge generated by wastewater treatment plants is not part of wastewater disposals, but nonetheless constitutes a potentially dangerous by-product of wastewater treatment. While the sludge contains fertilizer elements that may prove to be profitable (after appropriate treatment), it is also likely to contain toxic mineral and organic trace element, as well as pathogenic microorganisms.

The agricultural utilization of sewage sludge requires a high level of sanitation and stabilization of its organic matter in order to maintain soil, water and air qualities, and time to use such bio-residues appropriately as soil amendment and as sources of nutrients for plants. Improper sanitation poses a serious threat to human and animal health.

Objectives of S/P 2-4

- Evaluation of the chemical and biological properties of various bio-solids (compost) used in agriculture and soil fertilization and the effect of each use on soil, water and crops.
- Identification of suitable crops for cultivation using bio-solids and determination of appropriate application rates.
- Producing guidelines for the safe use of bio-solids (compost).

Activities of S/P 2-4

(i) Effects of composting sludge on different crops:
  - Preparation and collection of sludge.
  - Composting sludge in addition with other element.
  - Monitoring physical and chemical activities.
  - Monitoring microbiological parameters.
  - Installation of crops.
  - Agronomic monitoring.
  - Yield and fruit quality evaluation

(ii) Improve the legislation on bio-solids reuse: Collection of the existing data from previous researches including results from Activity 1 and elaboration of methodological guidelines for composting sludge and use in dryland agriculture.

(iii) Seminar organization and cooperation with the National agency for environmental protection and use of bio-solids in agriculture.

(iv) Socio-economic on impact of use of bio-solids in dryland agriculture.

Outputs of S/P 2-4

- Measurement of impact of bio-solids reuse on soil and crops.
- Draft Decree on bio-solids reuse.
- Socio-economic impact assessment of bio-solids reuse.

Main achievements

Composting sludge is conducted actually with the collaboration of IRA GABES with different mixtures (wheat straw, olive mile oil, etc.)

- When compost is mature, cultivation of cash crops (carrots, potatoes, alfalfa, and barley) will be conducted in Dec 2004 in the region of GABES.
- 2 experiments of biosolids reuse in cultivation of some species (sorghum, barely) are conducted by 2 graduate students at INRGREF research stations since July 2004.

- . Periodical analysis (physical, chemical, Heavy metals and bacteriological) of compost are conducted by IRA and CITET.

The cost of this SP is estimated at 66.000$US

Figure 11. Drying in open basins of waste water sewage sludge

Figure 12. Composting of waste water sludge

FUNCTIONAL GENOMICS OF DROUGTH TOLERANCE IN CHICKPEA AND LENTIL

ICARDA (SYRIA), BIOCENTRE (FRUNKFURT), INAT (TUNISIA)

Research Team: Hamza Sonia (associate professor, INAT) and Medini Maher (PhD student, INAT). Laboratoire de Génétique et Amélioration des Plantes (INAT, Tunisia)

Starting date- ending date : 2002-2004

Introduction

The goal of Tunisian partner in the BMZ project was to study the transcriptional response of chickpea seedlings to drought stress. The technique used for determining sequence induced by drought stress is DDRT-PCR based on the observation of polymorphic patterns resulting from amplification of transcripts extracted from stressed and non stressed seedlings. This technique is less efficient than microarrays since the later can assess simultaneously the expression of thousands of genes in a single experiment. However microarrays offer only the possibility to monitor the expression of the feature that is in the chip. Despite DDRT-PCR technique is laborious, time consuming this technique offers the possibility to identify new sequences involved in drought stress and it much less costly than microarrays. Moreover chickpea chips are not available in the market. A chip of *Medicago trunculata*, a closely related leguminous to chickpea has been developed, however this model plant is not a crop and therefore may lack several genes related to drought a chickpea crop may contain. The use chickpea germplasm known to be resistant to drought would be more appropriate to analyse the expression patterns in response to drought. In this study a daisy type of chickpea ICCV2 known to be tolerant to drought stress was used.

Results

Identification of new sequences by DDRT PCR

DDRT-PCR was reconducted using other kits than GenHunter kits. A combination of enzymes provided from Promega (MMLV, DNAase, RNAase inhibitor, Taq polymerase) was used instead of GenHunter kits and were able to provide nice polymorphic patterns. Several polymorphic bands were isolated from PAGE gels and for new sequences were obtained. H1, H3, H4 and H7 and their homology after BLASTN and BLASTX were shown in table1.

Sequence	BLASTX		BLASTN	
		E value		E value
H1	Cold regulated gene (Triticum)	6^{e}-21		
H3	ParB nuclease domain -cont	0.009	*Medicago trunculata* chromosome 2	2^{e}-04
H4	EST AU070273	5.6	*Medicago trunculata* chromosome 2	0.01
H7	Histone H3	9.5	Histone H3	

Semi-quantitative RT-PCR

Primers were designated from the obtained sequences for RT-PCR in order to verify whether theses sequences were really induced by drought or are artefacts. Because of lack of radioactivity, nothern blot couldn't be assessed. An alternative solution was the use of semi-quantitative PCR in multiplex conditions. The multiplex consisted of the amplification of the transcripts from stressed and non stressed seedlings simultaneously with to sets of primers. The first set is primers designated from a constitutive gene, the actin gene of pea. The second set was primers designated from the candidate sequences. The multiplex PCR was assessed for the sequences 181, 192, 219 and 214 (a sequence homologous to beta akin) as well to the new sequences identified later (H1, H3, H4 and H7). Interesting induced profile was obtained with the sequence 219, H1, H3 and H4. In fact comparing to the constitutive expression of the actin gene which showed equal intensity of the bands between non-stressed and stressed seedlings), PCR amplification with the primers designated from the candidate sequences generated differential banding intensity (fig 1). The sequences 219 and H3 were early induced by drought since at the first harvest of mRNA (7 days old seedling) differential intensity between PCR product from non stressed and stressed seedlings was observed. However the sequence H1 is induced later because PCR product was observed at 10 days after sowing.

The sequences 182, 192 and 214 were not induced by stress and could be experimental artefacts. The finding that sequence 214 homologous to βAKIN1.factor was not induced by stress is consistent with the observation described by Buitink et al 2003 who showed that *Medicago trunculata* βAKIN1 (MtAKINβ1) is constitutively regulated during germination of desiccated tolerant seeds.

Sequences	BLASTX	E value	Function/ *related to drought
181	hypothetical protein [*Arabidopsis*]	1e-23	unknown function
192	alanine aminotransferase,	8e-14	central role in photorespiratory pathway
214	AKINβ1 [*Medicago truncatula*]]	0.67 BlastN 1e-23	***Belong to SnRK1 complexes involved in desiccation tolerance, osmotic stress
219	protease inhibitor/seed storage/lipid transfer protein family	1e-08	*** lipid metabolism (drought)
H1	cold regulated protein [*Triticum*]	6e-21	***LEA proteins involved in cold and drought
H3	ParB like nuclease domain -containing protein	0.009	?
H4	EST AU070273	5.6	?
H7	*Medicago sativa* mRNA for histone	4e-04	***chromosome folding

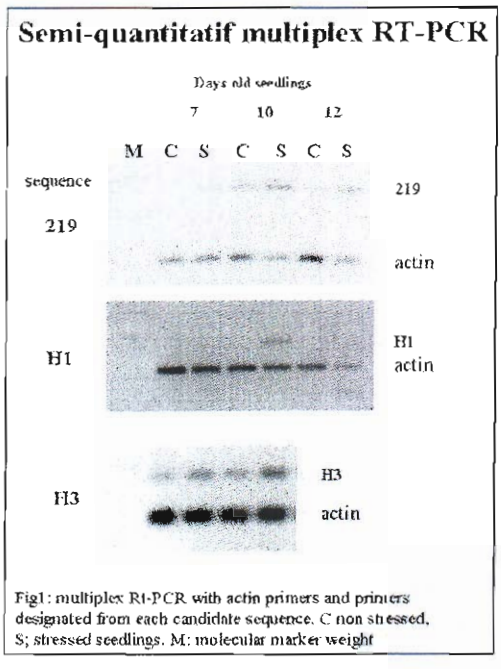


Fig1: multiplex Rt-PCR with actin primers and primers designated from each candidate sequence. C non stressed, S; stressed seedlings. M: molecular marker weight

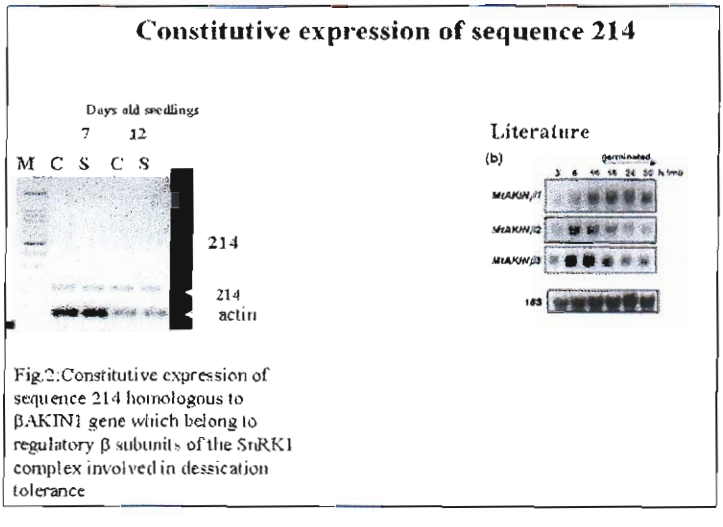


Fig.2:Constitutive expression of sequence 214 homologous to βAKIN1 gene which belong to regulatory β subunits of the SnRK1 complex involved in dessication tolerance

Conclusion

DDRT-PCR technique was able to identify sequences related to drought. From eight polymorphic sequenced bands, four showed inducible patterns (50%) demonstrating that in our condition DDRT-PCR technique is powerful for isolating differentially displayed sequences.

Two candidates sequences (219 and H1) were homologous to genes known to be involved in drought stress. The weak homology of the sequences H3 and H4 to predictable function lead to more investigation on the role of these sequences in drought tolerance.

In the future notherns will be realised to verify the inducible expression profiles of the for putative sequences (219, H1, H3 and H4).

This study brings to several perspectives: It would be appropriate to determine the whole sequences of these putative – drought related sequences by race PCR as well the identification of the promoter sequences. These finding would predict and look for which transcription factor that may interacts with the isolated promoters.

G.I.S. FOR WATERSHED MANAGEMENT IN THE ARID REGION OF TUNISIA (PROJECT NO. FG-TN-103)

1. Background

Objectives

(i) Investigation on the hydro-morphological behaviour of arid watersheds,

(ii) Development of tools for management and decision-makers based on GIS and IS technologies for a sustainable use of water and soil resources in arid environments.

Partner institutions

- Institut des Régions Arides (IRA), Médenine, Tunisia
- Purdue University, West Lafayette, USA
- International Centre for Agricultural Research in the Dry Areas (ICARDA), Aleppo, Syria.
- Institut National Agronomique de Tunisie (INAT), Tunis, Tunisia

Funding

Foreign and Agricultural Services (FAS) of the USDA.

Project team

Name	Institution	Function
Mohtar, Rabi H.	Purdue Univ. West La Fayette	Associate Professor US principal investigator
Khatteli, Houcine	IRA – Médenine – Tunisia	Professor Director General
Ouessar, Mohamed	IRA – Médenine – Tunisia	Researcher Foreign principal investigator
Ben Mechlia, Nétij	INAT – Tunis - Tunisia	Professor
Bruggeman, Adriana	ICARDA – Aleppo	Expert Natural Resources Management Program
Engel, Bernard A.	Purdue Univ. West La Fayette	Professor Head of the Purdue Center for Advanced Applications in GIS
Sammons, David J.	Purdue Univ. West La Fayette	Professor Associate Dean of Purdue University School of Agriculture Director of the International Programs in Agriculture
Abdelli, Fethi	IRA – Médenine - Tunisia	M.Sc.
Bracmort, Kelci	Purdue Univ. West La Fayette	Student
Ouerchefani, Dalel	IRA – Médenine - Tunisia	M.Sc.
Zerrim, Ammar	IRA – Médenine - Tunisia	Engineer

2. Achievements

2.1. Overview of water harvesting in Tunisia

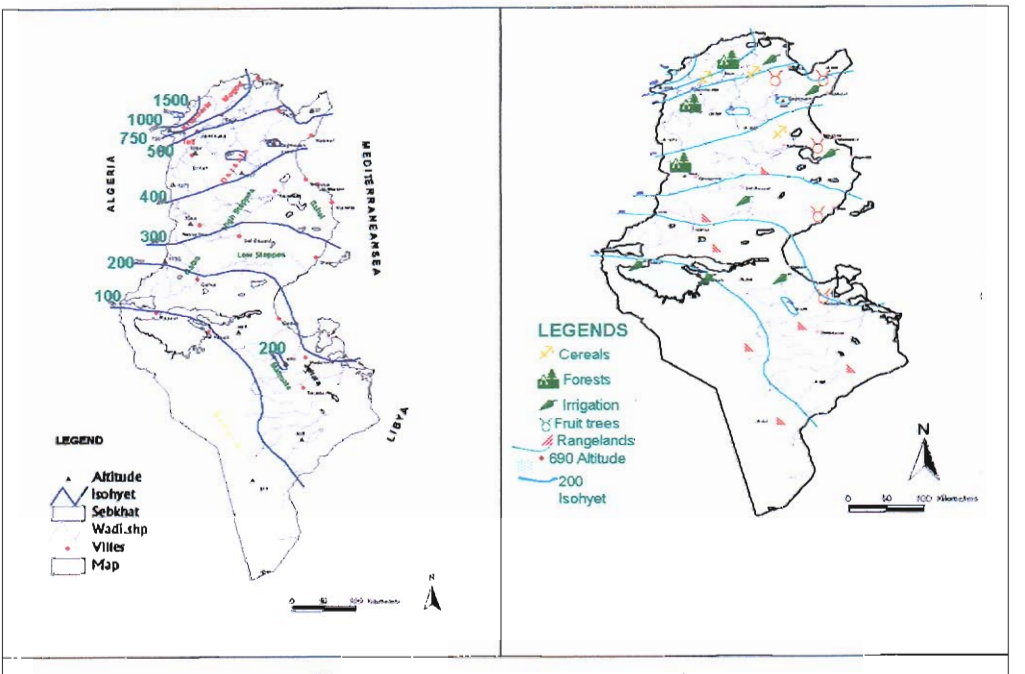


Figure 1. Agro-ecological zones of Tunisia

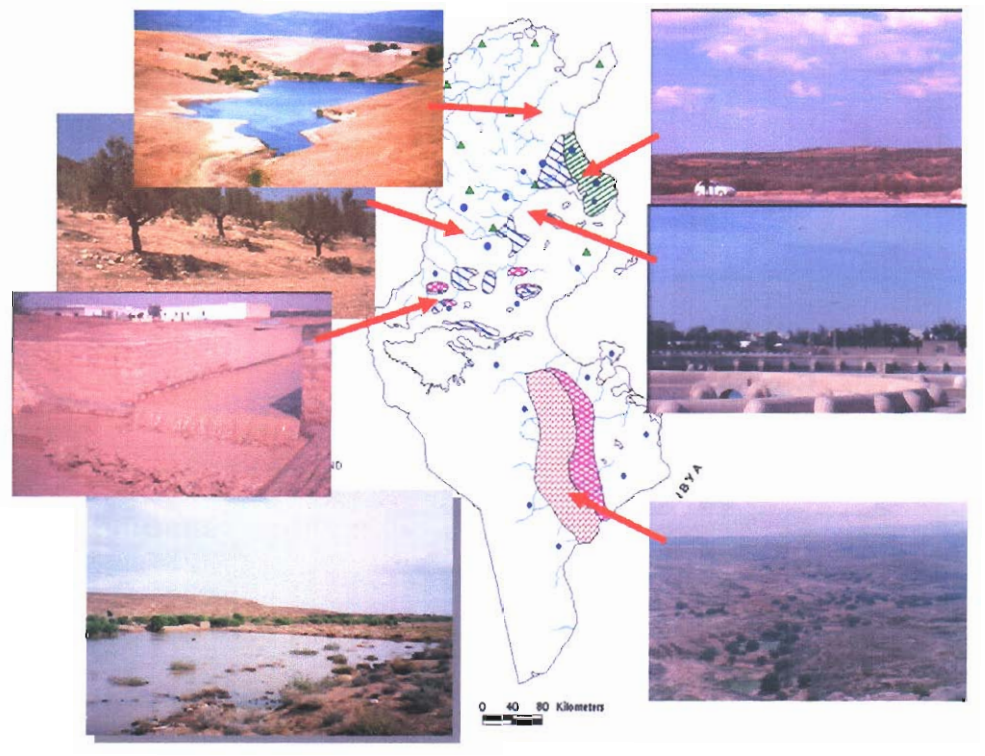


Figure 2. View of water harvesting techniques in different agro-ecological zones of Tunisia

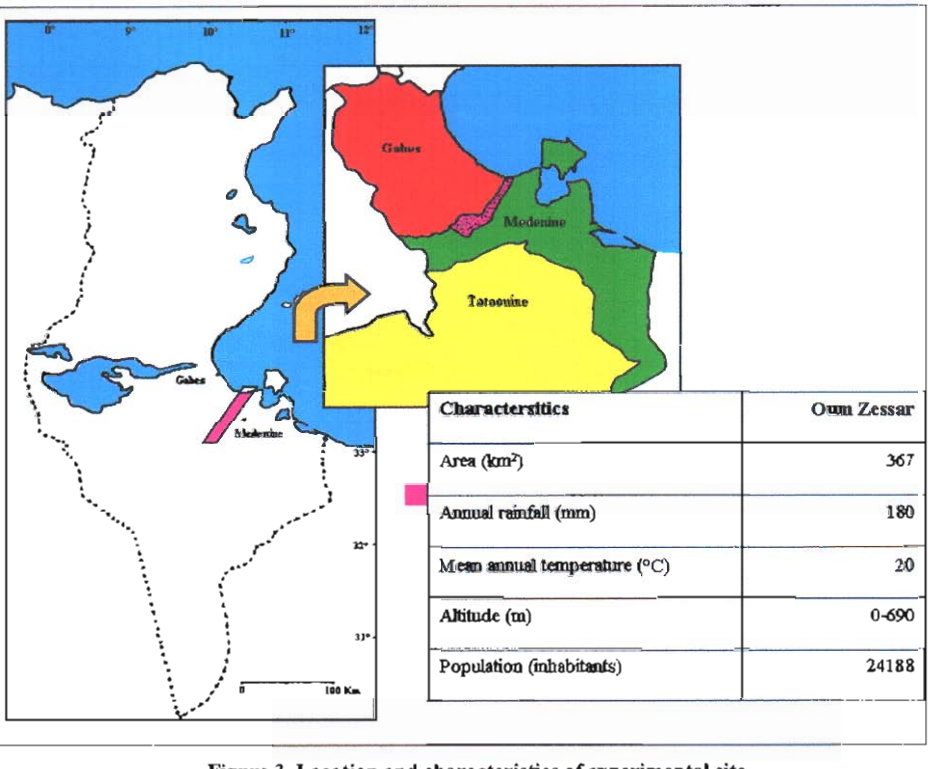
2.2. Watershed modelling with SWAT

The US-developed Soil Water Assessment Tool (SWAT), jointly developed by the USDA-ARS Grassland, Soil and Water Research Laboratory and Texas Agricultural Experiment Station Blackland Research Centre, both Temple Texas, is used to model the Oum Zessar watershed in Tunisia. The following modelling issues and data have been reviewed in detail:

- climate data
- soil physical data
- watershed delineation
- initial soil moisture content
- Irrigation from reach (to simulate water-harvesting by Jessours)
- crop dormancy
- surface runoff delay
- lateral flow
- groundwater processes
- assignment of climate data to sub-basins

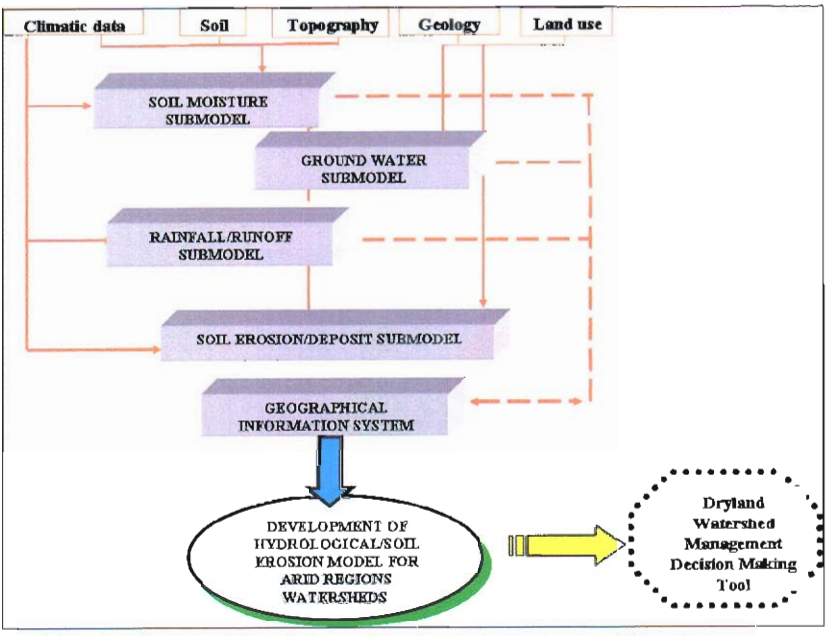
- How groundwater recharge and transmission losses being modeled as these are functions of water level in the reservoir.
- How to best represent Jessours, Gabions, and Tabias (multiple of these within the subbasin?

Study site

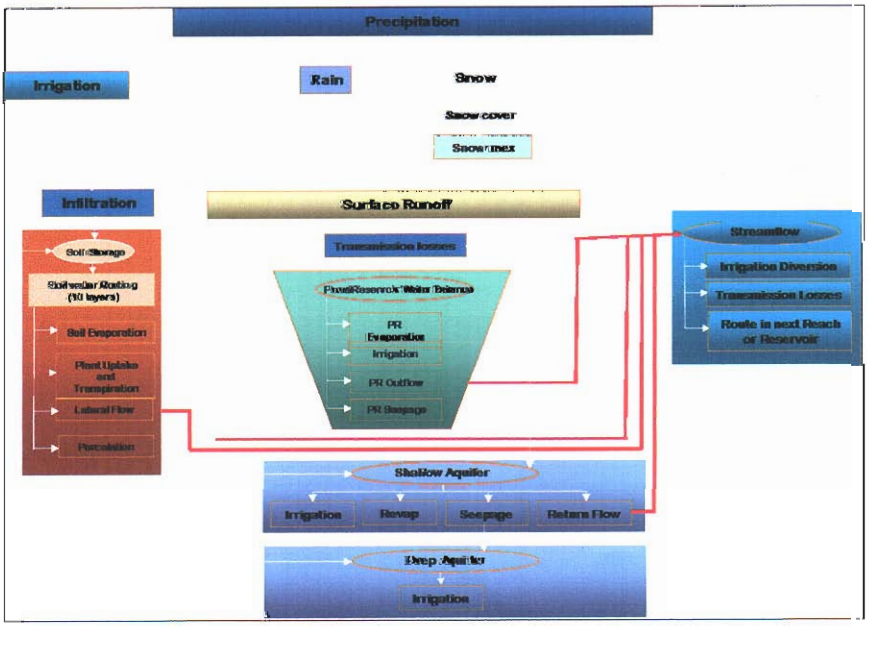


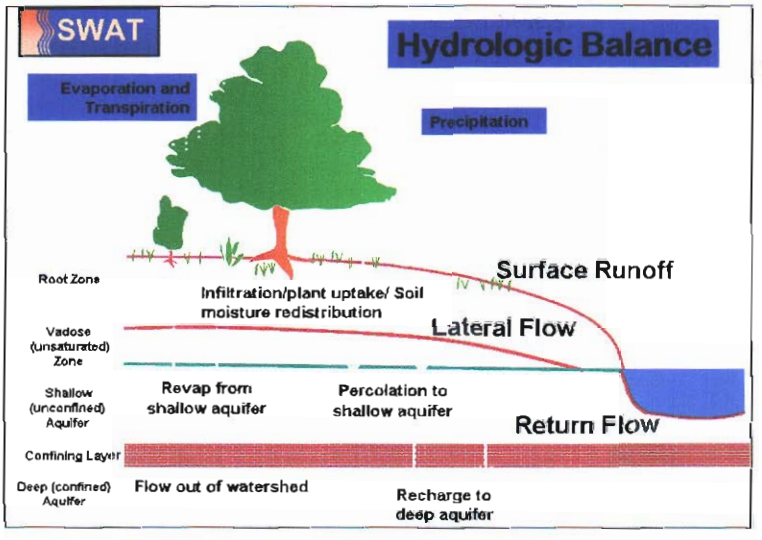
Characteristics	Oum Zessar
Area (km²)	367
Annual rainfall (mm)	180
Mean annual temperature (°C)	20
Altitude (m)	0-690
Population (inhabitants)	24188

Figure 3. Location and characteristics of experimental site



Schematic of pathways available for water movement in SWAT





Input data

The map Grid themes

- Elevation map Grid (DEM)
- DEM Mask (Watershed of oum Zessar)
- Land use map Grid
- Soil map Grid

Weather Data

Soils data

Crops data

Water data (Groundwater and irrigation)

Examples of input maps

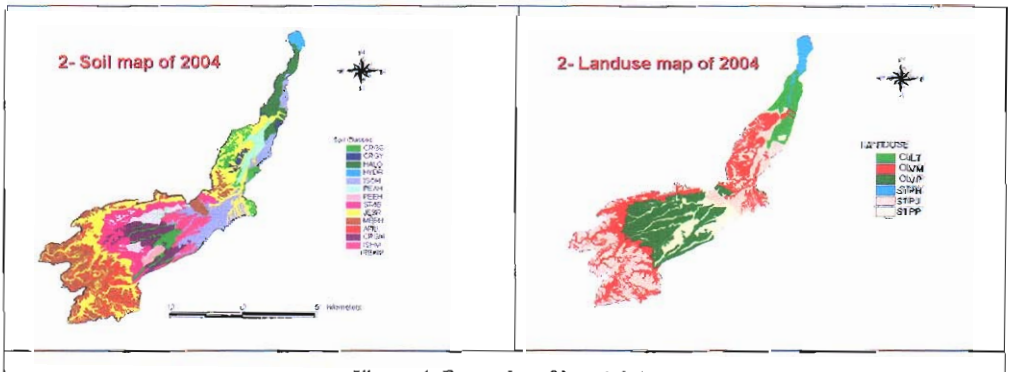


Figure 4. Examples of input data

2.3. WHT evaluation tool

A WHT evaluation tools was developed for jessours, tabias and gabions. The evaluation tool gives an index of the WHT present-day functionality based on physical inspection of a number of characteristics vital to the functionality of the WHT. The evaluation tool was applied to a random sample of WHT in southern Tunisia. The evaluations rated the following WHT characteristics: cross section, infiltration potential, cropping potential for cultivated areas, drainage area vegetation, dike material, and dike erosion. All WHT evaluated were in fair to good condition.

