ISLAMIC REPUBLIC OF MAURITANIA

Honor — Fraternity — Justice

Ministry of Economy and Finance

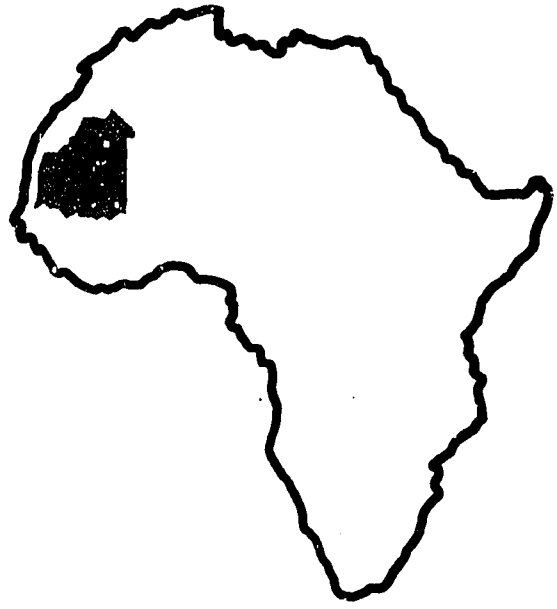
Directorate of Studies and Programming

RAMS PROJECT

Rural Assessment and Manpower Surveys

Oasis Agriculture

SS-4



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List of Abbreviations and Acronyms Used

RAMS	Rural Assessment and Manpower Survey (Evaluation du Secteur Rural et des Ressources Humaines)
USAID	United States Agency for International Development (Agence Américaine pour le Développement International)
IFAC	Institut Français de Recherches Fruitières Outre-Mer (French Institute for Fruit Research Overseas)
SCET	Société Centrale pour l'Equipement du Territoire (French; bureau in Tunisia) (Central Company for Infrastructure Development)
CEDES	Centre des Etudes de Développement Economique et Social (Center for Studies in Economic and Social Development)
FAC	Fond d'Aide et de Coopération (France) (Assistance and Cooperation Fund)
UCAA	Union des Coopératives Agricoles de l'Adrar (Adrar Union of Agricultural Cooperatives)
CEAO	Communauté Economique de l'Afrique de l'Ouest (West African Economic Community)
ENFVA	Ecole Nationale de Formation et de Vulgarisation Agricole (National Training and Agricultural Extension School)
CNRADR	Centre Nationale de la Recherche Agronomique et du Développement Rural (National Center for Research in Agronomy and Rural Development)
CILSS	Club Inter-Etat pour la Lutte Contre la Sécheresse au Sahel (Inter-Nation Club for the Fight Against the Drought in the Sahel)

SUMMARY AND CONCLUSION

1. In the framework of the RAMS Project, it was agreed that a subsectorial study should be made on oasis farming, in light of the place it holds in Mauritanian agriculture and the role it plays in production in the rural sector. The truth is that this subsector has not benefitted from serious actions equal to its problems and its social and economic importance, but it has nonetheless enjoyed limited, isolated actions which have been few and far between with no major impact on production.

   As it now stands, the only action worthy of note is the integrated development project for oases financed by USAID with a budget of $US 6,600,000. The outcome of this project should be determined by the level of efforts to be developed in the follow-up stage, since the project study in itself does not permit any a priori evaluation of its effects.

2. A perusal of the basic data has shown that from the ecological viewpoint and from that of the natural resources on the surface, it appears possible to develop oasis farming wherever water is available, as long as the best adapted plants are chosen; so, depending on the proper pluviometric conditions, the results of developing this activity in a given area would be determined based on purely economic criteria or on purely social criteria.

   As far as manpower is concerned, there do not seem to be any problems, quantitatively speaking. The qualitative aspects are characterized by very slow development due to a notable lack of concern on the part of the populations involved towards existing economic and political structures. The population more or less involved in this activity has been estimated at about 30,000 persons of working age.

3. The production zones in oasis agriculture are scattered over a wide area due to their very special nature (natural ecosystems).

We have been able to estimate that at present, these zones extend over an area of approximately 4,500 ha with 1,025,000 palm trees. Future possibilities would hinge particularly on mobilizing the deep underground water tables (artificial ecosystems). Moreover the production zones have greatly diversified systems of production. Thus, diversity originates from the differences in space given to production, in the human factor and its behavior as well as in the means of production. Three major groups of palm groves have been defined, based on the general criteria bearing on the main factors coming into play in the present production systems.

Although rather broad, this distinction has allowed us to:

3.1 get to the heart of a certain number of problems related to crops, techniques, methods and means of production and to legal conditions of exploiting the palm groves.

3.2 confirm that the different problems are not presented in the same fashion or with the same logic for the different sets of production systems.

3.3 identify the relation between oasis farming and other activities in the rural sector.

3.4 confirm that oasis farming is the highest-yielding and most profitable of the agricultural activities and that it is a definite place for building up and investing capital.

4. The present production level is estimated to be:
- 16,000 tons for fresh dates and ripe dates
- 1,500 tons for all the subjacent crops, which are predominantly vegetables.

The products are used in conformity with traditional practices, which are beginning to see some evolution. For now, there are no serious problems for marketing or storage, but this situation may change in the future if the sustained development of the subsector is foreplanned.

5. In the area of training and research, one sees an insufficiency which is both qualitative and quantitative, and a lack of integration with real problems of development. Because of this, their impact on production can only be negligible.

6. From the viewpoint of the impact of oasis farming on the environment, we are witnessing a constant deterioration of the environment of some oases, which is chiefly caused by intensive human activity.

In summary, we believe that under the present circumstances, this situation should evolve the same as it is now doing with diverse trends depending on the systems of production.. We believe that in the near future and in the absence of any intervention, the negative tendencies linked to physical and socio-economic degradation will override the positive ones, if only through man's increasing pressure on the environment. Elsewhere, these trends would be set off by weather conditions On the other hand, this agricultural subsector has considerable potential, which can be classified into two types:

- The first potential is found in the rationalization of exploiting what exists, while protecting it against deterioration. Development of this potential would encounter both subjective and objective constraints, and would require an integrated vision of the different

problems. In the first stage, this rationalization must attack only the most subjective constraints and must therefore be adapted to the different systems of production.

- The second potential is found in the creation of new ecosystems by putting underground water resources to use. Turning such potential into a concrete reality calls for rather ample material and human means and requires the installation of production systems which are viable technically and economically possible, and designed beforehand. Their conception must stem from a profound knowledge of current problems. Furthermore, modernization of this potential could be economically justified at any price for, as we have said, oasis farming is the most lucrative agricultural activity in Mauritania,by reason of its output and its role in maintaining the equilibrium in the exploitation of the Sahelian desert environment.

7. Our study of this sector has allowed us to come to the following conclusions:

- On the economic level, oasis farming contributes 25 to 35% of the agricultural GAP, not including the production of crops associated with date farming, which are of definite socio-economic interest.

- On the financial level; although it has been managed with the minimum of care and capital, this activity seems to be very profitable. It constitutes the agricultural activity with the highest returns for the labor and the most rewarding financially for those who practise it.

- On the technical level, the methods of production remain very limited on the whole. Many attempts at modernization have been made, but have not had the desired effect because they were not based on in-depth knowledge of the systems of production and their environment. Consequently, the effects of these actions could not be continued and some had negative effects on the environment.
- On the social level, oasis-related activities have always played a major role in stabilizing the balance in the exploitation of the Sahelian/desert environment and in the survival of the populations living in these regions.
- On the institutional level, we note the shortage and inefficiency of projects designed to stabilize, promote or encourage activities in this subsector or to preserve the invaluable heritage embodied in the oases.

In this way, in order to better execute its role or at least to preserve it, it is our opinion that oasis farming should be made the object of medium-term and long-term action programs, which have been well thought out to measure up to its economic and social importance and to its true problems. The main orientation of these programs will be studied in the second phase of the RAMS project, which will focus notably on:

- better knowledge of the surroundings and resources with a view to establishing a control system of the situation;
- a study of the possibilities of establishing a master plan for the safeguarding of oases threatened by degradation of any form;

the search for models of development for Sahelian-type production systems technically and economically viable for the purpose of distributing them. These models should take into account the specificity of the present production systems - their design and distribution should simultaneously imply:

- Agronomical research
- Scientific research
- Extension and training of supervisors
- A study of problems posed by land (tenure) laws
- The study of possibilities of modernizing oasis farming in the long run by creating new oases or by other means.

0. INTRODUCTION

0.1 OBJECT OF THE STUDY

The object of this study is to assemble and analyze the maximum amount of information about this subsector in order to provide a true picture of its present status. This picture should permit us to diagnose this situation with regard to development possibilities for this sector.

In reality, although it is limited in economic importance compared to other subsectors - livestock raising, for example - oasis farming constitutes one of the best adapted and most rational means of making use of a natural environment as arid and poor as that of the desert and Sahelo-desert zone of central Mauritania.

We also think that this type of agriculture plays a major role in maintaining the balance between man and his environment, due to its place in the system of exploitation of that natural environment.

Moreover, until now, this subsector has never received any particular attention outside of a few isolated activities of technical assistance which had absolutely no impact on its development and have mainly served the interests of the researchers.

There are just as many factors advocating a long-lasting action with its socio-economic importance and its role in maintaining a balance in the systems of exploitation of the environment.

