Kingdom of Morocco

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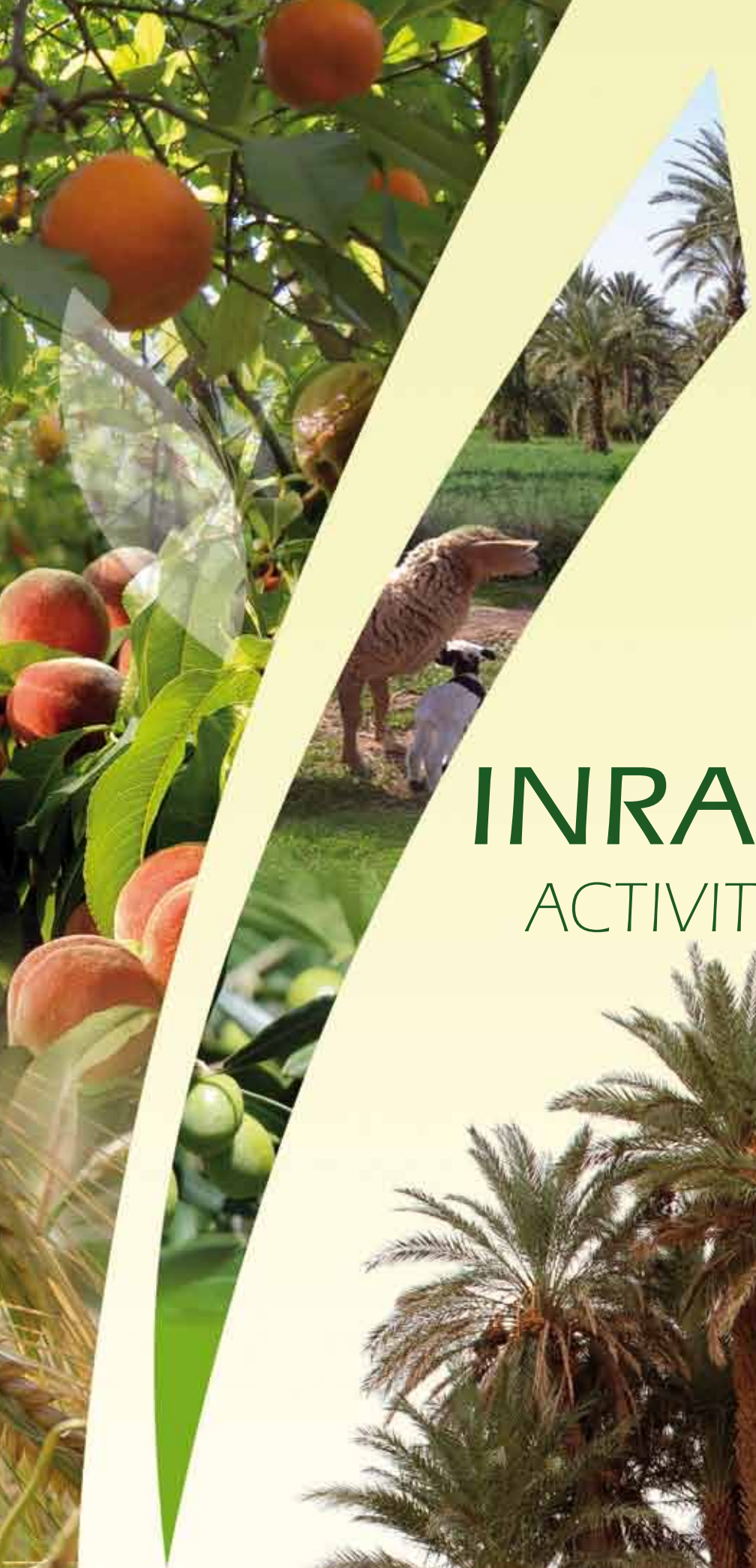


INRA 2010
ACTIVITY REPORT

His Majesty the king Mohammed VI

SUMMARY

During the year 2010, the activities of Research and R&D carried out by INRA have been part of a logical continuation of the activities undertaken since the launching of the Green Morocco Plan in 2008. They have been realized by the accompaniment and the active support of our researchers to the Regional Agricultural Plans (PAR) implementation.

Our main objective, which we share with our partners in the national agricultural research system, is to provide concrete answers to the objectives of this new agriculture development strategy in Morocco.

The regionalization and decentralization of research activities is a major ongoing work. Indeed, the creation of new Regional Agricultural Research Centers (CRRA) is undertaken to promote proximity research and to cover the regional specificities and diversities through the valorization of the achievements and the potential of each region for the benefit of rural communities. It is illustrated by the creation of the *in vitro* culture laboratory in Errachidia CRRA, which will be a pole of excellence in the date palm field and the oasis space development in general.

To ensure a harmonizing of a INRA research choices in accordance with the PAR, mid-term evaluation of the Medium Term Research Program (PRMT) 2009-2012 was conducted. It is a moment of judgment, reflection and debate on the work progress for a readjustment to

better identify the regional priorities and redefine the fields of action in accordance with the requirements and socio-economic environment in a permanent evolution.

The human capital, cornerstone of our development strategy, is a top priority in building our institution, and for more scientific and technological production.

Without being exhaustive, the 2010 activity report will try as much as possible to track the highlights of our Institute and unveil the major technology and science breakthroughs in various agricultural sectors and disciplines in accordance with the needs of PAR.

Remaining on the same momentum, we will work tirelessly to accompany the major restructuring of Moroccan agriculture projects initiated by his Majesty the King Mohammed VI to meet the challenges for sustainable agriculture and for the benefit of the rural people in Morocco.

Prof. Mohamed Badraoui
Director of INRA

HIGHLIGHTS

THE AGROPOLE OF BERKANE

Inaugurated by his Majesty The King Mohammed VI, the Agropole of Berkane, located in the commune of Madagh (province of Berkane) is a real mega-project for valuing the acquirements and the potential of the Eastern region and strengthening its strategic position in the sustainable agriculture development.

NEW CRRA WITH MISSIONS ADAPTED TO REGIONAL VOCATIONS

Through this policy, the INRA strengthens the research of proximity via the launching of new Regional Agricultural Research Centers.

INTERNATIONAL EXHIBITION OF AGRICULTURE IN MOROCCO SIAM 2010

With the fifth edition of The International Exhibition of Agriculture in Morocco, INRA participation focused on technology offer and its support in the achievement of the PMV objectives.

The stand of the INRA is articulated around: (i) the research directions by region and their alignment with the agricultural regional Plans (PAR), (ii)

the research results made available to agricultural production sectors and (iii) specific technologies to pillar II of the PMV in terms of conversion, intensification, development of local products and capacity-building.

SIDATTES 2010

The city of Erfoud hosted the first edition of the International exhibition of dates (SIDATTES 2010). On this occasion, the INRA presented its medium term research strategy 2009-2012 on the oasis system and the date palm, in particular, tools and techniques of propagation *in vitro* of the Palm tree illustrated by a Mini-Lab, new date palm varieties resistant to Bayoud and good quality fruit as well as a sample of processed products from the palm date fruit. A tasting session of those products was organized in honor of the visitors.

FIRST SCIENTIFIC DAYS ON THE DATE PALM

In the margin of the SIDATTES exhibition were organized the first study days on the date palm. A panel of national and international experts has been invited and offered the opportunity to learn and exchange the latest experiences, technologies and innovations in technical managment and valorization of date palm to a numerous audience (farmers, operators, producers, investors, teachers, researchers, extension, NGOs, etc.).

FAO AWARD OF MERIT

Once again, INRA research teams obtained the FAO award of merit of the year 2010. This prestigious prize was awarded to a multidisciplinary team of researchers led by Dr. Moulay Hassan SEDRA for their innovative and promising research on the date palm and the backup and regeneration of the Moroccan Palm Grove.

NATIONAL INNOVATION COMPETITION

In the 6th Edition of the National Competition for Innovation organized by the Moroccan Association for Research and Development, Dr. Mohamed Boujnah was awarded a prize for his research work relating to the development of a cheese spread with a vegetable fat produced with completely skimmed milk and rich in soy protein with a fat matter content of 32%. This cheese is rich in omega-3 and fatty acids.

HASSAN II ENVIRONMENT PRIZE

An INRA team of researchers and technicians led by Dr. El Faiz Chaouki has been honored with a Prix Hassan II Environment in the 2010 Edition for research on forage, pastoral, aromatic and medicinal plants aimed to reduce the loss of biodiversity and genetic erosion plants. Collections from thousands of kilometers will be exploited in selection programs and the domestication of these genetic resources which constitute a wealth for the improvement of the agricultural production in Morocco.

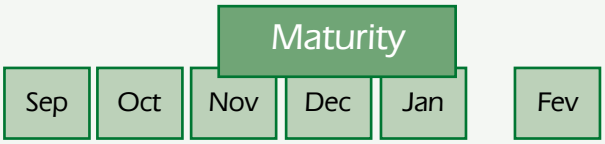
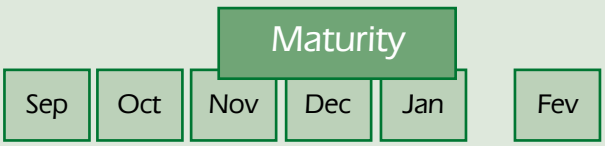
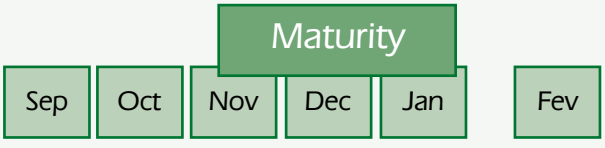
VARIETAL CREATION

SIGNIFICANT ADVANCES IN THE VARIETIES CREATION

Selection of 5 new olive varieties from crossing

Variety	Caracteristics
Tassaout	High productivity, rapid production entrance, more than 20% of oil content, 69% of oleic acid content, good fruit caliber, high auto-fertility (92%).
Mechkat	High Productivity, rapid production entrance, more than 20% of oil content, 82% of oleic acid content, good fruit caliber, high auto-fertility (88%).
Baraka	High Productivity, rapid production entrance, more than 20% of oil content, 72% of oleic acid content, average fruit caliber, regularity of production (>45% compared to the «Picholine marocaine»).
Agdal	High Productivity, rapid production entrance, more than 20% of oil content, 77% of oleic acid content, average fruit caliber, regularity of production, high auto-fertility (80%), a regularity of production and low vigor.
Dalia	High Productivity, rapid production entrance, more than 20% of oil content, 68% of oleic acid content, a small fruit caliber, drooping growth habit and low vigor.

NEW CITRUS CULTIVARS

Protected variety	Caracteristics
Mandarine AL MAHDIA 	
Mandarine ALMAAMORA 	
Mandarine AL GHARNAOUIA 	

KHAROUBA, FIRST BREAD WHEAT VARIETY FROM THE DOUBLED HAPLOID METHOD

Kharouba, the first Moroccan bread wheat variety from the anther culture *in vitro*, is registered in the official catalogue. It is a semi late variety. It has a wide adaptation range. It is a productive variety and resistant to the Hessian fly and the brown and yellow rust (Photo 1).

Photo 1: *Variety Kharouba in yield trial*

The crops genetic improvement program has led to the registration or the protection of 21 genetic lines (Table 1).

INTEGRATION OF THE BIOTECHNOLOGY TOOLS IN GENETIC IMPROVEMENT PROGRAMS

Bread wheat

The HVA1 gene, known for its role in drought tolerance, was introduced into several wheat varieties. Only embryos from varieties Marchouch and Raja were able to induce transformed plantlets. These plantlets were subjected to a confirmatory test of the HVA1 gene integration by the PCR technique using primers 35S and Bar. The results obtained have confirmed the presence of the introduced gene. These lines will serve to introduce this gene by conventional ways in the new varieties of bread wheat..

Durum wheat

Improving quality is considered high on the durum wheat breeding agenda. This character, largely influenced by

Species	Number
Durum wheat	3
Triticale	2
Bread wheat	2
Bean	1
faba bean	1
Citrus	3
Date palm	9
Total	21

Table 1: *INRA Varieties in registration or protection in the official catalogue*

the environment, was analyzed in four locations for four variety groups (old, recent, current selection, and foreign varieties known for their high quality). Gluten strength seems satisfactory at all sites without one. The yellow pigment content is variable according to the sites, but remains small compared to the millers requirements. The average vitreous aspect of all durum wheat varieties is important, including foreign ones. Lines in registration in the official catalog are distinguished from commercial varieties for the majority of quality parameters at each site. This difference is especially marked for the yellow pigment and gluten strength in which a significant difference was noted. These results reflect the priority given to quality in the durum wheat improvement program in recent years.

The application of molecular markers SSR to the quality of breeding lines and commercial varieties of durum wheat has identified the first results. The comparison of molecular data with the data quality related to the yellow color of semolina allowed to observe five alleles profiles of the marker Xgwm 499 related to the yellow color. Profile 2 of this marker includes the lines of the Mediterranean collection selected for their good quality linked to the yellow color of semolina (GCP80, PAG 70, PAG 67, GCP37, GCP32, PAG 20, PAG 96). The marker Xgwm 499 can serve as a selection marker for the yellow color of durum wheat semolina.

The transfer of drought resistance via genetic transformation allows the overcoming of the constraints of the conventional way. The transformation via Agrobacterium by introducing two plasmids HVA1 and LAE3 is tried for three varieties Isly Tomouh and Irden. The integration of the gene HVAI is confirmed in those three varieties. The transformed lines will be involved in the drought tolerance program of new durum wheat varieties.

Bean (Orobanche control)

Integration via three *Agrobaterium* strains in explants of three bean varieties of plasmids containing the sarcotoxin and ALS gene was performed. Colonies of three strains of Agrobacterium integrating the two plasmids were selected. These varieties showed a good capacity for regeneration and transformation. The introduction of Sarcotoxin and ALS genes was confirmed with the PCR technique by amplifying the 35S gene associated with both genes (Photo 2).

Photo 2 : Regeneration of plants from cotyledonary nodes and Plants transformed by sarco in medium containing hygromycin

Twenty populations were collected and characterized by 24 descriptors. The characters analysis allowed to rank these populations in six distinct groups. And genetic relationships between populations helped to classify them as belonging group (Figure 1). These populations will be integrated in the varietal creation program.