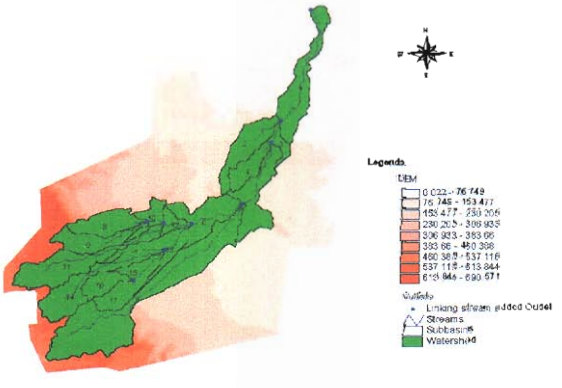
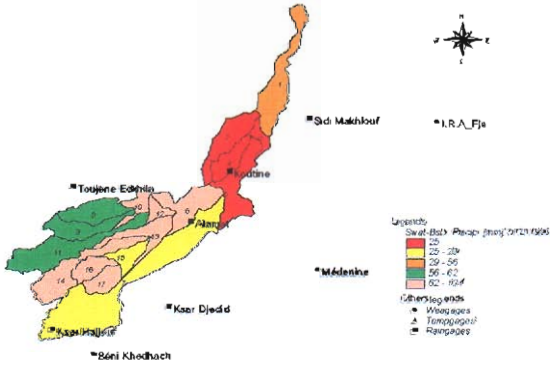
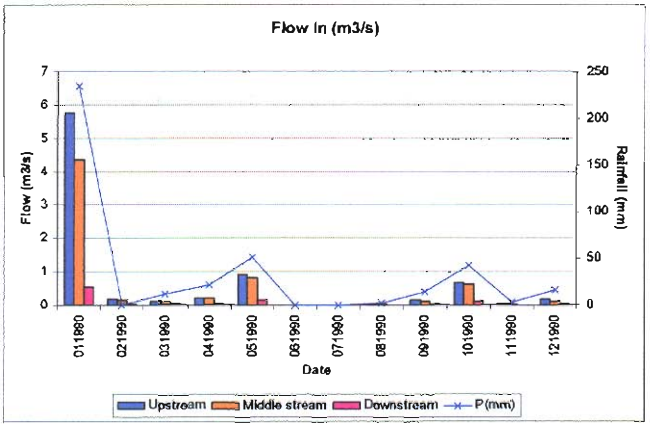


Figure 5. DEM and watershed delineation



It was used also to estimate the inflow and the outflow at the level of the different compartments of the watershed.



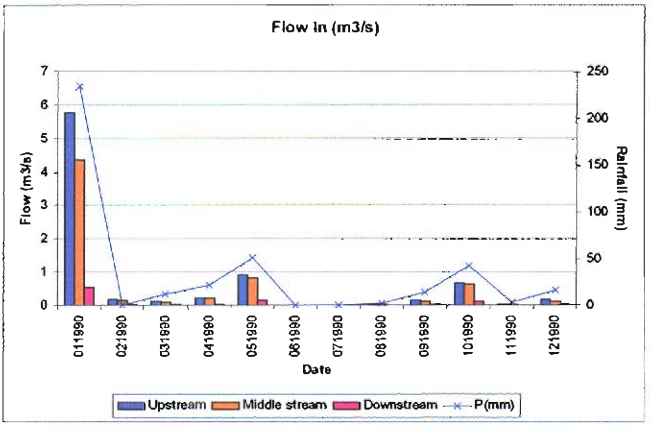


Figure 6. Flow in and flow out at the level of upstream, middle stream and downstream of the watershed

2.4. Meetings & exchanges

1. Two visits of Dr. Adriana Bruggeman to IRA: February 2004 and October 2004.
2. Two visits of Mr. Mohamed Ouessar to ICARDA: April 2004 and July 2004.
3. Visit of Dr. Rabi Mohtar to IRA: June 2004.
4. Training of Fethi Abdelli at ICARDA: April 2004.

- Training visit of Mrs Kelci Bracmort (Purdue University) at IRA: June 2004.
- Training of two technicians from IRA at ICARDA: July 2004.

2.5. Publications

Papers in preparation:

Bracmort, k., Mohtar, R.H., Ouessar, M., Bruggeman, A., Abdelli, F., Ouerchefani, D., Engel, B., 2005. Evaluation of Water Harvesting Techniques (WHT) in Southern Tunisia .

Ouessar, M., Bruggeman, A., Abdelli, F. Mohtar, R. Application of the SWAT model in a dry watershed of southern Tunisia.

The team was invited to contribute to a special issue of the *Arab Journal of Engineering Sciences* with a section on 'water harvesting' as following:

- Current practices : Ouessar and Bruggeman
- Site selection and sizing: Faraj and Mohtar
- Impacts of WHT : Ouessar and Faraj

3. Plan of future activities

3.1. SWAT modeling

The work on SWAT modeling will be achieved before the end of the year. It will concern mainly Validation and Scenarios development.

3.2. International workshop

An international workshop on "*Watershed management in dry areas: Challenges and opportunities*" will be held in Djerba, 4-6 Janaury 2005. It will be attended by scientists from Tunisia, Algéria, Morocco, USA, Syria and France. The proceedings will be published by ICARDA.

3.3. Exchanges / meetings

- It is expected that Mr. Abdelli Fethi (IRA) will spend one month (February 2005) training at Purdue University to work with Dr. Mohtar and his collaborators on the application of the HEC model to a sub-catchmeent of Oum Zessar watershed and the development web based simulation modeling.
- The final meeting of the project will be held on the occasion of the ASAE annual meeting in Florida (July 2005).

PARTNERSHIP TO IMPROVE THE RURAL LIVELIHOOD IN NORTH AFRICA AND WEST ASIA THROUGH STRENGTHENED TEACHING AND RESEARCH ON SHEEP AND GOAT PRODUCTION

M. Djemali
INAT, 43 Avenue Charles Nicolle 1082 Mahrajène, Tunis, Tunisia.

Period: September 2002- November 2003

Project partnership: IRESA (INAT & INRAT), ILRI, ICARDA, FVSU-USA, USDA

Efficient utilization of small ruminants in developing countries is a prerequisite for the opportunities to meet the future demands of food to improve the livelihood of poor people. Presently 800 million people suffer from hunger and malnutrition. A livestock revolution has to take place to meet the demands for food of animal origin. The productivity of small ruminants must increase to avoid overgrazing and subsequent degradation of natural resources. Animals and production systems must be adapted to local environmental, socio-economic and cultural conditions, and we have to ensure enough genetic diversity for the unknown future. Sheep and goats are important for the well being of poor farmers and national economic development in the countries of the sub-tropics and seasonally dry tropics of WANA. However, farmers in all countries face constraints to improving SR production, especially the links to markets, breeding, nutrition and management, and concerted action is needed to enable smallholder sheep and goat producers improve their livelihoods and contribute fully to national economic development and food security. There is need in WANA to assess markets and propose a production strategy that could include cross-breeding and accelerated (intensive) production of lambs for target markets as well as the organization of producers in cooperatives under semi-industrial production systems geared to produce, process and market lambs. To address all these issues and to help smallholders achieve their potential requires research and extension staff to be equipped with the necessary expertise, information and tools.

Teaching SR production is often not integrated with all other relevant disciplines. Furthermore in many universities those teaching sheep and goat production are more familiar with cattle production. As a result there are few university courses in the universities that give adequate attention to improving sheep and goat production.

The production of training materials will support the work of University faculty to train research and extension staff to meet the issues outlined above. The materials will provide trainers with ready access to case studies, data sets etc, relevant to the issues and constraints in their countries and regions. Despite the importance of sheep and goats (small ruminant livestock - SR) in the economic development and well being of poor people in the sub-tropics and seasonally dry tropical areas of North Africa and West Asia (WANA), farmers in this region continue to contend with problems in management, health, production and marketing of their livestock. R&D professionals in Tunisia work closely with farmers, and have the skills and awareness to address the complex of inter-linked issues, experience which will be valuable for the project. However, not all national research and teaching systems share this expertise. To sustain or to strengthen progress, universities need to train more small ruminant specialists with the skills to tackle complex issues. This process will be assisted by providing trainers with modern training and extension tools and materials which have been adapted for

the particular socio-economic, environmental and market circumstances of smallholder sheep and goat producers in these regions.

To meet the above goal, the Institut National Agronomique de Tunisie (INAT) and Institut National de la Recherche Agronomique de Tunisie (INRAT), ICARDA, Fort Valley University, Georgia, USA, USDA/FAS/ICD and ILRI collaborated on the project "Partnership to improve rural livelihoods in North Africa and West Asia through strengthened teaching and research on sheep and goat production" to develop and introduce training tools and materials that use information technologies to integrate data, information and knowledge products from WANA to address the smallholder sheep and goat production problems. This training resource CD-ROM on "Capacity building for sustainable use of small ruminants in developing countries" is an output from this project. It represents Version 1 and it is anticipated that Version 2 will be produced in the future by more partners in WANA and will be more comprehensive in providing more case studies, breed information, etc.

The training resource consists of six modules. These modules are the closest the product comes to a text book, because each module summarizes a set of basic knowledge, principles and concepts. We refer to this material as the "core knowledge". It should be emphasized that the modules are a summary – albeit a comprehensive summary – and not an exhaustive treatment of the subject. The information in the modules is structured to help engage the attention and interest of users – both faculty and students. Other resources on the CD complement the core knowledge and include case studies, breeds, books on sheep and goats and a small library.

Module 1. Livestock Development Objectives (LDO)

M'Naouer Djemali

National Institute of Agriculture of Tunisia (INAT),

Animal and Feed Resources Research Lab., 1082 Mahrajéne Tunisia

This module describes a generic process that could be used by livestock specialists in general and animal breeders in particular to establish Livestock Development Objectives (LDO), prior to specification of elements to be implemented for livestock development such as the breeding strategy and its breeding goal. Small ruminants development in a region, country or in a particular production system can benefit from results of this approach. This fundamental aspect of livestock development is commonly poorly addressed at the local, country, and international levels without proper involvement in the process of the main stakeholders in the livestock sector. At the end of the process an agreed overall strategy should be documented in detail with strong local ownership and including clear statements of the LDO and establish strategic priorities for action that are feasible technically, institutionally and financially. A link is made to a case study illustrating the use of this approach.

Module 2. Husbandry practices of ovine flocks in Tunisia: Present status and future prospects

Gley Khaldi

Institut National Agronomique de Tunisie. 43, Avenue Charles Nicolle,
1082 Tunis Mahrajène, Tunisie

In spite of its socio-economic importance and government policy support for the last three decades (bank loan, subsidy, etc.), the sheep production systems in Tunisia remained traditional and extensive, and are characterized by low productivity. The average productivity, expressed in number of lambs produced/female/year hardly exceeds 0.7 in dry regions of central and southern Tunisia. The figure for humid regions of the northern part of the country is also 0.85 which doesn't differ much from the previous one. Similarly, lamb growth rate is relatively poor and supplementary feeding is very rare. The average body weight at slaughter was around 22kg. A female up to the term of its productive life produces, on average, less than 11-12 kg of meat/year.

The low productivity of sheep in Tunisia, therefore, can only be explained by the likely limited genetic potential and/or by the unfavorable condition of the environment under which they are raised, particularly shortage of feed resources, common in all countries of North Africa. In order to try to understand the situation and determine the cause of low productivity of Tunisia's sheep flocks, so as to be able to suggest possibilities for productivity improvement. This module includes:

- Presenting meat-type ovine breeds of Tunisia, particularly their productive and reproductive performances.
- Presenting external constraints associated with harsh natural environmental conditions and husbandry practices.
- Suggesting techniques for improvement of productivity of sheep flocks, that could be easily adopted by farmers, who generally are poor and with limited skills.

Module 3. Small ruminants genetic resources

M. Djemali[1], S. Bedhiaf[2], R. Cardellino[4], H. Ibrahim[4]

[1].National Institute of Agriculture of Tunisia (INAT),

Animal and Feed Resources Research Lab., 1082 Mahrajéne Tunisia

[2].National Institute of Agricultural Research (INRA Tunisia). Animal and Forage Research Lab, Rue Hédi Karray, Ariana 2049

[3] FAO, Rome

[4] International Livestock Research Institute, P O Box 5689, Addis Ababa, Ethiopia

This module recognizes the importance of animal genetic resources, the need to use, develop and conserve these essential resources in a sustainable manner. Threats to world's animal biodiversity and the Global response to the loss of farm animal genetic resources are discussed. Breeding strategies and conservation programs to maintain and improve sheep and goats productivity are presented.

Module 4. Adding value to small ruminant raw products

H. Ibrahim

International Livestock Research Institute, P O Box 5689, Addis Ababa, Ethiopia

Farmers in developing countries, including smallholders in crop-livestock systems, strive to increase their income. There are three alternatives available to the farmers: reduce the production costs, increase intensity of production or increase the value of the products sold. To a crop-livestock system farmer this means adding value to crop or livestock products. The

concept of 'adding value' to farm products attracts attention among many researchers and development agents (Bachman 2001). The value of farm products can be increased in many ways but the effort can only be successful if all the stakeholders (farmers, processors, traders, government agents etc.) work together. Many policy makers believe that adding value to farm products is critical to sustainable development. The concept of value added agriculture gained momentum in response to the argument that the value of the raw farm product in consumer dollars continues to decrease.

Value added products are products that have an increased value because of processing. Adding value to livestock products can be done in various ways: small-scale processing, packaging or marketing. Farmers can add value by retaining ownership beyond the commodity stage. For example farmer co-operatives can share ownership of meat, dairy or skin processing plants.

This module discusses value added products with a focus on products from small ruminants and gives broad outlines of ways in which to add value to products. Links (full texts or Internet address) are available for additional information and detailed processing procedures. At the end of the module additional information resources are provided. The topic is complex and broad and therefore it is not possible to fully cover it in this module.

Module 5. Research methods

M. Djemali[1], H. Ibrahim[2]

[1] National Institute of Agriculture of Tunisia (INAT),

Animal and Feed Resources Research Lab., 1082 Mahrajéne Tunisia

[2] International Livestock Research Institute. P O Box 5689, Addis Ababa, Ethiopia

The goal in almost every experiment or a conducted survey is to condense and summarize the numbers that are gathered into a few values (known as parameters) or statements quantitative or descriptive that convey the essential of the results, the average or mean of a set of numbers is the most familiar and widely used summary. There are certain and relatively simple basic components that must be understood before even designing for an experiment. The same thing can be said about analysis methods and results interpretation. The objective of this module is describe what is needed as a prerequisite in order to have a reliable experimental approach in order for statistical summaries and analysis statements to be reliable.

Module 6. Farming System Approach: Concepts, Methods and Applications-The Case of the Zoghmar Community, Tunisia[1]

Véronique Alary[1], Mohammed Elloumi[2], Salah Selmi[3]

[1] CIRAD-Emvt/ICARDA, ICARDA Tunis, 6 rue Ibn Rachik, 2080 Nouvelle Ariana, Tunisie

[2] INRAT Tunisie,

[3] Ecole Supérieure d'Agriculture de Mograne, Tunisie

The understanding of the farming system, such as a complex and "unique" system, is recognition of major roles played by people not only as a steering element but also as historical and social components of the systems. However, research as well as development should understand the complexity of this system for reorganising it in more simplified models that allow reasoning some changes, technological and institutional innovation for example. So the typologies of farming systems are progressively developing and now they are

integrating in an approach of research for the diagnostic of the whole functioning of the farms. This approach is based on a conceptual framework related to the systemic modelling approach of the farms including the "family-farm" system (Osty, 1978; Brossier, 1987; Jouve, 1984).

The typologies are mainly based on multidisciplinary knowledge on the farms. If the holistic approach of the farming systems based on the systemic principles knows few changes during these last years, typological methods have improved a lot in order to respond to operational objective (use of typology under the framework of adaptation of technical advises) and to bring research outputs to end-users.

This module aims to describe the research method through the experience developed in a research project for the development in the Zoghmar community. The Zoghmar community is located in the Sidi Bouzid governorate in the semiarid zone of Central Tunisia. Despite the recent development of irrigation schemes, Zoghmar is known as agro-pastoral area and its main characteristic are: 1) its isolation 2) dominance of small ruminant production 3) integrated crop production for livestock maintenance 4) the importance of pasture land.

This community was selected under the framework of « the Mashreq/Maghreb Project » (ICARDA)2, a research and development project with major objectives being development through dissemination of new technologies (already verified by research) in arid and semiarid agro-pastoral areas, mainly engaged in small ruminant production. A modelling tool is also put in place so as to analyse the obstacles or preference for alternative technologies taking into account the mode of functioning of the farming systems, theirs interactions at the community level and theirs relations with their global environment.

Case studies

This training material includes a total of 10 case studies covering a variety of topics of great importance to readers.

List of Case Studies

1. Inventory of small ruminant genetic resources (Djemali and Bedhiaf)
2. Fattening and commerce of sheep: The role of Aïd El Kébir in the strategy of the Zoghmar livestock producer Community (Selmi et. al.)
3. Small ruminant development objectives: Tunisian example (Djemali)
4. Small ruminant management in M&M Project (Bedhiaf et. al.)
5. Characteristics of Small Ruminates Reproduction in Tunisia: Case Study of Female Ovine of Barbarine Breed (Khaldi)
6. Alternatives to improve the sheep recording system in Tunisia (Bedhiaf and Djemali)
7. Feeding, production and reproduction of Ewes of Barbarine breed in Tunisia (Khaldi)
8. Cross-breeding of native goats in Tunisia (Djemali)
9. Improving Prolificacy of Ewes In Tunisia (Khaldi)
10. Market opportunities for production and market insertion for small ruminant producers in Tunisia (Alary)

MANAGEMENT OF INDIGENOUS SHEEP GENETIC RESOURCES AND IMPROVEMENT OF FARMER'S INCOME UNDER CHANGES PROMOTED BY NEW MARKET DEMANDS IN NORTH AFRICA AND WEST ASIA / CASE OF TUNISIA (NEW PROJECT)

Research team:

Principal investigators:

M'Naouer Djemali (INAT), Luis Inigues (ICARDA), Sonia Bedhiaf (INRAT), Brigitte Hartwell (ICARDA), Micah Rosenblum (USDA).

Collaborators:

Seyoum Gelaye (Fort Valley state University, USA), Veronique Alary (ICARDA), Maria Wurzinger (University of Natural Resources and Applied Life Sciences, Austria), Office de l'Elevage et des Pâturages (Béja-Tunisia), Sicilo-Sarde Breed Association in Béja.

Starting date-Ending date: October 2004-December 2006.

Introduction

Tunisia is endowed with a wealth of sheep genetic resources adapted to a range of dry environments with extreme climate fluctuations during the year. Most of these resources (80%) are owned by small farmers with low income in rural areas. The Barbarine fat-tailed sheep is the most numerous and important breed in the country. The breed is well adapted to the prevailing agro ecologies with at least 9 different ecotypes allowing farmers to access specific production niches. However the breed has a rather low growth rate and its preference in the large urban markets is under change for an animal that produces carcass with a thin tail in contrast to the fat tail. The Barbarine fat tail represents an important portion (15%) of the carcass. In response to this trend, farmers are crossing the Barbarine with thin tailed breeds which in the long terms could have an impacting consequence in the integrity of the genetic resources. This is happening at the time when the fat tail is known as a criteria for adaptation to harsh conditions and fat-tailed animals are preferred for religious practices.

It has been, also, identified that the Sicilo-Sarde breed, the only indigenous milking sheep in the country is undergoing considerably population reduction due to the lack of management skills to produce competitively and a lack of information of farmers on the existing market opportunities. Indiscriminate crossbreeding with meat breeds could lead irreversible changes in the Sicilo-Sarde genetic structure. Interestingly important facts interact in the current production conditions of this breed:

- A well defined market with an unsatisfied demand for increased production to be processed into derivatives
- The involvement of the private sector that has installed capacity to absorb the production and processes the milk and strive toward organizing farmers in the region.
- The recently formed association of the Sicilo-Sarde producers and its need for technological improvement.

Objectives

- assess the degree of change in the genetic structure of Barbarine flocks and the degree of crossing between the Barbarine breed and thin tail breeds,
- identify appropriate management strategies for securing the integrity of small ruminant genetic resources while helping rural farmers to target opportunity markets.
- to develop management and institutional tools for market oriented production geared to the improvement of livelihood of producers of the Sicilo-Sarde sheep, through technological improvement of productivity, and conservation of the natural resources base and the genetic integrity of this breed,
- to test a model for application in other regions where similar situations exists.

Expected outputs

The expected outputs will be measured at:

- The household level by an increase of sheep owners income
- The national level by a total meat production increase
- An improvement of milk production
- A generating income through cheese making
- The organizational level by linking production to market through a breeding organization that will help producers alleviate existing constraints and promote their products
- The breed level by wise genetic management schemes to protect the Barbarine and the Sicilo-Sarde breeds from the negative effect of crossing them with other breeds
- The scientific level by enhancing research team work, publishing journal articles and developing case studies for the SR-CDROM.

Methodologies

Project 1. Barbarine-fattening

(i) Survey to characterize the production system:
   - types of lambs produced and fattened,
   - types of farmers that fatten and those that do not

(ii) Survey to characterize market channels

(iii) Survey to characterize consumers preference

(iv) Assess crossbreeding effects on lambs produced and the integrity of the Barbarine breed.

(v) Three Master degree students are identified:
   - One for Sidi Bouzid region
   - One for Siliana region
   - One for "Big" Tunis

Project 2. Sicilo-Sarde-milk and cheese

- Organize a workshop with farmers to assess the problems and constraints and to define issues that will be included in the characterization of the associated production systems.

- Develop the basis of an open nucleus system, decentralized and participatory, managed by the cooperative of producers.
- Assess individual milk production of main large dairy flocks in Béja
- Constitute an elite flock on the basis of a large screening of animals regarding their milk production.
- Develop genetic evaluation tools to enhance selection of rams and replacements
- One Master degree student is identified.

Plan of activities 2004-2005

- Prepare surveys (October-November, 2004)
- Field surveys (November-May, 2005)
- Milk recording (November – June, 2005)
- Screening of elite ewes (April-May, 2005)
- Present preliminary results (June, 2005)
- Masters results presentation (September, 2005)

DIVERSITE BIOLOGIQUE ET IMPORTANCES ECONOMIQUE ET CULTURELLE DES PLANTES AROMATIQUES ET MEDICINALES (PAM) DE LA TUNISIE MERIDIONALE

Mohamed Neffati

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1. Introduction.

La production nationale moyenne des principales PAM et leurs dérivés est de l'ordre de 8500 tonnes dont prés du quart est exporté, principalement vers l'Europe. La valeur de cette production est estimée à 14,2 millions de dinars dont près de 40% proviennent des produits exportés. Les huiles essentielles à elles seules rapportent plus de 65% de la valeur de ces exportations soit environ 3,7 millions de dinars.

En raison de leur importance économique, sociale, médicinale, écologique et culturelles, les PAM commencent, ces dernières années, à occuper une place de choix au niveau des différents secteurs, et notamment, celui de la recherche, de l'industrie, de l'agriculture, de la médecine et de l'environnement. Cette préoccupation s'est concrétisée à travers les politiques sectorielles et les orientations au niveau de ces secteurs.

Aujourd'hui, tous les justificatifs économiques, sanitaires et environnementaux sont réunis pour un regain d'intérêt pour l'utilisation des substances naturelles. Ce retour à la nature, motivé en outre par l'existence d'effets secondaires des produits de synthèse, a conduit les chercheurs ainsi que les industries pharmaceutiques, alimentaires et cosmétiques à investir dans la recherche des produits naturels comme les antioxydants, les colorants, les arômes, les huiles essentielles...

Au vu des opportunités qu'offre une conjoncture nationale et internationale assez favorable, les perspectives de développement du secteur des PAM s'avèrent réellement prometteuses et ce en raison de l'existence, entre autres :

- d'un patrimoine phytogénétique très riche en espèces utiles;
- d'un savoir-faire local en matière de valorisation des PAM;
- d'une demande accrue des PAM sous leurs différentes formes tant au niveau national qu'international;
- d'acquis et de compétences scientifiques et techniques au niveau des différentes fonctions de la filière des PAM.

Si à travers l'histoire, nos ancêtres ont su conserver le patrimoine culturel et cultural dont nous disposons aujourd'hui et surtout celui qui se rapporte aux plantes aromatiques et médicinales ; notre tâche aujourd'hui est de savoir valoriser ce précieux héritage en fournissant à la pharmacie, à la cosmétique, à la parfumerie et à la confiserie, des bases végétales pour leurs industries. Dans le présent travail nous tentons de diagnostiquer ce secteur en vue de lui permettre de jouer pleinement son rôle dans le développement économique du pays.

En adoptant comme définition des plantes médicinales et aromatiques toute plante renfermant un ou plusieurs principes actifs capable de prévenir, soulager ou guérir des maladies et/ou qui renferment des principes odorants, la gamme des PAM en Tunisie s'avère très longue et élastique et peut concerner la plupart des plantes spontanées et de nombreuses espèces arboricoles et herbacées cultivées. C'est pour cette raison que le nombre des plantes considérées comme médicinales varie considérablement d'une étude à une autre. Ce nombre varie en effet de quelques dizaines à plus de deux cents espèces.