0.2 DEFINITION OF OASIS FARMING AND ITS ROLE IN THE NATIONAL ECONOMY

0.2.1 Definition of Oasis Farming

The concept of the oasis has always brought to mind the poetic picture of somewhat paradise-like date-palm gardens right in the middle of the desert, which is true in a way. In fact, contrary to what laymen may think, the palm tree is the tree *par excellence*; it can only be grown in the desert *under certain non-desert conditions*, such as fertile soil, abundant water resources, from which stems the somewhat unusual and poetic nature of this concept.

However, experts have differed a great deal on the very definition of what an oasis is. For some, an oasis should encompass its three stages of culture, the first constituting the palm tree, the second a fruit-bearing stratum and the third an annual herbaceous stratum of vegetable and fodder crops; in the absence of the last two stages, the term "oasis" would be improper.

For others, such an image belongs more to legend than to reality, and the oasis should be composed of a commercialized plantation of date palms developed according to well-defined standards, etc.

To settle this matter, we will define oasis farming as *that set of agricultural activities practiced within an ecosystem in balance with the desert, which constitutes its surrounding environment and which is commonly called "oasis"*. *In other words, this is farming practiced in an environment made up of a secondary space of the desert and where ecological conditions are akin to that of the desert*

but are not entirely desert-like (fertile soils, an abundance of water, hydrophilous vegetation). Utilization of this environment alludes to the cultivation of the date palm, which is reputed to be the plant most adapted to such conditions; this bears out the old Arab saying that "the palm tree must have its feet in the water and its head in the burning sun".

In addition, the presence of the palm tree, under certain density conditions, has an effect on the desert environment, which some specialists designate as the "oasis effect", (1) manifested by the creation of a micro-climate favorable to other cultivation (fruit trees and annual crops) which would not be possible without the palm tree. Thus, the palm tree emerges as the balancing factor between the milieu in which it is planted and the desert.

In summary, we believe that the presence of the palm tree in an area is a necessary and sufficient condition to justify calling it an oasis. Now, whether the oasis is cared for or not, whether the date palm is alone or growing along with other subjacent crops, this depends only on the amount of human activity in the oasis and its economic setting.

0.2.2 Role of Oasis Farming in the National Economy

Oasis farming is represented almost exclusively by date cultivation. Other subjacent crops are associated with this date growing, such as:

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(1) El Ammami, 1968.

- Truck farming crops, various vegetables;
- Irrigated cereals including wheat and barley, and sorghum to a minor extent;
- Irrigated fodder crops with alfalfa as the only crop;
- Industrial or "commercial" crops, represented by henna, and tobacco to a minor extent.

Based on Mauritania's economic records for the period of 1973-1978 (2), the value at current prices of this subsector's production, excluding that of the companion crops, represented between 32 and 47% of that of farm vegetable production, or an average of 35%.

Considering that these values were computed from date production estimates, it must be stressed that this is a strict minimum. In fact, we believe that the production level is underestimated. Added to this is the production value of the companion crops, which, according to our estimates, represent:

- 8% of the production value of the fresh vegetables;
- 10% of the production value of wheat and barley;
- 100% of the production value of henna.

One must not place too much emphasis on the economic importance of this subsector, for in our opinion, it is outweighed by its social importance. In fact, according to our surveys and to literature on this subject, over 60% of production is used for the farmers' own subsistence; even if this part of the subsector seems relatively large, this is due to the fact that in the past few years there has been a deterioration of the cereal subsector following several years of bad weather.

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(2) Ministry of Economy and Finance, GIRM.

0.3 APPROACH TO THE STUDY

The approach adopted for this study is divided into two main phases:

0.3.1 Examination of Existing Information

This phase consists of collecting and critically examining existing information on the oasis subsector. This will entail: (i) learning about the prior projects in order to draw from them useful information for our study; (ii) collecting the basic data on available physical and human resources and; (iii) studying the potentials of the subsector from an ecological perspective.

0.3.2 Analysis of the Present Situation

This phase of the study consists of identifying the inadequacies and problems of the subsector as well as its potential. This is the most important part since after this analysis, general guidelines will emerge for the proposals of the second phase of the RAMS Project.

This phase was executed after several field trips and surveys by RAMS.

Our activities focused on identifying the homogeneous subregions characterized by sets of relatively similar production systems which could have some characteristics in common but also dissimilar ones. Numerous criteria were used which dealt with the environment in general.

Thus, in general our study will be composed of two major chapters:

- basic information bearing on available resources ;
- systems of production bearing on production problems from a technico-economic point of view.

In addition to these two chapters, we thought it necessary to attack certain problems subsequent to, compliant with or consistent with production, such as: land tenure rights, marketing and storage, training and research, its relation with other farming activities and its effects on the environment.

Chapter I. BASIC INFORMATION

I.1 THE PHYSICAL ENVIRONMENT

In this chapter, we will review the principal date-growing zones of Mauritania, make a brief expose on the physical environment and try to imagine the extent to which date farming can be practised under such conditions.

I.1.1 Principal Date-Growing Zones

The main date-growing zones are roughly superposed on the principal mountainous formations, which are: the Adrar, the Tagant, the Assaba and the Affole, occupying the central section of Mauritania. In fact, it is within and surrounding these formations that the most favorable conditions for date cultivation converge, viz. arid surroundings and available water. An uninformed reader might wonder about the consistency of these requirements of aridity and abundant water, but we add that the geological and geomorphological features of these formations have given rise to a new, extremely important hydrographic system characterized by sudden runoffs when rare rain falls on these formations. Alluvial zones storing underground water have developed within this system. It is in these zones, developed along the oueds, bathas and tamourets, that date farming has been established.

According to Munier (3), the area in which the date palm is cultivated in Mauritania could be inscribed in a triangle whose points would correspond to the localities of Kaedi on the river, Bassidounou in the southwest and

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(3) p. Munier, 1955

the palm grove in Char, located at the northern tip of the Adrar formation. This zone encompasses the regions of Adrar, Tagant, Assaba and the Western Hodh.

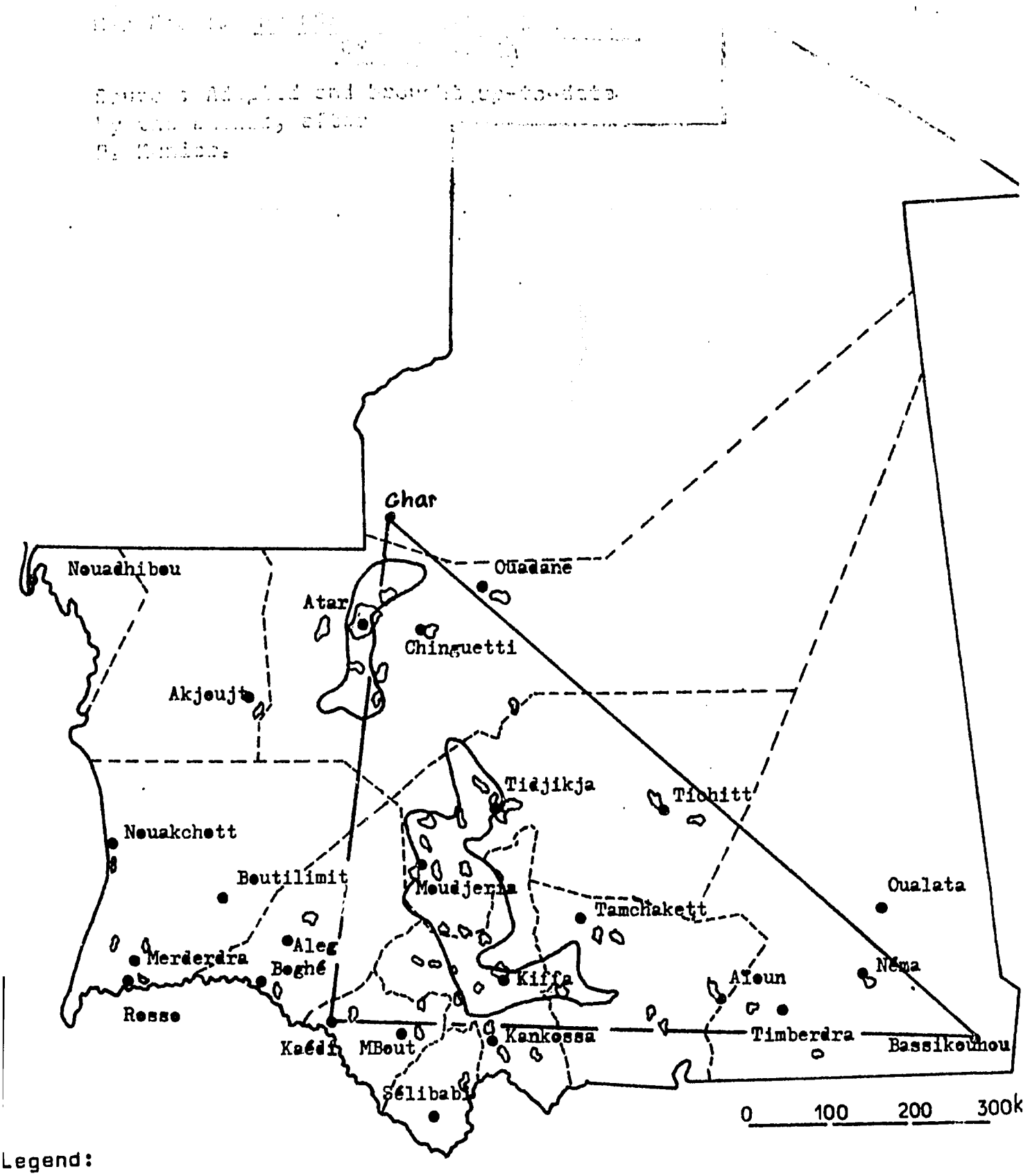
In reality, some oases or small palm groves are now found outside of the zones cited. This being so, during our field visits, we spotted palm groves as far as the Malian border, to the southeast (Adel Bafrou, Bousteila, Djiguenni), in the Guidimakha in Ould Yenge, in Brakna, not far from Boghe (Saboala) and from Aleg, in the Trarza in Rosso. and even in the vicinity of Akjoujt (cf. map No. 1).