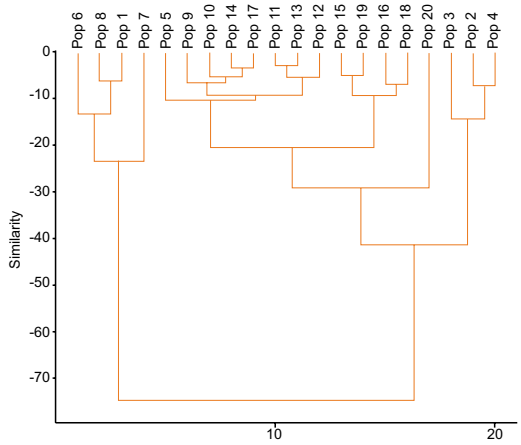


Figure 1 : classification of populations in belonging groups

Safflower

Three safflower genotypes numbered, 2, 40 and 78 were followed since the intermediate trials. Genotype 4 is the earliest coming to first flowering in 104 days followed by the control variety, Cartamar, with 107.5 days. Genotypes 78 and 40 are the latest with a cycle respectively of 116 and 113 days to flowering. The highest oil content (36.4%) was observed in genotype 78, confirming the intermediate trial result. Its grain yield is average (13.5 qx/ha), giving it the third rank behind Cartamar (19.6 qx/ha) and the genotype 2 (16.8 qx/ha). Genotypes 2, 40 and 78 were accepted for registration in the official Catalogue.

Lupine

Synthesis made after four years of advanced trials of lupine yield allowed to determine three lines L27PS2, L22PS2, and L6 / 4 M, having realized yields varying from 26 to 29 qx/ha. These lines will be presented for registration in the official Catalogue.

Apricot tree

Ten genotypes of an apricot collection were studied for their productivity in the region of Saïss. The genotypes of apricot fructify preferentially on the long shoots rather than on the flower cluster. In general, the production on the long shoots is sought because of the fruit quality. The floral density informs on the number of floral buds supported by linear centimeter of fruiting shoots. The results indicate that the best floral densities varieties ‘canino’ and ‘outat 2’ have a high proportion of the flower cluster and flowering shoot. The genotypes Canino and Outat 2 are selected as well for the fruiting support density as for the floral density and the fruiting capacity.

Olive tree

A collection of 88 olive tree accessions collected in 9 regions of production (Figure 2) was characterized by its oil

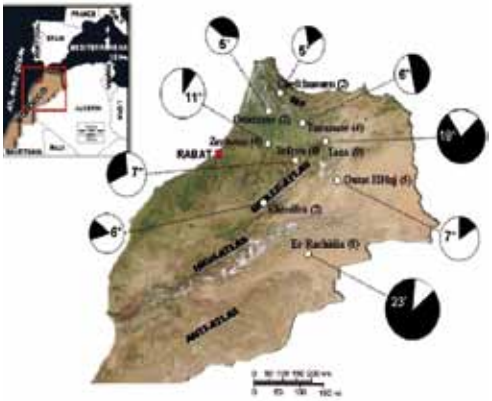


Figure 2 : Genotypes distribution and variability by region

content and the fruit weight average and by the molecular analysis of SSRs type. The results were compared to a standard Picholine Moroccaine variety and seven known local varieties. Oil content showed a very high variability between genotypes, growing regions, and the years of observation. The richest oil genotypes are from Sefrou and Taza areas. The molecular analysis has shown that the 88 accessions are distributed in 28 SSR profiles. Thus, 45 samples (51.1%) are similar to the «Picholine Marocaine» and 43 samples have different genetic profiles from the «Picholine Marocaine». Variability is not homogeneous in all regions. In Moulay Idriss Zerhoun, 11% only are similar to the «Picholine Marocaine», while they are of 87% in Errachidia (Figure 3).

In the prospected sample, there appears a dominance of the variety «Picholine Marocaine» in more than 50%. Despite the existence of a significant intra-varietal diversity, but on the 28 profiles, 22 samples differ only by 1 to 6 alleles which may be the result of the environment variability.

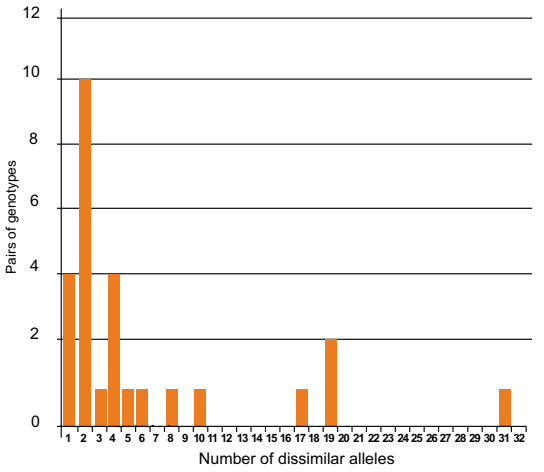


Figure 3 : Number of non-similar alleles between the «Picholine Marocaine» and the 27 SSRs profiles

Date palm

In vitro multiplication of date palm genotype was continued. To cover the needs of private laboratories, a total of 22.467 strains were produced during that year. The evolution of the multiplication is variable according to genotypes. It is noted that the Mejhoul variety stems were subject to an early greening and elongation.

The growth and development of plants belonging to the first clones from inflorescences four years after planting have continued without any anomaly or aberration of growth up to now. In addition, two vitroplants of the INRA-B26 clone have flowered for the first time in the experimental field of Er-Rachidia. These plants began producing four years after planting (Photos 3 and 4).

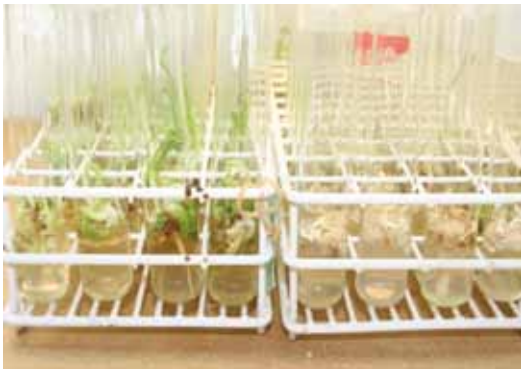


Photo 3 : Regeneration of Mejhoul plants

Photo 4 : Young plants from inflorescence came in production at 4 years of age

Citrus

The introduction of new rootstocks renowned for being resistant to the tristeza have been tested in local pedoclimatic conditions. Among the selected ones, Flhorag was tested for these effects on the productivity of Valencia late, Clementine Sidi Aissa and the orange Salustiana. The behavior of this rootstock on these varieties has been compared to other rootstocks on the same varieties.

The best results in terms of production for Flhorag are given with the Valencia Late. The average fruits weight (265 g) and the juice percentage (43.4%) are higher than those given by the other rootstocks. The Brix degree is less than that of the Troyer citrange and citrange carrizo rootstocks but similar to that of *Poncirus trifoliata* (Photo 5).

The variant groups of Salustiana, Sanguinilli and Grosse sanguine have been tested for their behavior in the region of Souss. Three promising clones with good quality and ability in the conservation have been selected. These clones will be proposed for the official catalog inscription (Photo 6).

GENE BANK: CONSERVATION OF PHYTOGENETIC RESOURCES

43.128 accessions of 256 species are conserved in the INRA gene bank. Five genuses (*Triticum*, *Hordeum*, *Medicago*, *Avena*, and *Helianthus*) represent more than 72% of the total accessions.

The exploration organized this year allowed to collect 20 species of trees and shrubs and 9 other pastoral species. In addition, 204 accessions have been multiplied and characterized (Figure 4).

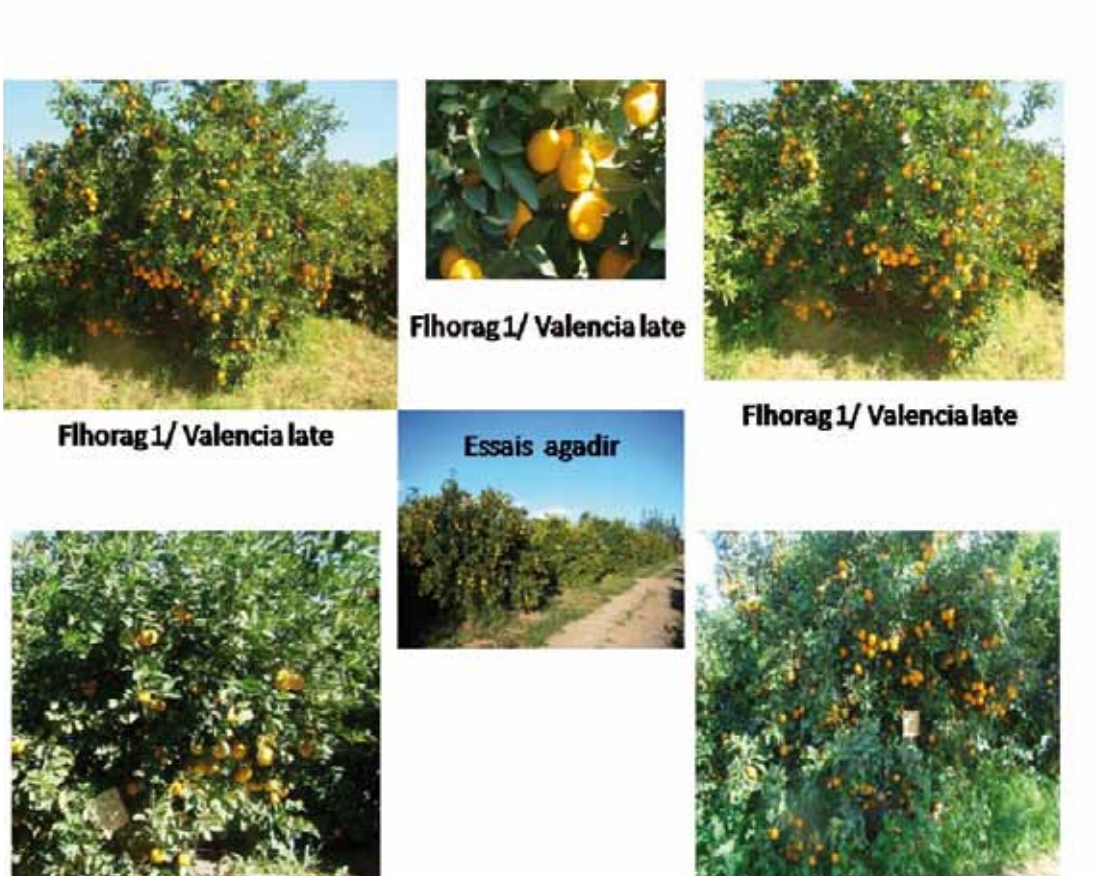


Photo 5 : Tree on Flhorag as rootstocks

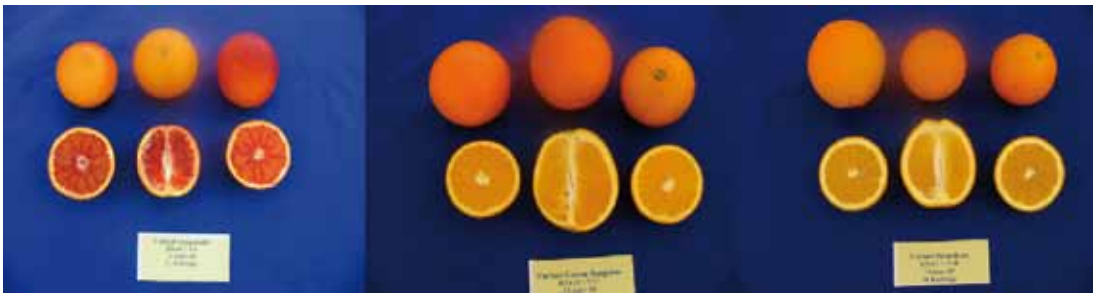


Photo 6 : Orange tree variants selected in the Souss Massa region

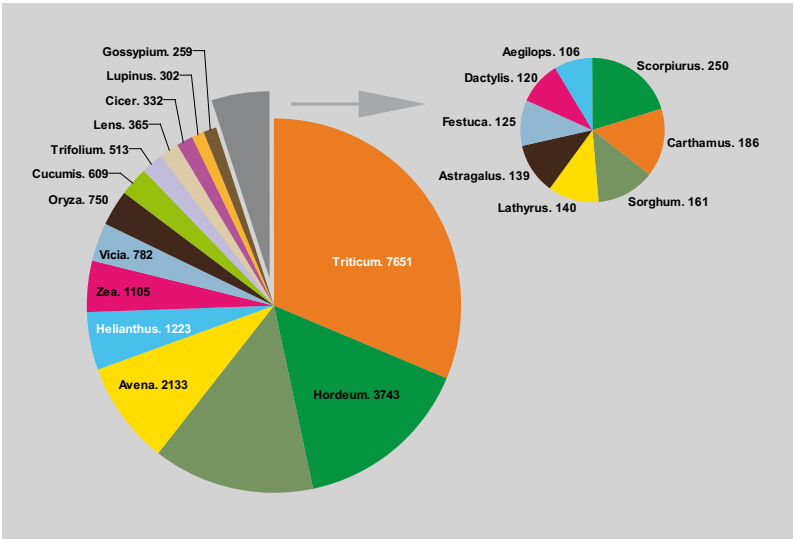


Figure 4 : Gene bank

PLANTS PROTECTION

CEREALS AND FOOD LEGUMES PESTS AND DISEASES SITUATION: A YIELD LOSS OF OF 25-30%

The climate conditions of this crop year have been very favorable to the development of diseases, insects and bad weeds.

Rust and Septoria : the main causes of wheat yield loss

The most prevalent wheat diseases are: Septoria (*Mycosphaerella graminicola* (Fuckel) Schroeter) (*anamorph Septoria tritici* (Desm.)), *Phaeosphaerea nodorum* (E.Müll.) Hedjar) (*anamorph Stagonospora nodorum* Berk.) Castell. & Germano), *Dreshlera tritici-repentis* (*anamorph Pyrenophora tritici-repentis*)), brown rust (*Puccinia triticina* Eriks.), yellow rust (*P. striiformis* Westendorp. *f.sp tritici*) and to a lesser degree root diseases.