Dans ce qui suit nous présentons succinctement le bilan des travaux effectués dans le cadre d'un projet de coopération IRA/USDA/ICARDA sur les PAM intitulé :" *Biological diversity, cultural and economic values of medicinal, herbal and aromatic plants (PAM) in southern Tunisia* " ainsi que les principaux enseignements qui ont pu en être tirés.

Ces activités peuvent être subdivisées en activités scientifiques et techniques et activités d'appui.

La première catégorie d'activités se rapporte aux aspects suivants :

- la réalisation d'une étude de filière des plantes aromatiques et médicinales et leur importance socio-économique tant au niveau national qu'au niveau de la zone cible du projet (la chaîne montagneuse des Matmata);
- la constitution d'une base de données, d'un fonds documentaire et d'un site Web pour le projet;
- l'élaboration de fiches techniques pour les espèces cibles les plus prometteuses;
- la réalisation de travaux de recherche sur ces espèces.

Les activités d'appui consistent en ce qui suit :

- l'identification des opérateurs nationaux intéressés par les PAM et de leurs rôles respectifs;
- l'échange d'expériences avec d'autres projets similaires à travers l'organisation de visites à ces projets et de rencontres scientifiques;
- la constitution d'un comité technique et d'un comité de pilotage pour le projet;
- la formation de chercheurs et techniciens participant à la réalisation du projet.

2. Présentation succincte du projet

Partenaires

Ce projet est réalisé dans le cadre d'un partenariat entre l'IRA, l'USDA - ARS-OIRP et l'ICARDA. Plusieurs autres partenaires nationaux (Organismes de développement, Organisations Socioprofessionnelles, ONG, Promoteurs privés, Institutions de recherche et d'enseignement supérieur ...) contribuent activement à la réalisation de ce projet.

Rappel des objectifs

Le projet vise les principaux objectifs suivants :

(i) Conserver, gérer et utiliser durablement, aussi bien *in situ* qu'*ex situ* les PAM des zones arides et semi-arides ;

(ii) Renforcer la collaboration entre les différents opérateurs;

(iii) Sensibiliser le public aux intérêts des PAM et aux risques qui pèsent sur ces plantes;

(iv) Mettre en place une base de données nationale sur les PAM.

3. Principales Réalisations

3.1. Choix des espèces prioritaires

En Tunisie, le nombre de plantes considérées comme aromatiques et/ou médicinales varie, en fonction des inventaires, de près de 40 espèces à plus de 200 espèces et ce en fonction de plusieurs facteurs dont parmi il y a lieu de mentionner l'étendue de ces inventaires, l'usage majeur des espèces ciblées par l'étude (médicinal, aromatique, condimentaire...) et l'importance accordée par l'étude aux aspects économiques et sociaux des espèces considérées. Le choix des espèces prioritaires dépend en effet de l'objectif visé et des activités à entreprendre sur ces espèces et de la région considérée.

Lors des discussions qui ont eu lieu à l'occasion des différentes rencontres organisées dans le cadre du projet (réunion des comités technique et de pilotage, mission de suivi...) il a été convenu de se limiter, à un nombre limité d'espèces. Il s'agit de celles qui présentent le plus d'intérêts tant économiques, sociaux qu'écologiques au niveau de la zone du projet (*Allium roseum, Artemisia herba-alba, Rosmarinus officinalis, Thymus capitatus, Capparis spinosa,...*).

3.2. Elaboration de fiches techniques pour les espèces cibles

A partir des informations disponibles, il a été procédé à l'élaboration de fiches techniques pour *Capparis spinosa* et *Rosmarinus officinalis*. Plusieurs informations se rapportant aux caractéristiques biologiques, à la répartition géographique, aux exigences écologiques, aux modes de propagation, aux techniques culturales, à la conservation, à l'usage *etc.* de ces espèces ont été consignées dans ces fichiers. Des fiches techniques de trois autres espèces sont en cours d'élaboration. Etant donnée le manque d'informations sur ces espèces leurs fiches restent préliminaires en attendant les données qui seront régénérées à travers les différentes activités de recherche menées par l'IRA et les autres institutions de recherche.

3.3. Constitution d'une base de données relatives aux PAM et d'un site Web pour le projet

Plusieurs activités ont été accomplies pour la création d'une base de données sur les PAM et d'un site Web pour le projet.

Parmi ces activités il y a lieu de mentionner :

- La collecte de références bibliographiques se rapportant aux PAM. Ces références ont été recherchées aussi bien au niveau national qu'international. L'appui des chercheurs américains à ce propos mérite d'être souligné. Grâce à leur aide des dizaines de références se rapportant aux plantes cibles du projet ont pu en effet être identifiées.
- La création d'un SIG constitué de plusieurs couches d'informations se rapportant aux paramètres suivants : climat, sol, végétation, niveau d'exploitation, infrastructure... En vue de compléter la formation des chercheurs spécialisés de l'IRA dans ce domaine, il a été procédé dans le cadre du projet à l'organisation d'une mission à l'ICARDA du 01 au 15/12/03.
- La création d'un site Web pour le projet. Ebauché à l'occasion d'une mission effectuée à l'IRA par un technicien spécialisé de l'ICARDA du 12 au 18 septembre 2003, ce site a été complété lors d'une mission qui a été effectuée par le technicien de l'IRA au siège de l'ICARDA du 01 au 15 décembre 2003.

Parmi les informations consignées dans ce site Web, il y a lieu de mentionner :

- la description du projet (objectifs, résultats, attendus, partenaires,...) ;
- la présentation des espèces cibles ;
- la liste des principaux rapports scientifiques et techniques élaborés dans le cadre du projet ;
- des photos galeries illustrant les différentes activités menées dans le cadre du projet.

3.4. Importance socio-économique et étude de la filière des PAM

Cette étude est réalisée à trois niveaux : local, national et régional.

3.4.1. Au niveau local

L'objectif est d'étudier l'importance socioéconomique et culturelle des PAM en milieu rural dans la région montagneuse des Matmata (zone cible du projet) (délégations de Mareth, Béni Khedache, Matmata El Guedima et Ghoumrassen).

La démarche méthodologique s'est basée sur des enquêtes par questionnaire auprès d'un échantillon représentatif des chefs de ménages intéressés par les PAM.

Les principaux résultats obtenus sont ci-dessus récapitulés :

- 63.5 % des exploitants exercent une activité en dehors de l'exploitation. La collecte et la vente des PAM constituent cependant une source de revenu non négligeable pour certains ménages de la zone;
- La collecte des PAM dans la chaîne des Matmata est destinée en grande partie à l'autoconsommation. Cependant, 25 % des ménages procèdent à des opérations de vente lorsque l'occasion se présente. D'apparence faible, cette proportion cache un important potentiel d'une prédisposition latente de la population à développer les activités économiques basées sur la valorisation des PAM;
- Sur un total de 72 espèces collectées et utilisées au niveau de la zone d'étude, la vente des PAM est limitée principalement à 4 espèces (Rosmarinus officinalis, Thymus capitatus , Juniperus phoenicea et Artemisia herba-alba). La quantité moyenne écoulée sur le marché est de 750 kg/an par ménage (30 kg à 4500 kg).
- Les prix de vente et les quantités moyennes vendues des PAM sont marqués par une grande variabilité liée à l'espèce, à la période de vente, à la nature de l'année et à la qualité du produit. La fréquence des ventes est plus importante pour Thymus hirtus et Rosmanirus officinalis .
- Les cartes de filière des principales espèces sont relativement simples et traduisent un nombre limité d'intervenants (les producteurs / exploitants, les intermédiaires, les marchands de détails et les consommateurs locaux).
- Les principaux problèmes entravant le développement du secteur des PAM d'après les ménages enquêtés se rapportent à la sécheresse, au méthodes inadéquates de récolte, aux méfaits du surpâturage et de la surexploitation.

3.4.2. Au niveau national :

L'étude nationale a porté sur les aspects suivants :

- Place des PAM dans les stratégies nationales sectorielles;
- Importance des PAM dans l'économie nationale;
    - Contribution des PAM au PIB

- Evolution des importations et des exportations des PAM
- Contribution des PAM à l'équilibre de la balance commerciale

- Les opérateurs nationaux et leurs rôles / les cartes de filières.

Les principaux résultats de cette étude peuvent être ainsi récapitulés :

- Sur la base des exportations de la dernière décennie du siècle écoulé et des estimations de la consommation locale, la production nationale moyenne des principales PAM et leurs dérivés est de l'ordre de 8500 tonnes/an dont près de 23% est exporté.
- La valeur de cette production est estimée à 14,2 millions de dinars dont 5,7 millions de dinars (40%) générés par les produits exportés, principalement, aux pays européens. Les huiles essentielles rapportent plus de 65% de la valeur de ces exportations.
- De l'ordre de 13,3 MD/an, la part du PIB généré par les principales PAM représente environ 0,06% du PIB total et 0,4% du PIB généré par le secteur agricole.
- La valeur moyenne des importations au cours des dix dernières années est de l'ordre de 2,3 MD enregistrant une réduction relative de 17% durant les cinq dernières années.
- La balance commerciale des PAM durant les dix dernières s'avère cependant toujours positive avec un taux moyen de couverture de l'ordre des 180% en 1992.

3.4.3. Au niveau international

Réalisée avec l'appui de l'USDA et de l'ICARDA, cette étude permettra de positionner la Tunisie au niveau du marché international et portera sur l'identification des contraintes et des opportunités de promotion des exportation des PAM et dérivés, de la formulation de recommandations permettant de surmonter ces contraintes et de maximiser ces opportunités.

Afin d'atteindre cet objectif, il est prévu de réaliser les travaux suivants :

- Identification des pays importateurs des PAM à partir de la Tunisie ;
- Identification des PAM susceptibles d'intéresser ces importateurs (l'UE et les EU) ;
- Evaluation de la compétitivité des produits tunisiens (identification des principaux concurrents) ;
- Evaluation de la régularité de l'approvisionnement, de la qualité des produits, de l'organisation du secteur des PAM, de la régularité des besoins des pays importateurs.

4. Conclusion et perspectives de développement du secteur des PAM en Tunisie

L'enseignement majeur tiré des informations recueillies à travers les différentes études relatives aux secteur des PAM en Tunisie est la nécessité de traiter ce secteur comme une filière globale comprenant un ensemble de fonctions faisant intervenir plusieurs opérateurs. Du fait qu'il concerne des intervenants qui relèvent de plusieurs départements (Santé, Agriculture, Recherche, Commerce, Industrie...), le développement de ce secteur ne peut, par conséquent, être assuré qu'à travers une approche multidépartementale et pluridisciplinaire impliquant les différents intervenants et ce en vue d'assurer la complémentarité requise et la synergie escomptée.

Le choix des plantes médicinales prioritaires doit s'effectuer en fonction de leur utilisation effective et/ou potentielle et de leurs intérêts économiques tant au niveau national qu'international, d'où la nécessité d'établir des listes spécifiques pour chaque zone agro-écologique.

La promotion de ce secteur requiert, par ailleurs, la prise en compte des deux dispositions suivantes :

- Instaurer un environnement économique et législatif permettant de favoriser les dynamiques de production et de transformation et d'encourager les initiatives des acteurs de développement qu'elles soient individuelles ou collectives.
- Développer une recherche appliquée et innovatrice qui doit être en mesure de mieux faire connaître notre potentiel naturel, de le préserver et d'offrir des solutions techniques à l'ensemble des questions qui se posent à tous les niveaux de la filière, depuis la production jusqu'à la transformation.

L'analyse des données relatives aux importations et exportations des PAM et dérivés, d'une part et du marché national et international en produits pharmaceutiques, cosmétiques, de parfumerie et de produit « Bio » à base de « PAM » d'autre part, met en exergue l'existence d'un marché immense pour ces produits.

Compte tenu des particularités de ses conditions écologiques et de la richesse de ses ressources phytogénétiques, la Tunisie peut, à travers la promotion des cultures des plantes aromatiques et médicinales, faire augmenter ses exportations dans des proportions considérables.

Le développement des exportations en PAM requiert cependant la prise en considération des aspects suivants :

- <u>En ce qui concerne les espèces cibles</u> :

Un inventaire exhaustif des plantes présentant un intérêt aromatique et médicinal constitue un préalable à toute activité visant la valorisation de celles-ci. Des données sur les potentialités productives de ces espèces ainsi que sur les conditions optimales garantissant une production de bonne qualité doivent être disponibles.

La domestication des plantes spontanées et leur mise en culture sont à considérer surtout pour celles qui sont très recherchées et qui se sont, par conséquent, raréfiées au niveau des formations végétales naturelles.

- <u>En ce qui concerne les aspects juridiques et réglementaires</u> :

L'instauration d'un environnement législatif permettant de favoriser les dynamiques de production et de transformation et d'encourager les initiatives des acteurs de développement qu'elles soient individuelles ou collectives s'avère d'une grande utilité pour le développement de ce secteur.

- <u>En ce qui concerne le marché</u> :

Le suivi de l'évolution de la consommation tant quantitative que qualitative et la connaissance des conditions d'accès aux marchés et des circuits appropriés de commercialisation et les techniques de commercialisation doivent être renforcés.

La réglementation et les exigences des importateurs devraient être préalablement connues par les fournisseurs et les exportateurs qui doivent être bien informés des normes, exigées par les marchés internationaux. Les capacités des organismes de promotion des exportations et des associations d'affaires doivent être renforcées afin d'augmenter leur efficacité.

Par ailleurs et afin d'assurer un marketing rapide et efficace le développement de techniques alternatives de vente (commerce électronique) s'avère indispensable.

Figure 1a. Conservation in situ d'espèces prometteuses de PAM

Figure 1a. Conservation in situ d'espèces prometteuses

Figure 2. Création d'une banque de gène d'espèces prometteuses

Figure 3. Mise en place d'un comité national de pilotage qui assure le suivi permanent des activités du projet

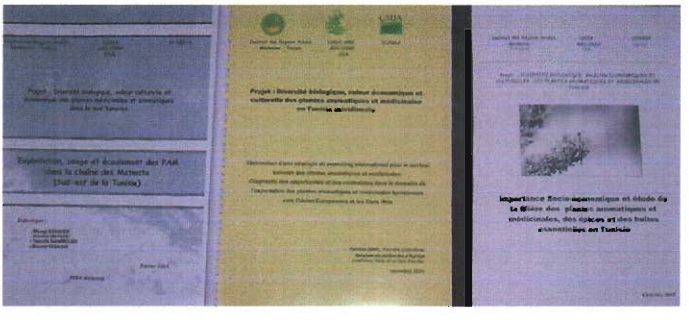

Figure 4. Elaboration de fiches techniques et d'études socio-économiques et techniques

RESEARCH ON IMPROVING PRODUCTIVITY OF OATS AS PRIORITY FORAGE SPECIES (FG-TN-106 (INRA/USDA-ARS)

1. Introduction

Oats, (*Avena sativa* L., *Avena bysantina* Koch) in pure stands, or associated with vetches are the major grown forages and the main component of crop rotation in Tunisian farming systems. They are mainly grown as a source of harvested fodder (silage or hay) for livestock, over a wide range of climatic and edaphic conditions ranging from the subhumid to the semi-arid regions of northern Tunisia. Increased production, resulting from using adapted varieties, will help to meet the ever increasing demand for forages and, therefore, to improve livestock products self-sufficiency. Better varieties associated with improved management practices will also provide a high return to farmers. Technology transfer packages on seed production will help the growth of a sustainable seed production system.

2. Objectives

- Evaluate and select oat varieties that are superior to presently prevailing ones for forage yield, tolerance to foliar diseases and with dual purpose capacity for use as green forage or hay.
- Develop improved associated with management practices and technology transfer packages for seed multiplication and large-scale production.

3. Expected output

- Oats are the major grown forage crop in Tunisia. They are also used extensively for grazing in the southern US. These forage crops play a key role in the productivity and sustainability of agricultural systems in both countries. Therefore, the transfer of improved technology packages to farmers would increase the sustainability of crop/livestock production and thus improve the rotational system and contributing to the preservation of the environment.
- This joint research project would strengthen the ties among investigators involved with this species and consequently, between their respective institutions. This project is complimentary to ongoing research in both countries.
- At the completion of the project, the best lines selected for this species would form the basis for large scale testing and seed increase and would help the sustainability of forage production.

Research Team

Principal Investigators

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Collaborators

Name	Area of specialization	Institution
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Mohamed El Mourid	Regional Coordinator	ICARDA, Tunis

Starting date – ending date: October 2002 – December 2005

4. Methodologies – Research highlights

During the 2003-2004 growing season, five evaluation trials of oat genotypes, one seed density and one foliar fungicide application on crown rust (Puccinia coronata f.sp. Avenae) of oat experiments were conducted in northern Tunisia on research stations and experimental fields using the appropriate experimental design and the number of replicates. In all trials, seeding rate of each genotype was adjusted based on laboratory germination and seed weight, planting were made in November 2003within the optimum planting-date window for the oat growing area, standard agronomic practices, in well prepared fields and with appropriate fertilization were adopted. Plots were hand-harvested except at Lafareg which were combine-harvested. Appropriate statistical analyses were performed for each character at each experiment. General view of the field trials at selected sites are given in figures 1, 2, 3 and 4.

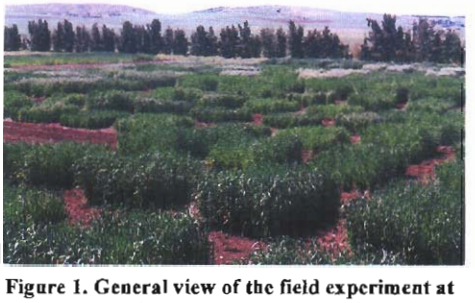


Figure 1. General view of the field experiment at Lafareg station (cropping season 2003-2004)

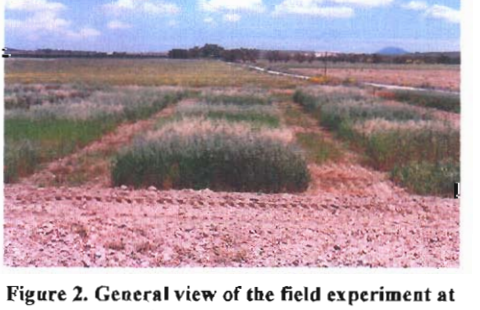


Figure 2. General view of the field experiment at Bou Rabia station (cropping season 2003-2004)

Figure 3. General view of the field experiment at Bargou experimental field (cropping season 2003-2004)

Figure 4. General view of the experiment related to the effect of seeding rate on forage and grain yield of fodder oat established at Lafareg

The amount of rainfall at the experimental sites is presented in Table 1. Most of the season was ideal for oat growth and development. Rains were frequent throughout the winter and spring months. The major constraints encountered were heavy rains during December and weeds infestations which did not favor good stands at Bargou and Ftetissa stations. Adequate moisture received during mid to late season favored later maturing genotypes at the subhumid sites (Fretissa and Lafareg). Rains received in June delayed grain harvest.

Table 1. Monthly rainfall (mm) during 2003/04 growing season at the experimental sites: Fretissa, Lafareg, Bou Rabia and Bargou.

	Location			
	Fretissa	**Lafareg**	**Bou Rabia**	**Bargou**
September 2003	91.6	64	136.6	60
October	34	65	59.8	92
November	23.6	34	49	11.5
December	247.5	185	140.9	200.5
January 2004	108.5	97	49.8	38
February	11.4	14	25.4	48.5
March	64	57.5	80.2	94
April	74	65	45.9	51
May	22.8	8	20.6	24
June	54.5	73	112	35.5
July	0	0	0	0
August	0	13	30.4	18
Total	731.9	675.5	750.6	673

4.1. Agronomic and morphological study of local oat genotypes

The trial included nine local genotypes collected from farmers over different regions of northern Tunisia: Bezina, Bni-brahim, Maachar, Blelma, Skhira and Borj-dhab from Bizerte; Nefza from Beja; Fernana, from Jendouba, and Sidi-khiar from le Kef, the commercial variety Fretissa and two experimental lines (Av01-9 and Saia). These genotypes were evaluated for a second consecutive cropping season for their agronomic characters at two experimental stations: Lafareg station, near Beja and "Fretissa" farm, near Mateur. The

experimental design was a randomized complete block with three replications. Plot size, seeding rates and management practices were similar to those reported last year. Forage was assessed by harvesting one time during heading stage. Grain harvest was carried out when all the genotypes reached maturity.

Analysis of variance was performed on yields, plant height and reaction to diseases. The response means were compared using Duncan's test at 5% level of significance.

4.1.1. Days to heading and plant height

Genotypic differences in days to full heading were significant. Local genotypes are mostly late maturing. Genotypes were grouped in three classes; an early heading group represented by Fretissa and Av01-9, intermediate heading represented by Bni-brahim, Fernana, Nefza, Saia and Sidi-khiar while late maturing is represented by the local genotypes Blelma, Bezina, Borj-dheb, Maacher and Skhira (table 2).

Concerning plant height, local genotypes were taller than genotypes Fretissa and Av. 9 which make them more suitable for high fodder yield.

Table 2. Earliness of the 12 genotypes.

Genotype	Earliness*
Bezina	181
Bni-brahim	174
Fernana	174
Maachar	181
Blelma	188
Skhira	188
Nefza	174
Av01-9	167
Fretissa	167
Borj-dhab	188
Saia	174
Sidi-khiar	174

At both sites, highest dry matter (DM) yields were recorded for Bezina and Borj-dhab, while the lower DM yields were obtained with Av01-9. Genotype Fretissa had the lowest grain yields mainly at Lafareg. This genotype is an early maturity type and was severely attacked by birds.

4.1.2. Dry matter yield (DMY)

The combined analysis of variance did not show significant differences of yield between the 2 sites. However, the DM yields produced at Lafareg were slightly higher than those registered at Fretissa. Additionally, the interactions of genotypes by sites were not significant indicating that ranking of genotypes on DM yield basis was almost similar in the 2 sites. However, forage yield varied among genotypes (table 3). Genotype Sidi Khiar was the most productive with 10.8 T DMY / ha while Bni Brahim was the less productive (6.82 T DMY/ha).

Table 3. Forage yield and plant height of oat varieties studied at Lafareg, Fretissa

Genotype	Lafareg			Fretissa		
	DMY (t ha^{-1})		Plant height (cm)	DMY (t ha^{-1})		Plant height (cm)
Bezina	13.251	(1)*	142	13.255	(2)*	138
Bni-brahim	10.628	(7)	133	11.864	(4)	144
Fernana	10.553	(8)	131	11.512	(5)	141
Maachar	10.143	(10)	124	12.307	(3)	148
Blelma	11.934	(6)	147	10.024	(8)	128
Skhira	12.927	(3)	135	11.076	(6)	133
Nefza	10.159	(9)	128	7.648	(10)	140
Av01-9	9.226	(12)	139	6.734	(12)	137
Fretissa	9.972	(11)	138	10.706	(7)	129
Borj-dhab	13.077	(2)	146	13.630	(1)	144
Saia	11.982	(5)	153	9.859	(9)	140
Bni-khiar	12.397	(4)	151	7.464	(11)	133
Means	11.354		139	10.507		138
CV (%)	20.36		3.92	17.16		10.25

*Rank

4.1.3. Grain yield Reaction to major diseases

Analysis of variance showed significant differences among genotypes for both 1000 seeds weight and the number of spikes m^{-2}. Grain yield varied greatly among genotypes. Grains from Fretissa and Av. 9 could hardly be recovered because of bird attack (table 4).

Table 4. Grain yield and straw yield of oat genotypes at Lafareg and Fretissa.

Genotype	Lafareg				Fretissa			
	Grain yield (t ha^{-1})		Straw yield (t ha^{-1})		Grain yield (t ha^{-1})		Straw yield (t ha^{-1})	
Bezina	0.753	(8)*	9.577	(8)*	1.529	(6)*	9.815	(8)*
Bni-brahim	0.630	(9)	9.243	(11)	1.306	(7)	10.833	(6)
Fernana	0.478	(11)	10.375	(5)	1.637	(5)	9.259	(10)
Maachar	0.771	(7)	10.590	(3)	1.766	(4)	9.491	(9)
Blelma	0.968	(2)	10.347	(6)	1.292	(8)	6.250	(12)
Skhira	0.950	(3)	10.486	(4)	1.216	(10)	11.296	(5)
Nefza	0.922	(4)	10.257	(7)	1.895	(3)	11.667	(4)
Av01-9	1.503	(1)	10.889	(2)	2.805	(1)	15.741	(3)
Fretissa	0.404	(12)	9.396	(9)	1.280	(9)	19.769	(2)
Borj-dhab	0.506	(10)	6.833	(12)	1.173	(11)	8.704	(11)
Saia	0.807	(6)	13.111	(1)	0.792	(12)	21.389	(1)
Bni-khiar	0.908	(5)	9.257	(10)	2.193	(2)	10.741	(7)
Means	0.82		10.218		1.596		11.813	
CV (%)	18.89		17.76		36.18		24.90	

*Rank

There was little variation among genotypes in reaction to diseases (Table 5). Among the local genotypes, genotypes Nefza, Fernana and Sidi-khiar were moderately tolerant.
Genotypes Saia and the selected line Av. 9 proved to be resistant. Genotypes Fretissa and Av. 9 scored lower mean than the local genotypes and Saia (*A. strigosa*) which suggest that *A. sativa* varieties are more resistant to lodging than *A. bysantina*.
There was less variation among genotypes in reaction to diseases. Promising local genotypes are much better adapted than the selected ones and in consequence they could be introduced in a crossing nursery.

Table 5. Reaction to CR, PM and BYDV of the tested genotypes at Lafareg and Fretissa stations.