I.1.2 Climatic conditions

According to M. Leroux (4), the combined influence of the tradewinds from the sea, in addition to its distance from the sea, divide the country into two major climate zones: the Saharan region and the Sahelian region, each subdivided int two areas: a coastal zone and a continental zone (cf. map No. 2).

- Saharan Mauritania is subdivided as follows: first is the northern coastline (outside of Nouakchott), characterized by constant humidity, low temperatures and slight rainfall, with most of it falling in autumn and, secondly, the true Saharan part, characterized by extremely arid air, very low precipitation made almost insignificant by high temperatures and the high evaporation levels resulting from them. It is thereby the most arid of the Mauritanian regions.

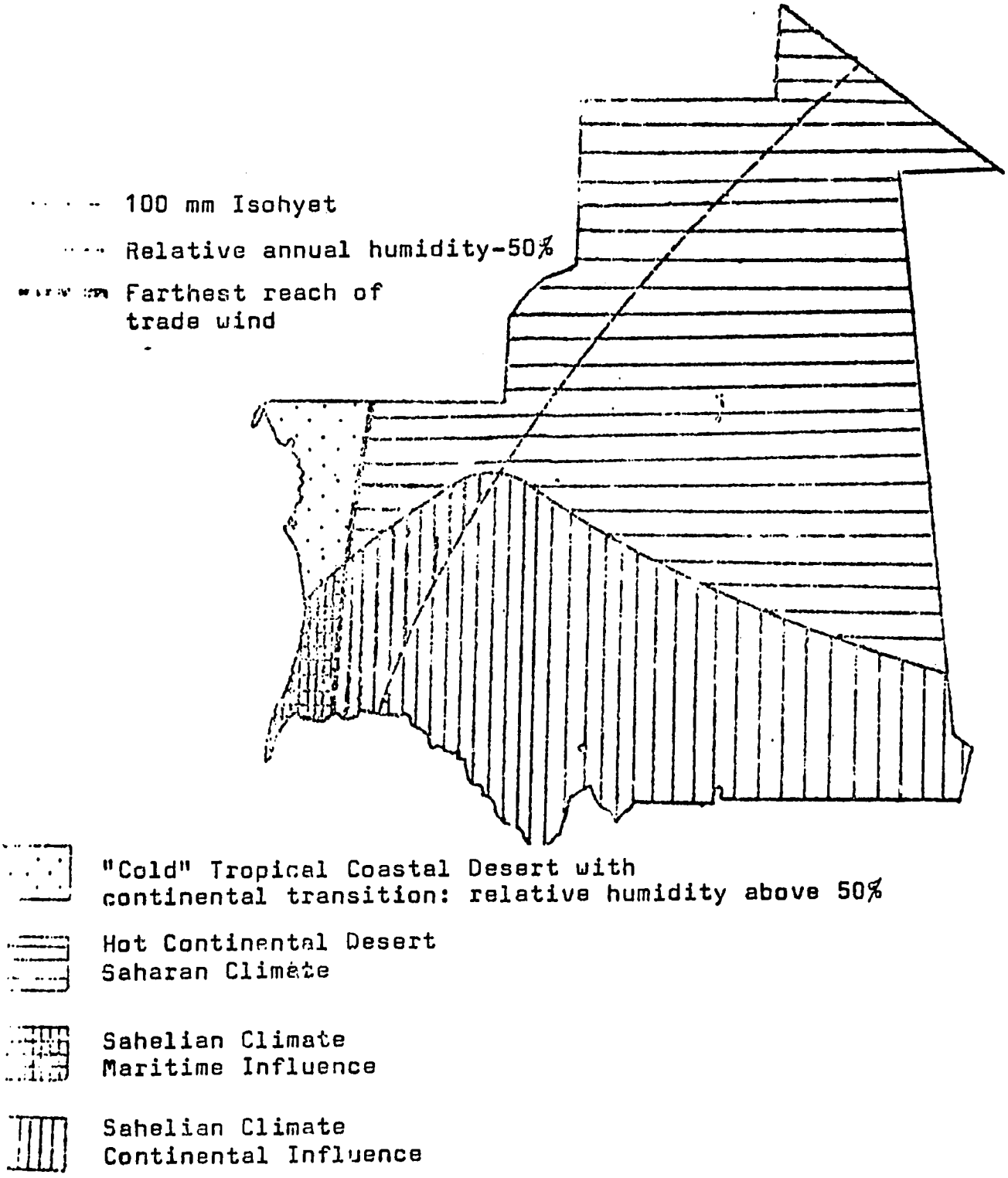
(4) M. Leroux, 1977.



Legend:

- ● city or town
- Palm groves
- limit of the oasis agro-ecological zone
- administrative boundaries

Map No. 2. THE CLIMATIC ZONES



- Sahelian Mauritania, bordered somewhat to the north by the 150 mm isohyet, is in turn divided into:
  - a coastal zone characterized by constant humidity, freshness and summer rains;
  - a continental zone with a more varied climate characterized by a dry winter, high temperatures and summer rains, which can be quite substantial because of the prolonged monsoon.

We are interested in three main climate conditions for this study: the temperature, the atmospheric humidity, and the rainy season. Some data are given on the characteristics of the principal climatic zones in Table No. 1.

I.1.3 Soils

According to C. Barbey (5), there are 5 distinct types of soil in Mauritania:

- The raw mineral soils of the desert, classified into deposit soils and ablation soils; these soils do not allow vegetation and cover the greater part of the territory.
- The immature, evolving soils, grouped into several sub-types, based on their climatic or non-climatic origin and the kind of rock on which they develop; they are basically found in the northern part of the Western Hodh and in the Eastern Hodh.
- The isohumic soils; these soils have evolved little, are relatively rich in organic matter and classified into 3 sub-types, according to the richness of their swelling clay content, and the rock on which they develop; they are found in the Western Hodh, in the Karakoro basin, and in the Akchar, the Azeffal and the Trarza.

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(5) Atlas de la République Islamique de Mauritanie, p.22, 1977.

Table No. 1: Summary of Some Climatological Data

			J	F	M	A	M	J	J	A	S	O	N	D
Maritime influence	SAINT-LOUIS	MT °C	21.9	21.8	21.9	21.5	22.2	25.5	26.9	27.4	28.0	27.5	25.4	22.7
		RH %	58	63,5	68	74.5	80.1	82	81.5	82	81	75	64.5	59
		R mm	0.8	1.4	0.0	0.2	1.3	7.2	44.2	160.9	96.7	28.5	2.4	3.3
	ROSSO 1941-60	MT °C			27.6	(yearly average)								
		RH %			42.5	(yearly average)								
		R mm	0.6	1.2	0.0	0.9	1.5	8.0	43.0	135.6	81.3	31.9	1.9	4.1
	MATAM	MT °C	23.4	25.4	28.5	31.3	33.6	32.8	29.5	28.3	28.1	29.2	27.4	23.7
		RH %	43	40.5	35	31	35	46.5	64.5	75	74.5	66	55.5	47.5
		R mm	0.9	0.8	0.3	0.1	4.0	50.4	128.8	202.3	122.0	22.4	2.4	2.3
	BOUTI-LIMIT	MT °C	23.0	24.8	26.8	29.2	31.7	32.1	30.3	29.8	30.3	30.3	27.8	22.4
		RH %	28.5	26	28	29	32.5	43	58	64	60.5	46	35.5	34.5
		R mm	0.7	1.7	0.4	0.9	4.2	5.4	44.7	70.3	54.9	14.8	2.8	3.0
Continental influence	ALEG	MT °C	23.9	25.6	28.6	31.4	33.6	32.3	30.4	28.1	29.6	31.4	28.9	23.9
		RH %	–	–	–	–	–	–	–	–	–	–	–	–
		R mm	0.5	1.0	0.0	1.0	5.5	8.9	63.1	111.8	55.0	13.9	2.7	0.7
	KIFFA	MT °C	23.0	24.9	27.6	31.2	34.3	34.1	31.6	29.6	30.4	31.0	27.6	22.8
		RH %	26	24	21	20	24.5	41	56	66.5	62.5	44	34	32
		R mm	0.6	0.8	0.8	0.9	3.7	24.6	91.3					
	AIOUN	MT °C	23.3	23.3	28.2	31.8	34.9	33.1	31.0	28.7	30.3	31.8	28.2	22.9
		RH %	19.5	18.5	15	15	21	35	55	68.5	58	31	25.5	25.5
		R mm	0.3	2.0	4.0	0.2	1.0	14.8	99.0	106.5	52.4	4.5	1.5	1.6
	NEMA	MT °C	24.3	27.2	29.6	33.1	35.6	34.4	31.4	29.6	30.4	32.3	29.4	24.1
		RH %	22.5	22.5	18	16.5	23	40	56.5	65	59.5	33	21	23.5
		R mm	1.1	0.3	0.2	1.7	11.2	35.5	69.0	116.7	62.3	11.7	1.0	2.3