The septoria epidemic level in infested fields was with a mean severity of 40%. Brown rust was the second important wheat disease with a mean severity of 30%. Oidium and common bunt were detected on durum and bread wheat, but to a lesser extent. Black rust (*P. graminis* Pers. f. sp *f.sp. tritici* Eriks. E. Henn) was limited to a few fields of durum wheat. The Covered smut attacks have been identified in bread wheat fields (Figures 5 and 6).

The net blotch (*Pyrenophora teres* Drechsler) has been the most important disease of barley with a severity of 70%. Note also, the scald resurgence (*Rhynchosporium secalis* Oudem.). (Davis), because of the wet conditions in this crop year.

A national plan of wheat rusts control

Given the seriousness of the situation of wheat rust and to develop awareness of these diseases, the INRA organized two international workshops whose recommendations have been taken as the basis for the development and implementation of a National Plan for Prevention and Control.

Insect pests in wheat

Among insect pests of wheat, the Hessian fly (*Mayetiola spp*.) was by far the most important problem particularly in the late- sown wheat fields with the percentages of 40% infestation and a mean severity of 25%. Other pests of a lesser importance, especially the wheat bulb fly and different species of aphids were also present. Large Wheat stem borer (*Cephus spp*.) attacks on straw were noted at the end of the wheat cycle.

Missed early weed control

Because of the continuous and late rains, fields' weed invasion was very important because of the absence of early weed control. These conditions have also

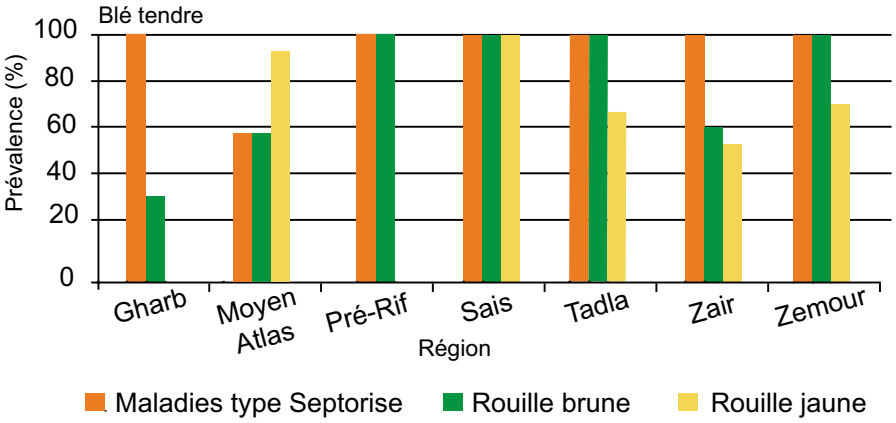


Figure 5 : Prevalence of major bread wheat diseases in different regions during the 2009-2010 crop year

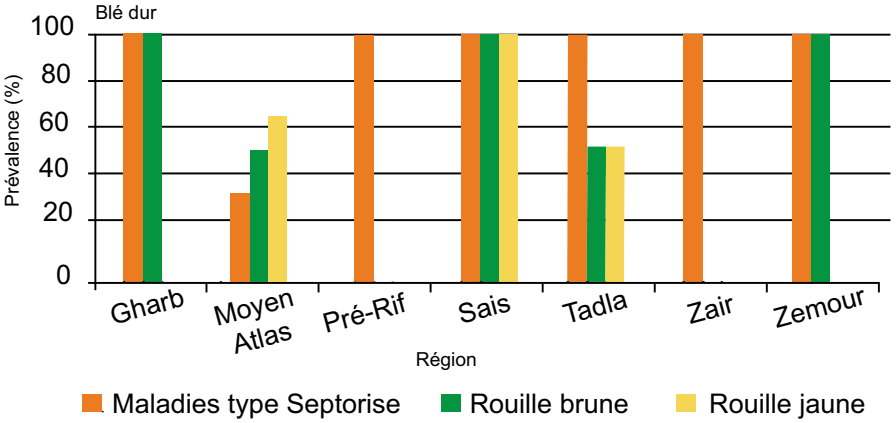


Figure 6 : Prevalence of major durum wheat diseases in different regions during the 2009-2010 crop year

caused progressive weeds germination. The adventive flora was dominated by species of brome with an average of 71%. Note that in the region of Chaouia, cereals yield losses are estimated at 15%.

Diseases of food legumes

In the case of the food legume diseases, Ascochyta blight (*Ascochyta rabiei* (Pass.) Lab) and Fusarium wilt (*Fusarium oxysporum* Link) were the main threats to the of chick peas culture, mainly in the Abda and Chaouia regions. Infestations of a lesser importance caused by rust (*Uromyces ciceris-arietini* Grognot) Jacz. (& Boyd Grognot) Jacz. (& Boyd) and alternaria (*Alternaria alternata* (Fr.) Keissl.) were also observed on this culture. The Chocolate spot (*Botrytis sp.*), rust (*Uromyces fabae j.* Schröt.) and alternaria (*Alternaria* SP.) are the most common diseases on Fava Bean crops. The first disease was the most widespread and destructive for these crops. The pea culture was mainly affected by anthracnose (*Ascochyta* sp.). Infestations without importance of powdery mildew (*Erysiphe polygoni* (Vaňha) Weltzien) and rust (*Uromyces pisi-sativi* (pers.) Liro), were also observed on this culture. The presence of Ascochyta blight

(Ascochyta fabae. fsp lentils Gossen, Sheard, C.J. Beach & Morrall), were observed in some lentils fields without real impact.

DEVELOPMENT OF PEST MANAGEMENT STRATEGIES FOR WHEAT

Resistance of wheat cultivars and breeding lines to Septoria

In controlled conditions of a nursery, Evaluation of 89 wheat lines to Septoria revealed a large genetic diversity in the responses of these lines. 8 lines with total immunity were identified and could be used as resistance sources against several races of this pathogen.

Research on multiple disease resistance in wheat

Evaluation of resistance of two local germplasm collections to brown and yellow rust showed that bread wheat is far more sensitive than durum wheat. Among this material, 4 varieties were completely immune to yellow rust and 20 to brown rust.

Moreover, evaluation of CIMMYT wheat nursery to prevalent diseases revealed a resistant line to Septoria and yellow rust. This line will be put forward for registration in the official catalogue and/or its introduction in crossing blocks.

Selection for root rot resistance

Evaluation in root rots controlled conditions of a bread wheat collection has highlighted a genetic variability among lines and allowed to select 27 tolerant lines.

Selection of doubled haploid resistant lines

Within the framework of the project "generation Challenge program", the application of screening by 3 primers to find resistance characters to yellow rust, proteins with high molecular weight and the presence of chromosome 1R of rye on 500 haploid lines allowed the selection of 67 double haploid lines combining these three characteristics. With a view of their future performance in real conditions, these lines will be considered as developed germplasm or varieties to propose for registration.

Performance of chemical products for the control of wheat leaf diseases in the semi-arid zones

With regard to the fungicide treatment, a study was conducted on the performance of products composed by: Fluquinconazole, Flutriafol + Carbendazim, Epoxiconazole, Fluzilazole + Carbendazim, Propiconazole for control of leaf diseases of wheat in semi-arid zones . In this framework, yield losses were estimated at 21% for durum wheat Karim and 23% for bread wheat Achtar. The products

composed by Fluquinconazole and of the Epoxiconazole were the most efficient in the first case while those composed by Fluquinconazole and Propiconazole have shown better efficiency for leaf diseases control associated to Achtar. Under these conditions, the leaf treatments have permitted a yield gain up to 10 qs/ha (Table 2).

Moreover, in Sidi el Aidi, the evaluation of new herbicides effectiveness highlighted better Bromus rigidus control by a product composed of Pyroxsulam + Cloquintocet - mexyl.

In Khemis Zmamra, the product composed of Aminopyralyde + Florasulam (355 + 150 g/kg) has proved more effectivene in the control of weed species of *Scolymus maculatus* l., *Malva parviflora* l., *Cichorium endivia* l., *Sylibum marianum* (L.) *Convovulus arvensis* l., *Sonchus oleraceus* l., *Torilis nodosa* (L.) Gaertn. Gaertn., *Anagallis foemina* Mill., *Rumex pulcher* l., *Ridolfia segetum* Moris, *Sinapis arvensis* l., *Papaver rohas* l. and *Emex spinosa* (L.) Campd.

Rays gras resistance to 'FOP' herbicides in the Tadla

In the Tadla region, the monitoring of infestations by rays gras 'FOP' herbicide in cereal and sugar beet plots has highlighted the presence of this weed in several localities of the irrigated Tadla perimeter including plots treated with the FOP family herbicide such as clodinafop.

This observation was confirmed by field trial, where a product of the fop family based on the fluazifop-butyl in post-emergence has proved clearly less effective that the herbicides belonging to other families, especially the propyzamide (800 g/ha) in post-emergence, S-metolachlor (1440 g/ha) in pre-emergence, clethodim (120 g/ha) and iodosulfuron sodium + mésosulfuron sodium + mefenpyr diethyl (300 + 60 + 900) g/ha in post emergence (photo 9).

Identification of resistance sources to Ascochyta blight of chickpea.

In experimental stations of Sidi El Aidi and Merchouch, an evaluation of 62 chickpea entries for Ascochyta blight resistance (*a. rabiei*) allowed to select one resistant line and 8 moderately resistant lines (Photo 7).

	Achtar		Karim	
	Yield	Gain (%)	Yield	Gain (%)
Fluquinconazole	30.50	16.95	45.32	27.65
Epoxiconazole	34.94	27.50	43.05	23.83
Flutriafol + Carbendazime	31.97	20.77	41.19	20.39
Flutriazole + Carbendazime	33.52	24.43	38.05	13.82
Propiconazole	35.00	27.63	41.71	21.39
Témoin	25.33	-	32.79	-

Table 2 : Yield (qx/ha) in grains average (%) of chemical treatements to control foliar diseases of durum wheat Achtar and wheat Karim.

Photo 7 : Assessement trial of the efficiency of treatments based on iodosulfuran sodium+ mesosulfuran sodium+ mefenpyr diethyl (300+60+900 g/ ha), for ray grass control in Tadla.

Weed control in food legumes

In the matter of chemical weed control research on food legumes (fava bean, pea and lentil), a pre-emergence treatment based on pendimethalin (1200 g/ha) confirmed for the second year its high efficiency level for weed control for a long duration from 75 to 90 days after emergence. The metribuzin (350 g / ha) tested this year has given results comparable to those of the preceding crop year.

The two treatments have proved effective in the lentil fields without causing phytotoxicity in contrast to the first year experiment. However, pre emergence treatment based on bentazon, metribuzin and prometryn ensured average to low efficiency, probably because of their late application, due mainly to the very frequent rains which plagued this season (Photos 8, 9, 10, 11).

Photo 8 : Selection trials for chickpea resistance to Ascochyta blight.

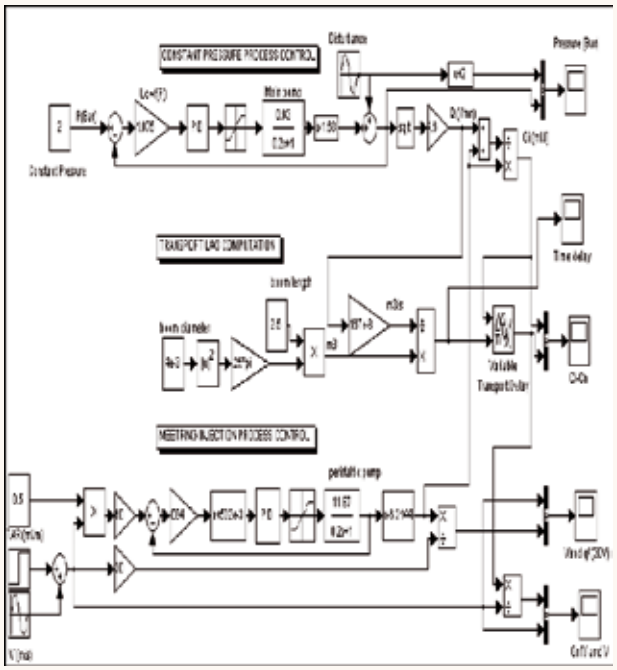
Photo 9 : Effectiveness of the treatment based on pendimethalin (1200 g/ha) in pre emergence for lentil weed control in Tadla

Photo 10 : Effectiveness of treatment based on pendimethalin (1200 g / ha) in pre emergence for peas weed control in Tadla.

Photo 11 : Effectiveness of the treatment based on metribuzin (350 g/ha) in pre emergence for lentil weed control in Tadla

DEVELOPMENT OF A SPRAYER BY DIRECT PESTICIDES INJECTION WITH VARIABLE RATES

A small direct injection sprayer equipped with a five-metre ramp was designed to remedy the difficulties related to the manual sprayers use. This prototype has been performed to manage the applied dose in real time via an electronic regulator. The control system has been optimized according to the operator progress speed variation to have a better dynamic response (response time). Two control strategies have been implemented with control loops with a feedback effect adjusting the injected pesticide dose in the pressure pump upstream for operator speeds of around 1 m/s (±0.5). The prototype field evaluation trial is scheduled for 2010-2011.



Model of electronic regulator developed on Matlab-Simulink

CONTROL OF CITRUS FRUITS ENEMIES

Evaluation of rootstock resistance to Phytophthora spp.

The evaluation of 10 rootstocks resistance to *Phytophthora citrophthora* (R.E. SM. & E.H. Sm. Leonian) highlighted a variability of response depending on the strain and the inoculation technique. The results also showed a high resistance level of the hybrid '*Flying dragon* X *Poncirus trifoliata*'. The rootstocks *Citrus volcameriana*, Citrange troyer Citrange carrizo, Citrumilo swingle 74-1, Citrumelo swingle 57-98-506 were moderately resistant in the same way as the bitter orange. Furthermore, big aggressiveness variability between different Moroccan populations of P. *citrophthora* and P. *parasitica* Dast was revealed by the RAMS technique (Random amplified microsatellite) (Figure 7 and 8).