Genotype	Lafareg			Fretissa		
	Crown rust (CR)	Powdery Mildew (PM)	BYDV	Crown rust	Powdery Mildew	BYDV
Bezina	5	5	3	6	5	4
Bni-brahim	6	5	2	4	4	3
Fernana	4	3	3	5	5	3
Maachar	4	3	3	4	6	3
Blelma	7	5	2	4	4	2
Skhira	5	3	3	6	4	2
Nefza	4	5	2	6	4	3
Av01-9	3	1	2	2	5	1
Fretissa	2	1	2	3	3	1
Borj-dhab	5	5	2	4	5	4
Saia	1	1	3	2	5	1
Sidi-khiar	5	5	2	4	4	3
Means	4.25	3.5	2.55	4.38	4.55	2.61
CV %	28.81	0	31.71	40.96	21.50	33.77

4.2. Evaluation of the 2003 Quaker International Oat Nursery (QION) pure lines

Small amounts of seeds (6 g) of 95 pure nearly homogeneous lines of oat, obtained from Dr. R. D. Barnett, University of Florida, Quaker Oat International Nursery and the two Tunisian varieties (Fretissa and Mejerda) used as local checks (systematically after every 10 lines) were evaluated.

Seeds from each pure-line and checks were planted as un-replicated plots of 2 m rows with 0.3 m apart at two experimental stations: Bou Rabia station (near Tunis) and Lafareg (near Beja), during 2003-04 cropping season in an observation nursery. Standard agronomic practices were adopted. Visual rating (1-9) where 1 is excellent and 9 is poor have been used to evaluate vigor and disease tolerance. Observations on phenological stages, straw diameter, grain yield and 1000 seeds weight were recorded.

Based on their average grain yield; scored forage yields, and tolerance to the major foliar diseases, 20 lines were selected. These were: Q03-18, Q03-31, Q03-45, Q03-46, Q03-49, Q03-60, Q03-62, Q03-63, Q03-69, Q03-74, Q03-78, Q03-79, Q03-82, Q03-83, Q03-84, Q03-85, Q03-86, Q03-89, Q03-90, Q03-100 (Table 6).

The above identified lines will be advanced to preliminary yield trials at two sites, to estimate their forage and seed yielding ability and tolerance to the major foliar diseases, particularly crown rust.

Table 6: Major characteristics of the selected 20 lines at Lafareg.

Entry No.	Source	Earliness	Growth habit	Grain yield (g per 0.6 m^2)
L18	MN02124	Intermediate	Erect	218,7
L31	MN02215	Late	Erect	225,9
L45	MN02218	Late	Erect	200,5
L46	MN02220	Late	Erect	221,7
L49	MN02226	Late	Erect	137,7
L60	MN02235	Late	Erect	171,1
L62	TX01Ab7093	Late	Prostrate	159,6
L63	TX01Ab7096	Late	Prostrate	120,5
L69	WIX6865-5	Intermediate	Erect	193,3
L74	MN94238	Intermediate	Erect	274,4
L78	MN98133	Intermediate	Erect	161
L79	MN00206	Intermediate	Erect	122
L82	ND970651	Late	Erect	153.7
L83	ND981502	Late	Erect	237.9
L84	ND981674	Intermediate	Erect	195.3
L85	ND980351	Late	Erect	126,4
L86	ND981275	Intermediate	Erect	231,5
L89	AC Assiniboia	Intermediate	Erect	157.6
L90	IL96-10351	Intermediate	Erect	186,6
L100	Drummond	Late	Erect	67,9

4.3. Evaluation of selected pure lines from the 2002 QION

Twenty-five oat lines from 2002 Quaker International Oat Nursery (QION-2002) were screened for resistance to crown rust in greenhouse conditions, after artificial inoculation with three Tunisia prevalent populations of crown rust. Twelve lines showed reactions ranging from immunity (no visible symptom) to moderately resistant (moderate pustules with chlorosis or necrosis). These were: Q02-11, Q02-15, Q02-18, Q02-20, Q02-28, Q02-29, Q02-35, Q02-37, Q02-42, Q02-44, Q02-48, Q02-55 (Table 7). These lines will be tested in 2004-2005 for resistance consistency.

Line reactions to the 3 isolates between 0-1 were considered resistant (R) and retained to a second evaluation next year (2005), the others were susceptible (S). The following nine lines Q02 were resistant to artificial inoculations: 11, 18, 20,28, 29,35,37, 42 and 44 (table 8). Notation scale ranged between 0 (healthy plant) to 4 (plant leaves covered by large pustules without chlorosis or necrosis).

These 25 pure lines were also evaluated at 2 INRAT experimental stations: Bou Rabia and Lafareg using a randomized complete-block design with three replications. Each plot consisted of 4 rows, 3 meter long. Observations were taken on the phenological stages; reaction to powdery mildew (PM), crown rust (CR), stem rust and BYDV which were noted during March and April. Measurements were also recorded on grain yield at Lafareg (table 9).

Table 7. Infection type and line reactions to artificial inoculation with 3 races of crown rust performed to oat seedling lines in pots under greenhouse culture.

Line code	CR_{Pc45}	CR_{Pc54}	CR_{Pc40}	Global line reaction
Q02-08	3	;	4	S
Q02-09	2	1	4	S
Q02-11	0	0	;	R
Q02-13	3	3	2	S
Q02-15	0	;	1-2	R
Q02-18	;	0 ;	0	R
Q02-20	;	;	;-1	R
Q02-24	4	3	4	S
Q02-28	0	0	;-1	R
Q02-29	;	0	;	R
Q02-30	4	2	2	S
Q02-34	3	3	4	S
Q02-35	0	;	;	R
Q02-37	0	0	;	R
Q02-42	;	;	;-1	R
Q02-44	;	0	1	R
Q02-48	;	3	;	S
Q02-55	;	0	2	S
Q02-70	2	3	4	S
Q02-71	2	4	4	S
Q02-73	4	4	4	S
Q02-85	3	3	4	S
Q02-87	2	4	4	S
Q02-93	4	2	2-3	S
Q02-96	2	2	3	S

Table 8. Infection type and line reactions to natural infection of CR, stem rust, PM and BYDV virus performed in open field at Lafareg station during 2004 growing season. Notation were done in late May at grain-filling stage.

Line code	Crown rust	Stem rust	Powdery mildew	BYDV	Global line reaction
Q02-08	3-4	0-4	+	++	S
Q02-09	0-1	0	+	+	MR
Q02-11	0	0	-	+	R
Q02-13	2	4	-	-	MS
Q02-15	0	0-4	-	+	R
Q02-18	0-1	0	-	+	R
Q02-20	0	4	-	+	R
Q02-24	4	0-4	-	-	TS
Q02-28	0	0	-	-/+	TR
Q02-29	0	0	-	-/+	TR
Q02-30	4	4	-	-	TS
Q02-34	4	4	-	-	TS
Q02-35	0	0-4	-	-/+	TR
Q02-37	0	0	+	-	R
Q02-42	;	0	+	-	TR
Q02-44	0	4	+	-/+	TR
Q02-48	0	0	-	-	TR
Q02-55	0	0	-	-	TR
Q02-70	3	0	-	+	S
Q02-71	3	4	-	-	S
Q02-73	3	4	-	-	S
Q02-85	4	0-4	-	-	TS
Q02-87	4	4	-	-/+	S
Q02-93	3-4	4	-	-	S
Q02-96	2-3	0-4	-	-	S

Table 9. Mean values of DMY, plant height, grain yield, and harvest index for the 25 genotypes studied at Lafareg.

Genotype	Source	DMY (t ha^{-1})	Plant height (cm)	Grain yield (t ha^{-1})	Harvest index (%)
8	ND960851	7.64	155.0	1.96	0.27
9	ND960620	8.79	151.0	2.33	0.29
11	ND960611	8.27	147.0	2.46	0.25
13	IL95-1241	11.15	141.0	3.27	0.38
15	MN98133	12.11	161.5	1.78	0.21
18	ND961161	6.67	126.5	2.13	0.24
20	ND970651	9.30	157.0	1.76	0.20
24	WIX7994-2	8.82	153.5	1.67	0.25
28	I196-11037	12.16	158.5	2.07	0.24
29	I196-11039	10.17	166.0	3.85	0.39
30	P971A9-7-4	11.86	151.0	2.78	0.29
34	MN98244	8.59	145.5	2.14	0.30
35	WIX8177-1	9.63	148.5	2.89	0.32
37	A9535D118-4	8.32	132.5	1.82	0.28
42	A978GIB-172	6.29	116.5	1.77	0.27
44	A9818IBIB-I4	7.89	109.5	2.07	0.40
48	L9424-A12-B1	8.71	93.5	1.77	0.26
55	Drummond	8.59	102.5	2.92	0.29
70	MN01AR1036	10.02	152.0	1.94	0.20
71	MN01AR1039	11.67	155.5	1.94	0.20
73	MN01AR1047	11.79	148.5	2.94	0.27
85	MN01AR1092	11.74	156.0	2.24	0.23
87	MN01AR1096	8.83	159.5	2.35	0.20
93	MN01AR1252	7.23	160.0	2.05	0.26
96	MN01AR1286	12.63	162.0	1.84	0.18
Means		9.55	144.40	2.27	0.27
CV (%)		20.41	5.60	29.60	23.11

On the basis of agronomic score and CR tolerance under field and greenhouse conditions, twelve lines Q02-11, Q02-15, Q02-18, Q02-20, Q02-28, Q02-29, Q02-35, Q02-37, Q02-44, Q02-48, Q02-55, Q02-73 with superior forage and grain yields and good tolerance to CR were selected for further evaluation in intermediate yield trials.

4.4. Evaluation of selected pure lines from the 2001 QION

From the 100 QION lines grown in 2001, 25 lines were selected in 2002 for their agronomical performance, and were screened in 2003 for their resistance to crown rust. Only 12 lines were chosen and evaluated during 2003/04 growing season. The experimental design was a randomized complete block with three replications. Plots consisted of 6 rows that were 0.30 m apart and 3.0 m in length. The trial was planted early November 2003. Forage was assessed by harvesting one time during full heading stage. Grain harvest was carried out when all the genotypes reached maturity. Analysis of variance was performed on yields, plant height and reaction to diseases. The response means were compared using Duncan's test at 5% level of significance.

Most of these lines were resistant to crown rust, but due to a heavy stem rust attack during the 2003-2004 season, some of these lines proved highly susceptible to this latter pathogen. According to our observations at Bou Rabia and Lafareg stations, only 5 lines were resistant to both crown and stem rusts, and have good tolerance to powdery mildew and BYDV. Among these 5 lines, only 3 were also good performers for DM and grain yields.

These were: Q01-26, Q01-25, and Q01-33. Q01-26, mainly has a high potential to become a candidate for registration in the Catalog. They have as a source ND 9508252, ND 950981 and TAMO 397, respectively (table 10, 11).

Table 10. Mean values of DMY, plant height, grain yield and harvest index for the genotypes studied at Lafareg.

No. entry	Genotype	DMY (t ha^{-1})	Plant height (cm)	Grain yield (t ha^{-1})	Harvest index (%)
25	ND 9508252	7.67	133.67	1.97	0.16
26	ND 950981	**11.91**	141.33	**3.29**	0.23
33	TAMO 397	9.12	118.33	1.50	0.15
34	LA 604	7.46	109.00	2.09	0.20
35	Horizon 314	6.85	112.00	3.21	0.28
39	FLX512-1-B3-W1	8.34	79.33	3.11	0.32
43	LA9326E10-4-2-I1	9.06	101.67	2.3	0.19
44	TX93Ab715-G2	8.03	118.33	1.51	0.16
46	TX98Ab2680	6.33	109.33	1.13	0.13
52	TX96M1384	7.15	123.33	1.66	0.15
85	00MNAR1156	6.46	128.00	2.41	0.22
95	QR1730	10.34	135.67	2.26	0.17
Fretissa	Fretissa	7.20	125.33	0.90	0.10
Av01-9	Av01-9	7.39	136.33	1.81	0.14
Means		8.09	119.40	2.08	0.18
CV (%)		17.84	5.75	16.36	17.87

Table 11. Reaction to CR, PM and BYDV of the tested genotypes at Lafareg.

Genotype	Crown rust	Powdery Mildew	BYDV
25	1	5	2
26	1	2	1
33	1	6	2
34	1	2	2
35	1	2	2
39	1	4	2
43	1	5	2
44	6	4	1
46	1	3	2
52	4	4	2
85	2	5	2
95	2	4	1
Fretissa	1	3	2
Av01-9	2	4	1
Means	1.76	3.86	1.71
CV (%)	58.89	37.85	58.44

Resistance to CR in oat genotypes is not stable and new fungi races frequently develop. Therefore, selecting new oat genotypes with tolerance or resistance to CR allows for more profitable oat production.

4.5. Performance of selected advanced lines for forage production

Twelve oat genotypes: four commercial varieties (Fretissa and Mejerda from Tunisia; Amlal et Tissir from Morroco), four introduced varieties from Spain (Prevision, Coker, Saia and Cobina) and four advanced lines (Av01-1, Av01-2, Av01-3 and Av01-9), were evaluated for agronomic characters at four sites: Lafareg, near Beja; Fretissa, near Mateur; Bargou, near Siliana; and Bou Rabia, near Tunis. The experimental design was a randomized complete-block with three replications. Plot size, cultural practices, observations, measurements and data analyses were similar to the agronomical study of local and introduced oat genotypes (7-1 section).

The combined analysis of variance showed significant differences of DM and grain yields and plant height between the 3 sites. Generally, the DMY produced at Lafareg were higher than those registered at Fretissa and Bargou. Additionally, the interactions of genotypes by sites were significant indicating that ranking of genotypes on DM yield basis was not similar in the 3 sites.

Forage yield varied significantly among genotypes (table 12). The 2003-2004 cropping season was favorable for both hay and grain oat production. Whenever good stands were achieved and harvest was on time, oat yield were very good. Late planting due to wet soils reduced yield at Bargou and Fretissa sites. The performance of the genotypes at Fretissa and Lafareg and Bargou sites are presented in tables 12, 13.

Table 12. Forage yield and plant height of oat varieties studied at Lafareg, Fretissa, and Bargou.

Genotype	Lafareg		Fretissa		Bargou	
	DMY (t ha^{-1})	Plant height (cm)	DMY (t ha^{-1})	Plant height (cm)	DMY (t ha^{-1})	Plant height (cm)
Prévision	9.952	131	8.816	121	3.52	86
Coker	8.957	97	4.129	111	2.201	74
Saia	12.414	164	10.854	130	4.106	115
Mejerda	15.095	160	7.466	132	3.331	93
Fretissa	11.790	148	5.296	121	2.498	71
Amlel	11.532	149	6.105	121	3.999	99
Tissir	13.924	132	13.881	133	3.596	87
Av-9	13.105	153	7.952	125	3.463	86
Cobina	12.080	160	8.514	126	5.08	102
Av.01-1	13.180	125	8.556	127	2.646	76
Av.01-2	11.418	153	9.227	122	2.309	71
Av.01-3	11.737	153	7.745	124	1.399	83
Means	12.099	144	8.212	124.444	3.178	87.222
CV (%)	12.16	4.99	23.09	8.49	27.939	8.926

Variation between genotypes were noted for the heading date. Fretissa and Av-9 were earlier than the introduced genotypes.

Table 13. Earliness of the 12 genotypes

Genotype	Earliness Nbr of days
Prevision	196
Coker	203
Saia	189
Mejerda	203
Fretissa	182
Amlel	175
Tissir	203
Av-9	175
Cobina	189
Av.01-1	196
Av.01-2	182
Av.01-3	182

*Number of days from sowing to anthesis

At both sites, reaction to crown rust (CR), powdery mildew and BYDV were more important at Fretissa station than at Lafareg, although weather conditions were almost similar. The most tolerant genotypes were Saia, Fretissa, Amlel. Tissir and Av.01-2. Severe symptoms were noted on Prevision, Coker and Cobina, the three Spanish varieties (table 14).

Table 14. Reaction to CR, PM and BYDV of the tested genotypes at Lafareg and Fretissa stations.

Genotype	Lafareg			Fretissa		
	Crown rust	Powdery mildew	BYDV	Crown rust	Powdery mildew	BYDV
Prevision	6	5	3	6	4	2
Coker	8	1	1	6	6	2
Saia	1	7	1	2	4	2
Mejerda	2	3	1	4	4	1
Fretissa	1	3	1	2	4	2
Amlel	1	3	1	1	2	2
Tissir	1	7	1	2	3	2
Av-9	2	5	1	3	4	1
Cobina	6	3	3	4	4	2
Av.01-1	4	3	1	4	6	2
Av.01-2	1	1	1	2	4	2
Av.01-3	2	7	1	3	5	2
Means	3	4	1.33	3.27	4.28	1.83
CV %	30.15	0	0	36.28	31.43	56.97

Grain yield varied significantly between genotypes (table 15). Over all sites, Amlal gave the highest grain yield while Coker the lowest. Variety selection is an important decision when changing from the sub humid to the semi-arid regions.

Table 15. Grain yield, Straw yield and harvest index of oat varieties studied at Lafareg, Fretissa. and Bargou stations.

Genotype	Lafareg					Fretissa					Bargou				
	Grain yield ($t\ ha^{-1}$)		Straw Yield ($t\ ha^{-1}$)		HI (%)	Grain yield ($t\ ha^{-1}$)		Straw Yield ($t\ ha^{-1}$)		HI (%)	Grain yield ($t\ ha^{-1}$)		Straw Yield ($t\ ha^{-1}$)		HI (%)
Prévision	2.476	(7)*	8.975	(9)*	0.22	0.717	(11)	4.213	(12)*	0.15	0.289	(3)	1.602	(9)*	0.15
Coker	1.06	(12)	7.199	(12)	1.33	0.899	(9)	6.805	(10)	0.10	0.206	(8)	2.176	(5)	0.10
Saia	1.182	(11)	13.492	(1)	0.08	0.879	(10)	20.185	(1)	0.04	0.209	(7)	2.621	(3)	0.07
Mejerda	1.921	(9)	10.260	(4)	0.16	0.672	(12)	9.167	(8)	0.07	0.257	(5)	1.704	(6)	0.12
Fretissa	1.870	(10)	9.664	(8)	0.16	1.921	(5)	12.963	(6)	0.13	0.172	(9)	1.657	(8)	0.09
Amlel	3.111	(2)	9.889	(5)	0.24	3.662	(1)	15.556	(4)	0.19	0.572	(1)	1.685	(7)	0.25
Tissir	2.822	(4)	9.781	(7)	0.22	1.576	(6)	17.824	(2)	0.08	0.237	(6)	3.769	(1)	0.06
Av-9	2.621	(6)	10.524	(3)	0.20	2.470	(3)	14.722	(5)	0.14	0.454	(2)	2.241	(4)	0.16
Cobina	2.264	(8)	11.020	(2)	0.17	1.256	(7)	8.056	(9)	0.14	0.27	(4)	3.241	(2)	0.08
Av.01-1	2.708	(5)	8.834	(10)	0.23	0.937	(8)	5.185	(11)	0.15	0.162	(10)	1.574	(10)	0.08
Av.01-2	3.285	(1)	9.868	(6)	0.25	2.449	(4)	12.454	(7)	0.16	0.159	(11)	1.213	(12)	0.12
Av.01-3	3.006	(3)	7.973	(11)	0.28	2.931	(2)	15.648	(3)	0.16	0.083	(12)	1.241	(11)	0.06
Means	**2.36**		**9.790**		**0.20**	**1.697**		**11.898**		**0.13**	**0.255**		**2.060**		**0.11**
CV (%)	21.42		14.80		24.24	25.28		22.12		24.77	53.12		31.22		46.41

* Rank

4.6 Effect of seeding rate on forage and grain yield of fodder oat (cv Meliane) under favorable environments in Tunisia

Abstract

The effect of eight seeding rates (from 100 to 450 seeds m-2 with an increment of 50) on subsequent forage and grain production of Meliane fodder oat cultivar was studied over two sites and two consecutive cropping seasons. Results showed that grain yield, forage yield and plant height did not significantly varied with seeding rate but depended significantly on year and site by year interaction. Individual plant phytomass, stem diameter and major grain yield components were significantly affected by seeding rate, and grain yield seems to be compensated through variation of grain yield components. Over all sites and years, Meliane averaged 0.2234 and 1.4445 kg DM m-2 for grain and forage yield, respectively. Principal component analysis revealed that with lower seeding rates (until 250 seeds m-2, plants with high stem diameter and high individual phytomass were obtained; while greater seeding favored forage yield and we obtain smaller plants with lower stem diameter.

Introduction

Fodder oat constitutes the main widely cultivated forage crop in sub-humid and semi-arid regions of Tunisia under rainfed conditions. It covers over 170000 hectares and accounts for about 60% of yearly winter forage cultivated areas (Anonymous, 2000). Generally, farmers are advised to sow forage oat at a rate of 300 viable seeds m-2 for either forage and grain production purpose (Chakroun and Gouhis, 1998). Nevertheless, more needs to be known about the effects of seeding rate on grain yield of the new released cultivars. Therefore, a two-site trial was carried out for 2 years on Meliane cultivar where the effect of several seeding rates on fodder yield, grain yield, yield components were examined.

Material and methods

The Meliane cultivar was used in this study. It is a new oat cultivar (cv) released in 1998, and is a high yielding erect oat cultivar and moderately resistant to crown rust. Trials were carried over two cropping years 2002-03 and 2003-04, at 2 different sites each year. The first year, the trial was established in Lafareg experimental station of INRAT (in North West region of Tunisia) and in Oued Souhil experimental station of INGREF in Cap Bon region. Each site belongs to sub humid bioclimatic stage. Soil types were vertisol and sandy clay soils in Lafareg and Oued Souhil, respectively. The Oued Souhil station is provided with an irrigation network with treated wasted water of ONAS enabling a complementary irrigation when needed. In the second cropping year, trial was carried out under rainfed conditions, in Lafareg site and in Fretissa, which is an OEP (Office de l'Elevage et des Pâturages) pilot farm belonging to sub-humid climatic stage with 600 mm of long term annual precipitation mean. Table 1 describes the main characteristics of the sites used.

Table 1. Experimental sites characteristics.

	Lafareg	Oued souhil	Lafareg	Fretissa
	2002-03	2002-03	2002-04	2003-04
Soil type	Vertosoil	sandy clay	Vertosoil	Vertosoil
Climatic stage	Sub-humid			
Sowing date	12/11/2002	26/11/2002	4/11/2003	19/11/2003
Previous crop	chickpea	fallow	Vicia	Sulla
Seedbed preparation	Conventional			
Long term precipitation (mm)	650	550	650	600

In each site, a randomized complete block design with three replicates was employed. Eight seeding rates, 100, 150, 200, 250, 300, 350, 400 and 450 viable seeds m-2 were used. Plots consisted of 6 rows, 2 m long and 25 cm apart. Plots was fertilized with 50 kg P ha-1 prior to sowing and 120 kg N ha-1 partitioned in 40 kg N ha-1 at emergence, 40 kg N ha-1 at tillering stage and 40 kg N ha-1 at the booting stage. Weeds were controlled with 1.5 l ha-1 of Basagran M (bentazone at 480 g ai l-1 + MCPA at 125 g ai l-1) at 4 leaves stage while weeds are at 3 leaves stage. During 2002-03 cropping year in Lafareg , manual harrowing was necessary in march to control the remaining weed species (such as Ridolfia segetum Morris and Bromus rigidus Roth). In each site, crown rust was controlled by one application of a triazole fungicide at its recommended rate.

Observations were taken on the phenological stages according to Zadoks et al. (1974) scale.

The following morph physiological traits were also recorded:

- Emerged Seedlings m^{-2}
- Forage yield (kg ha^{-1}); calculated on 2 rows basis at anthesis. Fresh weight was recorded and a sub-sample of 500 g was dried to determine dry-matter content.
- Individual phytomass (g $plant^{-1}$). the mass of an individual plant.
- Plant height (cm) measured on ten random plants from each plot, as the distance from the soil surface to the top of panicle
- Grain yield calculated on one row basis
- Number of panicle m^{-2}, grain yield per plant, number of grains per panicle and 1000 grains weight.

Data were analyzed by GLM procedure of SAS software (SAS, 1990), where site and year are considered as random. Because, sites were different each year, we tested the significance of nested effects: site within year noted site (year); replication within the interaction year by site noted Block (Year x S)m and the site by seeding rate interaction within year noted Site x D (Year) .

Results and discussion

For all sites used (Lafareg, Oued Souhil or Fretissa), total annual precipitation was above thirty year mean precipitation in both years. In Oued Souhil, irrigation was unnecessary because of regular distribution of the precipitations during the whole growing season. The 2002-03 season was favorable between tillering to pre-anthesis period due to the above mean precipitation from November to February. Also, high spring precipitation occurred in March to April which was favorable to the post anthesis development and grain formation period (table 1). In Oued Souhil site, strong North West wind occurred in winter and caused significant wind damage which consisted in significant mechanic lodging area.

Table 1. Monthly precipitation occurred in Lafareg and Oued Souhil respectively during 2002-2003 cropping season.

month	Lafareg	Oued Souhil	Lafareg	Fretissa
	2002-03	2002-03	2003-04	2003-04
September	23,9	38,2	64	91.6
October	24,4	14,4	65	34
November	48,7	100,7	34	23.6
December	40	54,7	185	247.5
January	115,7	102,5	97	108.5
February	59,9	50,4	14	11.4
March	23,9	35,3	57.5	64
April	86,3	50,3	65	74
May	16,3	9,3	8	22.8
June	17,5	4,3	73	54.5
July	0	0	0	0
August	0	9,3	13	0
Growing season precipitation	408,3	407,5	533.5	606.3
Annual precipitation	**456,6**	**469,4**	**675.5**	**731.9**

Also, a good precipitation occurred in the 2003-04 cropping year either in Lafareg or in Fretissa sites. A very high precipitation happened in December in Fretissa caused lodging and seedlings losses in some plots.

Emerged seedlings m^{-2}

Number of seeds emerged for each seeding rate and sites are given in table 2. Emergence rate was closely dependant on seeding rate, and we noted that a highly significant and positive coefficient of correlation was obtained between the two parameters ($r = 0,95$; $n=96$, $p<0,01$ for all sites). Good seedbed preparations and significant rain occurrence just after sowing may constitute well conditions for a good emergence and cover establishment.

Table 2. Emerged seedlings number m-2 at each site.