MT = Mean temperature
RH = Relative Humidity
R = Rainfall

TaBLe No. 1 cont'd: Summary of Some Climatological Data (13)

			J	F	M	A	M	J	J	A	S	O	N	D
SAHARAN REGION	MOUJERIA	MT °C	25.0	25.8	29.4	32.6	34.8	34.5	32.0	30.5	31.9	31.9	29.1	24.1
		RH %	–	–	–	–	–	–	–	–	–	–	–	–
		R mm	0	1.6	5.0	0.2	1.5	11.4	41.7	87.4	60.2	13.4	2.3	1.2
Maritime influence	TJIDJIKA	MT °C	20.1	22.2	24.6	28.1	31.6	33.3	31.8	30.7	31.0	29.3	25.0	19.6
		RH %	38.5	35	33	28.5	29.5	36	48	56	53.5	45.5	43.5	44
		R mm	0.4	3.8	1.7	0.0	4.2	8.9	20.5	53.2	35.8	8.8	3.4	1.6
	NOUAKCHOTT	MT °C	21.9	23.3	24.8	25.7	27.0	28.2	27.9	28.6	29.6	29.1	26.2	21.5
		RH %	46.5	51	54.5	56	58	64	72	74.5	68.5	61	52	48.5
		R mm	0.9	1.7	0.7	0.5	0.6	1.2	13.4	60.4	39.8	9.4	3.0	6.8
	NOUADHIBOU	MT °C	19.0	19.6	20.3	20.4	21.4	22.6	22.8	23.8	25.1	24.0	21.8	19.3
		RH %	62.5	63.5	64.5	66	65	67	73	74	68	68	67	63
		R mm	1.9	1.3	1.7	1.1	0.2	0.8	0.3	2.6	6.9	7.1	8.0	4.4
CONTINENTAL SHELF	AKJOUJT	MT °C	22.1	22.1	26.3	28.7	32.1	34.6	33.4	32.6	33.0	31.3	27.0	21.6
		RH %	46.5	41.5	39	36.5	33	34.5	47	54	50.5	40	41	47.5
		R mm	1.1	1.9	0.9	1.2	0.6	2.6	7.8	41.0	29.5	8.0	6.8	4.7
Continental influence	TAMCHAKETT	MT °C	–	–	–	–	–	–	–	–	–	–	–	–
		RH %	–	–	–	–	–	–	–	–	–	–	–	–
		R mm	0.3	1.4	0.7	0.7	7.3	15.8	68.6	86.9	67.6	11.4	1.5	2.7
	ATAR	MT °C	20.2	21.8	29.3	27.5	31.0	34.1	34.4	33.8	32.7	29.8	25.3	19.8
		RH %	41	39.5	37.5	33	31	27.5	36	43.5	42.5	39.5	39	42.5
		R mm	1.1	1.4	1.5	0.3	1.3	2.4	5.9	31.9	37.8	7.5	7.5	4.3
	BIRMOGREIN	MT °C	19.0	20.7	23.4	25.0	27.9	30.7	33.6	33.7	31.9	28.1	24.0	18.7
		RH %	47	40.5	43	45.5	43	47	36	37.5	41	48	51	54.9
		R mm	3.3	3.5	0.8	0.3	0.1	0.7	0.3	3.9	12.4	12.9	7.7	9.9

(13) Charles Toupet: 1975

MT = Mean temperature
RH = Relative humidity
R = Rainfall

- The hydromorphic soils: these are very compact and impervious soils which have developed on the alluviums along the Senegal River.
- The halomorphic soils: these soils have a very high alkaline content and are represented only to a limited degree in Mauritania (coastal region and catchment areas); they are unsuited for cultivation.

Now, as far as our study is concerned, oases are found on a relatively wide range of soils belonging to all the types mentioned except the halomorphic soils. It is also worth noting that in general, the oases are located on the alluvial tracts of the Oued, "Msila", and "Patha", presenting rather special soil conditions and constituting micro-zones inside the different geomorphological settings, which partially explains their rather small size.

I.1.4 Water Resources (cf. Map No. 3)

In this paragraph, we intend to take a brief look at Mauritania's water resources, which are capable of being mobilized for agricultural needs and, among other things, for oasis farming. Underground water as well as surface water will be examined.

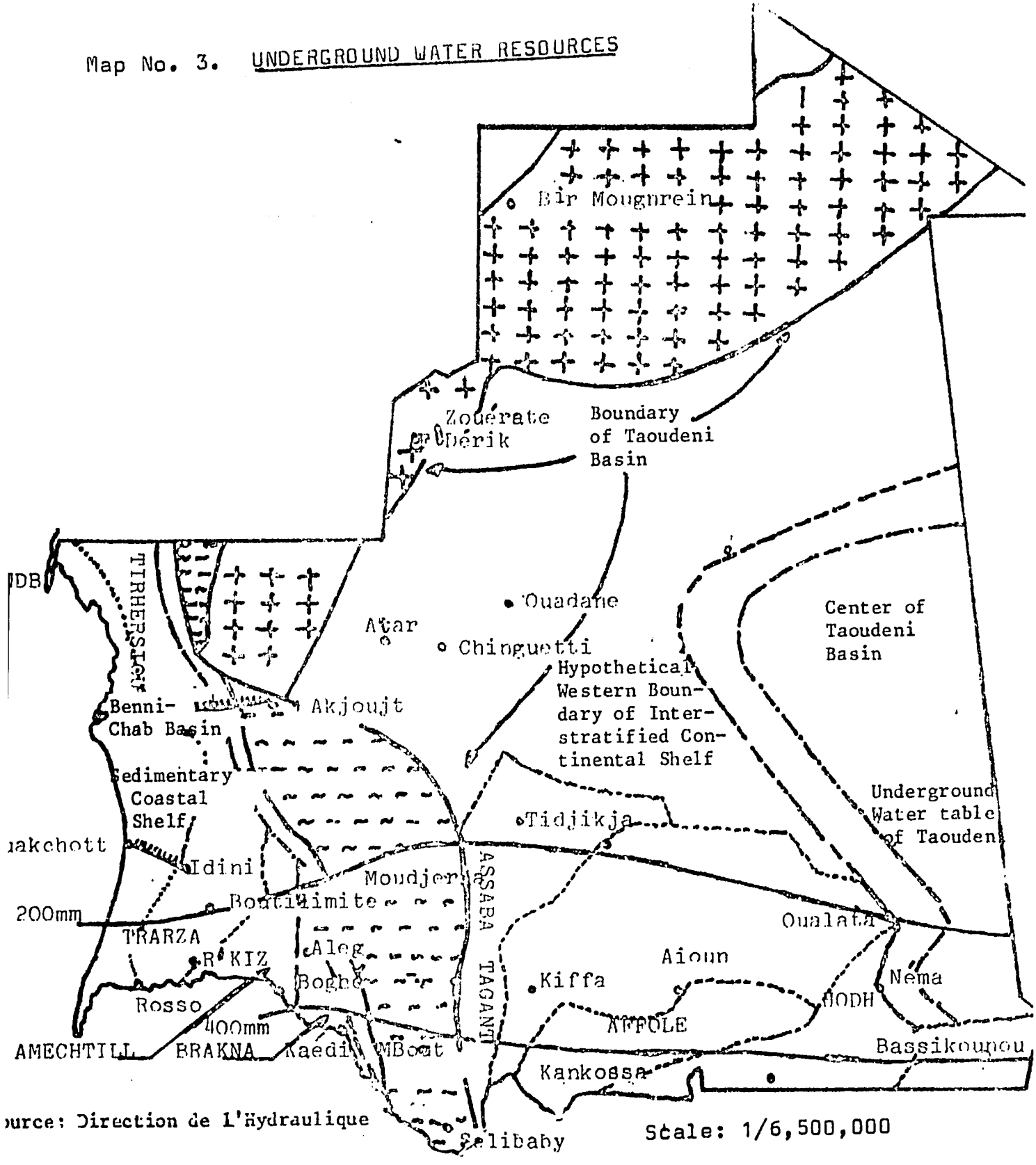
I.1.4.1 Underground Water

Various studies have revealed that Mauritania now has large underground watertables, the most important of which are:

I.1.4.1 Coastal Sedimentary Basin

This basin is estimated to have reserves of 70 billion m^3. The flows presently being exploited run at about 40,000 m^3/day, 146 million m^3/year. These quantities are insignificant compared to the size of the

Map No. 3. UNDERGROUND WATER RESOURCES



ource: Direction de l'Hydraulique

LEGEND:

- Boundary of Basin Substratum
- Boundary of Sedimentary Basin
- Approximate Boundary of Dry Slope
- Water Supply Pipe
- Boundary of Interstratified Continental Shelf
- "Arc des Mauritanides"
- Boundary of Saline Slope
- Crystalline Basin

reserves in the first place, and secondly, in relation to the present flow coming from the alluvial fold, for which an estimate of 15 million m^3/year has been proposed. This basin stretches southward as far as Senegal and northward as far as Nouadhibou.