Leafhoppers on citrus fruit

In Afourer, the monitoring of leafhoppers populations dynamism in three citrus orchards (Moroc late, Clementine and Navel) indicates a beginning of similar activity of these pests on the three varieties from the end of flowering until mid-July. The infestation peak is reached

in June. The maximum infestation is noted for the variety Navel with an average of over 33 insects per trap.

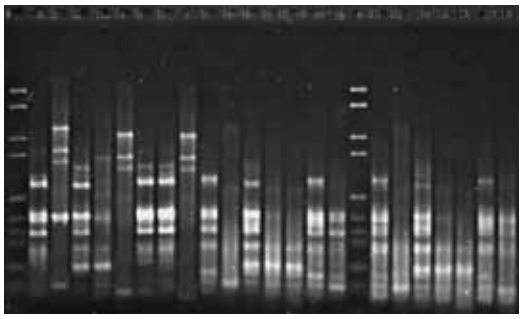


Figure 7 :RAMS analysis gel for 28 Phytophthora citrophthora strains by primer 5'ATAGTGTGTGTGTGTG

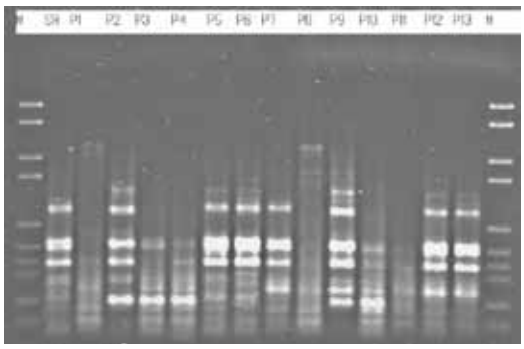


Figure 8 : RAMS analysis gel for 14 of Phytophthora parasitica strains by primer ' AAGGTGTGTGTGTGTG

Molecular markers for the identification and screening of Bayoud strains

The techniques of PCR ISSR, specific PCR, RAPD, have been tested to detect the variability of 6 pathogen strains *F. oxysporum* f.sp. albedinis (TFA) isolated from Palm trees in Morocco, Algeria and Mauritania and a non-pathogen strain from Jordan. Results showed, on the one hand, important polymorphism evaluated at 89.9%, and on the other hand, a net discrimination between pathogens and non-pathogen strains. Recombination between the three PCR methods showed a complementarily for Foa screening.

Research on Foa secreted toxins, the Bayoud agent

Research for the development of an *in vitro* test by inoculation of toxins extracted from Foa in detached Palm leaves, helped to identify new under fractions of toxins some of which would be determinants for the parasite pathogenicity.

PHYTOSANITARY PROTECTION OF THE OLIVE TREE

Development of a biological control against verticillium wilt

Within the framework of research of the *Verticillium dahliae* (Kleb) antagonists, the characterization of a collection of 23 bacteria inhibiting this fungi growth revealed the presence of 18 strains of the genus *Pseudomonas* and 5 others of *Bacillus*. Among this collection, seven strains have demonstrated a marked antagonistic power. The technique of the PCR-RFLP has generated a polymorphism to distinguish between these 7 strains.

Development of a rapid test for the assessment of olive varieties reaction

The behavior assessment of 30 olive varieties, belonging to 12 Mediterranean countries, through the use of the culture filtrate *V. dahliae* on leaves and loose twigs, showed variability in varietal

behavior. The variety Sayali (Tunisia) and Uljarica (Croatia) have expressed high resistance after 13 days of experimentation.

The Olive parlatoria scale:an emerging pest in Tadla

The Study on the bio-ecology of olive parlatoria scale (Parlatoria oleae Colvée), an emerging olive tree pest in the Tadla perimeter, indicated the beginning of mobile forms since late May with a maximum pullulating in early July (Photo 12). A significant fruit, rather than leaves, infestation was also observed with the trend reversed during the fruit maturity period.

Mapping and fire blight biological control

The prospecting carried out in the orchards of Azrou, El Hajeb, Immouzer and Sefrou, revealed a wide spread of fire blight disease in these areas.

Photos 12 : Symptom of Parlatoria oleae attack on leaves and fruit.

The bacterium incidence was very high. This year, the attacks were visible on almost Pear varieties especially Passe crassane, Morettini, Dr. j. Guyot, William's and Coscia. However, the disease incidence on apple and quince was more moderate, in contrast to previous years when the quince was the most affected.

Despite favorable climate conditions, different varieties of apple have shown significant tolerance levels. Moreover, morphological and biochemical characteristics of new strains of *Erwinia amylovora* Burrill have confirmed the presence of this bacterium. These results were reaffirmed by the RT PCR which gave a better diagnosis because of the presence of the amsC and the aRN23S genes in all strains (Figures 9 and 10).

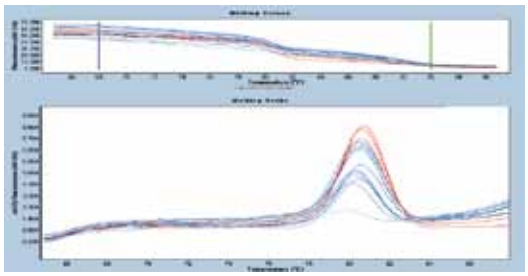


Figure 9 : Result of amsC gene amplification by PCR in real time on a few strains of E. *amylovora* collected in 2010

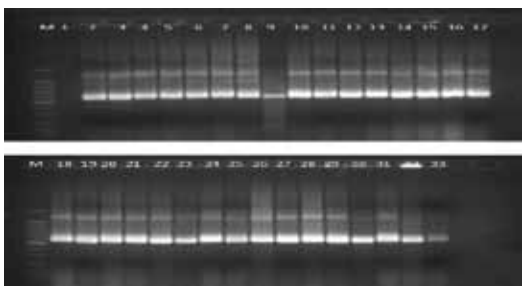


Figure 10 : Electrophoresis Profiles of PCR product in real time during the aRN23S gene amplification on strains of E. *amylovora* collected in 2010

Furthermore, the aromatogram method highlighted the bactericidal effect of essential oils of 12 medicinal and

aromatic plants (*Mentha rotundifolia* l., *Lavandula angustifolia* Mill, *Mentha pulegium* l., *Mentha aquatica* l., *Thymus zygis* Loefl., *Origanum elongatum* Emb., *Salvia pratensis* L.), (*Rosmarinus officinalis* l., *chrysanthemum coronarium* l., *Cladanthus wrasse* l., *Pelargonium capitatum* l., *Citrus aurantium* L). Their secondary metabolites (carvacrol, thymol, and santoline) showed a strong antibacterial activity (Photo 13).

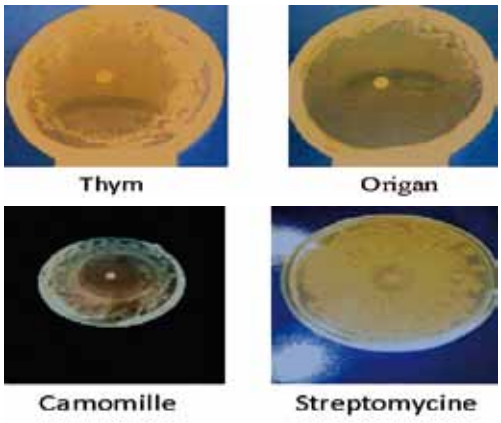


Photo 13 : Aromatogramme of a few HE and streptomycin tested on E. amylovora

Evaluation of Rosaceae rootstock for black Capnode resistance

The evaluation of resistance to the black capnode (*Capnodis tenebrionis* Linnaeus) of a collection of almond and apricot rootstocks showed different levels of sensitivity. Myroboblon and GF677 rootstocks are highly sensitive to this pest. The varieties, Agdez and Delpatriarca were less sensitive and much less appreciated by the capnode larvae. Among the INRA germplasm, O11, X13, D6 and Z8 almond rootstocks

showed a significant resistance level (Photo 14).

Photo 14 : Apple attacked by the black capnode

Detection of Agrobacterium vitis Conn on young vineyards

The results of biochemical and biological analysis of 30 vine plant samples of Red glob and Muscat varieties from the region of Meknès-Hajeb-Saïss bearing tumors at grafting have revealed the presence of *Agrobacterium vitis* (formerly called A. tumefasciens, biovar 3) (Photos 15 and 16). These results were confirmed by a molecular diagnosis of isolated strains by Bio PCR, conventional PCR and real-time PCR. This last technique is a fast and reliable tool that can be used for the diagnosis of healthy aspect plants.

Weeds in sesame fields and chemical control

In the Tadla perimeter, a first inventory of weeds associated with the Sesame

Photo 15 : Plants of vine bearing tumors (1-4: Red Glob variety, 5 and 6: Muscat variety).

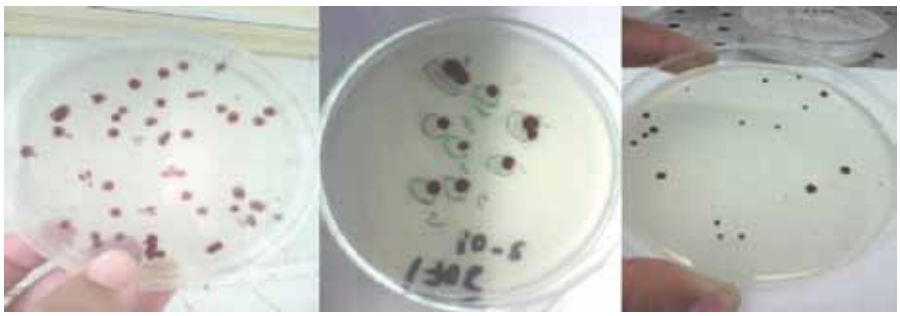


Photo 16 : Aspect of A. *Vitis* colonies on Roy and Sesser medium

culture allowed the identification of about 25 species mainly of spring and summer. Perennial monocotyledon weeds are represented mainly by *Sorghum halepense* (L.). *Cynodon dactylon* (L.) Comm. While among the annual dicotyledone weeds, *Portulaca oleracea* l. and *Amaranthus retroflexus* l. are the most representative.

Under these conditions, the evaluation test of three herbicides highlighted a significant effect of a product based on alachlor (4 l/ha) while herbicides based on Pendimethalin and S-Metolachlor were phytotoxic at doses of 330 g / and 960 g/L (Photos 17, 18 and 19).

Photo 17 : Untreated sesame plot invaded by weeds

Photo 18 : Symptom of Sesame phytotoxicity following a Pendimethalin based treatment

Photo 19 : Good efficiency of alachlor without phytotoxicity for weed control of the sesame culture.

AGRONOMY AND AGRICULTURAL MACHINERY

IMPROVEMENT OF RAINFED AREAS OLIVE PRODUCTION BY THE OPTIMIZATION OF SUPPLEMENTAL IRRIGATION

Results of water intake at different stages of the olive tree growth and development, (the variety Picholine Marocaine in Meknes), shows that one irrigation after fruit setting has the greatest positive impact on the fruit caliber with as a consequence on the yield improvement and the oil content by 47% compared to the control not irrigated. Compared to the results of previous years, irrigation just before a floral differentiation (April) is required in dry years to increase the rate of flowering and fruit setting.

IDENTIFICATION OF THE MORPHO-PHYSIOLOGICAL CRITERIA OF ADAPTATION TO THE THERMAL AND WATER STRESSES OF AUTUMN CEREALS CROPS

Fifteen durum wheat varieties (*Triticum durum* L. var. durum) including 5 old, 5 intermediate and 5 recent have been studied at Sidi El Aidi (Settat) in irrigated conditions and Jemaa Shaim (Safi) under rainfed conditions. Significant relationships were found between grain yield and the temperature of the vegetation cover (Figure 11), as well as with spectral indices such as: the radiation use efficiency, the vegetation cover photosynthetic surface indicator (RNDVI and GNDVI), and the vegetation cover water condition indicator.

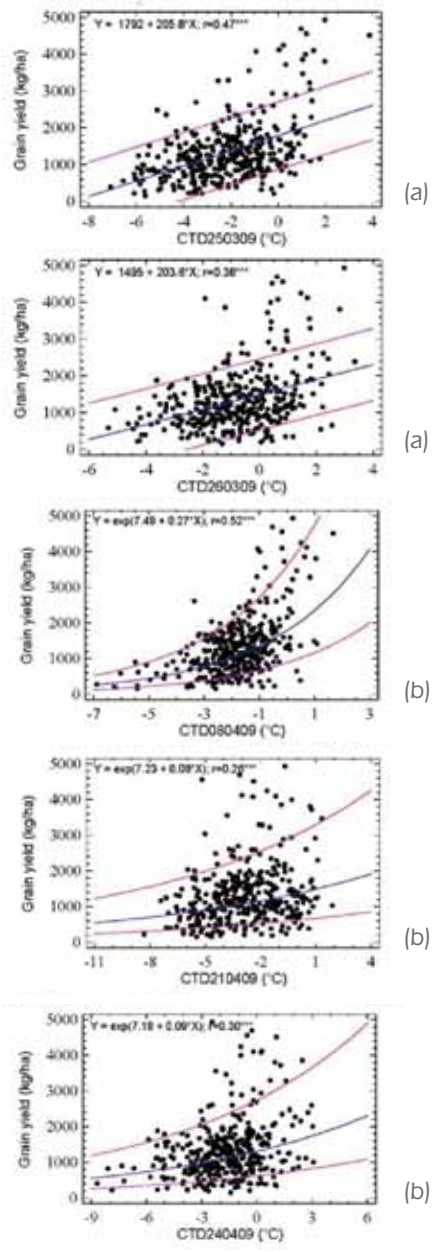
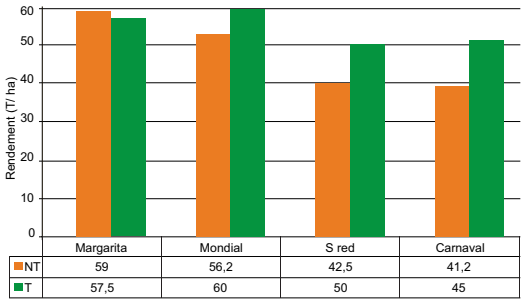


Figure 11 : Relationship between grain yield and vegetation cover temperature in March (4a) and April (4 b).