Treatments viable seeds m^{-2}	Seedlings emerged $m^{-2} \pm$ SD			
	Lafareg	Lafareg	Oued. Souhil	Fretissa
	2002-03	2003-04	2002-03	2003-04
150	137,3 ± 13	169 ± 17	168,0 ± 34	152.3 ± 20
200	236,0 ± 90	202 ± 10	193,3 ± 6	192 ± 3.4
250	229,3 ± 29	275 ± 31	284,0 ± 54	246 ± 9
300	274,7 ± 32	312 ± 11	301,3 ± 48	304.3 ± 9.6
350	321,3 ± 20	379.3 ± 9	369,3 ± 28	350.3 ± 16
400	393,3 ± 10	454. ± 40	440,0 ± 38	406 ± 5
450	448,0 ± 32	481. ± 39	504,0 ± 80	437.6 ± 6

Forage production

The results of the combined analysis of variance for forage yield are shown in table 3. Differences between cropping years and sites were statistically significant. However, statistical analysis revealed no significant effect of seeding rate on forage yield.

Table 3. Source of variation significance of the combined analysis of variance for two cropping years, three sites (different sites each year), and eight seeding rates for forage yields. Years (Y), 2002-03 and 2003-04; Site (S), Lafareg and O.souhil, the fist year and Lafareg and Fretissa at the second year; seeding rates (D), from 100 to 450 viable seeds m-2. Effect within blanks refers to the nested variables tested because different sites are considered each year.

.	df	Forage yield	Phytomass	Stem diameter	Grain yield	Plant height
Year	1	***	***	***	***	***
Site (year)	2	***	*	NS	***	NS
Block (Year x S)	8	*	*	NS	NS	NS
D	7	NS	***	***	NS	NS
Year x D	7	NS	*	NS	NS	NS
Site x D (Year)	14	NS	NS	NS	NS	NS
Total	95					
Error	56					
Coefficient of Variation (%)	-	17.25	23.79	15.56	22.99	7.44

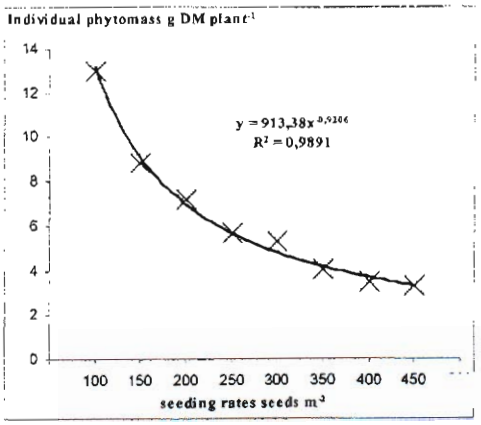
*; **; ***: significant at 5%, 1% and 0,1% levels respectively

The forage yield obtained was significantly higher in 2002-03 than in the subsequent cropping year. The mean highest forage yields were recorded in Oued Souhil (1.973 kg DM m-2). The proximity of this site from the sea influence (higher winter mean temperature), and also the amendment of the soil with ONAS peat, a sub-product of wasted water treatment, which has been done in 2001-02 cropping year may explain the very high mean yields obtained. The lowest forage yield was obtained in Fretissa in 2003-04. Meliane cultivar yielded 1.1764 kg DM m-2 over the eight seeding rates (table 4). A severe non treated crown rust attack in late season caused this low yield performances comparatively to the other sites.

Table 4. Values (± s.e.) of forage yields for the eight seeding rates over three sites and two cropping years. Averages values are significantly different if fallowed by different letters.

Seeding rates	Lafareg 2002-03	Oued Souhil 2002-03	Lafareg 2003-04	Fretissa 2003-04	Average
100	1,48 ± 0.39	2,00 ± 0.14	1,03 ± 0.28	1,12 ± 0.17	1,411a
150	1,35 ± 0.11	1,95 ± 0.2	1,01 ± 0.31	1,07 ± 0.12	1,347a
200	1,62 ± 0.16	1,92 ± 0.09	1,09 ± 0.11	1,14 ± 0.23	1,447a
250	1,47 ± 0.17	1,92 ± 0.18	1,02 ± 0.28	1,32 ± 0.22	1,436a
300	1,67 ± 0.08	2,27 ± 0.12	1,10 ± 0.35	1,17 ± 0.24	1,554a
350	1,66 ± 0.07	2,00 ± 0.21	0,86 ± 0.17	1,14 ± 0.12	1,417a
400	1,64 ± 0.31	1,88 ± 0.07	1,13 ± 0.12	1,14 ± 0.17	1,455a
450	1,93 ± 0.07	1,82 ± 0.10	1,07 ± 0.13	1,28 ± 0.01	1,528a
average	1.0± 0.23a	1.97± 0.17c	1.04a±	1.17 ± 0.17b	

In another side, seeding rate had significantly influenced phytomass as expressed by individual plant dry matter weight (iP) and also mean stem diameter as expressed by the third node mean stem diameter. A strong relationship was found for both parameters with seeding rates (figures 1, 2). These relationships imply a morphological differentiation of plants with varying seeding rates, which can be proven through variation of stem diameter and individual plants size.



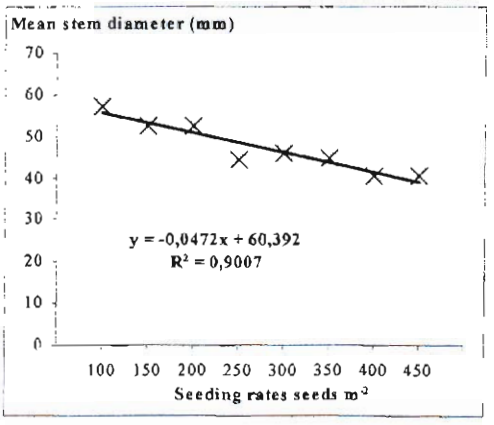


Figure 1. Relationship between seeding rates and both individual plant phytomass and mean stem diameter.

Grain yield and yield components

Grain yield depended significantly on the year and the sites within years factor, and was not statistically affected by seeding rate. The grain yield was significantly higher in 2002-03 (2400 kg ha-1) than in 2003-04 where it averaged 2000 kg ha-1 (Table 5). The highest grain yields were obtained in Lafareg in both years (2760 kg ha-1). The lowest yields were recorded in Fretissa in 2003-04 year. Oat yielded 1325 kg ha-1 because of a severe crown rust attack in late season. In Oued souhil, mean grain yield was equal to 2081 kg ha-1. It was negatively affected by mechanic lodging caused by winter strong winds occurred in late February which affected randomly the plots. However, the average mean yield of 2230 kg ha-1 still comparable to that mentioned by Chakroun et Gouhis (1998) for the cultivar Meliane.

Table 5. Values (± s.e.) of grain yields for the eight seeding rates over three sites and two cropping years. Means values followed by different letters are significantly different at 5% level.

Seeding rates	Lafareg	Oued Souhil	Lafareg	Fretissa	Mean
Seeds m^{-2}	2002-03	2002-03	2003-04	2003-04	
100	2872 ± 110	2129 ± 600	1862 ± 788	3261 ± 481	2531 ± 79a
150	3000 ± 455	1526 ± 352	1729 ± 652	2537 ± 113	2198 ± 87a
200	2967 ± 536	1560 ± 801	1112 ± 266	2747 ± 502	2096 ± 96a
250	2848 ± 301	2745 ± 681	1201 ± 126	2745 ± 484	2385 ± 85a
300	2665 ± 513	2125 ± 308	1094 ± 562	2565 ± 147	2112 ± 74a
350	2738 ± 555	1854 ± 428	1175 ± 431	2751 ± 285	2130 ± 78a
400	2502 ± 590	2389 ± 816	1379 ± 146	2668 ± 258	2234 ± 33a
450	2605 ± 114	2318 ± 273	1047 ± 175	2779 ± 749	2187 ± 65a
Mean	2775 ± 450a	2081 ± 526b	1325 ± 546c	2756 ± 513a	

Grain yield components

Table 6 shows the results of the analysis of variance for grain yield per plant , and the three primary yield components.

Table 6. Source of variation significance of the combined analysis of variance for two cropping years, three sites (different sites each year), and eight seeding rates for grain yields and primary components

Source of variation	dl	Grain yield	Panicles m^{-2}	1000 kernels weight	Grain yield $plant^{-1}$	Spiklets $panicle^{-1}$	
						dl	significance
Year	1	***	NS	NS	***	1	NS
Site(year)	2	***	**	***	***	1	NS
Block(Year x S)	8	NS	NS	NS	NS	6	NS
D	7	NS	***	***	***	7	NS
Year x D	7	NS	NS	***	NS	7	NS
Site x D (Year)	14	NS	NS	NS	NS	7	NS
Total	95	-	-	-	-	70	-
Error	56	-	-	-	-	41	-
Coefficient of Variation (%)	-	22.99	24.26	9.52	34.34		22.19

*; **; ***: significant at 5%, 1% and 0,1% levels respectively; □ : represent Block mean square

Grain yield per plant

Grain yield per plant was significantly affected by the year, site(year) and seeding rate factors. The average yield per plant was 1.09 g plant-1 in 2002-03 and 0.92 g plant-1 in 2003-04. Increasing seeding rate from 100 to 450 seeds m-2 caused a significant reduction of grain yield per plant by about 80% (from 2.34 to 0.46 g plant-1; figure 3).

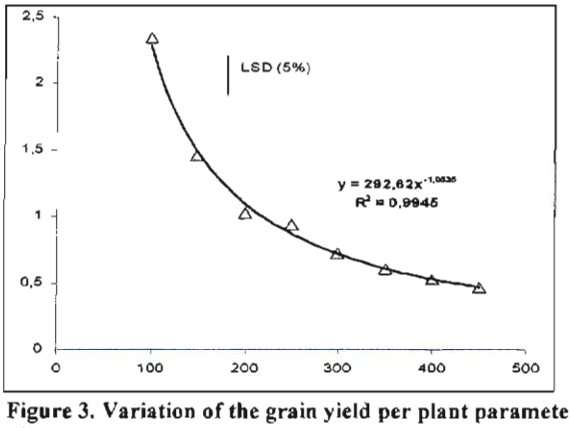


Figure 3. Variation of the grain yield per plant parameter with seeding rates. Values are averaged through two years and three sites.

Panicle m^{-2}

This component was strongly and logically dependant on the utilized seeding rate because it was high positively correlated to number of seedling emerged (data not shown). It also depended on the site (year) effect. In fact, in Fretissa, a huge rain occurred in December (over 240 mm; table 1) caused the elimination on some emerged seedling in the first block.

Number of spiklets per panicle

This component was not measured in Lafareg in the second cropping year. It was no significantly affected by any factor and remained stable and relatively high over the eight

seeding rates, the three sites and two cropping years. This parameter averaged 55.3 spiklets panicle-1 over two years which confirm the high potential of Meliane cultivar for seed production.

1000 grains weight (TGW)

Only the first year thousand kernel weight was submitted to the analysis of variance. It was significantly dependant on the seeding rate and site factors (table 6). Mean TGW averaged 40 g and seemed to increase with seeding rate (figure 4).

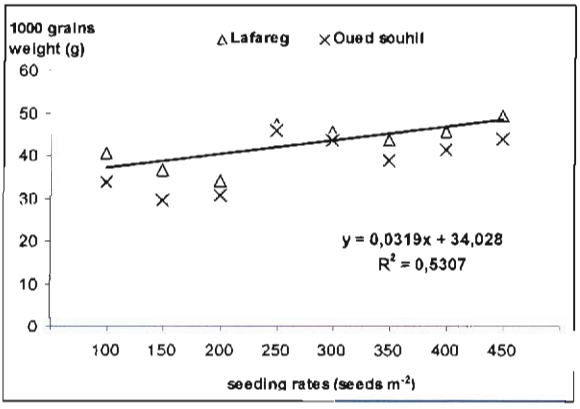


Figure 4. Variation of thousand grain weights with seeding rates

Correlation with yields

Table 8 shows the Pearson correlation coefficients between grain yield and grain yield components for the whole data, the two cropping years, three sites, and eight seeding rates.

Correlation analysis indicated a strong positive relationship between grain yield and both number of panicles m-2 and thousand grain weight (Table 8). Since the grain yield was not affected by seeding rate, there is a matter of evidence that a compensation amongst yield components occurred. In fact, a moderate negative correlation was obtained between number of spiklets panicle-1 and 1000 grains weight. Compensation had also occurred through a negative relationship between grain yield per plant and both panicle m-2 and spiklets per panicle (r= -0.2, n=96).

Table 8. Pearson correlation coefficient matrix of between

	Grain yield	Grain yield per plan	Panicle m^{-2}	Spiklets $panicle^{-1}$	TGW
Grain yield	1				
Grain yield per plant	0.58***, n=96	1			
Panicle m^{-2}	0.27***, n=96	-0.20*, n=96	1		
Spiklets per panicle	ns	-0.20*, n=96	ns	1	
1000 grains weight	0.41***, n=48	ns	0.38***, n=48	-0.40*, n= 71	1

*; **; *** significant at 5%, 1% and 0,1% levels respectively; √: indicates the number of observations on which the coefficient of correlation was calculated.

In O. Souhil, no evident relationship was obtained between seeding rates and grain yields. best R2 obtained was equal to 0.08 for a quadratic regression.. However, in Lafareg, although seeding rate did not significantly influenced grain yield, a quadratic regression with high R2 was established e between these two parameters. Maximum yields were obtained with the lower seeding rates (100 to 200 seeds m-2). Correlation matrix indicated that, grain yield variation was mainly related to kernel weight ($r = 0,41$, $n = 48$; $p = 0,0039$). Among grain yield components, only kernel weight was significantly affected by seeding rate. In fact, seeding rates was positively correlated to kernel weight ($r = 0.51$; $n = 48$; $p = 0.0002$). and the number of panicle m-2 ($r = 0,46$; $n = 48$; $p = 0.0005$) and negatively correlated to the number of grain panicule-1 ($r = -0.65$, $n = 24$; $p = 0.0002$).

Principal component analysis

The two years mean values of all variables were submitted to principal component analysis to determine effect of seeding rates on forage, grain yield and related variables.. The eigen values indicated that the two first components account for 85% of the standardized variance (67.8% and 18.0%, respectively). Study of the vector loading revealed that the first principal component had positive loading on individual phytomass, stem diameter grain yield, and negative loading on forage yield. The second principal component was highly and positively represented by grain yield t (table 4).

Table 9. Relative contribution of most measured variables to the grouping of seeding rates as quantified by principal component analysis. Loading of each variable and the first two principal component with explanatory percentages are presented.

Variable	First Principal component	Second Principal component
Grain yield	**0,411535**	**0,82009**
Stem diameter	**0,548369**	-0,288604
Phytomass	**0,585287**	0,056788
Forage yield	**-0,432862**	0,490852

Consequently, seeding rates located in the positive side of the axis 1 (right side) induced an increase in stem diameter, individual phytomass and grain yield This increases was permitted by the lowest seeding rates (until 250 seed m-2; figure 5). The greatest seeding rates (300 seeds m-2 and higher) which are located at the negative side (left side) of the first axis favored, however, forage yield.

Conclusion

In this two years trial, we found that contrarily to the rationale admitted by farmer, varying seeding rates from 100 to 450 seeds m-2 did not significantly alter both forage and grain yield of fodder oat. In General, farmer trends to increase unjustifiably seeding rates to much higher extend than it is needed. It is proven in this trial, that it is not necessary to use high seeding rates for maximizing either grain or forage production. Reduction of plant density is compensated by kernel weight and grain number panicle-1.

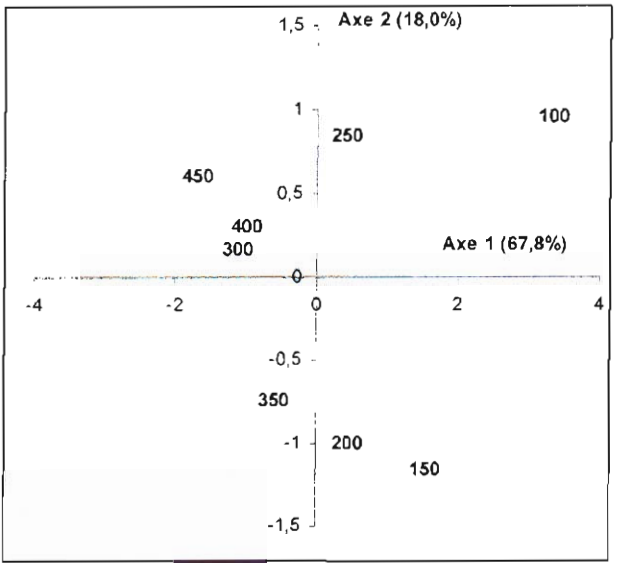


Figure 5. Principal component biplot for 8 seeding rates.

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4.6 Effect of foliar fungicides application on crown rust (Puccinia coronata C.) of oat

Rationale

Crown rust is the main oat disease in Tunisia. Some years, it causes losses of over 50% of forage and grain yield. In order to establish a technical package for both oat forage and oat seed production, a two sites trial was carried for two years on two oat varieties known for their high susceptibility to crown rust.. This report presents the results obtained in the first year.

Material and Methods

During the cropping seasons 2003-04, three foliar fungicides programs were applied on two susceptible cultivars which are Av95, an Avena sativa oat genotype known for its high susceptibility to crown rust (Mansour et al., 2001) and a local oat variety (Avena byzantina Koch) originated from Maacher (near Sejenane) region which proved to be highly susceptible to the disease (Chakroun et al. 2003). The fungicides programs applications are as follows.

A : Control, no chemicals applied

B : Mancozèbe (1500 g ai ha^{-1}) at late tillering (february 6^{th}) + Epoxiconazole (125 g ai ha^{-1}) at heading (march 26^{th})

C : Two applications of Epoxiconazole (125 g ai ha^{-1}): the first at heading (in march 26th) and the second at one month later

D : One application of Mancozèbe (1500 g ai ha^{-1}) at late tillering (application in February 6th)

During the first year, the trial was installed in the INRAT Experimental station of Lafareg and it was designed as a split plot design with three replications. Fungicides programs were arranged as the main plots, and all possible combinations between 2 varieties and two clipping treatments in sub-plots. Clipping treatments consisted of two forage harvesting strategies which are:

- One harvest of forage at heading stage
- dual harvesting of forage, once at la tillering (growth stage 31 at Zadoks et al. (1974) scale) and then harvesting regrowth when it reaches heading stage (stage 59 at Zadoks scale).

Seedbed preparation was done according to a conventional scheme with deep plow tillage after the first significant autumn rain (> 10 mm) followed by two Offset disk tillage before sowing. Phosphate is applied at 45 Kg P2O5 ha^{-1} and were incorporated to soil with the offset tillage. The trial was hand sown on 1st November 2003. Nitrogen was applied at 30 kg ha^{-1} at emergence and 70 kg ha^{-1} at late tillering. Clipped plots received 30 supplementary kg N ha^{-1} just after the cut (forage removal). Observations were taken on forage yield, seed yield, and visual disease severity expressed as the percentage of attacked foliar surface by crown rust. Crown rust disease notations were based on the international oat descriptor of IPGRI. Data were analyzed by the mean of ANOVA procedure of SAS software and means were separated by the Duncan test at 5% level.

Preliminary results

Table 1 shows the analysis of variance for the measured variables for one year and one site.

Table 3. Source of variation significance of the analysis of variance for four fungicides application programs, (P), two clipping treatments, two genotypes (G) and three replications (Rep)

.	df	Forage yield	Grain yield	1000 grains weight	Seeds density	Attacked surface % (1)	Attacked surface % (2)	Attacked surface % (3)	Attacked surface % (4)
P	3	*	***	ns	***	*	**	***	***
P x Rep	8	*	ns	ns	***	ns	ns	ns	*
Cl	1	***	***	**	ns	ns	ns	ns	ns
Cl x P	3	ns	ns	ns	ns	ns	ns	ns	ns
G	1	***	***	*	***	*	***	***	***
G x P	3	ns	***	ns	ns	ns	***	*	*
G x Cl	1	ns	***	ns	***	ns	ns	ns	ns
G x Cl x P	3	ns	ns	ns	ns	ns	*	ns	ns
Total	47	-	-	-	-		-	-	-
Error	24	-	-	-	-		-	-	-
Coefficient of Variation (%)						110.32	81.2	60	29,8
R^2						58.0	77.0	81.6	93.4

*; **; ***: significant at 5%, 1% and 0,1% levels respectively; ns : no significant

Visual percentage of leaf area covered with crown rust symptoms

Percentage of leaf area covered with crown rust symptoms was visually estimated four times after heading stage. The four percentages were statically affected by either fungicides program or genotypes. Differences between treatments are more significantly affected by fungicides program with the two latest estimated percentages. In fact, Av95 was significantly more sensitive to crown rust than Maacher. Furthermore, the lowest estimated percentage was usually observed in the dual triazole application program. The control (A) and the D program (one early application of mancozeb) were not significantly different.

Forage yield

Forage yield was significantly affected by fungicide combinations applied at, clipping treatment and oat genotype. Over all treatments, Maacher local genotype yielded more than the cultivar Av95 (1027 g DM m-2 against 816 g DM m-2). The best forage yield was obtained with the C combination which consisted of dual applications of epoxiconazole. The C and B programs of fungicides application gave the best mean forage yield (0.96 kg m-2), They are followed in a decreasing order by control and B program (0.86 kh m-2). In economic term, dual-application of Epoxiconazole can not justify the forage yield enhancement comparatively to the one application treatment.

Grain yield and seeds density

Grain yield was significantly affected by either fungicides combinations, clipping treatment,, and genotype. A strong interaction was found between genotype and fungicide program indicating that the two oat cultivars reacted differently to the applied fungicides combinations. Best grain yield was obtained with dual application of epoxiconazole fungicide (combination C), where it reached 324 g m-2. Grain yield was statically the same for the remaining fungicides treatment, control, B and D and reached a mean value of 150 g m-2 which represent a yield reduction of about 38% comparatively to the C dual application treatment.. One early season application of Mancozebe did not protect the crop against later fungi contamination. Furthermore, Lower grain yields and seeds densities obtained in control treatment and with D program have proven the interest of using fungicides for oat high quality seed production.

Forthcoming steps in 2004-2005

- Continue the evaluation trials of the selected plant material from the 2002 and 2003 QOIN with emphasis on the leaf rust resistance under greenhouse and field conditions.
- Introduction of Oat genetic material from the USA universities and the Quaker International Oat Nursery (2004 nursery) and preliminary evaluation.
- Selection for evaluation under different environmental (field) conditions (outstanding lines will be increased at the main location for preliminary replicated trials).
- Seeding rates effect on oat forage seed yield at the field level (using conventional driller).
- Effect of foliar fungicides application on crown rust (*Puccinia coronata* C.) of oat (for a second year).

Sustainable management of the Agro-Pastoral Resource Base in the Maghreb (SDC Project, Phase II)

Sustainable management of the communal pastoral resources in the Ouled Chéhida community/Prefecture of Tataouine (Tunisia)

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1. Introduction

The project started effectively during the year 2004. In 2003, the main achieved activities were limited to valorisation of the available data, mainly those of the M&M team in the framework of the survey of the PRODESUD project. This permitted us to make a detailed descriptive analysis of the socio-territorial unit (UST) of Ouled Chehida about social, economic and land tenure contexts, as well as a typology of pastoral production systems and a participative development of the rangeland deterioration map on the basis of the toponymic map (Annual Report, 2003).

In 2004, the program was readjusted as due to the delay of the 2003 activities, four research activities have been carried out with variable advancement levels.

(i) Mapping the current vegetation types of the study area and monitoring their dynamics since 1990

- Treatment and classification two images SPOT-1990 and Landsat2000 thanks to GIS and remote sensing softwares (Arcview and Erdas).
- Data field collection according to the Braun-Blanquet method
- Statistical analysis of the field data and plant community determination
- Achievement of the vegetation type maps (1990 and 2004)
- Assessment of the vegetation type dynamics

(ii) Structure and productivity of the main ecological systems

- Plant cover and species composition,
- State of the soil surface
- Plant density
- Range value and grazing capacity

(iii) Determination of the real nutritional value of rangelands (problem of skeletal rangeland nutritional efficiency).

- Collection of samples of dominant range species
- Determination of nutritional value of the dominant range species,
- Analysis of soil samples for the two rangeland types resulting from the shepherd investigation
- Analysis of blood for two animal herds grazing the two rangeland types,

(iv) Study of communal pastoral resource use strategy

- Achievement and analysis of 93 investigation- shepherd.
- Semi-structured maintain with the shepherds and breeders,
- Assessment of the communal watering points management problems,

2. Mapping the current vegetation types of the study area and monitoring their dynamics since 1990

2.1. Methodology

In order to achieve the ecological system map, the methodology adopted is based on an integration of the field data (Braun-Blanquet type) and those spatial (SPOT images taken in 1990 and 2000). To study the dynamics of the different land use as well as plant communities, a map extracted from an older image is compared to the one of the current state, thanks to GIS (Arcview) and Erdas softwares, and differences observed between the two maps may emphasize this dynamics. The methodology adopted for the achievement of this survey is represented in figure 1.