It is possible to distinguish, based on the recess of the substratum, the geological formations and their ages, several levels and watertables, namely:

- the Brakna watertable
- the Anchtil watertable
- the Trarza watertable
- the Inchiri watertable
- the Tirhesioum watertable

These tables are found in the form of bands between the arc des Mauritanides and the coast. Water is drawn from them at variable depths; they flow at rates of between 5 and 90 m^3/hour, and the quality of their water is generally good.

I.1.4.1.2 L'Arc des Mauritanides

There are three distinct types of aquifers, based on their lithology; these are watertables of good chemical quality. Regular useable flows vary widely, depending on the table, from 0.1 to 100 m^3/hr.

I.1.4.1.3 The Southeast Mauritania

Here one finds surface-waters which are regularly renewed located south of the 200 mm isohyet. One can find them in the numerous eolian sand-filled zones which stretch out in the southern part of this isohyet, notably in the Aouker, the Hodh, the Affole, etc.

Flows which may be used from time to time range from 0.1 to 10 m^3/hour. These tables are present when rainfall allows, but also when impervious layer of bedrock prevents any deep infiltration.

From east to west, there are:

+ The Guidimakha
  Where resources from these tables are limited most of the time.

+ The Assaba
  Where great potential is contained in the ridge of sand dunes running along the mountains to the east. It is also quite easy to exploit the potential of the water-tables on the Karo-koro alluviums.

+ The Affole
  The underground watertable of the Aioun sandstone is the largest aquifer in the region, spreading out over a wide area. Occasionally exploitable flows vary from 0.2 to 2 m^3/hour.

+ The Hodh
  These alluvial tables are widely utilized at present (450 wells). An expansion in the number of wells should be limited to certain areas and would require preliminary prospecting.

+ Aouker
  This is an underground table located beneath the eolian sands of Aouker, which occupy a sandy formation 15 to 60 mm thick. It is exploited by over 350 wells and oglats. Occasionally exploitable discharges run about 1 to 3 m^3/hour.

I.1.4.1.4 The Watertable of the Taoudeni Basin

This table's reserves are estimated at 19 billion cubic meters, the same density as the table in the Trarza, which is approximately 1 billion m^3/km^2. Seventy wells are now drawing from it.

Its utilization by wells drawing 200 m^3/hour should not present any technical problems if this can be justified economically.

This basin covers approximately two-thirds of Mauritania and spreads out over a good part of West Africa. Its hydrogeological conditions differ along the edge from its central section. Along the edge, conditions are more arduous. Positive results have already been noted near Zouerate (Azrag, Oued El Gah) and in the region of Achram (Tagant/Assaba), but research will have to be pursued.

In the central zone,conditions are more favorable to the existence of deep, widespread underground tables, but solid data on this is difficult to obtain.

The characteristics of the aquifers have been provided for this table and do not seem to be continuous, due to the existence of a fault, located 0.50 ENE, which tends to be impervious. These aquifers are:

- the table of the Dhar Nema-Oulata, ranked among the largest table presently known of in Mauritania. Its source is 100 km west of Nema;
- the table of the Ouartemachet rift.

I.1.4.2 <u>The Surface-Waters</u> (6)

There are recyclable resources. They originate from rainwater which either does not evaporate or does not soak into the soil. These runoff waters are utilized for recession plot farming and in the form of ephemeral streams (oueds),

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(6) Moulaye Abdallahi, 1880.

they feed the aquiferous tables, which are generally used in the palm groves. This leads first of all to a discussion of the volume of precipitation, which the dimensions of this research depend on a great deal, and secondly, about the hydrographic network that makes it possible to utilize this resource.

I.1.4.2.1 Volume of Precipitation

The total volume of precipitation received by a given area is one of the main factors in determining the amount of runoff available.

In Mauritania, rain falls during the rainy season (hivernage), generally between June and October. The rainfall level varies from zone to zone and gradually decreases as one travels from south to north; thus, Selibaby receives 650 mm/year and Nouadhibou only 25 mm/year.

It would be very difficult to make a general assessment of the water cycle due to the vastness of the territory and the irregularity and spatial distribution of rainfall.

Four-fifths of Mauritanian territory belong to a desert climate to the north, but in the south the 230 mm isohyet which passes through Boghe, crosses Mauritania from west to east. Taking into account what has been said, the average rainfall level is estimated at 100 mm/year; for a total area of 1,085,000 m^2, 100.5 billion m^3 of rain falls over the entire territory and only 5% of 5.425 billion m^3 of it infiltrates the soil and feeds the water-tables; the rest drains off and evaporates.

Generally speaking, runoff is possible only if precipitation goes beyond a certain ceiling; however, certain environmental factors set up conditions favorable

to surface runoff for the slightest rainfall. Among these factors we note:

- the frequency and intensity of this precipitation;
- the features of the soil surface;
- the slope of the land;
- ground vegetation.

The combination of these factors with the volume of precipitation, how they are spaced in time and their combination with the environment's temperatures, may or may not lead to runoff into a drainage network.

I.1.4.2.2 The Drainage Network

The physical features of Mauritanian land are such that the largest oueds drain off into catchment areas, where water levels are kept within certain bounds, depending on the relative level of evaporation and deposits.

Only the head basin of the Karakoro and the western zone of the Assaba plateau reveal oueds with at least ephemeral drainage throughout their course, before draining into the Senegal River.

The coastal sedimentary basin is characterized in its southern part by the absence of a major drainage system. In contrast, to the north, a certain number of "Khatts" have underground runoff marked by a denser line of vegetation (Khatts, Ataoui, Khattes des Agels, etc.). In the zones farther north (Tasiast, Inchiri, Tiris, Zemmour, etc.) runoffs are very localized and strictly bounded by reliefs (Oueds of the Akjoujt region, Touerfa Oued coming down from the Kedia of Idjill). The northern regions reveal only occasional traces of runoff at the fringes of some depressions.

The cliffs demarcating the border of the Taoudeni basin give way to a whole line of oueds, the largest of which are in the Adrar; the Oued Seguilil and Oued El Abiad merge into the "Ghrara" of "Yaghref", while in the Tagant, the Tamouret En-naâje is formed where the three Oueds draining the entire western part of the plateau are met. Further east, the Tidjikja and Imoudran Oueds run into a depression occupied by the Khatt.

In the southeast, the former post-Tertiary network stands out clearly, with the old tributaries of the Karakoro (Tayart-Taskass) or of the kelembine (the Misle, Tayar, Tachoualet, El Munja, Ouassa Oueds). This entire system is more or less clogged by sand sifting in and is lost in the dissipating ponds, the most important of which is that of Mahmoude.

West of the Assaba is the only system that, with a clearly-defined ridge in the Aftout and the Guidimakha, breaks down into several major oueds: Charfa, Niorde, Savalel and especially the Gorgol, whose catchment basin holds 11,250 m^3 of water. All of these Oueds end up in Senegal, draining an average of 15 billion m^3/year.

Perennial watertables are extremely rare:

- Rkiz Lake is at the end of the Aftout Echchergui Depression, and is only filled when the Senegal River overflows.
- Aleg Lake is a catchment basin which captures the waters from the Kechi Oued during the rainy season. It fills up at various times, and is usually dry during the months of February-March.

Other ponds of lesser importance or old backwaters linked to the Senegal River during periods of flood, are the only other principal watertables.

Elsewhere in the northern regions, a few small "Gueltas" are sometimes permanent because they serve as springwater outlets for underground runoff.

Briefly, one can only speak of springs if there is an appreciable drainage of the rainwater. This drainage depends on the combination of several factors and can only be substantial in regions with vast surfaces of enormous rocks of clayey soils on the surface (Aftout), or in regions receiving large volumes of rainfall.

From the viewpoint of volume, the quantities of runoff water and filtered water only represent 5% of the total rainwater deposit, which reveals rather low potential.

Since this resource is recyclable, it must be exploited with caution and the degree of recyclage must be taken into account. On the other hand, the unfiltered quantities can be increased by means of appropriate techniques.

I.1.5 Possibilities and Limitations of Date Tree Growing in Mauritania

In this section, we will try to situate date-growing ecologically and to examine the behavior of the palm tree with respect to the conditions of its surrounding environment. But to do so, we must briefly cover date palm ecology.

I.1.5.1 Ecological Requirements of the Date Palm (Phoenix dactylifera)

I.1.5.1.1 As concerns the climate, the date palm requires rather strict adaptation to the special conditions of the climate, generally speaking. It is usually said that in order for its fruits to mature normally, the date palm demands very high temperatures and a very arid atmosphere. But these requirements are peculiar to the pre-Saharan continental oasis varieties and are not as imperative for the varieties of coastal oases, for example. Hence, the date palm, a priori, offers some possibility of adaptation by virtue of its variability.