POTATO YIELD AND TUBERS QUALITY IMPROVEMENT BY BIOFERTILIZER APPLICATION

In the Larache region, Biofertilizer was applied on four season potato varieties: Carnival, Simply red, and Margarita (red varieties), Mondial (white variety). The results show that the foliar treatment based on amino acid, allow better potato growth: 6.15% to 10.2% of stem height and 7 to 18 yield improvement depending on the variety (Figure 12).



	Margarita	Mondial	S red	Carnaval
NT	59	56,2	42,5	41,2
T	57,5	60	50	45

Figure 12: *Yield gaining of potato varieties with treatment with biofertilizers (T: Treated; NT: Not Treated).*

SOIL AND ROOTS ENDOMYCORRHIZAL STATUS OF DIFFERENT POTATO VARIETIES CULTIVATED IN THE LARACHE REGION

In the soils of Larache region, trials of endomycorrhizal spores isolation and enumeration were conducted for estimation of mycorrhization parameters of three potato varieties roots.

The results show the presence of four mushroom types according to their color (black, Brown, dark brown, yellow brown). The population density is 24 and 51 spores per 100 g of dry soil, respectively for a non-cultivated soil and cultivated soil. These values are low in comparison with the density of other arid or semi arid soils (Avg = 300 spores per 100 g of dry soil). Moreover, the natural frequency of mycorrhization is important for Margarita and Simply red varieties, however it is average for the Carnaval variety (Figure 13).

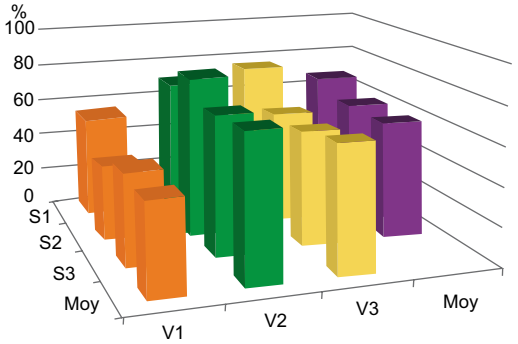
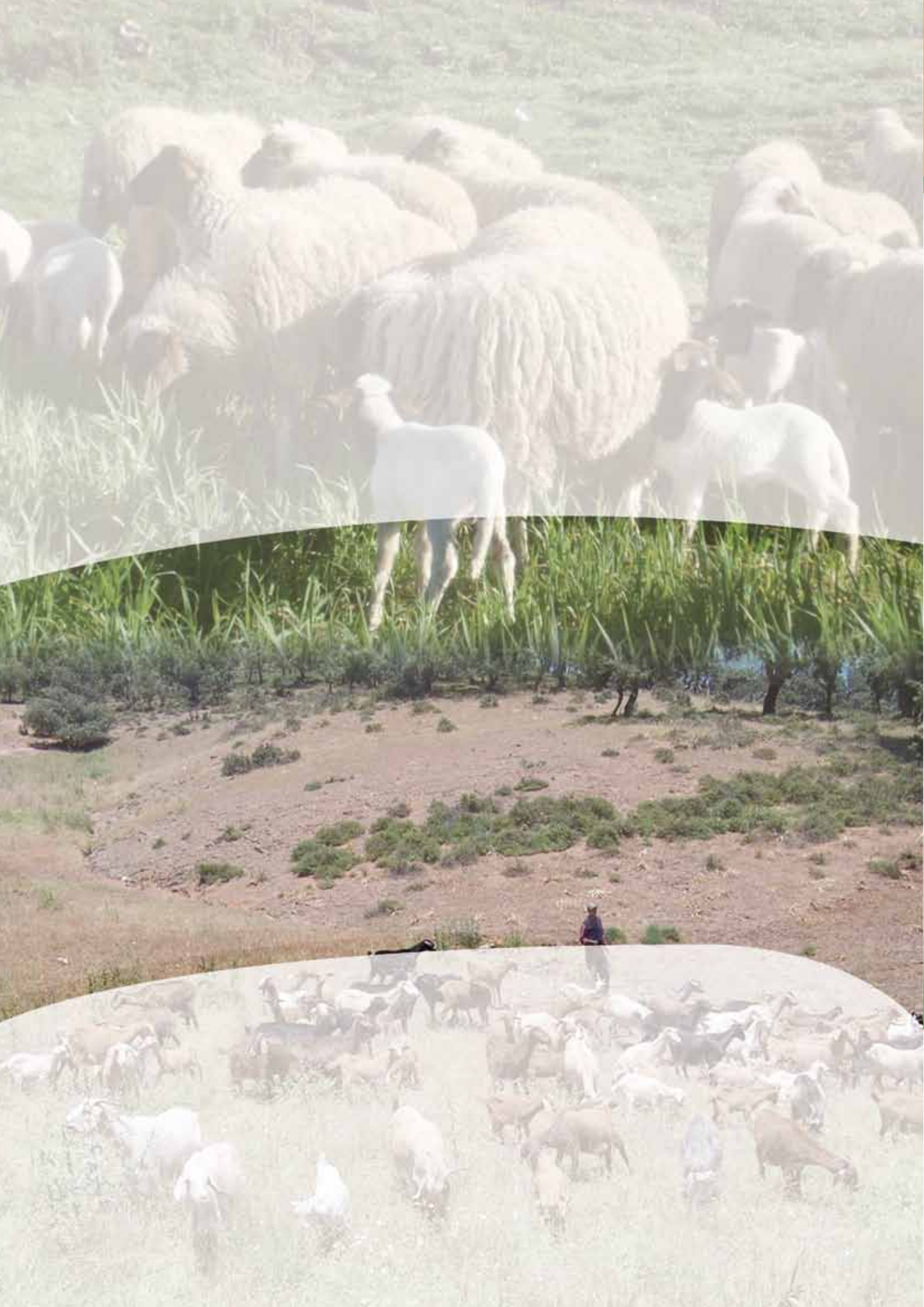


Figure 13 : *Mycorrhization frequency of potatoes varieties according to the different soil types:*

- *S1: phosphorus enriched soil with peanut as previous crop);*
- *S2: phosphorus enriched soil with potato as previous crop;*
- *S3: control in unfertilized fallow cropland;*
- *V1: Carnaval;*
- *V2: Margarita;*
- *V3: Simply red).*



ANIMAL PRODUCTION

KNOWLEDGE OF REPRODUCTION APTITUDES OF BOUJAAD LOCAL OVINE RACE

Within the framework of the characterizations of the race Boujad aptitudes, the parameters scrotal circumference, height and testicular diameter and epididymal diameter of the rams were significantly influenced by the season. Indeed, the measure values are high in the sexual season May-June, remain stable in July-August and become low in November-December. The radio-immunoassay dosage of testosterone confirms this trend (Figure 14). Indeed, the season has been a highly significant effect on the testosterone concentration. However, a decrease in sexual activity was observed in August, due to excessive temperatures, because a revival was recorded in September.

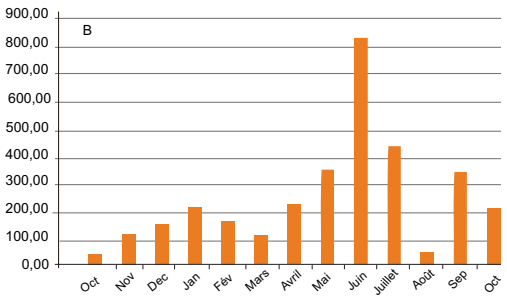


Figure 14 : Plasmatic profil of P4 in a Boujaad ewe lamb.

The study of Boujaâd ewes seasonality, non pregnant during one year, by the analysis of ovarian activity and progesterone dosage, has shown that the average sexual season duration is 6 months and 14 days. A high individual variability of 4 to 8 months was observed.

Similarly, the study of Boujâad ewes puberty by progesterone profiles analysis (P4), since the age of three months to 16 months, showed that the average age at puberty is 200 ± 33 days (Figure 15). This age varies from 147 to 226 days for Ewe with 31 kg weight on average and 7 to 10 months old on average.

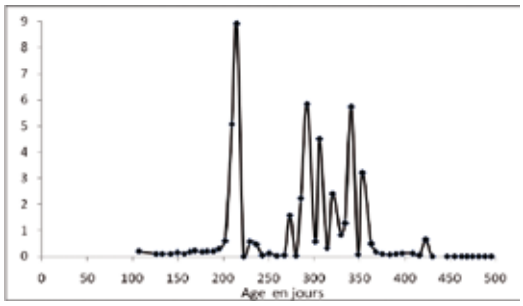


Figure 15 : Concentration profil of P4 in a Boujaad ewe lamb.

ASSESSMENT OF BODY CONDITION OF LOCAL RACE EWES DURING LAMBS BREASTFEEDING

The assessment of body reserves mobilization of suckling ewes Timahdite, D'man and INRA 180 in two conditions was conducted. The (S1) condition is where ewes are conducted on pasture without their lambs with night breastfeeding only, and (S2) condition where sheep are on pasturage and breastfeeding lambs day and night. The ewes body condition was evaluated

by subjective measurements: body condition marking (NEC) and objective measurements: ewes weight evolution and echography measurements on the 13th ewes coast (The backfat thickness EGU, the Longissimus Dorsi muscle thickness EMU and the Longissimus Dorsi muscle surface SMU).

The results showed that the breastfeeding ewes genotype and type of conduct had a significant effect on the weight, the body condition mark, the backfat thickness, the Logissimus dorsi muscle thickness and surface of the muscle.

The significant fall in weight has shown that the body reserves mobilization during the 1st month of breastfeeding (Figure 16), critical period when the milk is the only lambs food, resulted in important losses of ewes weight: 147, 95 and 114 g/j, respectively for for D'man, Timahdite and INRA180.

The averages of the NEC measurements were: 2.61, 3.19 and 2.70 respectively for D'man, Timahdite and INRA180. However, from the 2nd month of breastfeeding, we observed a slight reconstruction of ewes body reserves (Figure 17). It resulted an improvement of the NEC from 2.61 to 3.21 for D'man, 3.19 to 3.94 for Timahdite and 2.70 to 3,26 for INRA180. These results are confirmed by the improvement of the echography measurements of EGU, EMU and EMS characters for three genotypes (Figure 18). This can be explained by the fact that the lambs started ingesting solid foods at the 2nd month: concentrated for the S1 and barley for the S2, in addition to the pasture improving this year.

In addition, ewes performance were consistently higher in the S2 conditions compared with the S2. And, the pre - weaning lambs growth was significantly influenced by the genotype, then the food system S1 and S2 had no significant effect.

VALORIZATION OF GOAT'S

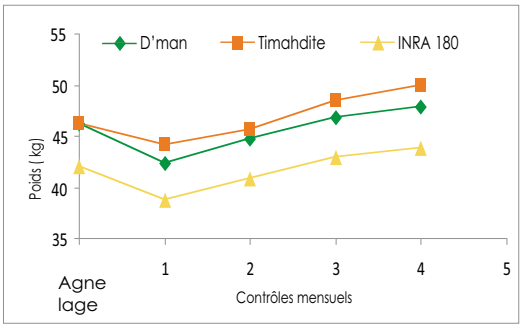


Figure 16: Weight evolution of ewes according to genotype.

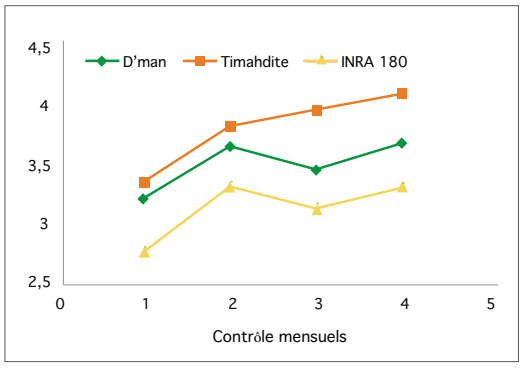


Figure 17: Evolution of ewes' corporal state according to genotype.

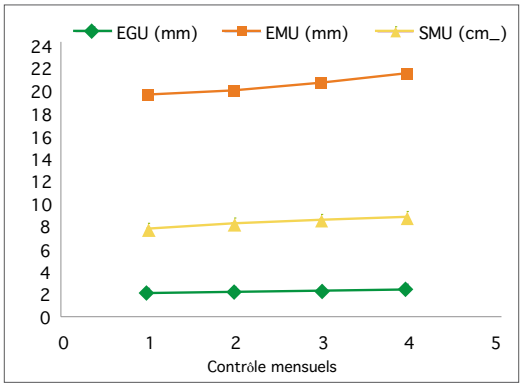


Figure 18: Evolution of ultrasound measures in ewes all types mixed up.

MILK IN THE NORTH AND IN THE SOUTHEAST OASES

The study on indigenous lactic bacteria of goat's milk that have technological characteristics that can be used as starters strains for the manufacture of semi refined cheese, allowed the selection of 9 strains among 220 isolated strains for the ferments preparation. The results of physicochemical, microbiological and organoleptic analysis on three cheese lots obtained from the lactic ferments showed that the protein and fat composition is similar to other foreign cheeses.

For the sensory analysis, it did not show major flaws as bitter or pungent taste, indicating a good global quality. However, the tasters have detected a back taste with an intense acidity, probably due to excessive proteolysis and strong acidification.

FIRST RESULTS OF THE CHARACTERIZATION OF GOAT MEAT

To assess the quality of goat meat in the North, pH controls, dry matter content, of ash, water retention capacity, proteins content, lipids and collagen content and fatty acid profile were performed on samples of the *Longissimus Dorsi* muscle. The results showed that goat meat is 5.70 pH, 78.52% of humidity rate, 1.37% of total fat rate, 9.73% of protein and 38.55% of water retention capacity. Goat meat is characterized by the dominance of fatty acids: oleic (C18: 1), palmic (C16: 0) and stearic (C18: 0).
Moreover, the results of the study on the Atlas goats carcasses characteristics in the municipal slaughterhouse of Aït Bazza (province of Boulemane) showed that slaughtered goats present low carcasses and bacteriological analysis of meat revealed a very poor quality pertaining to bad hygiene conditions when slaughtering and cutting and the absence of cold chain in the meat shelves.