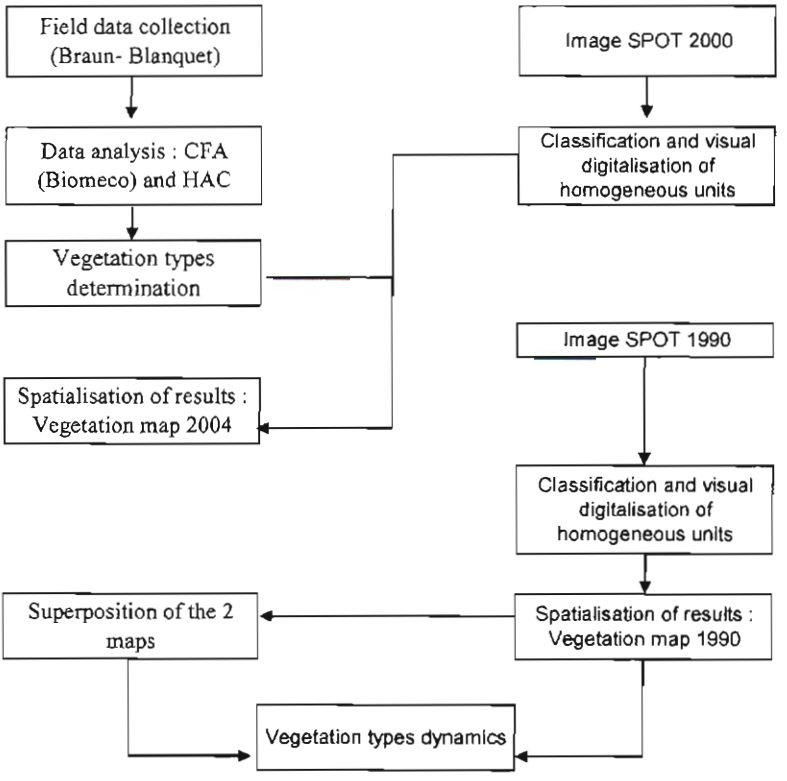


Figure 1. Chart of the main steps for data analysis

2.1.1. Field data collection

A complete description of the site has been done according to the method of Presence / absence and abundance / dominance (method of Braun Blanquet): (dominant vegetation, evaluation of plant cover, determination of vegetation strata and species composition...) and recording the geographical coordinates (with GPS) of the described site. Totally, more than 135 sites distributed in the whole study area (figure 2) were described

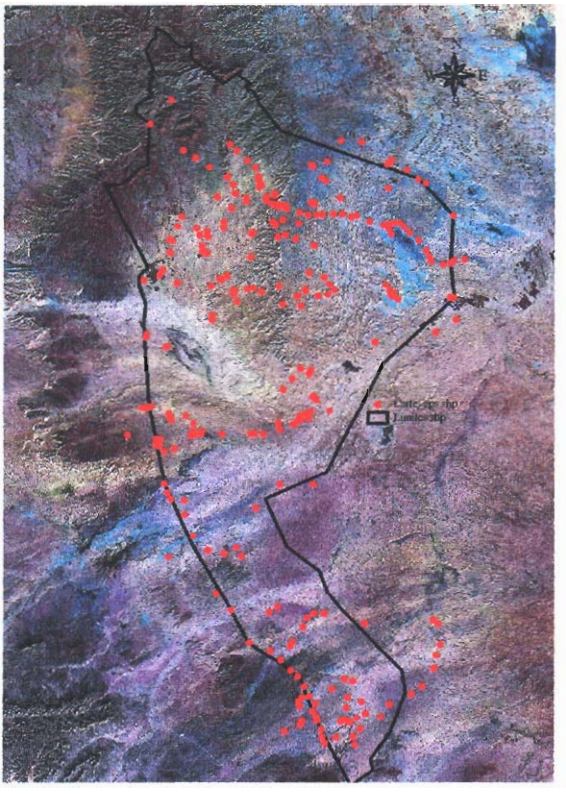


Figure 2. Distribution of the described sites within the study area of the UST d'Ouled Chehida

Soil type

In each site, the survey includes a description of the geomorphology (hills, valleys, streams or sand dunes,...) and of the soil type. Indeed the determination of the state of soil surface is made on the soil type as well as the composition of its surface state (stones, water erosion, wind veils, crusts,...). Generally, in the study area, five main soil types can be found, it is about the skeletal soils (mostly located in the piémont), loamy (to the north), sandy (to the South), salty and especially gypsic soils.

Plant species

Identified species in each sampling site are species that appear in the surrounding of the point for which we took the geographical coordinates (the most often it doesn't exceed 30 m from

this point). Sampling sites characterized by very low species richness are those reposing on skeletal substrata that don't permit an appropriate emergence and establishment of vegetation. An average of 5 to 25 species was recorded in all sites.

Dominance

In each sampling site, the determination of the dominant species is indispensable to the good progress of the next steps of the work. Indeed after the identification of various groups of vegetation (according to CFA presence / absence), we proceed to the abundant and dominant species determination (by the hierarchical ascendant classification HAC abundance / dominance). At last step, comes the ecological system typology that consists in giving, in general, to each delimited polygon on the image the name of the most two dominant species in the sampling site having the corresponding geographical coordinates.

To distinguish the most dominant species in each sampling site, we used codes according to the percentage that represents the target species in relation to the totality of species being recorded in the described site describes, indeed:

- If the species is absent, we record the code (0) ;
- If the species is just present, we record the code (+) ;
- If the species have a percentage less than 5, we record the code (1) ;
- If the species have a percentage varying from 5 and 25, we record the code (2) ;
- If the species have a percentage varying from 25 and 50, we record the code (3) ;
- If the species have a percentage varying from 50 and 75, we record the code (4) ;
- If the percentage is higher than 75, we record the code (5).

Each sampling site data have a list of species differing by their dominance.

Plant cover

The visual evaluation of the plant cover in each sampling site has a considerable importance to interpret the significance of each identified color in the image. Indeed the reflectance of the soil surface is directly related to the degree of vegetation cover since the naked soil is more reflective that the covered soil (because of the light radius absorption by vegetation).

The collected data were subjected to methodical treatment (qualitative and quantitative) in order to extract the results. Indeed meaning software of data analysis (*Biomeco*), a Factorial Analysis of Correspondences (FAC) is made on the various describers or parameters we dispose to determine the different vegetation types available in the UST of Ouled Chehida. The principle of this analysis can be defined as follows:

2.1.2. Data analysis

FAC presence / absence

Based on the data collected from the different sampling sites, we do a table containing in rows the plant species (123 species) and in columns the number of sampling sites (from 1 to 135). At each sampling site, the species takes the value (1) if it is present and (0) when it is absent. This table is deducted from the raw table containing data of abundance / dominance of species as it is already noted previously.

A first AFC is made on the whole collected data (in presence / absence). The achieved results are going to be subjected to an Ascending Hierarchical Classification (AHC) which permits to distinguish the different groups of data according to the species composition.

FAC abundance / dominance

The data of each identified group will be collected in a separated table extracted from the raw table. Each of these groups will be subjected to a FAC abundance / dominance. The applied AHC to results of these FACs permits to determine the various plant communities.

Vegetation types mapping

After determining of the different vegetation types, we proceed to the spatialisation of the results. This step is achieved thanks to *Erdas* and *Arcview* softwares. After combination of the results of the supervised and visual classification, for each identified polygon, an identifiant as well as the name of the identified plant community by the FAC will be assigned. Each community is composed of set of field data collected from several sampling sites with their geographical coordinates. The superposition of these coordinates on the image of the study area permits to give the spatial distribution, and thus the map of the vegetation types.

2.2. Preliminary results

The results of the FAC presence / absence applied over the whole data permits to distinguish 10 different groups of the collected field data. In order to determine the vegetation types characterizing the study area, a FAC presence–absence has been applied on the whole data (135 sites with a total of 122 species). This Analysis aims at determining the ecological significance of axes of the FAC as studying plant species contributions on each side of the axis taken into account.

The graphic representation of the axes results in a cloud of points well distributed on the first three axes that include to them alone the majority of the own values and percentages of inertia of the analysis axes (table 1).

Table 1. Proper values and percentage of inertia of the FAC axes.

AXIS	1	2	3	4
Proper value	0.4	0.37	0.35	0.31
Percentage of inertia	5.39	5.01	4.72	4.19

The study of the plant species contribution to the first three axes of the FAC doesn't permit, in our case, to determine the ecological significance of these axes since the plant species are present either on one or on the other side of each axis.

Concerning the phytosociological significance of the axes of the FAC, it was necessary to represent the various groups on the one hand (10 groups) and sous-groups that have been identified by the AHC on axes of the FAC and on the other hand to determine the localization of field data that characterizes each group in order to determine the great classifications of the studied plant communities.

As examples figures 3 & 4 show the distribution of the 135 data field collected in the different sampling sites, on the axes 1 – 2 and the axes 1 – 3 of the FAC.

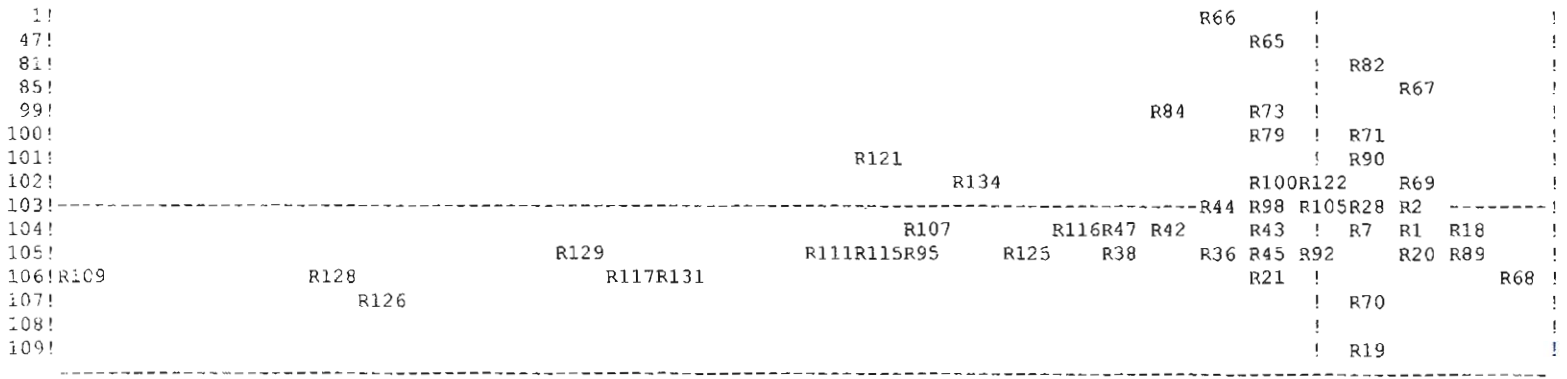


Figure 3. Distribution of the 135 points – field data sites on the axes (1 – 2) of the FAC.

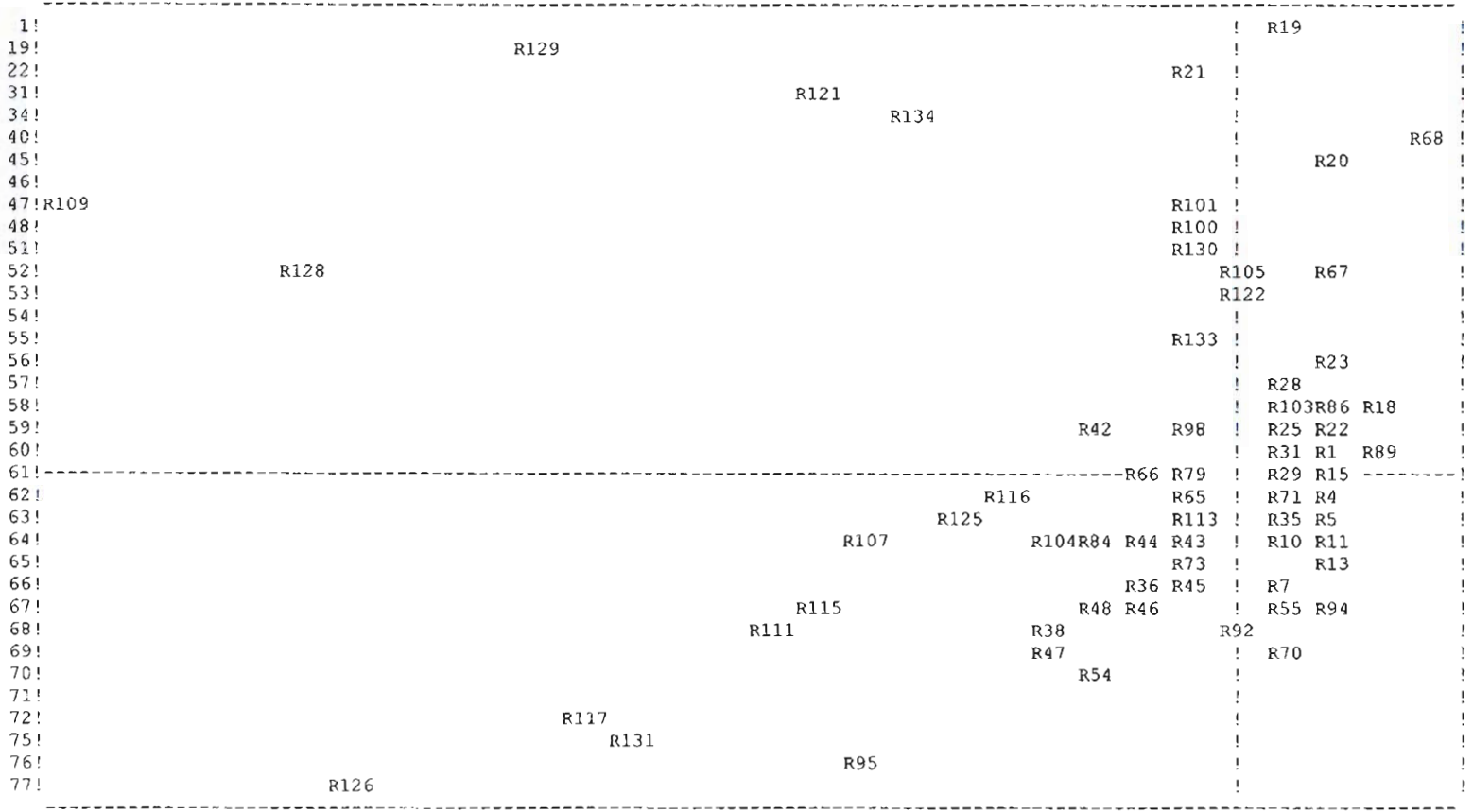


Figure 4. Distribution of the 135 points – field data sites on the axes (1 – 3) of the FAC

The digitalisation of the images SPOT 1990 and SPOT 2000 (figure 5) as well as the different steps of the statistical analysis of the field data have allowed to produce the vegetation types maps (figure 6) of the year 1990 and the year 2004 (since the field reality was achieved in 2004).

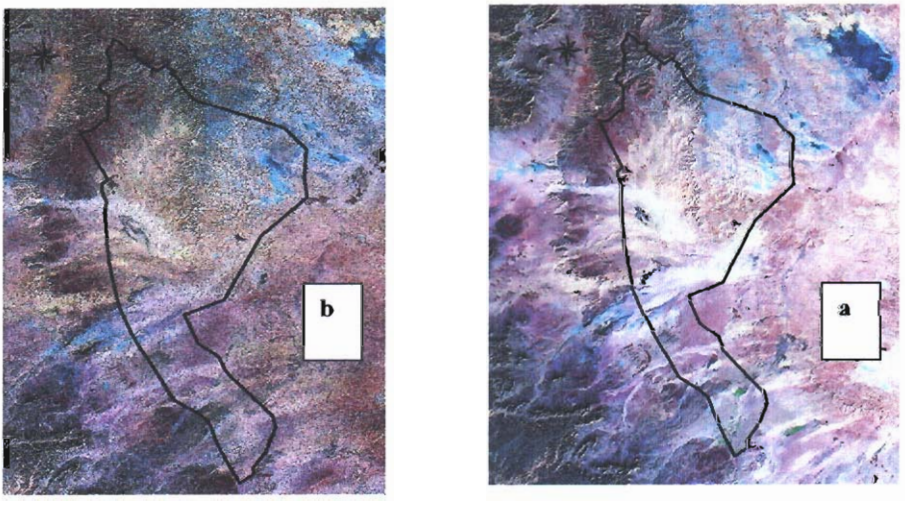


Figure 5. SPOT images taken in 1990 (a) and 2000 (b) being served to the achievement of the two vegetation type maps of the both dates.

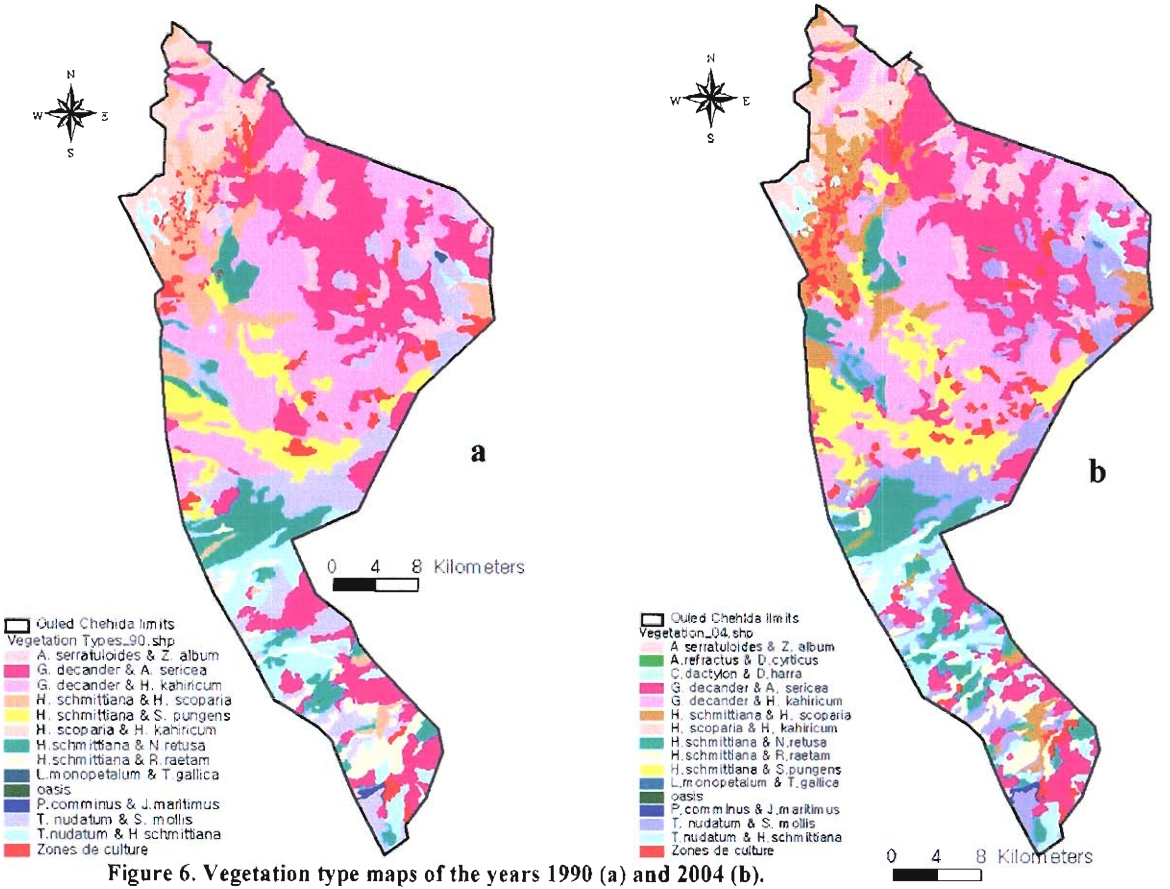


Figure 6. Vegetation type maps of the years 1990 (a) and 2004 (b).

Covering an area of about 128000 ha, the region of the UST Ouled Chehida is actually dominated by a xerophile vegetation mainly *Gymnocarpos decander* and *Anthyllis sericea* (26169 ha). Secondly come *Gymnocarpos decander* and *Helianthemum kahiricum* (24081 ha) as well as *Traganum nudatum* and *Suaeda mollis* (15261 ha).

The other vegetation types have a lesser area which varies from 10713 has for *Hammada schmittiana* and *Stipagrostis pungens* to 33 ha for *Cynodon dactylon* and *Diplotaxis harra*, the type occupying the abandoned cultivated lands.

The evolution in terms of areas of both vegetation units as well land use types since 1990 to 2004 is presented in table 2. This table shows clearly the high decrease of the rangeland area as due to cultivation. In deed, the favourable climatic conditions recorded during the year 1995 – 1996 has led to an increase of cultivated areas mainly with barley to more than 32 %. Concerning vegetation type dynamics, it seems clearly that the unit *Hammada schmittiana* and *Stipagrostis pungens* tends to increase and to subsidize other units. As psammophile species, *Stipagrostis pungens* is an important indicator of mobile sand and it is well known that it prefers to cover the sand dunes. For this reason, it seems that other units were severely overgrazed and were thus subjected to wind erosion and sand storms. The vegetation types that have been reduced are mainly *G. decander* and *H. kahiricum* as well as *L. monopetalum* and *T. gallica*.

Table 2. Summary changes in vegetation and land use types since 1990

Vegetation type	Area, (ha)		Evolution, %
	1990	2004	
A. serratuloides & Z. album	**3763,2**	**4486,4**	**19,217**
A. refractus & D. syrticus	0	44,7	*
C. dactylon & D. harra	0	33,6	*
G. decander & A.sericea	28283,1	26169,4	- 7,473
G. decander & H. kahiricum	**28220,5**	**24081,6**	**- 14,666**
H. schmittiana & H. scoparia	10050,7	10570,8	5,174
H. schmittiana & N. retusa	9268,9	9899,6	6,804
H. schmittiana & R. raetam	4178	4292,5	2,740
H. schmittiana & S. pungens	**7863,7**	**10713,3**	**36,237**
H. scoparia & H. kahiricum	7480,8	7182,6	- 3,986
L. monopetalum & T. gallica	**75,2**	**51**	**- 32,180**
P. communis & J. maritimus	171,8	169,5	- 1,338
T. nudatum & H. schmittiana	8316,2	9392	12,936
T. nudatum & S. mollis	16026,8	15261,1	- 4,777
Oases	18,1	18,1	0
Cultivated areas	**4208,9**	**5559,7**	**32,093**
Total	**127926**	**127926**	

3. Structure and productivity of the main ecological systems

Based on the socioeconomic survey undertaken with shepherds, the palatability of the same species differs from one site to another according to soil characteristics (may be as a result of mineral contents), we decided to monitor more than the 14 vegetation types determined and resulting from the map. Twenty three (23) plant communities (table 2) representing the different plant formations and distributed in the different soil types of the UST, were selected for a deep assessment of the state of their plant cover, The survey concerned some indicators in relation to vegetation (global cover, species composition, richness and density as well as the rangeland productivity and grazing capacity) and to the state of the soil surface (wind veil, crust, litter, stones).

Tableau 2. Main identified plant communities and their location sites

N°	Pant communities	Site
1	*H. schmittiana* and *H. sessiliflorum*	El-Malaab 1
2	*G. decander* and *F. cretica*	El-Malaab 2
3	*A. sericea* and *G. decander*	Echraf
4	*H. schmittiana* and *H. scoparia* 1	Khouimra 1
5	*H. intricatum* and *N. retusa*	Khouimra 2
6	*H. intricatum* and *G. decander*	Dabdebet Bir Lethla
7	*S. pungens* and *H. schmittiana*	El-Frida
8	*R. raetam* and *H. schmittiana*	Ejdaida
9	*H. schmittiana* and *H. scoparia*	Mnikher
10	*H. schmittiana* and *R. raetam*	Fesguia
11	*G. decander* and *A. sericea*	Louffalej
12	*H. schmittiana* and *S. pungens*	Meched Khlifa
13	*H. schmittiana* and *R. raetam*	-
14	*R. suaveolens* and *H. schmittiana*	Dhahret lehsan
15	*A. glaucum* and *L. guonianum*	Bir Maleh
16	*H. scoparia* and *H. schmittiana*	Jderia
17	*H. schmittiana* and *R. raetam*	Bhirit Lekhrab
18	*H. schmittiana* and *Lotus pusillus*	Gueriess
19	*N. retusa* and *H. schmittiana*	Agareb (Maghni)
20	*H. schmittiana* and *R. raetam*	Mtibna
21	*H. sessiliflorum* and *N. retusa*	Erraboudi 1 (Maghni)
22	*G. decander* and *S .tetrandra*	-
23	*N. retusa* and *A. uniflorum*	Erraboudi 2 (Maghni)

3.1. Methodology

At the level of each identified plant community, three permanent transects of a 20 m length each, were established. Theses transects serve to measure the global vegetation cover, the species composition as well as the state of the soil surface thanks to the point sampling method described by Daget and Poissonet (1971). Results are expressed in:

a) Global vegetation cover;

b) Species composition (CSP)

c) Pastoral value (Vp): it ponders, indeed, the CSP of each species by its quality index (IS) and by the global plant cover(R) according to the following formula (Floret, 1988):

$$\mathbf{Vp = 0.2 \times \sum(CSP_i\% \times IS_i) \times R}$$

The specific indices (IS) used are those suggested by Le Houerou and Ionesco (1973) for the steppic area of Tunisia. They varied from 0 (unpalatable) to 5 (very palatable).

The determination of the pastoral value permits to estimate the annual grazing capacity (GC) that the rangeland can support according to the following formula (Waechter, 1982 ; Daget et Godron, 1995) :

$$\mathbf{GC}\ (\text{cattle.ha}^{-1}.\text{an}^{-1}) = \mathbf{0.2\ Vp}$$

To convert it to sheep unit: $GC = (0.2\ VP \times 0.16)$

Concerning the survey of the plant density, three permanent qaudrats of 20 m² each were established at each site and serve to the dynamics of perennial and annual species.

3.2. Main results

It should be first noted there are several constraints and difficulties that we met by the time of the measurements (autumn 2004) and that they are mainly due to the prolonged drought that characterize the study area for more than 6 or 7 years. Thus the annual vegetation was, indeed, either completely absent in the major part of the UST or dried up and therefore with it was difficult to identify it.

3.2.1. Global vegetation cover

Figure 3 representing the mean global cover of vegetation at the level of the different plant communities, shows that these rates are very variable from a site to another according to soil conditions (example the outcrop of the gypsum crust in the station 6 (Debdabet Bir Lethla)) and the degree of the animal pressure. These rates vary indeed from 6 to 39%.

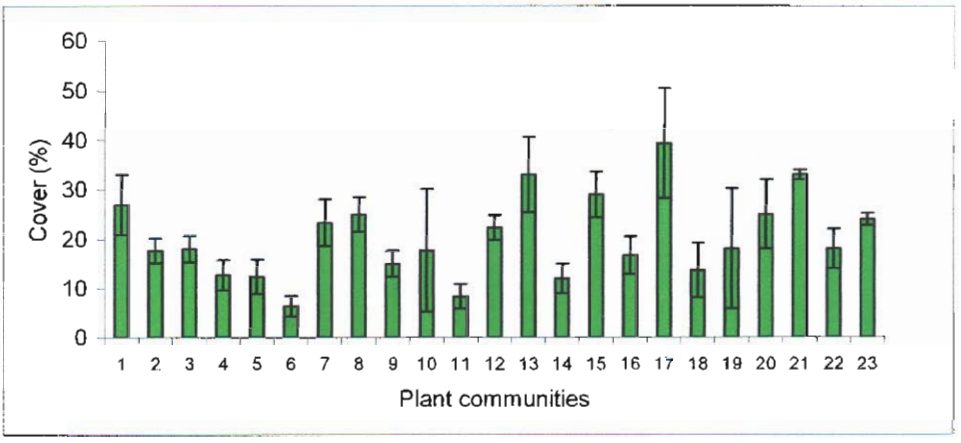


Figure 3. Means of plant cover as determined in the different communities (autumn 2004)

The rangeland vegetation of the study area is very sparse and scattered. The annual species are very scarce and germinate only immediately after rain, they are opportunist and ephemeral species able to grow and to flower rapidly, covering soil for short periods. Perennial plants are characterized by an adaptive strategy, permitting them to survive for more or less long periods, according to the degree of disruption.