However, it so happens that the growing area for the date palm is always limited by two principal climatological elements, which are: the average temperature and the average moisture content. Actually, the palm tree is a thermophilic species (requiring plenty of heat); its growth and fructification necessitate certain minimum temperatures. According to the works of W.T. Swingle, R.W. Nixon, T. Fischer and T. Kearney, in the Mediterranean zone and in California, these minimum temperatures are the following:

- 8 to 10° C is the lowest temperature for vegetation, below which plant growth ceases.
- 18° C is the lowest for blooming or fructification, below which there is not fructification.
- 30° C is the starting temperature from which the intensity of photosynthesis is at maximum.
- Starting at 38 to 40°, photosynthetic activity begins to decline. Taking these results, a temperature standard was established expressing the sum of day temperatures between the beginning and end of fructification, which in theory corresponds to average temperatures above 18° C.

Table No. 2: Data on the Standard Heat Levels for Fruit Bearing and Annual Hygroscopic Levels

	REGIONS IN THE WORLD		MAURITANIA		
Region	Totals of temperatures Average 18°C (May 1-Oct.31)	Annual Hygroscopic Level %	Region	Totals of temp. Aver. 15°C (15 March-15 Aug.)	Annual Hygroscopic Level % (20)
Elche (Spain)	840	68	Nouadhibou	577.5 (951)+	66.5
Laghouat (Algeria)	990	-	Nouakchott	1365 (1872)+	58.8
Alexandria (Egypt)	1238	69	Rosso	1560++	42.5
Giseh (Egypt)	1210	69	Bir-Mogreïn	1672	44.5
Port Saïd (Egypt)	1217	74	Boutilimit	1848	40.5
Gabès (Tunisia)	1373	66	Tidjikja	1873	40.9
Abbassia (Egypt)	1508	62	Matam	1968	51
Gafsa (Tunisia)	1521	57	Aleg	1981	-
Caïro	1593	-	Akjoujt	2047	42.6
Phoenix, Arizona (U.S.A.)	1677	-	Atar	2056	37.7
Kébili (Tunisia)	1768	62	Aïoun	2077	32.3
Nefta (Tunisia)	1820	60	Kiffa	2094	37.6
Biscra (Algeria)	1836	48	Moujéria	2215	-
Touggourt (Algeria)	1854	44	Néma	2225	33.4
Basra (Irak)	1872	59	Saint-Louis	1122 (1485)+	72.4
Tozeur (Tunisia)	1975	61	Kankossa	-	44.4
Bagdad (Irak)	2356	-			
Khartoum (Sudan)	2742	33			

+ between May and Oct. ++ According to P. Munier

(20) The annual hygroscopic level is only a measuring tool, computed from the minimum and maximum levels in order to make comparisons with the other regions.

These norms compare with the Mediterranean and Californian phytoclimatic data, limiting the sum of temperatures over 18° C (between May 1 and October 31) to 1200° C for the best yield of the date palm crop. The standard of 990° C, which corresponds to the Laghouat oasis located on the southern piedmont of the Saharan Atlas in Algeria, is considered to be the ecological boundary of the palm tree.

Other climatic factors must be taken into account, for they often limit possibilities of expansion. These are the average hygroscopic index (or the humidity of the air), rainfall and summer storms.

- Very high humidity slows down and hinders the ripening of the dates by acting on the transpiration process. It has been demonstrated that an average humidity level of 90% stops all maturing and causes physiological damage in the still green dates (saturation of the dates with water and bursting of the skin).

- Very low humidity dehydrates the dates and considerably depreciates their quality.

- Rains coming at the time of blossoming tend to rot the inflorescences, and are harmful to fertilization.

- Rains coming later on impede and slow down ripening. Rains and storms occurring during the maturing stage of the date induce cracking of the skin and rotting of the fruit, thereby incurring partial or total loss of the harvest.

Finally, we add that the date palm is heliophilous, or a lover of strong light. An insufficient amount of light favors the development of the palm leaves to the detriment of fruit bearing.

I.1.5.1.2 As concerns water needs, there is a qualitative aspect on the one hand and a quantitative aspect on the other hand.

- The Qualitative Aspect: The date palm tolerates salinity fairly well. According to the SCET-SEDES research (7) conducted in Tunisia, the following may be conceded:
  - 2.5 g/liter of dry residue is the optimum amount.
  - 3.5 g/liter of dry residue is tolerable without decreasing the yield, but only with excellent drainage.
  - 5 g/liter of dry residue is the practical limit, which should not be passed because there is a decrease in the yield inversely proportional to the effectiveness of the drainage.

  According to Schoeler (8), the palm tree is tolerant of contents of 4-5 g/l of dry residue, when the water is used with discrimination.

  It is also suspected that having low quantities of salt is indispensable to the growth and quality of the date, but this theory remains unconfirmed.

- The Quantitative Aspect: In general, given the arid conditions of the date tree growing zones, the water needs of the palm tree are quite substantial. In a Mediterranean

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(7) SCET: Société Centrale pour l'Equipement du Territoire (Tunisie).
CEDES: Centres des Etudes de Développement Economique et Social - France.

(8) INA - Tunisia, 1972. Cours d'Arboriculture.

climate and a pre-desertic zone, the net need for the most demanding varieties have been developed (9) to 23,500 m^3/ha/mm, which equals 28,000 m^3 in gross, including losses, or a continuous flow of 0.91/s/ha, in theory. For less demanding varieties, the needs have been evaluated as 17,500 m^3/ha/yr, or a continuous flow of 0.561/s.

In Mauritania, according to P. Munier (10) at the experimental station in Kankossa (rainfall 450 mm), the palm tree's water needs have been estimated as:

- Cold, dry season: 1.5 m^3/palm/week, the underground water-table being 2 m deep.
- Hot, dry season: 1.5 m^3/palm every 5 days, the underground watertable being from 2.5 to 3 m deep.
- Rainy season: 0.

One deduces from this that for an average plantation of 150 trees/ha, some 8,000 m^3/ha/yr is required considering a precipitation level of 450 mm (4,500 m^3/ha) and a fresh underground watertable from 2 to 3 m deep.

I.1.5.1.3 From the viewpoint of the soils, the date palm is somewhat demanding about their quality. Even though its roots are quite resistant to asphyxia, they cannot grow in stagnant water. Thus, it has been determined that the level of the underground watertable must be at least 1.5 m deep; when saline soils are present, washing

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(9) CRUESI-Tunisia, 1967

(10) P. Munier, 1973.

by bringing in additional irrigated water is necessary to prevent salt from accumulating among the roots.

I.1.5.1.4 From the viewpoint of fertilization, chemical fertilizers are generally necessary to maintain a certain level and quality of production, but there is very little experimental information on the types of fertilizers that are necessary, the amounts to apply or the periods during which they should be administered.

However, it is admitted that the palm grows better in good soil with little or no fertilizer than on poor soil with large amounts of fertilizer. Furthermore, the fertilizer formulas must be adjusted to the type of soil in each plot of land and must consider the content of the irrigation water for certain elements such as potassium, phosphorous, etc.

In California, nitrogen is used in various forms. The quantities applied are determined by whether it is utilized alone, combined with other fertilizers or when the rest of the companion crops are planted. The latest studies on this region have indicated that a dosage of 2 to 3 kg of nitrogen per palm tree is adequate in certain types of soils.

In the arid zones, the palm tree responds generally well when potassium and phosphorous are spread over most soils. It also appears that fertilizing associated crops is quite beneficial to the palm tree.

As for organic fertilizers, it is known that they are widely utilized in the best palm groves of North Africa and in the Middle East. In California, fertilizer is used

in proportions of 12.5-38 tons per hectare; it is usually used during the last winter rains or after the winter companion crops.

In Mauritania, the climatic conditions differ from the regions cited; its needs in fertilizers must be studied and determined locally.

I.1.5.2 Conclusion: Potentials and Limitations in Date Growing in Mauritania

In order to define the area of the date palm ecologically, it will be necessary to examine the ecological factors first because other factors are also involved. These other, socio-economic factors will be examined later.

As for the ecological factors, temperature is considered to be the most limiting factor but is not a problem in Mauritania because average temperatures never drop below the minimum growing temperature or the minimum fructification temperature, even in coastal areas such as Nouakchott and Nouadhibou. The growth of the palm tree is therefore continuous. Flowering occurs in temperatures of 20 to 25° C during the first quarter of the year (January to March) and fructification never takes more than 150 days. In the other date-growing regions of the world, flowering takes place in temperatures of about 18° C beginning in March and continues from 30 to 50 days; fructification lasts an average of 180 days (May to October).

For a more solid idea, Table 2 on page 30 shows a few standard temperatures for fructification and a few annual hygroscopic indexes for Mauritania, in comparison with other date palm growing regions.