RANGELAND IMPROVEMENT

The Phyto-ecologic study of the pastoral area in the province of Rhamna showed that the vegetal cover is constituted essentially of very degraded annual steppe.

In the Oriental, a hundred of pastoral species which can be used in the restoration of degraded rangeland, the fight against desertification and for the improvement of the floristic biodiversity have been tested. The results showed that the germination rate varies from 0% (*Agropyron cristatum* and *Scrophularai canina*) and 100% (*Oryzopsis miliacea* cases). About 110 species and ecotypes sown, 90 could germinate. Some seeds germinated after one week while others did so after 3 months (the case of *Phillyrea angustifolia*). Plant issues from this germination were transplanted to our pastoretum. Thus we have currently 80 species in the INRA *pastoretum* of Oujda, thirty species in the El Aioune *pastoretum* and ten species in a pastor from Maâtarka to see ten species behavior in more arid environments.

ENVIRONMENT AND NATURAL RESOURCES

THE NATIONAL PROGRAM OF AGRICULTURAL LAND SUITABILITY MAPS

The National program of agricultural land suitability maps is a program of the Ministry of Agriculture and the Maritime fishing which has been performed since 1988 by the INRA with institutional partners on all agricultural rainfed areas of the country. Currently, the program has made almost 6 million hectares of maps of rainfed areas and the program is still expecting other extensions. This is a considerable effort undertaken by INRA knowing that the useful agricultural area is approximately 8.7 million hectares. This year, the study concerned 214.000 ha in El Hajeb (Figure 19) and 240.000 ha of area in Settat (Ben Ahmed) (Figure 20).

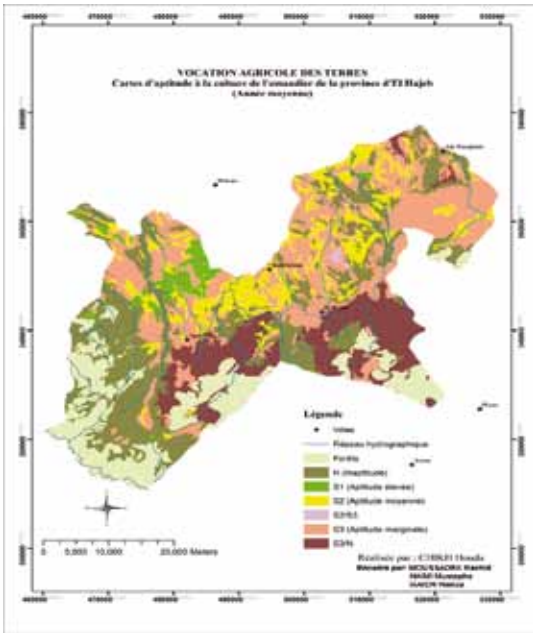


Figure 19: Agricultural land suitability map of El Hajeb

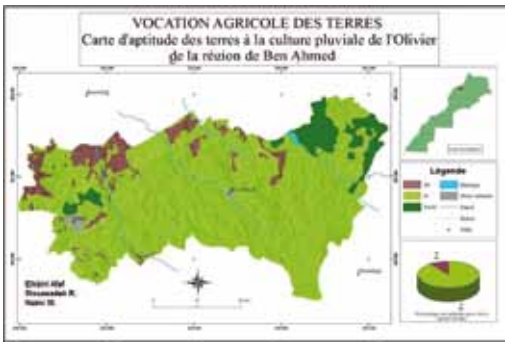


Figure 20 : Agricultural land suitability map of Beni Ahmed (Settat)

IMPACT OF CLIMATE CHANGE ON MOROCCAN AGRICULTURE

Original studies of the impact of climate change on Moroccan agriculture were conducted for the first time in Morocco. The objective of these studies is to determine technical options for our agriculture adaptation with climate change and to avoid potential crisis situations. The interaction of climate change with the production mode and land use in the rural commune Lamzoudia (Chichaoua) is very instructive in this regard. The analysis shows that between 1960 and 2009, there was an increase in cereal crop area over the rangeland and a reduction in olive tree areas and fruit tree species due to the reduction of water resources and the decline of the water table level (Figure 21). In this commune we moved from an extensive system and diversified farming to a semi intensive system based on sheep, cattle and sheep farming above ground, poultry farming (Chair chicken), and the implantation of collection and sale of milk cooperative.

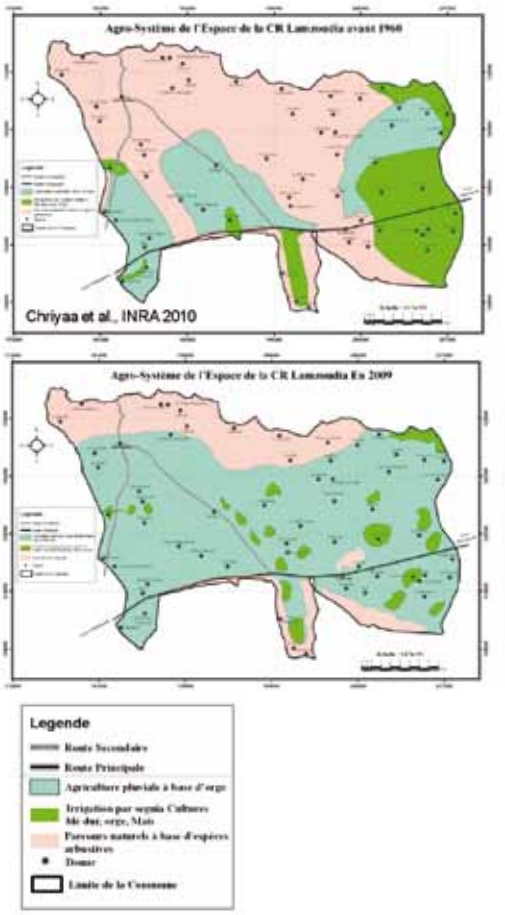


Figure 21 : Modification of production systems and of land use due to climate change at Lamzoudia rural area (Chichaoua).

PREDICTION OF CEREAL CROP HARVEST

The prediction of cereal crop harvest provides an independent and complementary information source to the classic agricultural statistics. INRA has started in 2007 a research program, in collaboration with the Joint Research Centre of the European Commission, for the production of a newsletter of crops meteorological monitoring and cereal crops harvest forecasting.

Currently, this program published already two newsletters for the years 2008-2009 and 2009-2010 (Figure 22). Early forecasts of cereal production for these two crop years have been very close to the official agricultural statistics.

Figure 22: Prediction Bulletin of crop harvest for the 2009-2010 crop year http://mars.jrc.it/mars/Bulletins-Publications/Joint-Bulletin-AGRI4CAST-INRA-Morocco-2010

THE CULTIVATED SOIL FERTILITY MAP IN MOROCCO

Within the framework of the cultivated soil fertility map project, the INRA developed fertility mapping of cultivated soil in the national level: Potassium, phosphorus and organic matter, in addition to other classical soil attributes.

This mapping will help to guide reasoned use of fertilizer for a better crops fertilization and the development of regional mean forms of fertilization for major crops. The first fertility maps are available on the computer (Figure 23). They concern the regions of Gharb - Chrarda, Rabat - Salé - Zemmour - Zaer, Chaouia - Ouardigha and Meknes - Tafilalet. To realize these maps, about 8000 soil analysis were conducted. A training program on Geographical Information Systems and GPS was conducted for the benefit of managers and technicians involved in the convention.

GLOBAL EVALUATION OF

Figure 23 : Web Portal for the consultation of the cultivated soil fertility map in Morocco

THE ARID RANGELAND DESERTIFICATION IN MOROCCO

The analysis of arid rangeland desertification in Morocco by satellite imagery shows that 82% of arid area is occupied by rangeland which is essentially dominated by classes: bare soil, herbaceous vegetation, deciduous shrub vegetation and Savannah mosaic / shrub or forest (Figure 24). The establishment of a global monitoring system based on space remote sensing, biophysical and socio-economic (expert classification)

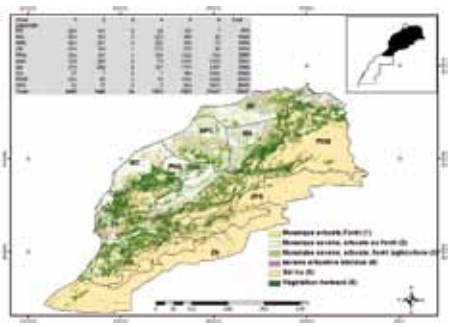


Figure 24 : Occupation of rangeland soil by pastoral zone (in 1000 ha) in Moroccan dry area

data is undertaken by INRA to provide decision-makers with a suitable and operational tool of the temporal and spatial monitoring of desertification (Figure 25).

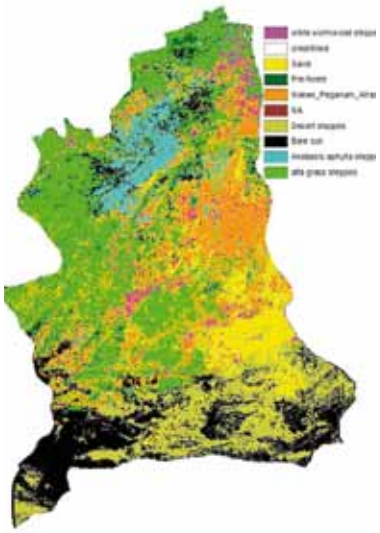


Figure 25 : The land cover situation in the Oriental by the expert classification (Mahyou et *al.*, 2010).

Data Sources: MARA (19) and Globcover for North Africa (14).
MC: Coastal Meseta, MPC: the Mamora area and Central Plateau, RB: Rif area and its borders, MA: the Middle Atlas, ANP: north Atlas plateau and Plains, HAC: High Central Atlas and Oriental, ZA: Zone of Argan tree, ZS: Sahelian Zone, SPS: pre-Saharan Areas, POM: plateau of the Oriental and the Moulouya Valley.

ESTABLISHMENT OF A OF BIOLOGICAL WAKEFULNESS SYSTEM IN THE ORIENTAL

The establishment of a biological wakefulness system in the «Hauts Plateaux» has become one of the major concerns of the national programs of arid and semi-arid environments management. The results show that the phenomenon of degradation threatens currently about 80% of this area. Grazing lands are in deprivation of their plant cover and the cultivated area is in extension on fragile lands. The main indicators of this degradation are the vegetation cover reduction, the appearance of degradation plants indicator, and the high rate of silting areas and bare soil (Figure 26).

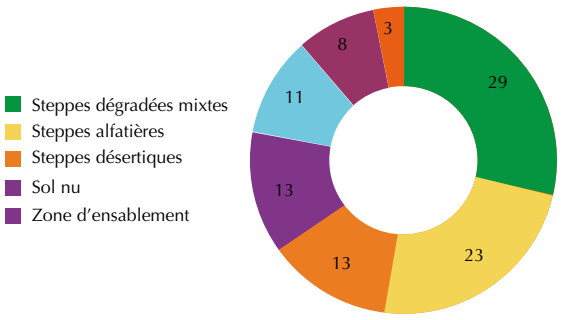


Figure 26 : Importance of the different classes of land in the Highlands of the Oriental (%)

EFFECT OF FENCING ON REGENERATION AND PRODUCTION OF AN ENDANGERED SPECIES: MORICANDIA ARVENSIS

The study showed a highly significant effect of the *Moricandia Arvensis* protection on biomass, specific air recovery and the density of this species in Ain Béni Mathar Oujda (Photo 20, Figure 27).

Photo 20 : Photos of Moricandia arvensis (Maatougui, 2010)

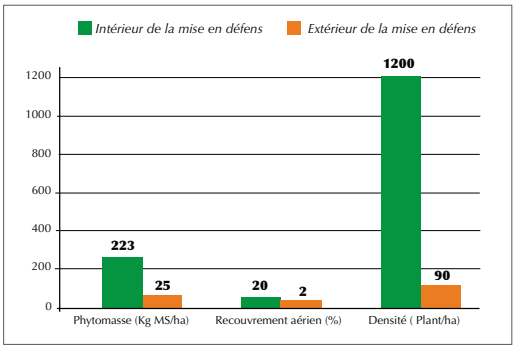


Figure 27 : Effect of fencing on vegetation parameters of Moricandia arvensis

SOCIO-ECONOMICS & RESEARCH AND DEVELOPMENT

ECONOMY AND RURAL SOCIOLOGY

The Clementine of Berkane, a sector to promote

In the Oriental, The diagnostic of the Berkane clementine sector shows that this culture still suffers from several constraints that limit its profitability like: the orchards' old age, the poor technical conduct mastery, the technical supervising weakness and the insufficiency of irrigation water valorization (in Dh/m3). In addition, the non control of fertilization and plant protection generate high charges and a negative impact on the environment and on the production quality and quantity. The absence of weather stations on the perimeter, the harvest sale on tree, the very high labor costs and the absence of any farmers technical conduct data archiving exacerbate the situation.

Aggregation, a challenge for the success of the GMP

In the region of Meknès-Tafilalet, a study on the perceptions of the olive oil sector stakeholders to aggregation, including their expectations and requirements to adhere has been conducted. On the structural level, it is question of: (i) the olive orchard minimum area that should exceed the mean of five hectares for the aggregate, (ii) right of the olive orchard propriety, (iii) the permanent irrigation through an inexhaustible water source, (iv) facility access to the olive orchard and (v) non-practice associated cultures. On the technical level, it is question of expectations on tree pruning technique, fertilizing, and harvesting storage conditions that constitute the key factors of olive oil quality. On the organization level, the potential aggregators consider that the aggregation is an organization form based on the collective coordination effectiveness. Considering the existence of certain points of discord, public authorities are called to play their role as facilitator to find a consensus between the stakeholders of the aggregation contracts.

The socio-economic dimensions of the climate change effects

The results of the study on the mechanisms of adaptation to climate change in rural communnitie in two contrasting ecosystems : plain and

mountain (the rural commune of Lamzoudia in Chichaoua and the rural commune of Tabant in Azilal) through the evolution analysis of the plant and animal production systems, natural resources (water, soil and vegetation cover), agricultural and non-agricultural activities, sources of income, rights to land property, agricultural investment and land price since independence have shown significant changes:

- Limited water availability;
- Vegetal cover completely changing,
- Modern agriculture replaces food agriculture;
- Extensive animal production system eplaced by semi intensive system;
- Out farm work has become practical operation and non- agricultural income represents more than 50% of the total income of the household;
- Significant investment from other regions and land price increased from 10 to 20 times according to location, soil type and depth of the water table.