During fall, the measurements meaning the point sampling method concerned mostly perennial species, since the annual species are still in phase of dormancy as due to the prolonged drought.

The plant cover varies from 6.33% to 39.33% according to the plant community. The highest value (39.33%) is recorded in the community of *Hammada schmittiana* and *Traganum nudatum* (community 17), what can be imputed to the fact that this last is located in a sandy depression, often overfed with runoff water. This depression is dominated by nebkas (sand dunes) that can present a diameter of about 1 - 3m, what increases their contribution to the total plant cover.

Some communities are characterized by the most important cover, varying from 20% to 33%, these communities are governed either well by low range value species; *Hammada schmittiana* (C20), and *Hammda scaparia* (C9), or by tolerant grazing species such as, *Helianthemum sessiliflorum*, *Helianthemum kahiricum*, *Argyrolobium uniflorum*, *Stipagrostis pungens* and *Retama raetam*. To these communities are added those that have been fenced; communities 2, 21, and 23 what encourages regeneration of some species such as, *Rantherium suaveolens*, *Stipagrostis plumosa*, *Stipa lagascae*.

This sparse vegetation is resulting in the continuous overgrazing, what can lead to the plant community destruction, and thus soil erosion, and progressively toward the desertification. It should be noted that the total plant cover is lower than the critical threshold (20-25%) below which erosion appears (Le Houerou 1995). Indeed the high decrease of the plant cover, or even their disappearance around watering points, under the human and animal activities, let the soil superficial layer exposed to wind, dragging a sand mobility where regeneration is not more possible. The generalization of the wind veil, is considered as the result of the deterioration of the plant cover.

3.2.2. State of the soil surface

In most communities, the soil surface is mainly dominated by the wind veil (Figure 4). The importance of this rate in the study area, can be attributed to the regression of the plant cover and thus to sand movement (Floret and Pontanier, 1982). On loamy and gypsum soils, the soil surface is partially, occupied by structures unfavourable to the establishment of plants (stones and crusts). In addition, the abundant litter in some sites, will drag the improvement of the soil structure.

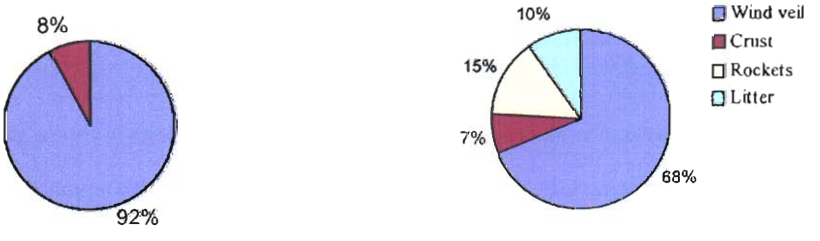


Figure 5. Surface soil states in the communities 7 (left) and 13 (right)

The analysis of the data relative to the soil surface state of each community, collected during the autumn 2004, show a remarkable generalization of the wind veil which sometimes exceeds 98%, translating a high sensitivity of soils to desertification after a deterioration of the plant cover as due to overgrazing and cultivation.

The abundance of the wind veil appears in three different zones:

- Around watering points, the regression of the plant cover leads to the extension of wind veils wind as due to animal trampling and human action (community 10).
- On deeper sandy formations which offer a beneficial effect for some species as *Stipagrostis pungens* (community 7).
- --In the depressions, characterized often by the presence of the Nebkas, which are sandy accumulations fixed by some psammophile shrubs (community 17).

The contribution of the crust, strong layer that constitutes a handicap face to rain water infiltration and plant emergence, is relatively low. Mostly, it does not exceed 6%. This can be explained by the high degree of overgrazing during the whole year, what may favour the soil sand movement. In the community 18 situated close to a cultivated area, the decrease of animal trampling and the mechanical action of rains have led to the extension of the crust (14 %). However, the strong contribution of the crust is recorded in communities 4 and 5 with 57% and 53% respectively, which are situated on gypsic soils with an alluvial accumulation. The importance of this layer is favoured by the rarity of the animal pressure, not for protection purposes but avoided shepherds as they consider these areas very poor and insufficient for animal nutrition with very low range value species., because it is considered

how inefficient of point of view nutrition, because of the abundance of weak pastoral value species. Based on the socioeconomic survey, shepherds consider that the palatability as well as the nutritive value of the same species may change from site to other according to mineral soil content. Le Houerou (1995), Akrimi et *al.* (1993) consider that with a soil texture more or less, the crust constitutes a physical obstacle reducing the water infiltration in favour of runoff on one hand, and preventing the penetration of seeds, and the emergence of seedlings on the other hand.

In this same site (community 5), stones represent 31% of the state of the soil surface, and 30% in community 23 but they don't exceed 10% in the other communities.

The litter represents 43% in the plant community 4, resulting in the mortality of some perennial species (*Hammada scoparia*), and of very rare annual species of weak palatability (*Ifloga* spicata). In the other communities, this rate doesn't exceed 11%, this is imputed, either to the consumption of the litter by animals, or that it is swept by wind.

3.2.3. Species composition: specific contribution to plant cover (Csp)

The results of the CSP as determined in the 23 plant communities are presented in table 3. It shows that *Arthrocnemum indicum* (halophyte) represents the most important specific contribution 89.89%, in the community of *Arthrocnemum indicum* and *Limoniastrum gyonianum* (G15), but this contribution becomes week or even zero in all the another communities.

Hammada schmittiana, *Stipagrostis pungens*, and *Retama raetam* have the highest contribution in their own communities, about 85.71%, 70.35%, and 65.45% respectively.

Hammada schmittiana is the most abundant species. It is almost met in all communities, *Retama raetam* is present in 45.5% of the communities, whereas *Stipagrostis pungens* is only present in the sandy communities G7, G11, G12.

Anthyllis sericea, Gymnocarpos decander, Helianthemum sessiliflorum, Hammda scoparia, Fagonia cretica, Traganum nudatum, Rantherium suaveolens, Nitraria retusa, and *Helianthemum intricatum* are characterized by variable contributions from 20% to 43%, the first four species are present in 9 different communities. The other are found in 4 to 7 communities, whereas the presence of *Helianthemum intricatum* is recorded in 2 different communities (G5, G6), with a specific contribution of about 43.18%.

Argyrolobium uniflorum and *Deverra tortuosa* are met in 3 and 4 communities, with a maximal contribution of 12%.

Anarrhinum brevifolium, Salsola brevifolia, Salsola zygophylla, Stipa tenacissima, Lotus pisilus, are species of good range value, what confirms their presence only in one community. Their contributions vary from 10% to 19%.

The other species such as *Suaeda mollis, Slasola brevifolia, Zygophyllum album, Tamarix gallica, Stipagrostis plumosa, Stipagrostis ciliata, Reaumaria vermiculata, Limonium pruinosum, Linaria aegyptiaca, Limoniastrum gyoninum, Erodium glaucphyllum, Echiochilon frctucosum, Atractylis flava*, and *Anabasis orpodiorum*, are species with low specific contribution to plant cover which varied from 0.95% to 9% according to communities.

In general the mean specific contributions, the most important, are those of *Hammada schmittiana* (28.56%), *Retama raetam* (10.15%), *Hammada scoparia* (7.62%), and *Gymnocarpos decander* (6.23%). This can be attributed to their ability to competition in degraded areas and to their resistance to grazing, in spite of their pastoral interest.

Oher species such as, *Anthyllis sericea, Arthrocnemum indicum, Helianthemum intricatum, Helianthemum sessiliflorum, Nitraria retusa, Stipagrostis pungens, Traganum nudatum*, recorded their presence with a mean contribution of about 4%, according to communities, soil requirements, and to their dynamics in degraded lands.

The high palatability of some species such as *Anabasis oropodiorum, Anarrhinum brevifolium, Argyrolobium uniflorum, Echiochilon fructicosum, Lotus creticus, Lotus pisilus, Stipagrostis ciliata, Stipagrostis pulmosa*, does not avoid their presence, but with a weak contribution weak. This can be explained by their faculty to occupy soils subjected to a weak disruption. It is the case of *Argyrolobium uniflorum*, or by their regeneration after protection as the case of *Anabasis oropodiorum* and *Stipagrostis plumosa.*

Fagonia cretica (2.58%), *Haplophyllum tuberculatum* (0.2%), *Erodium glaucophyllum* (0.05%), *Reaumuria vermiculata* and *Zygophyllum album* (0.45 %) are species of weak pastoral interest and tend to take the place of the high pastoral interest species.

Table 3. Specific contribution of species met in the studied plant communities.

Species	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12	G13	G14	G15	G16	G17	G18	G19	G20	G21	G22	G23
Anabasis oropediorum	0	7,246	0	0	16,67	16,67	0	0	3,922	0	0	0	0	8,333	0	0	0	0	0	0	0	0	0
Anarrhinum brevifolum	0	0	0	0	0	13,23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4,63	0	0
Anthyllis sericea	0	1,515	37,35	0	0	0	0	0	2,564	0	0	0	0	28,94	0	0	0	0	0	0	0	0	0
Argyrolobium uniflorum	0	0	0	0	0	0	0	1,282	0	0	0	0	0		0	0	0	1,515	0	0	0	0	0
Arthrocnemum glaucum	0	0	0	0	0	0	0	0	0	0	0	8,333	0	0	23,23	0	0	0	0	0	0	0	0
Atractylis flava	0,95	0	0	0	0	0	0	0	38,02	0	0	25	35,69	6,25	0	0	0	0	0,901	1,449	8,048	2,222	11,08
Atractylis serratuloides	2,86	0	11,01	0	0	11,11	0	1,587	0	0	0	0	0	0	0	0	0	0	0	0		0	0
Cleome arabica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10,4	0	0	0	0	
Deverra tortuosa	5,48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,515	0	0	0	2,632	0	0	0
Echiochilon fruticosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,781	0	11,63
Erodium glaucophyllum	0	0	0	0	0	0	0	0	0	0	0	1,19	0	0	0	0	0	0	0	0	0	0	0
Fagonia cretica	0	26,88	13,73	0	0	0	0	0	0	0	0	0	0	2,083	0	0	0	0	3,333	1,667	8,101	0	5,149
Fagonia glutinosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,564		0
Gymnocarpes decander	1,08	24,18	23,73	0	0	20,37	0	0	2,564	0	0	0	0	0	0	1,515	0	0	0	0	8,974	0	0
Hammada schmittiana	21,08	5,797	0	50	0	0	24,8	18,48	12,82	0	59,18	60,71	9,333	22,92	0	38,64	0	0	0	0	0	0	0
Hammada scoparia	7,87	0	0	26,92	0	0	0	0	12,82	0	18,46	0	6,667	4,167	0	42,97	36,35	74,44	29,41	67,45	9,444	8,116	3,816
Haplophyllum tuberculatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4,762	0	0	0	0	0	0	0
Helianthemum intricatum	0	0	0	0	50	38,62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helianthemum kahiricum	0	9,259	10,99	5,128	0	0	0	0	0	0	0	0	0	0	0	0	33,41	13,64	28,3	17,55	5,271	0	12
Helianthemum sessiliflorum	40,56	3,03	0	0	0	0	0	5,168	0	0	2,564	0	0	0	0	0	0	0	0	2,632	0	18,1	0
Limoniastrum guonianum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6,061	0	0	0	0	0	0	0	0
Limoniastrum monopetalum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7,871	0	0	0	0	0	0
Limonium pruinosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31,11	0	15,24	0	29,24
Linaria aegyptiaca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	66,67	0	0	0	0	0	0	0	0
Lotus creticus	0	0	0	0	0	0	1,852	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0
Nitraria retusa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22,37	0	5,135	0	8,571	0	4,598
Reaumaria vermiculata	0	0	0	0	8,333	0	0	0	0	0	0	0	0	3,704	0	0	0	0	0	0	0	0	0
Retama raetam	8,33	0	0	0	0	0	0	65,45	0	0	19,79	0	17,33	12,04	0	0	0	0	0	0	3,419	0	6,667
Rhanterium suaveolens	6,67	0	0	0	0	0	1,852	0	3,704	0	0	0	0	2,083	0	0	0	0	0	0	0	21,4	5,333
Salsola tetrandra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6,199	0
Salsola vermiculata	1,90	10,61	3,175	0	0	0	1,149	0	2,564	0	0	0	0	2,083	0	0	0	0	0,901	5,175	20,44	0	1,333
Salsola zygophylla	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20,23	0
Stipa lagascae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13,04	0
Stipa tenacissima	0	11,48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,449	0	3,509	8
Stipagrostis ciliata	0	0	0	0	0	0	0	8,038	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stipagrostis plumosa	3,23	0	0	0	0	0	0	0	17,1	0	0	0	18,1	0	0	0	0	0	0	0	0	0	0
Stipagrostis pungens	0	0	0	0	0	0	70,35	0	0	0	0	4,762	0	0	0	0	0	0	0	0	0	0	0
Tamarix gallica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4,04	0	0	0	0	0	0	0	0
Traganum nudatum	0	0	0	17,95	8,333	0	0	0	0	0	0	0	12,88	0	0	10,61	0	0	0,901	0	3,516	7,18	1,149
Zygophyllum album	0	0	0	0	16,67	0	0	0	3,922	0	0	0	0	7,407	0	0	0	0	0	0	0	0	0

3.2.4. Plant density

The results relative to the density of perennial species recorded in each community are presented in the following table. These results show the presence of 52 species. Disruptions and the different types of stress play a fundamental role in the variation of the species density and their dynamics.

The density of perennial species in the study area, varies from 0.53 to 8.03 individuals/m², this variation depends on community, soil properties and degree of the animal pressure.

The density is slightly higher in the protected area and lowest in the very degraded communities. The low difference observed between the protected zones and those that are disrupted, is the result of some herbaceous perennial species with high dynamics such as *Argyrolobium uniflorum, Plantago albicans*, and *Lotus pisilus*, and of other unpalatable species such as *Fagonia cretica* and *Fagonia glutinosa.*

The high density is recorded in the communities *Helianthemum sessiliflorum* and *Hammada schmittiana*, and *Helianthmum sessiliflorum* and *Argyrolobium uniflorum*, of about 8.03 and 7.35 individuals/m² respectively, with a contribution of *Helianthemum sessiliflorum*, of 4.57 individuals/m². This density of *Helianthemum sessiliflorum* is the result of the response of this species to a short term protection and the weak proportion of the strong layer (crust) in the soil surface. The short periods of grazing alternated with periods of rest, are generally more favourable than the strict protection (Froret 1981), what permits the perennial seedlings to be established and encourage the annual species germination.

Arthrocnemum indicum (2.25 individuals/m² in the community 15) a halophyte species is resistant to grazing as due to its weak palatability, but its density has profited from salinity.

Fagonia cretica, species refused by animals (Houerou 1973), has an important density which reaches 1.71 individuals/m².

Hammada schmittina (1.11 individuals/m² in the community 13), and *Stipagrostis pungens* (0.35 individual/m² in the community 7), are the species which are not highly affected by the animal pressure.

The low pastoral value of *Hammada scoparia* explain its mportant density in some communities such as *Hammada scoparia* and *Helianthemum kahiricum* (G4).

On a chalky superficial skeletal soil, the density of *Anthyllis sericea* and *Gymnocarpos decander* is imopratnt in the communities more or less degraded (communities 3 and 11), than in the areas protected or highly degraded.

The important density of *Argyrolobium uniflorum* is recorded different communities. This can be explained by the capacity of the species to the establishment in disrupted areas. According to Chaieb (1989), this species does not support the long-term protection and prefers moderate grazing.

Densities of *Anabasis oropdiorum, Echiochilon fructicosums, Stipagrostis,plumsas,* and *Anarrhinum brevifolium*, are very low when the disruption is frequent and intense.

3.2.5. Pastoral value and grazing capacity

The range value which constitutes a good indicator of the rangeland quality was in most communities very weak indicating thus a mediocre state. The lowest value was found in community 4 with 4.51 while the highest one was recorded in community 17 with 17.26 (figure 8). These values may be highly improved with the abundance of annuals in rainy years. As the grazing capacity is depending on the pastoral value of the rangeland, it varies in

the same way as this descriptor (figure 9). Therefore the lowest value is recorded in community 4 (0.14 sheep unit/ha/year) and the highest one is that permitted by community 17 (0.55 sheep unit/ha/year).

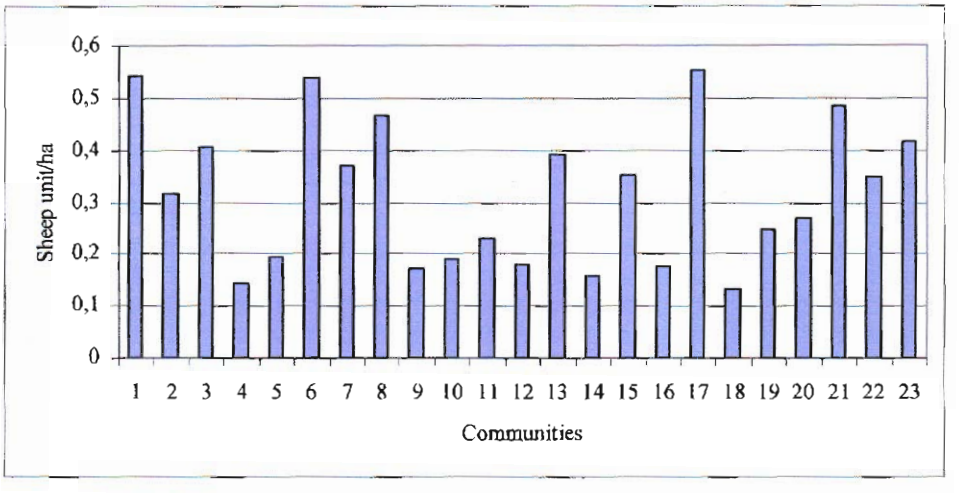


Figure 9. Variation of the grazing capacity according to studied plant communities in the study area.

3.3. Problem of nutritional efficiency of rangelands

Vegetation measurements and grazing capacity calculation according to the formula presented by Floret (1988) are not enough to estimate the reel range value of the rangelands. Indeed, users of these areas mainly shepherds, use other indicators in order to appraise the pastoral value. According to a zootechnical approach, they sequence rangelands in two types:

The good rangelands, called MREDDA, are those characterized by e fertile and deep soils, that offer a high nutritional forage resulting in good appearance and health of te animal.

The bad rangelands, MOHTTMA, are those found on skeletal soils marked by a the abundance of gypsum or of active chalk. The animals of these areas are very often skinny and suffer from sanitary problems such as the arthritis (illness known by the name local El Hechem) and the fragility of bones (fractures).

This classification doesn't take into account neither the global plant cover nor the species composition of the rangelands, nor even, in some cases, contradictory indeed to the plant ecology assessment, the best rangelands "MREDDA" are often more grazed, therefore vegetation is strongly degraded and less developed. Whereas the same species on the MOHTTMA rangelands are well developed (two to three times more than those of MREDDA) and the global plant cover is often better. It is important to note that some indicatory species of the MERDDA such as *Hammada scoparia* do not grow in the MOHTTMA.

3.3.1. Problematic

An important disequilibrium in the rangeland use, the gypsic areas with a good biomass production are underused, whereas other rangelands overused, are bare and threatened by the risk of an irreversible deterioration.

3.3.2. Hypothesis

The first observation on sheep – goat herds using gypsic rangelands shows a clear fragility of theirs bones (Fracture, Arthritis...) permits us to advance the hypothesis that it is dealing with a mineral unbalance problem.

3.3.3. Objectives

- To understand the biochemical mechanism limiting nutritional efficiency of range species on gypsum substratum.
- To suggest catalytic supplementation permitting better valorisation of the skeletal range " MOHTIMA "

3.3.4. Methodology

(i) *Samples collection.* We are going first to start by collecting samples of range species growing on both rangelands types (MREDDA, MOHTTMA,) during three seasons, summer, end fall-beginning of winter and spring.

(ii) *Samples analysis.* Collected species, dried and ground are going to be subjected to several types of analysis in order to determine their conventional chemical composition (DM, Ash, OM, ADN, ADF, ADL, etc.), detailed mineral composition (Calcium, Phosphorus, Magnesium and trace elements), anti-nutritional component-s (total tannins, condensed tannins, oxalates).

(iii) The *in vitro* digestibility (gas production method) and *in vivo* digestibility (total faecal collection method)

(iv) Analyses of blood for two herds of animals (sheep, goat and camels) that graze on MREDDA rangelands as well as those that graze on MOHTIMA rangelands.

(v) Analysis of soils for the two types of rangelands (MREDDA and MOHTIMA).

3.3.5. Preliminary results

Results of the analysis of the anti-nutritional components of species, collected in summer 2004, show that some species have some strong contents in oxalate. The oxalate has the capacity to form a complex with calcium which may decrease it and may led to a hypo-calcimea. This assessment will be confirmed after blood analyses, programmed in the framework of this activity.

4. Study of the strategy of the communal use of pastoral resources

4.1. Investigation/survey of shepherd

To understand the strategy of the population of Ouled Chéhida concerning the pastoral resource utilization, investigations for shepherds were done in rangelands (rangelands close to communal watering points or private underground cisterns).

The investigation includes about 250 questions classified in 12 categories:

- Identification of the shepherd and localization of the grazing land;
- Main residence and family of the shepherd
- Residence on rangeland and associate shepherd
- Structure of the herd
- Shepherd / breeder relationship
- Mobility of the herd and choice of rangelands
- Information about rangelands
- Information about other herds distribution and shepherd/shepherd relationship
- Food supplementation and watering of the herd
- Scheme of the reproduction
- Sanitary problems of herds
- Strategy of purchase and sales according to the year

The investigation has been achieved in summer time (July, August and September 2004), during this period the frequency of watering is often one day over two, therefore the opportunity to meet the maximum of herds that don't move away from watering points, is important.

4.2. Results of the investigation/survey on shepherd

The investigation touched 87 shepherds who keep some mixed herds (sheep – goat) and 6 shepherds of camel herds.

The total small ruminant number is about 20.000 heads that is distinctly lower than the numbers found at the time of the investigation – household done in 2002 (29.000). It is probably attributed to the following points:

- In the present investigation, only adult female units are taken into account.
- During summer time, a part of the herd returns to the main residence.
- Herds grazing out of the study area are not also investigated.

Results of the investigation shepherd (summer 2004)

Fraction	Main residence	Herds on rangelands	Breeders number	Average number of herd	Sheep number	Goat number	Total number	Herd number / breeder
O. Sâad								
	Remtha	16	136	215	2368	1072	3440	25
	Esskaier	5	48	210	780	270	1050	22
	Remada	6	68	234	1180	224	1404	21
	Maghni	3	12	235	470	235	705	59
O.Soltane						0	0	
	G. O. Soltane	26	244	210	3840	1620	5460	22
	Meghit	11	120	220	1890	530	2420	20
	El Gabel	7	56	230	1120	490	1610	29
	Remada	7	34	310	1465	705	2170	64
	Maghni	6	16	230	950	430	1380	86
Total		**87**	**734**		**14063**	**5576**	**19639**	
Mean				**232.67**	**161.64**	**64.09**	**225.74**	**37.47**

The investigation shows that 19639 small ruminant heads (14063 sheep female units and 5576 goat female units) belonging to 734 household, but grazing in 87 herds, an average of herd number about 225 heads. This shows the importance of the association practice, indeed about of 80% of the population of Ouled Chéhida use the communal rangelands either directly (Owner shepherd) or by association with other herd if the number is not enough profitable to cover costs of a shepherd's recruitment.

97% of investigated shepherds are accompanied by an associate shepherd (Melhag) who is generally member of the family of which the majority of pupils that benefits the opportunity of the summer vacancy. The shepherd needs help particularly in period of lambing (December -January) since herds will be kept in two groups one for the female and their kids "Halabba" and another for the young kid and non pregnant females "Jeledd". During this period, breeders recruit a shepherd who will be paid monthly.

Relationship Breeder/Shepherd

The investigation shows shepherd's majority (81%) are owners of small herds of 80 head mean size. In the same herd it keeps others by association. 10% of investigated shepherds are salaries "Mkari" who keep herds of only one owner or a breeder association but under the breeder's responsibility who possesses the biggest part of herds. Only 9% of shepherds who keep the family's herds that doesn't exercise the association.

Two main types of association exist: monthly and yearly.

Monthly association: it is exercised by the breeder who has lower than 10 head size. The keeping expenses are estimated to 2 DT /head/month with food supplementation expenses if it is necessary. In this type of association the breeder doesn't intervene to the management of the herd on rangelands, the shepherd is the main responsible on the choice of the area, the path of grazing and the choice of watering points. The breeder can recover his animals when he wants.