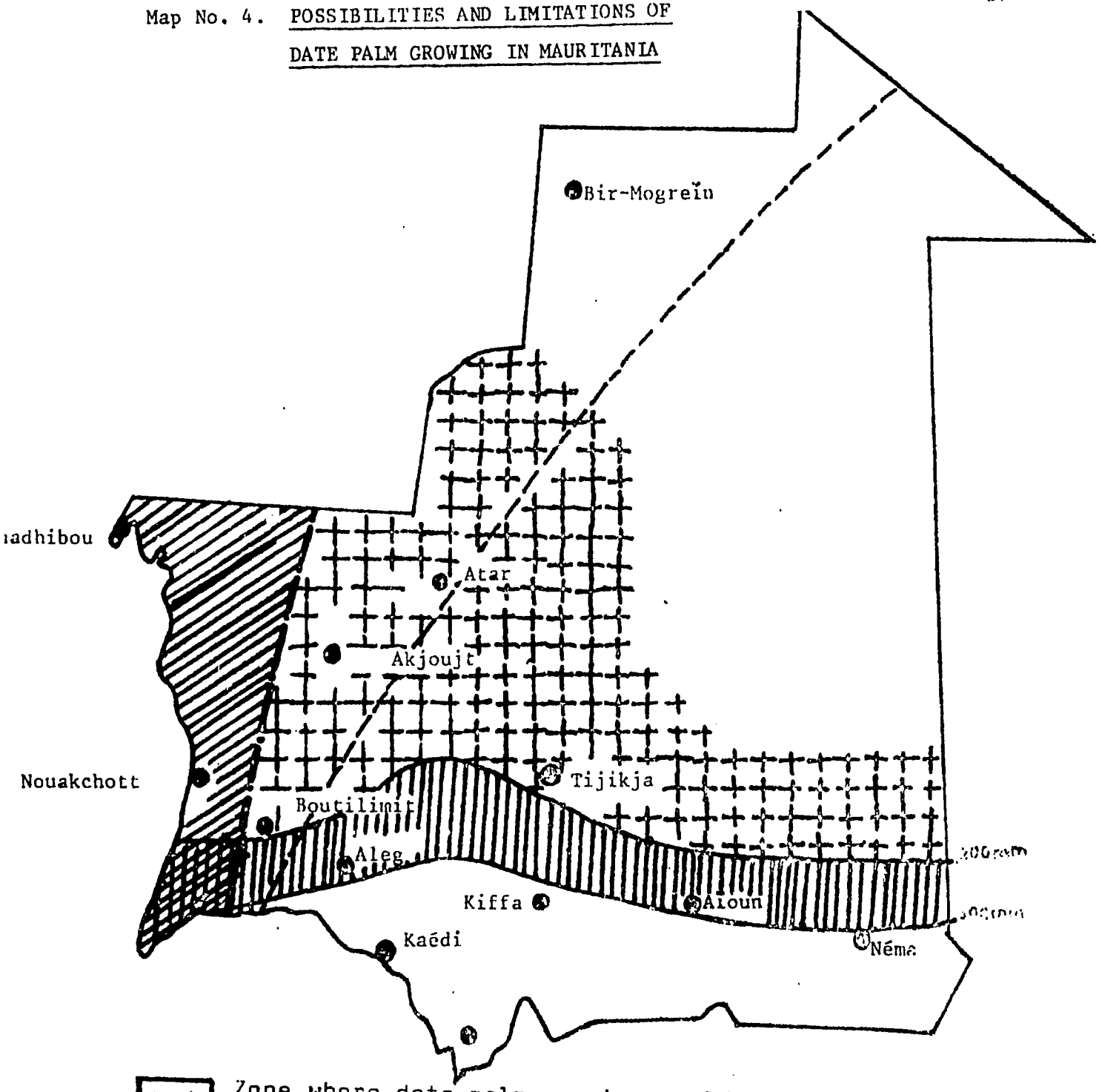
Upon examing this table it becomes clear that the data on the Mauritanian regions are very close to those of other date-growing regions. It must also be pointed out that the data on the temperature totals correspond to just 150 days for Mauritania, contrary to 180 days for the other regions.

Thus, after studying the temperature and hygrometric factors, we can conclude, taking into account the variability of the date palm and its ability to adapt, that the cultivation of the date palm can be practised anywhere in Mauritania. Nonetheless, in studying the information on precipitation (Table No. 1), one notes that the risk of compromising the ripening of the dates increases as one travels southward, starting from the 200 mm isohyet. It was also observed that in a palm grove near Nouakchott, the dates do not mature, probably due to an excess of humidity. This is apparently quite normal because these are local varieties brought in from the Adrar or the Tagant.

Taking the preceding into account and looking at it from an economic point of view favoring artisanal date-growing, one can distinguish five agricultural zones or regions for the palm tree (cf. Map No. 4):

a. The Saharan climatic zone with a continental sub-zone, in the northern part of the 200 mm isohyet, where palm tree cultivation would, on the surface, appear to be economically feasible with no risks. From the standpoint of water sources, this region covers a good part of the coastal sedimentary basin and that of the Taoudeni (see Map No. 3).

Map No. 4. POSSIBILITIES AND LIMITATIONS OF DATE PALM GROWING IN MAURITANIA



Zone where date palm growing would be economically feasible and free of risk

Zone where date palm growing would be economically feasible using adapted plants

Zone where date palm growing would be economically feasible by protecting the harvest against rain

Zone where date palm growing is compromised by the rainfall level

Zone where date palm growing would be compromised by excessive humidity and the rainfall level

Annual Isohyet

Relative humidity equal to 50%

Farthest extent of the trade wind

Principal towns

b. The Saharan climatic zone with a coastal subzone, in the northern part of the 200 mm isohyet, where date tree cultivation would run no risks and be economically feasible if plants adapted to the climate were chosen. In the final analysis, it is up to agronomical research and experimentation.

c. The band lying between the 200 mm isohyet and the 300 mm isohyet is bordered to the west by the farthest reach of the Trade Wind (Discontinuité d'Alize) where date tree growing would be economically feasible, but with more or less sophisticated date-growing techniques combined with an appropriate selection of plants.

d. The Sahelian climatic zone with a continental subzone, south of the 300 mm isohyet; practically speaking, it would be difficult to cultivate the crops profitably unless an inexpensive way was devised for using the dates in the "Bleh" stage or very early-maturing varieties were selected or introduced. As it is, the cycle of fructification in this zone is only 135 days (Kankossa) (11). One could also conceive of selecting varieties which taste good at the "Bleh" stage, but then there would be a problem of storage and disposal.

e. The Sahelian climatic zone with a coastal subzone, south of the 300 mm isohyet, where date-growing would be jeopardized by the rainfall factor and by excessive humidity due to the area's proximity to the ocean.

Now, if one looks at this from the social viewpoint, as far as Mauritanian date-eating habits are concerned,

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(11) P. Munier, 1973

one can admit that the date palm may be cultivated everywhere. It would thus prove interesting to determine just how much the different regions could be made to specialize in either date production in the strictest sense or in the production of "Bleh". Should date-growing be practised south of the 250 mm isohyet, its positive and negative effects on the environment should be evaluated; wherever water resources permit, the presence of the date palm could create an environment favoring the development of other crops.

I.1 THE HUMAN ENVIRONMENT

In this chapter we propose to study the human element involved in the oasis subsector. We will discuss the populations involved, the ways in which this human element has organized to exploit the oases, the extent of this populations' knowledge in date palm growing, and their long experience in it, etc.

I.2.1 Total Population

The agro-ecological zone of the oases, as defined in baseline RAMS study, is scattered over 6 different regions, namely: the 2 Hodhs, the Assaba, the Adrar and the Tagant. It groups together 256 (12) out of 1349 in these regions, or 19% of all the localities.

It encompasses a sedentary, rural and urban population of 122,837 inhabitants representing 31.6% of the total sedentarized population. For the remaining nomadic

(12) BCR, 1977

population, assuming constant sedentary-nomadic ratios (13) in each region, this population can be estimated at 128,874 inhabitants or 48.15% of the nomads in the regions mentioned. In short, the total population for this agro-ecological zone can be estimated in 1977 as having been 247,715 persons representing 35.8% of the residents in these regions and 18.3% of the total population residing in Mauritania. At present, this population should be 256,767 strong (14), including 141,753 sedentarized inhabitants and 115,012 nomads.

According to the village sheet designed in 1977 by the Statistics Bureau, cultivators and breeders practise oasis farming in 489 villages and hamlets scattered throughout the 12 regions; these villages include 25,354 cultivators, 3,075 stock-raisers and 2,480 herders, plus a resident population of 246,769 inhabitants. Approximately 80% of the cultivators are concentrated in the oasis zone of the Adrar, the Tagant, the Assaba and the two Hodhs.

I.2.2 Population Involved in Oasis Agriculture

It would be difficult and nearly impossible, in the framework of this study, to make a positively exact estimate of the populations involved in this subsector. It would be easier to say that the entire population is implicated, for this is true in a way; or to say that no one is implicated, for rarely is oasis farming the only way a group makes its living, but it is part of a set of production systems which vary according to the physical and human setting. This

(13) RAMS, Base Line Study B2, 1980.
(14) Ibid.

activity involves the farmer, the breeder, the merchant, the civil servant, the herder, etc., whatever their social standing.

Furthermore, this activity stretches out over the territory, extending beyond the agro-ecological zone such as it has been defined.

Nonetheless, we have attempted to make an estimate based on the survey made in the scope of the RAMS project in November, 1979, which provided the following results inside the oasis agro-ecological zone:

- 66.6% of the people practise oasis farming. These persons were selected at random from among the sample villages selected for the survey on production and who include farmers,herders and other rural workers (artisans, shopkeepers, etc.)
- 33.33% practise other agricultural activities or stock-raising, or both at the same time.

Within the sample population practising oasis farming:

- 20% practise oasis farming alone
- 23% practise farming other than oasis farming
- 56% are engaged in other activities (farming or stock-raising or an activity other than farming, or a combination of the three) in addition to oasis farming.