Irrigation water, a rare resource to better enhance

The research results on techno-economic efficiency and water irrigation valorization in the perimeter of Tadla show that farms using pumping valorize better water with 2.04 Dh/m3 index, followed by those that combine dam water and pumping with a Dh/m3 1.36 index, then those using dam water with 1.09 Dh/m3 index (Figure 28).

In addition, citrus valorize better irrigation water with an index of 3.47 DH/m3, which is far higher than other crops, followed by the sugar beet (1.76 DH/m3) cereal crops (1.58 DH/m3), alfalfa (1.45 DH/m3), Sesame (1.31 DH/m3), Olive tree (1.23 DH/m3) and the forage maize (1.21 DH/m3) (Figure 29).

On the other hand, citrus are also the most profitable for the farmer because they realize a net margin of 15.709DH/ha, followed by alfalfa and forage maize.

VALORIZATION OF THE RESEARCH ACHIEVEMENTS

Valorization of cactus ecotypes

The results of trials installed at the farmers' in the region of Souss for the valorization of the cactus genetic material collected in the *arboretum* of the Agadir CRRA, have shown that ecotypes MZ3, 149, 137, 105 and 36 are well adapted to the environment with high revival rate which exceed 90%.The majority of ecotypes (MZ3, 36, 128, 172, 135, 142 and 149, 137, 105 and 41) showed a normal growth and development despite the difficult conditions, with an average number of 4

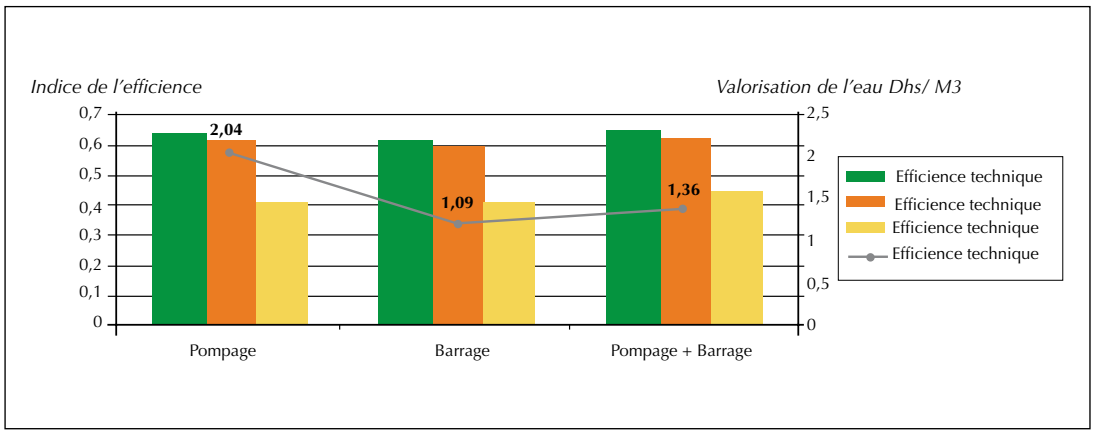


Figure 28 : water valorization by Tadla farmers

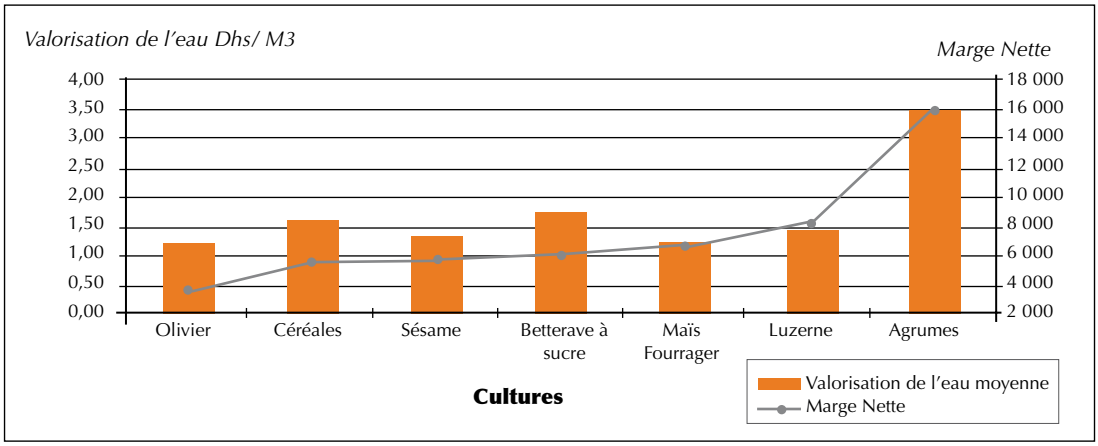


Figure 29 : Water valorization depending on crops in Tadla

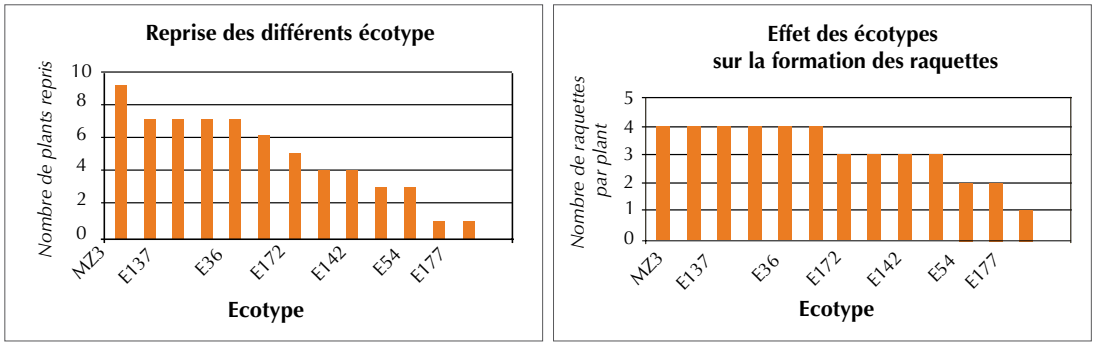


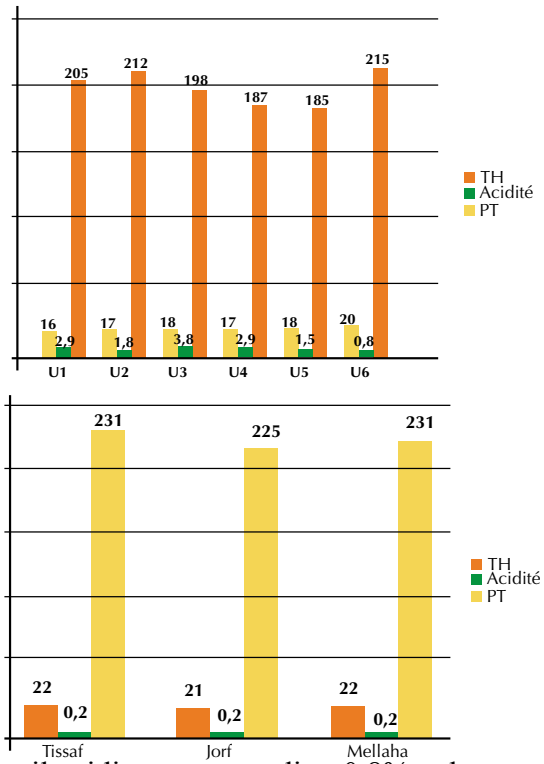
Figure 30 : Valorization of cactus in Souss

rackets by plant (Figure 30).

Good practices for the extraction of olive oil

The results of the comparison of six olive trituration units in Boulemane through collection and analysis of olive oil samples, of margines and grignons showed that the olive paste in these units is in permanent contact with the ambient air.

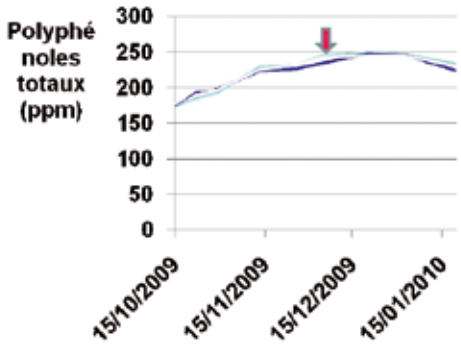
This situation increases the oxidation risk and the loss of volatile compounds that are important for the oil quality. In addition, the oils issue from the different units are of lampante type, except for unit n°6 which produces a virgin type with



oil acidity not exceeding 0.8%, whereas the unit n°3 produce of very poor quality oil (3.7% acidity) (Figure31).

Figure 31 : Comparison of olives trituration practices in Boulemane

It is also shown that optimal harvest date on the site is situated around the first week of December. This date allows good quality oil, with high oil content,



an important rate of total polyphenols and low acidity rate (Figure32).

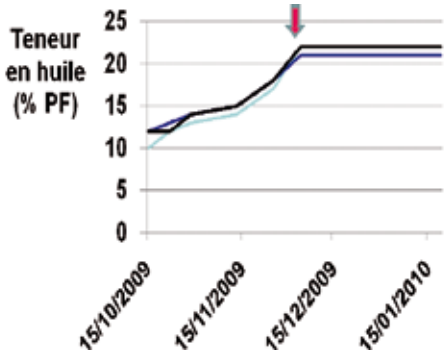
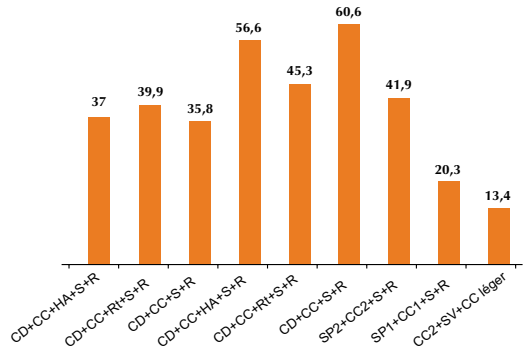


Figure 32 : Comparison of the olive oil quality according to the harvesting date in Boulemane

Optimal tillage sequences in heavy soils

In the Gharb (Sidi Allal Tazi) pedoclimatic conditions, the results of trial to determinate the optimal tools combination for primar and second tillage to of the better bread wheat yield (variety Arrehane) have shown that the tillage sequence that created the highest stand (404 plant/m²) is S4 (Subsoiler + Cover-Crop + Alternative harrow + seeder + roller) with the yield of 56.6 q/ha. However, the highest yield (60.6 q/ha) is obtained with a stand of 380 plant/m² produced by sequence S6 (Subsoiler + Cover-Crop + Seeder + Roller). The difference between S4 and S6 is due to the decrease of 1000 grain weight in the S4 sequence. The superiority of the two sequences is due to the fact that the subsoiler helps water infiltration and storage and avoids its stagnation (figure 33).

CD = Disc plough, CC = Cover-Crop,
HA = Alternative harrow, S = Seeder,
R = Roller, Rt = Rotavator, SS = Subsoiler,
SP = Stubble Plow, SV = Broadcast seeding



(Semis à la volée).

The numerals indicate the number of crossing.

Figure 33 : Yield of bread wheat according to the tillage sequence in the Gharb

Improvement of arborist's income by good practices of the Apple culture

In the Anougal and Azgour valleys (mountainous regions of Marrakech), the results of a real environment trial with INRA technical way on good practices of the Apple culture, including the pruning, thinning, and plant protection, compared to the control based on the farmers practices, showed an improvement of both quantitative and qualitative production. Thus, the yield increased by 50%. Apple selling price improved by 71% from 3.5 to 6 Dh/Kg with regard to apple quality improvement. Thus the income increased by 166% (Table 3).

An optimal maize crop management sequence in the Western High Atlas

In the High Western Atlas, the results of an irrigated real environment trial for the introduction of good practices on the maize culture (new varieties and technical way) to improve and stabilize the productivity, showed a significant mean yield gain of 10 Qs/ha. The used varieties are Alinéa, Panama, DK 315, Pollen, Surivan, Saxxoo, and the local variety. Thus, the first 3 varieties are in importance order Alinéa, Pollen and Surivan and produced respectively 44, 40 and 36 qs/ha, against an average of 30 Qs/ha for the other three varieties and 20 Qx/ha for the control (local variety).

Fodder maize, a technical way for the farmer's income improvement

In the Tangerois region, the results of a real environment trial on the maize show that the INRA technological package (including the variety choice: the hybrid pioneer vs. the local variety) allowed yields at least two times higher than those of local practice for cob and green production (65.9 et 75.7 vs 32.5 ; 19.61 and 21.13 vs 9.25). Yields obtained with thetillagel by animal traction are superior

to the mechanic traction because of the difficulties of mechanization on rough land (Table 4). The adoption of the INRA technical ways helped to improve the profit margin of 8.000 DH and 11.000 DH respectively for the mechanized way and animal traction way as seen below (Table 5).

Synthesis of technologies transfer days

In 2010, the INRA organized over 160 of technology transfer days, open days, training, information, animation, and awareness on more than 70 themes covering different INRA achievements. These days were organized for the benefit of more than 4.000 people who were executives and technicians from administrations, associations, agricultural cooperatives, farmers, farmers sons and rural women.