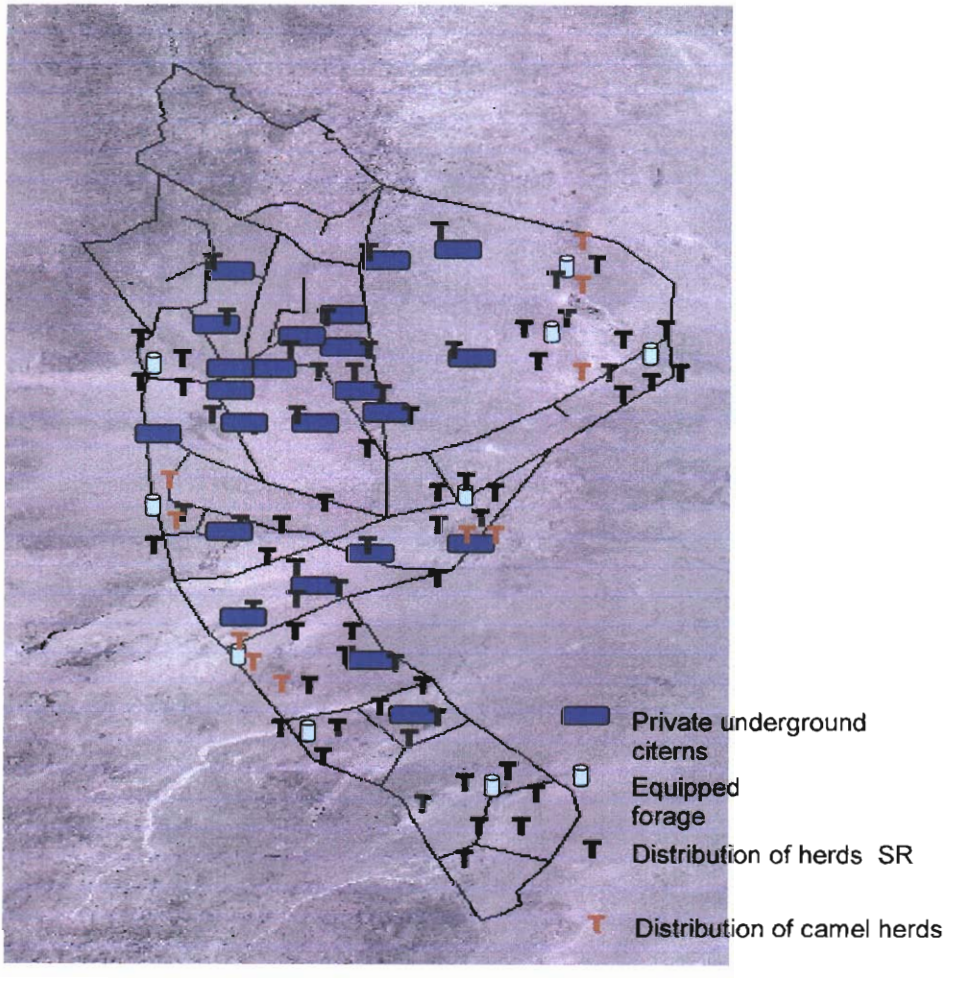
Yearly association: it is the type the available, the payment of association expenses is calculated by Dhami (25 heads), the breeder pays from 270 to 300 DT/year/Dahmi with a female kid (~ 80 DTS) and the equivalent of 12 Wibas of barley (3 DT/Wiba, a 36 DT), a total of about 400 DT/25 heads.

The breeder contributes according to the size of the association to the payment of one month of holiday for the shepherd/year. In this type of association, the breeder who has the highest herd size can intervene to the management of the herd on rangeland (the choice of the grazing area, choice of watering points ...) this intervention takes the shape of discussion and advices, the decision, in this case, is shared between the shepherd and the members of the association. The regulation of counts is done from the Zazz (the mowing) to the next Zazz, often the month of the May. If one of partners wants to recover his animals he must pay the expenses of association of all year round.

Spatial distribution of herds

The distribution of herds on rangelands mostly depends on attachment points (Residence of the breeder): a way to minimize expenses of transport of the food and the shepherd's visits. The herd of Ouled Soltane or their points of attachment are El Gasser can not be find in the south of the UST (near Maghni), and herds or their owners reside at Remada and graze the nearest rangelands such as Karab, and the central zones of the UST (map 2).

Map 2 : Spatial distribution of herds during the investigation period.



The mobility of herds in rangelands

The investigation permitted us to clear some rules of herd mobility, indeed it depends on the year and the season:

Dry year

- The accessible and nearest grazing lands to selling points of the food and water. Herds only made short circuits or to move from one watering point to another.

Average year

- A big competition for the best rangeland choice that has been watered during months of fall but this mobility is often limited by the fact that they have needs again of supplementation and don't count on the production of rangelands.
- Some great breeders even move outside of the UST but all depends on the potentiality and the production of these rangelands, an exploratory visit is generally necessary.

Good year

- During the good years the mobility of herds is function of the season,
- In spring, breeder use the best and the most faraway rangelands from watering points and places of residence, because herds are not still dependent on supplementation and watering (the frequency of watering exceeds 1 month if herbs are still available)
- In summer, the frequency of watering is one day / two and displacements don't exceed a radius of 5km from the watering point.
- In fall, it is the beginning of the rangeland utilization and they should profit from the first rains of fall, this information is considered Confidential.
- In winter, the appropriate season of lambing, the mobility is often limited the "Jeladd".

The supplementation in rangelands

- During dry years the supplementation in rangelands is a very common practice in arid zones, 100% of breeders and during all year round offer barley with variable quantities and frequencies.
- During average years, the food supplementation is during 7 critical months (August-February). Whereas in good year the supplementation doesn't pass 2 to 3 months (November –January: lambing).
- The supplementation of camel herds is limited to a preparation to the lute and birth (2 months: December-January) birth and lute at the same period.
- The supplementation is mainly based on barley, or a mixture of mixture of some by-products of cereals and olives (according to the availability). The quantity varies between 700 g and 1kg / head for the small ruminants and 3 to 5 kg for Camels.

IRDEN PROJECT

Dr. DAALOUL ABDERRAZAK, National Coordinator

Introduction

Prior to the execution of the work plan that has been agreed upon by the steering committee, a meeting was held with all the participants to discuss the feasibility of scheduled activities and setting up the criteria in choosing target farmers population and sites of on farm trials, sample size for the economic study, and provisions regarding the operating of the seed unit related matters as: maintenance, seed business perspective, and sharing benefits of this unit. Rural families were identified (one in each site) at Zaghouan and Siliana to carry out the end products particularly coucous based on hygienic conditions. These two families will be provided with landrace cultivars (Biskri and Chili) and the processed couscous will be labeled and exhibited in markets and fairs. However it has been agreed that analysis or recorded parameters related to processing time, costs and sensorial related traits will be carried out within the INAT technology laboratory.

Figure 1. IRDEN Project team

Early rains were favorable for seed bed preparation and most trials were established at an optimum seeding date. Rainfall distribution from September to January is described in figure 1 for Zaghouan and Siliana areas respectively.Although September and October were less rainy compared to the previous cropping season, rain quantities were sufficient to timely carry out recommended cultural tillage. It is however noticed that adequate rainfall with sufficient quantity occurred during November and was largely superior to 2003 cropping season. Late November rain and rainfall during December and January was beneficial for

seed emergence and stand establishment. Limited flood damage was also reported in some areas, while excessive rains caused a major delay for nitrogen and weed control applications.

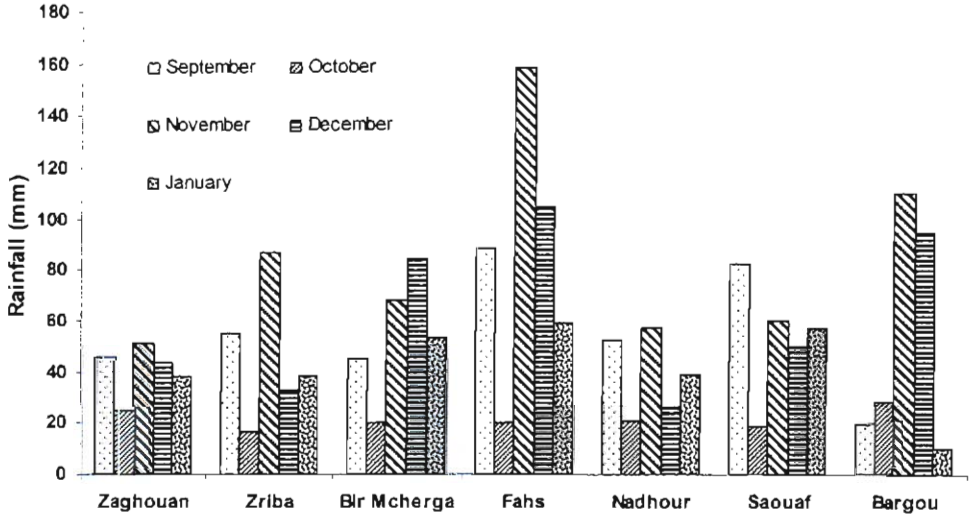


Figure 1. Monthly Rainfall distribution at the target sites

1. Transfer of technology

Transfer of technology activity included the establishment of on farm trials using the recommended cultural practices of durum wheat production in the semi arid growing conditions and the assessment of seeding rates of the of the three durum wheat cultivars: Karim, Om Rabiaa and Razzak. This latter activity is conducted at three locations: Zaghouan, Siliana and at Bou Salem. The main objectives is to determine optimal seeding rates within each area and determine potential associations between grain yield, yield components and quality related traits. This activity is carried out within a master thesis at INAT.

1.1. On farm trials

Four on farm trials were set up using Karim, OmRabiaa and Razzak with two on farm trials at each site: Siliana and Zaghouan. The seeding rates used for these trials were 175 kg/ha for both Karim and Razzak and only 155 kg/ha for OmRabiaa. Results generated from these trials will be compared to the common farmers' practices and estimate production technical efficiency of the recommended techniques. All these trials were supervised by CTC agronomist, regional cereal unit officers and extension service agents. Zaghouan and Siliana .

Table 1. Description of on farm trials

Site	Description
ZAGHOUAN Roueyhi Hedi (Farmers' association of Seltane) FAHS: GHRIFET	**Area**: 1,5 ha
	Previous crop: Fallow
	Tillage
	- Deep plowing February

	- 4 tillages with offset:June (1), October (1), November(2)
	Fertilizer application
	- DAP application (prior to sowing): 75kg/ha of DAP based on soil analysis
	- 1st Nitrogen application 100kg/ha (Jan 24)
	Sowing date: December 2
	Sowing method: Seed combine (drill)
	Varieties used by farmer: Karim and OmRabia
ZAGHOUAN Roueyhi Hedi (Farmers' association of Seltane) FAHS: GHRIFET	**Area**: 1,5 ha
	Previous crop: Fallow
	Tillage
	- Deep plowing: May
	- 4 tillages with offset:August (1), September (1) October (1), November(1)
	Fertilizer application
	- DAP application (prior to sowing): 50kg/ha of DAP based on soil analysis
	- 1st Nitrogen application 150kg/ha (Jan 20)
	Sowing date: November 28
	Sowing method: Hand broadcasting and seed covering with discs
	Varieties used by farmer: Razzak
ZAGHOUAN Roueyhi Hedi (Farmers' association of Seltane) FAHS: GHRIFET Abdelhamid Khammaria EJJOUF NORTH : ZRIBA	**Area**: 1,5 ha
	Previous crop: Fallow
	Tillage
	- Deep plowing May
	- 4 tillages with offset:August (1), September (1) October (1), November(1)
	Fertilizer application
	- DAP application (prior to sowing): 50kg/ha of DAP based on soil analysis
	- 1st Nitrogen application 150kg/ha (Jan 20)
	Sowing date: November 28
	Sowing method: Hand broadcasting and seed covering with discs
	Varieties used by farmer: Razzak
SILIANA Zouaoui Hamdane SIDI ZID-BARGOU	**Area**: 1,5 ha
	Previous crop: Water melon
	Tillage: 3 tillages with offset:September (1), October (1), November(1)
	Fertilizer application: DAP application (prior to sowing): 50kg/ha of DAP based on soil analysis4)
	Sowing date: November 29
	Sowing method: Seed combine (drill)
	Varieties used by farmer: Karim

Mensi salem MARJAA AOUAM-BARGOU	**Area**: 1,5 ha
	Previous crop: Fallow
	Tillage
	- Deep plowing March
	- 4 tillages with offset:May (1), September (1) October (1), November(1)
	Fertilizer application: DAP application (prior to sowing): 100kg/ha of DAP based on soil analysis
	Sowing date: December 29
	Sowing method: Hand broadcasting and seed covering with discs
	Varieties used by farmer: Karim

Farmers used seeds from on farm trials achieved during the previous cropping season. Data pertaining to the various practices, costs and dates of applications will be monitored for both IRDEN on farm trials and farmers' field. Using the three cultivars of durum wheat within each trial was intended to assess farmers' perception of cultivar adoption and identify possible farmers' preference criteria. This information could provide indicators on farmers' behavior toward technical innovations and particularly the use of cultivar Karim that continues to be widely grown by farmers covering almost 65% of the total durum wheat area, although it is declining in septoria tolerance and yield performance.

1.2. Seeding rate trials

During previous cropping seasons it has been noted that farmers use an excessive seeding rates. These rates often did not justify the seed characteristics when using either certified seeds or on farm seeds. This practice was found to be associated with an increased cost per ha mainly in semi-arid area. Excessive seeding rates in the semi arid growing conditions were associated with lower specific weight because of a greater competition between plants and therefore lower price premium was paid because of low quality traits. Based on these observations, an initiative aiming to determine optimal seed density of the main durum wheat cultivars (Karim, Razzek and OmRabiaa) is carried out at three locations. Five seed densities were calculated on the basis of seed characteristics as outlined in Table 2.

Table 2. Densities and corresponding seeding rates of the three durum wheat cultivars

Target density (Plant m^2)	Adjusted density* (Plant m^2)	SEEDING RATES (kg/ha)		
		Karim	Razzek	OmRabiaa
200	230.0	115.5	119.7	104.3
250	287.5	144.4	149.6	130.4
300	345.0	173.3	179.5	156.4
350	402.5	202.2	209.4	182.5
400	460.0	231.1	239.3	208.6

* Adjusted to an average of 15% (due to germination rate and other foreign kernels

Sowing was carried using an experimental seeding drill of CTC. These trials were arranged as split plot design where cultivars represent the main plot and seeding density represents the sub-plot. Each plot has a total area of 14 m^2. Triticale was sown around each of these trials to

reduce border effects. Data on emergence, diseases, morpho-physiological traits, yield and yield components and quality related traits will be carried out. Description of the sites and cultural practices are summarized in Table 3.

Table 3. Description of seeding rate trials

Sites	ELKodiat –Bou Salem	Sminja- Zaghouan	Bargou- Siliana
Farmers	CTC	Med Aziz Bou Hajba	Belhassen Kharroubi
Sowing date	November 25	December 7	December 4
Cultural practices	**-4 Tillages** -September (1) -October (2) -November (1)	**- Deep plowing** April **-4 Tillages** (offset) -June (1) -October (1) -November (1) -December (1)	**- Deep plowing** March **-4 Tillages** (offset) -June (1) -October (1) -November (1) -December (1)
Previous crop	**Wheat**	**Oats (silage)**	**Fallow**

At Bou Salem, the trial will be carried out using complementary irrigation. An application of 75 kg/ha of DAP was applied during sowing in all trials.

2. Activity of Seed Component

This activity included characterization of the on farm seeds, establishment of seed trails of old cultivars, assessment of certified versus on farm seed trials, seed treatments and conception of brochure and seed unit operation.

2.1. Comparative advantage assessment of certified seed versus on farm seed trials

Three trials were realized in each site using certified seeds that will be compared with on farm seeds. The main objective of this component is to assess the comparative advantage of certified seeds as compared to on farm ones under identical farmers' cultural. All these trials are managed by farmers and only certified seeds of either Karim or Razzak are provided to them. These trials are sown on two ha one of each is sown with certified seeds and the other with on farm seeds of the same durum wheat cultivar. Assessment of plant population, weed density, diseases and yield components will be recorded in both fields. Furthermore these trials will serve for seed multiplication for these farmers and other neighboring ones. Framers' training on field cleaning and quality seed production techniques will be based on these trials and other selected farmers' field.

Seeding rates for certified seeds were standardized to 160 kg/ha for either Karim or Razzak. The total size of the trial covers 2ha where 1 ha is sown with certified seeds and the remaining 1ha is sown with on farm seeds. Table 4 summarizes the characteristics of these trials.

Table 4. Characteristics of certified versus on farm seeds trials

Site	Description
ZAGHOUAN Rejeb Rhaiem Sidi Aouidet FAHS	**Previous crop**: Water melon **Tillage**: Deep plowing + 3 tillages with offset **Fertilizer application** :100kg/ha of DAP + 100 kg/ha Nitrogen **Sowing date**: November 30 **variety:Razzak**
Bouderbala ben Jemaa EJJOUF EAST : ZRIBA	**Previous crop**: Fallow **Tillage**: Deep plowing +2 tillages **Fertilizer application**: 50kg/ha of DAP+50kg /ha Nitrogen **Sowing date**: December 7 **Variety** Karim
Salah Ben Taieb El Wafi BIR M'CHERGA ENNADHOUR	**Previous crop**: Tomatoe **Tillage**: Deep plowing +3 tillages+2irrigations **Fertilizer application**: 50kg/ha of DAP+100kg /ha Nitrogen **Sowing date**: December 2 **Variety** Karim
SILIANA Oueslati Noureddine MARJAA AOUAM- BARGOU	**Previous crop**: Water melon **Tillage**: Deep plowing + 3 tillages with offset **Fertilizer application** :80 kg/ha Nitrogen **Sowing date**: December 23 **variety:**Razzak
Kharroubi Belhassen SIDI AMARA-BARGOU	**Previous crop**: Fallow **Tillage**: Deep plowing +4 tillages **Fertilizer application**: 80kg /ha Nitrogen **Sowing date**: December 14 **Variety** Karim
Mohammed ben Ali Zid SIDI SAID- BARGOU	**Previous crop**: Fallow **Tillage**: Deep plowing +4 tillages **Fertilizer application**: 90kg /ha Nitrogen **Sowing date**: December 22 **Variety** Karim

2.2. Assessment of on farm seed characteristics

This activity is carried using 500 grs sample of on farm seeds of selected farmers in each site. A major emphasis on farmers using old cultivars is considered in this investigation. Determination of foreign matters, shriveled kernels and germination was achieved using 30 samples from each site. Adjusted seeding rates were recommended for each of these farmers. Most of these farmers are located at Ejjouf (Zaghouan) and Bargou (Siliana). Within each of these areas, farmers provided with DIVIDEND to treat their seeds. In each area an equivalent of seed treatment fungicide of 30 to 40 tons of seeds was distributed. This operation reached a total of 42 farmers. Average seed characteristics for each cultivar are described in Table 5.

Analysis of sampled seeds indicated that foreign matters and broken kernels represent 14.6 and 11.3 % of the total weight respectively. It is however noted that greater percentages were observed for Chili that was collected from Bargou area and was associated with the lowest germination rate.

Table 5. Characteristics of on farm seeds: (Percentage of foreign matters, broken kernels and germination rate)

Cultivar	Foreign matters	Broken kernels	Germination rate
Karim	13.2 ± 3.8	11.4 ± 2.7	98 ± 1
Razzak	13.1 ± 4.4	9.8 ± 3.1	96 ± 2
Biskri	13.7 ± 3.8	8.4 ± 3.2	97 ± 1
Mahmoudi	12.8 ± 4.3	8.1 ± 2.2	93 ± 2
Chili	19.1 ± 3.1	16.7 ± 3.4	79 ± 3

2.3. Mass selection of collected population of landraces

During last cropping season a sample of 100 heads were selected from farmers' field who use landrace such as Chili, Mahmoudi, and Biskri at EJJOUF and BARGOU. These samples of heads were sown onto plots at the experimental station of Mograne in order to carry out selection and reduce heterogeneity so that cultivar identity will be retrieved. Cultivar with greater purity will be increased to assess end product quality related traits in a collaborative research program with the food technology laboratory of INAT.

2.4. Provisions of the seed unit operation and farmers' training

During the past two years, the team has organized several meetings with the community of farmers and identified potential leaders located at Marjaa Aouam and Sidi Aouidet. These farmers are used to exchange and sell cleaned seed to their neighbors particularly for the old cultivars. Hence, the seed unit will reinforce this activity and extend it to other areas. Therefore a program of seed cleaning activity will be jointly scheduled by the IRDEN team and regional agriculture services. These activities will be carried out at three main locations: BARGOU, SIDI AOUIDET and EJJOUF. The maintenance of the equipment will be carried out by the machinery department of INAT. It is however worth noting that development of seed business is considered since there is an opportunity of subsidies of the equipment. Economic feasibility and sustainability of this business should be considered along with other legal issues and partnerships with seed cooperatives. These issues were discussed in four

workshops organized by Office des Céréales, COSEM, CCSPS, Seed multipliers, farmers and research institutes.

Several farmers' trainings on seed conditioning using the acquired equipment are scheduled in the target sites. These trainings include the selection of field for the production of quality seed, rouging of off-type, harvesting, seed cleaning and treatment, and finally seed conservation techniques. A descriptive brochure of these different activities will be edited and distributed to both farmers and regional technicians.

3. Economic activity

Technical efficiency investigation using last years farmers (25 in each site) will continue. Questionnaire has been distributed to monitor and record the various farmers' activities. More over, market opportunity study of on farm end product will be estimated using on farm processed couscous and bread that will be exhibited in local markets.

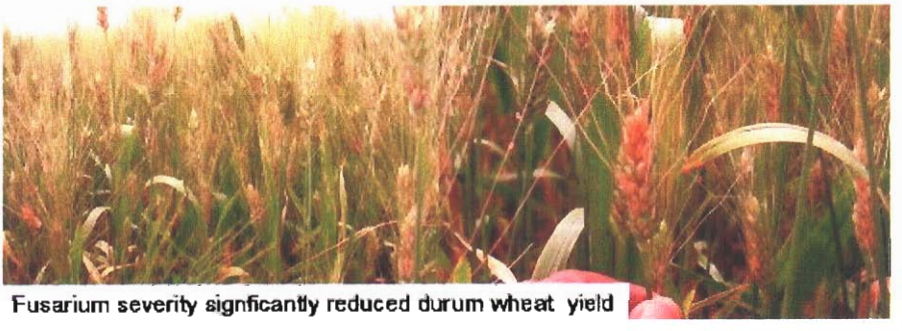
4. Quality end products

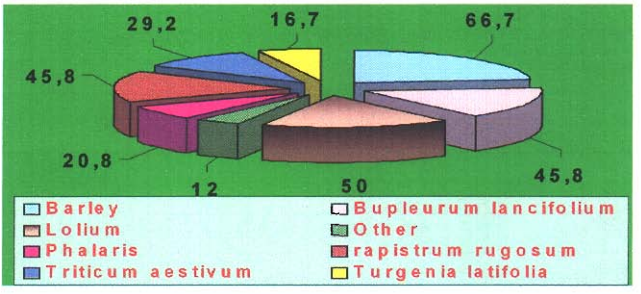
Samples of on farm couscous processed from EJJOUF area were currently provided to investigate nutritional value and organoleptic characteristics and compared to industrial manufactured couscous. Two families are identified to process derived durum wheat products at both sites within the promotion of rural woman program. These families will be provided with semolina to process couscous that will be labeled and exhibited in the market. This activity is aiming to promote on farm products and improve farmers' income.

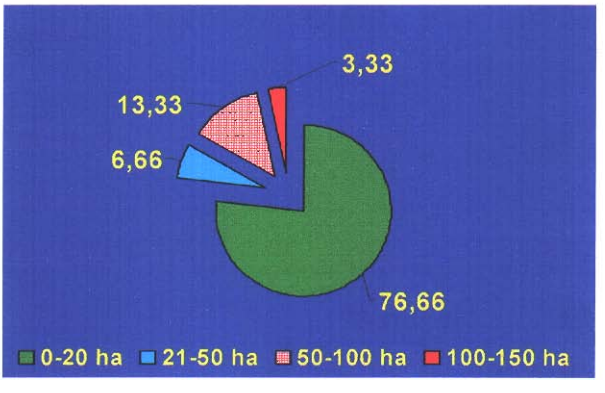
Edition of compiled data from previous surveys on durum wheat end products is underway. This document will include inventory of durum wheat products, consumers' preference and quality characteristics of the main durum derived products.

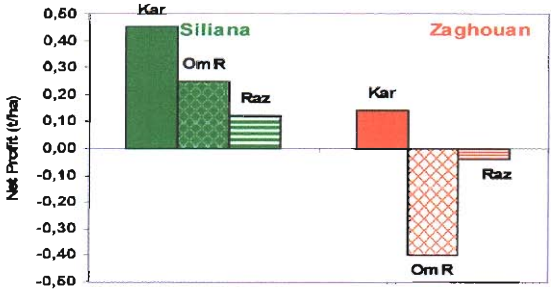

Seed cleaner after improvement
Bulk Seeds
G p 89.32%-Imp.Id 10.28%-Imp Ig 0.4%
Light Impurities
G p 7.5%
Imp 92.5%
Cleaned seeds
Gp 94.66%
Broken K 5.33%
Imp 0.01%
Heavy Impurities
Shrinked kernal 45.1%-Imp54.3%
$Z = \frac{10,68 - 5,34}{10,68} = 50\%$

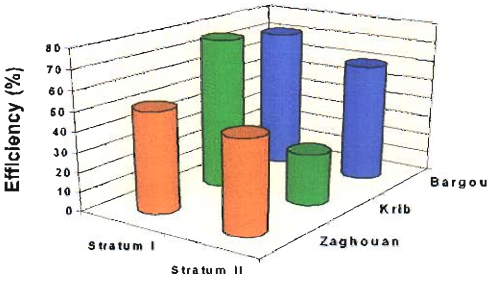

Effect of diseases on grain yield


Fusarium severity signficantly reduced durum wheat yield


29,2
16,7
66,7
45,8
20,8
12
50
45,8
Barley
Bupleurum lancifolium
Lolium
Other
Phalaris
rapistrum rugosum
Triticum aestivum
Turgenia latifolia


3,33
13,33
6,66
76,66
0-20 ha
21-50 ha
50-100 ha
100-150 ha


Net Profit (t/ha)
0,50
0,40
0,30
0,20
0,10
0,00
-0,10
-0,20
-0,30
-0,40
-0,50
Kar
Siliana
OmR
Raz
Zaghouan
Kar
Raz
OmR


Efficiency (%)
80
70
60
50
40
30
20
10
0
Stratum I
Stratum II
Zaghouan
Krib
Bargou

NARS/TUNISIA/ ICARDA
NATIONAL COORDINATION MEETING

Hôtel Kamsa Corinthia- Gammarth, October 18, 2004

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