	Control	Trial	% improvement
yield (Kg/tree)	10	15	50
Sale price (DH/Kg)	3,5	6	71
Production value (DH/tree)	35	90	157
Production charges (DH/tree)	20	50	-
Income (DH/arbre)	15	40	166

Table 3 : Apple productivity and income improvement in the High Atlas mountain zone

Technical ways	Green yield t/ha	Height Avg/pl	Stem thikness cm	Stem number /m2	Cob yield qs/ha	Total yield T/ha
Trial with animal traction	90	2,06	2,68	18	75,7	21,13
Trial with mecanization	87,5	1,9	2,56	15	65,9	19,61
Control with farmer practice	53,7	1,25	1,70	31	32,5	9,25

Table 4 : The yield of forage maize according to technical ways tested in the Tangérois

Plot	Production cost DH	Grain yield qx/ha	Sale price DH	Profit margin DH
Control	2725	32,5	9750	7025
Trial with mecanization	4750	65,9	19770	15020
Trial with animal traction	4450	75,3	22590	18140

Table 5 : Profit margin of forage maize according to the tillage sequence in the Gharb

Golden Delicious

Evaluation of apple yield

Red Delicious

Appreciation of apple quality

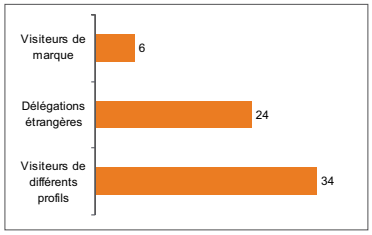
The INRA director at the opening ceremony of INRA-AMPPC day

Training days at CRRA Agadir on olive breeding techniques

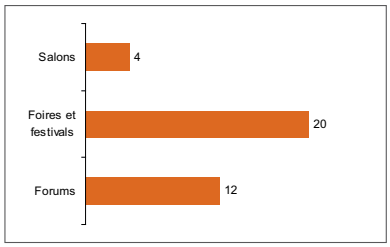
COMMUNICATION, COOPERATION & HUMAIN AND FINANCIAL RESOURCES MANAGEMENT

EDITION AND COMMUNICATION

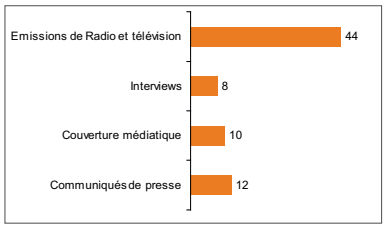
Communication & management of scientific and technical information An opening for the exchange of information and experiences



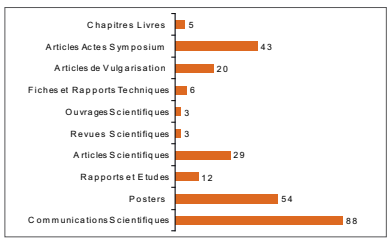
Active participation in scientific and technical events to learn more the research acquired



A fruitful collaboration with the press and media



Scientific, technical and institutional publications: a capital tool for the promotion of knowledge



Procedings of the international workshop on date palm red weevil

Date palm technical specifications in arabic

AL AWAMIA
N° 123-124

Agenda 2011 « special date palm »

INRA Activity report 2009 in Arabic, French and English.

INFORMATION MANAGEMENT

Acquisition and of Documentation processing

- Subscription to 43 periodicals (the list is available on the INRA Website);
- The collection of the INRA Central Library was enriched by 67 books purchased or obtained through national and international inter-institutional exchange.

The Exchange management

Al Awamia 121-122 has been distributed to 36 organizations in 18 countries.

Information Awareness: Web news

Relying on information research tools: rapid reporting services «alerts», the RSS files, databases, news bulletins, this bulletin of awareness is now at the 71st edition.

Local databases

Documentary Databases with 6000 references on current literature non- INRA or published by INRA. INRA databases are accessible via the Web address (http://webagris.inra.org.ma:120/agris) or the central web from the IST topic / Documentation / documentary data Base.

International databases

More than 20 international databases (CABI, Tropag, Agris, Agricola, Sesame, Teeal) are available on CDROM and the list is available on the INRA Web site.

Literature review and documents consultation in library

More than 217 bibliographical research studies have been made available to INRA researchers in different disciplines of agricultural research and related fields. In support to INRA scientist projects, assistance and mentoring for bibliographic research were provided with more than 109 documents loans.

Virtual library

- Local resources: Implementation of a virtual library are accessible on the local network of 10 INRA Regional centers and the Scientific Division. The installation, configuration, collection updating, tutorials preparation, post installation were the subject of training for the benefit of communication staff.

Online resources

Online access via the network of academic research and teaching «Marwan» since May 2009 to:
Scopus: www.scopus.com
ScienceDirect: http://www.info.sciencedirect.com/content/
Agora: www.aginternetwork.org.

Internet network

INRA migration to the new MARWAN III system allowed more fluidity and operationality for internet service access.

WEBSITE INRA (www.inra.org.ma)

The new INRA Portal is reinforced by an ambitious intranet platform dedicated

exclusively to the institutional staff: policy makers, managers, researchers, technicians and technical clerks.

- The attendance number of this site increased by 29% between October 2008 to 2009 and October 2009 to 2010 (Source: Google)
- The number of visitors recorded during 2010 reached 35.000 (Source: Google);
- The site has been visited from 117 countries around the world (source Google).

COOPERATION

A means of opening for information and expertise exchange

At the international level, the INRA continues to develop partnership with organizations such as ICARDA, FAO, IAEA, UNIDO and the IOC.

At the regional level, successful collaboration is underway particularly with ACSAD, AOAD, AAAID, IDRC particularly. As for cooperation with the European Union, it is performed within the FPRD framework.

Concerning bilateral cooperation with European and American countries, INRA is trying open up more on and collaborate in a productive way with its partners.

Thus, with The USA, cooperation concerns INRA's participation in MCA Maroc. With France, 15 PRAD relating to various research areas are ongoing.

With Spain, the collaboration area concerns especially goat farming. And with Belgium, Argan tree and goat farming in the north of Morocco are the mains cooperation fields.

At the South - South cooperation level, cooperation and collaboration concern especially the development of agriculture in the African continent.

Cooperation with the MAPM and PROFERD relates to various research fields (plant protection, genetic improvement, product valorization, water management, arboriculture, biotechnology, crop production, animal production, Aromatic and medicinal Plants and local products).

With ORMVAs, conventions relate to the realization of demonstration trials on different cultures for the introduction of new crops, demonstrations on good practices for the rehabilitation of rangelands in mountainous areas, in brief, strengthening decentralized research and technical assistance.

Other conventions have been signed with the SPAD for scientific and technical assistance.

INRA cooperates with other organizations including the 'Agence du Sud' for the sheep and goat productivity improvement in the South of Morocco, the LARATES laboratory of the Royal Gendarmerie for development of studies on industrial hemp exploitation.

In its Public-private collaboration framework, INRA signed several conventions especially with OCP group for the development of the map of fertility grown soil.

With the Rhamna Foundation for sustainable development, INRA will assist the private sector and local actors for the cactus development and valorization in

The Rhamna region. In addiction, INRA continues to collaborate with nurseries for the multiplication of protected olive varieties and certified citrus plants.

INRA has also held a number of conventions with different organisms: the Faculty of medicine and pharmacy of Rabat, BIOPHARMA, 'société agro-industrielle de Saïss', the economic interest group «Tanmia Al Filahia», the Social Development Agency, the company Development Finance Consultants Morocco, PalmAgro-Morocco, Euro Consultants, Agriconsulting Morocco S.A. and AFC Consultants International GmbH, ARYSTA Life Science France.

FINANCIAL AND HUMAN RESOURCES MANAGEMENT

Human resources

The staff number of the fiscal year 2009 was 1.102, decreased by 32 positions (30 retirements by age limit, 1 death, and 1 resignation). 30 new recruitments have been carried out (10 Researchers, 18 technicians, 1 application engineer and 1 administrator), bringing the staff number to 1.100 agents in the fiscal year 2010.

Promotions

The staff promotion under the fiscal year 2010 concerned 104 officers, including 101 own officers and 3 detached agents receiving promotions in their original frames. The number of promoted agents represents 10% of the INRA staff number.

The staff status

The amendment No. 9/2010 of the special INRA staff status has been approved. It concerns the extension of provisions of Decree No. 2.10.061 of 30 rebia I 1431 (March 17, 2010) amending and supplementing Decree No. 2.04.403 of 29 Shawwal 1426 (December 2, 2005) concerning the promotion conditions of state employees and those of the Decree No. 2.10.062 of 30 rebia I 1431 (March 17, 2010)) establishing exceptional provisions of state employees promotion ranked at grades from 1 to 4.

Diploma trainings

A31 follow training courses including 7 newly registered (Table 6). Note that 74% of these trainings are followed in Morocco, 16% in Spain and 10% in Belgium. Funding is done in inter-institutional collaboration and international cooperation.

Training abroad

In total, 30 trainings were conducted for the benefit of 28 INRA members of staff including 26 researchers and 4 technicians. These trainings were conducted mainly in Europe (approximately 64%), and are funded through bilateral or multilateral cooperation projects (Table 7).

Missions and participation in scientific events

In total, 166 missions abroad were achieved by 113 agents, researchers and researchers, to 35 countries. They provide a means for the exchange of knowledge and experience , exploration, and realization of various partnership and cooperation links (Figure 34).

Development sessions

The training targets different categories of staff. It focused on themes such as the control of the Court of Auditors, the liability of authorizing agents, Geographic Information Systems, bioinformatics, biotechnology, foreign languages, computer science and accounting.

	Doctorat	Master	1er Cycle	Licence	Total	Funding
In Morocco						
F.S. T. Marrakech	3					Free of charge
F. Sc. Kénitra	8	1	1	1		Free of charge
F. Sc. Meknès	1					Free of charge
F. Droit Meknès				1		Free of charge
F.S.T. Settat				1		Free of charge
F.S. T. Tanger	1					Free of charge
F. Sc. Ben M'Sik	1					Free of charge
F. Sc. Agadir	3					Free of charge
F. Droit Rabat			1			Free of charge
Abroad						
Belgium	3					Belgian cooperation CIHEAM/IAMZ and others
Spain	1					
Total	26	6	1	3	31	

Table 6 : Distribution of the diploma courses in 2010

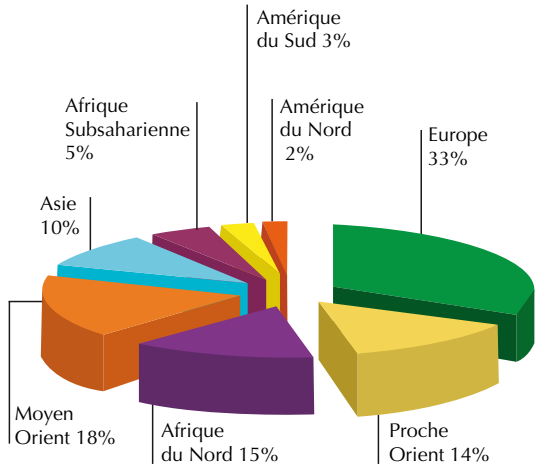


Figure 34 : Distribution of missions by destination

host country	Training number
France	11
Spain	4
Syria	3
Tunisia	3
Belgium	2
Libya	2
Netherlands	1
Sweden	1
Turkey	1
USA	1
Kenya	1
Total	30

Table 7 : Distribution of trainings by host country

FINANCIAL RESOURCES (FIGURES 35 & 36)

The operating budget of INRA in the fiscal year 2010 has been 142.653.057,00 divided as follows:

Employee Expenses	139.846.969,00Dh
Equipment Expenses	2.460.427,00 Dh
Capital budget	103.600.000,00 Dh
Mission support	30.182.840,00 Dh
Headquarters	12.620.000,00 Dh
Regional centers of agronomic research	51.197.160,00 Dh
Maps of soil fertility projects	9.600.000,00 Dh

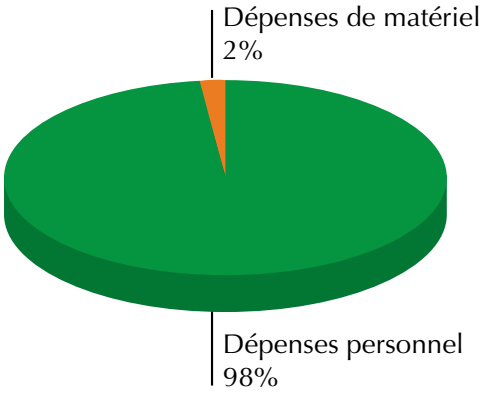


Figure 35 : Distribution of capital budget

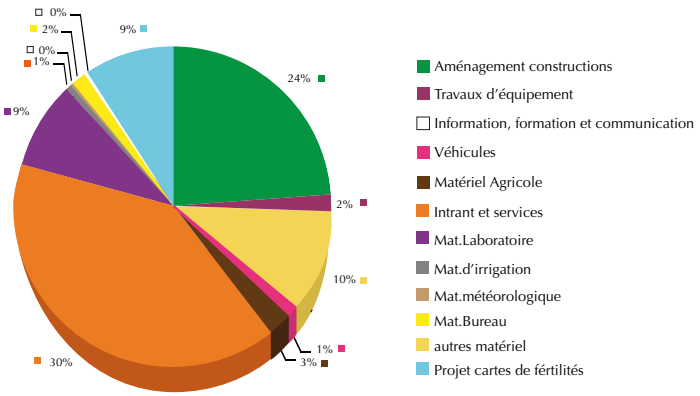


Figure 36 : Distribution of operating budget

AAAID	Arab Authority for Agricultural Investment and Development
IAV	Institut Agronomique et Vétérinaire Hassan II
ACSAD	Arab Centre for the Studies of Arid Zones and Drylands
ICARDA	International Centre for Agricultural Research in the Dry Areas
AIEA	Agence Internationale de l'Energie Atomique
INRA	Institut National de la Recherche Agronomique
CIHEAM	Centre International des Hautes Etudes Agronomiques Méditerranéennes
MAPM	Ministère de l'Agriculture et de la Pêche Maritime
CIMMYT	Centro Internacional de Mejoramiento de Maíz y Trigo
MCGP	Moroccan Collaborative Grant Program
COMADER	Confédération Marocaine de L'Agriculture et du Développement Rural
OADA	Organisation Arabe pour le Développement Agricole
COI	Conseil Oléicole International
ONG	Organisation Non Gouvernemental
CRDI	Le Centre de Recherches pour le Développement International
ORMVA	Office Régional de Mise en Valeur Agricole
CRRA	Centre Régional de la Recherche Agronomique
PRAD	Projets de Recherche Agronomique pour le Développement
CT	Centre de Travaux
PRMT	Programme de Recherche à Moyen Terme
DPA	Direction Provinciale d'Agriculture
PROFERD	Projets Fédérateurs de Recherche et Développement
FAO	Food and Agricultural Organization
SIAM	Salon International de l'Agriculture du Maroc
FST	Faculté des Sciences et Techniques

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