Applying these results to the population figures, one finds:

- 31,192 heads of households involved in oasis farming, using the estimate for the total population in the oasis agro-ecological zone.

- 20,585 cultivators, breeders or herdsmen involved in oasis farming, not counting merchants and other professionals.
- Finally, the working population partially or totally engaged in this activity comprises between 20,600 and 31,300 persons.

Considering the Plan's information on the production value of the subsector and that of the GDP (Gross Domestic Product) per capita for the rural sector and for 1975, it can be concluded that in theory, 22,260 persons earn their income from oasis farming. For the entire agricultural population this figure is 71,785 persons. Therefore, approximately 31% of the population making their living from farming alone earn money from oasis farming.

I.2.3 Working Population, Employment (15)

In Mauritania, the working population is comprised of 406,524 persons representing 30% of the population living in Mauritania. This gainfully employed population is divided into:

- Urban and rural sedentarized persons with 259,166 workers representing 45% of the total sedentary group.
- Nomads, with 147,359 workers representing 33% of the total nomadic group.

This gainfully employed population is distributed as shown below among the different sectors of economic activity:

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(15) RAMS, Human Resources Unit, 1980.

- Sedentarized: 259,166 gainfully employed persons in:

• Agriculture	103,213	(39.8%)	
• Livestock Raising	36,147	(13.9%)	55.0%
• Fishing	2,362	(0.9%)	
• Forestry	711	(0.3%)	
• Crafts	12,161		4.7%
• Other Sectors (Industries and Services)	104,162		40.2%

- Nomads: 147,369 gainfully employed in:

• Agriculture	22,583	(15.3%)	
• Livestock Raising	116,323	(78.9%)	94.2%
• Crafts	1,821	(1.2%)	1.2%
• Other sectors	4,632	(4.5%)	4.5%

There are 45,091 unemployed active persons, composed of

- 42,460 sedentarized persons in the male population aged 12 and over, or 7.4% of the total sedentarized population.
- 2,631 nomads in the male population aged 12 and over, and women who are heads of the household, or 0.59% of the total nomadic population.

It must be noted that those considered active include:

- Sedentary males aged 12 and above.
- Male nomads aged 12 and above and the female heads of households only. Because of this, the non-working population is estimated to total 356,121 persons, including:
  - 269,880 sedentarized persons, representing 47.3% of the total sedentarized population.
  - 86,241 male nomads, representing 19.37% of the total nomads.

Moreover, for the agro-ecological zone of the oasis, transposing the results in the table below the gainfully employed population should total 76,293 individuals, distributed by sector of activity as shown in the following table.

Table No. 3 Distribution of the Active Population in the Oasis Agro-Ecological Zone by Economic Sector

Economic Sector	Sedentary	Nomadic	Sector Total	%
Agriculture	14,146	6,332	20,478	26.7
Herding	4,916	32,685	37,601	49.3
Fishing (16)	-	-	-	0.0
Forestry	95	-	-	0.1
Crafts	1,662	508	2,170	2.8
Industry, Commerce and Services	14,218	1,860	16,078	21.0
Totals	35,037	41,385	76,422	100

(16) Fishing was not taken into account

The non-working population has a total of 44,142 persons, 36,076 of whom are sedentarized and 8,066 of whom are nomads. This population is comprised of male children aged 12 and over, which represents relatively high potential in manpower next to unemployed persons of working age.

I.2.4 Forms of Economic and Social Organization

The agro-ecological zone of the oases is almost exclusively populated by Moors. "Les terrains de culture dans cette zone, portent,comme l'ensemble des terres des pays Maures, la marque d'une appropriation collective de caractère traditionnellement tribal. C'est généralement dans les limites de ce cadre que s'effectue l'appropriation familiale ou individuelle. Ainsi, les noms des principales palmeraies du pays évoquent-ils immédiatement les noms des tribus qui en sont propriétaires: Chinguetti appartient aux Idawali et Lagheal; Atar, Akjoujt et leur environs aux Smassid et aux Ideichilli, Ksar El Barka et Rachid aux Kounta, Tidjikja aux Idawali, etc." (17)

Yet, despite this tribal character, "la famille monogame constitue toujours l'unité de base de la société Maure. Nettement individualisée dans l'espace, elle correspond généralement à une tente et elle jouit en principe, malgré les liens qui l'unissent aux ensembles plus vastes tels que la tribu, la fraction de tribu ou le campement, d'une autonomie dans la gestion de ses biens et où le mari joue le rôle principal. Cette unité incluait très souvent dans le milieu traditionnel un ou plusieurs indépendants (esclaves surtout)." (17)

Hence, the family emerges as the basic socio-economic unit in this agro-ecological zone, and represents the main form of organization for developing the land.

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(17) RAMS, 1980. Sociological Study.

This form of organization provides insight into the relatively specific nature of the Moor's social organization (18) in general. To mention only the most important of those traits, it is recalled that "le système social Maure a toujours fait place et continue à faire place à des exigences de solidarité, de générosité (le devoir d'hospitalité est une obligation), s'étendant souvent à un nombre d'individus tel que tout calcul économique fondé sur des données numériques précises est non seulement impossible, mais pratiquement sans objet dans la mesure où les acteurs sociaux eux même n'ont ni l'envie ni la possibilité de faire la moindre prévision budgétaire." "Ainsi...les normes qui régissent les rapports entre les différents membres de cette société ne peuvent revêtir qu'une signification approximative qu'il serait illusoire d'en tirer des conclusions sur par exemple, les budgets familiaux."

Within the milieu of a nomadic encampment, for example, if someone should kill an animal, receive gifts or a consignment of goods, he must share it with all his neighbors and must always set aside a part of his earnings to support his dependents and relatives in need.

Another rather important characteristic resides in the fact that family property is a function of tribal ownership in most cases and is only rarely directly exploited by the owner: most often, Haratines do the majority of the farm work and are compensated in various ways. Less often it is cared for by slave-servants (or abids) and

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(18) RAMS, 1980. Sociological Study

very rarely by the owners themselves or members of their families.

In addition, production among these activities was organized in a traditional manner and with respect to subsistence living and customary trade, and continues to bo so to a certain degree. Nowadays, the organization is very slowly evolving into more developed forms, or in contrast, into more degraded ones, depending on spatial or socio-eoonomic changes occurring locally or regionally (building of a new road, development of a town, drought, desertification, etc.). These present forms of organization are almost entirely autonomous with regard to existing socio-political structures. This is confirmed, moreover, by the absence of any economic, professional or socio-professional institution aimed at bringing about or provoking any change in the systems of production.

However, in past years, certain changes have been encouraged and have led to the establishment of agricultural cooperatives just about everywhere in Mauritania. In the oasis zone, 80 cooperatives were formed in the Adrar and merged into a union, and 57 unions in the Tagant. In the present state of things, although they still exist, these cooperatives have not been successful because no change has taken place in the systems of production; they are thereby nothing more than pre-cooperative groups, in most cases composed of producers from the same extended family or of the same clan. Their impact on production is negligible.

In summary, it can be said that the forms of economic and social organization utilizing the environment of the oasis are oriented more towards a subsistence

economy and traditional trade economy than towards an artisanal or market economy. The lack of socio-economic and political actions appropriate to development needs is behind the fact that these forms are not evolving at all and that the production systems are stagnating and disintegrating to a certain extert. This disintegration leads ultimately to the abandonment of oasis-based activity, rural exodus and a general socio-economic deterioration of life in oases.

This phenomenon will not stop on its own and requires sustained intervention by local authorities.

I.2.5 Knowledge of the Population in Date Palm Growing and the Antiquity of their Experience with the Crop

Literature on this subject reveals that date palm cultivation was introduced long ago in Mauritania, but really took off in the 17th century in the Adrar. Between the 17th and 19th centuries, date-growing developed in the Tagant. Not until the early 20th century did it reach the Assaba, and later on other regions such as the Hodhs, the Guidimakha, the Gorgol, the Brakna and the Trarza.

On the whole, the level of knowledge in practising date-growing is rather mediocre, even among the populations where this type of farming is most ancient (Adrar and Tagant). This goes back to the crop's traditional nature and to the manner in which the oases were exploited. In reality, date tree growing is only one of many components in the exploitation of this environment, and its place in the economic life of the populations has remained somewhat limited.

Moreover, farming in the oases in most cases implies indirect farming: oasis ownership usually evokes the image of well-endowed white Moors (or Beidans) capable of financing the building of palm groves: date palm growing implies Haratines and slave-servants. The former, who started date tree cultivation, possess knowledge which is either inherited or passed on to them, and which has not evolved at all due to their absentee status, since they only come near the palms during the harvesting season, called the "GUETNA"; the latter have the same amount of knowledge that was ingrained in them by the first group. A knowledge passed down from generation to generation with no improvements, because of a lack of motivation. Another indication which we believe confirms what we have set forth, is that there has never been the least innovation originating from the personal experience of any typical date farmer; it is also worthy of note that the manual tools used in other date palm growing areas have never been introduced; only the palm tree and the basic principles of farming have been introduced.

Now considering the principal date-growing regions in Mauritania, it is easy to assert that the cultivators in the Adrar and the Tagant are more familiar with the basic date-growing methods than those in other regions, where the level of know-how is nearly nonexistent.

Chapter II. SYSTEMS OF PRODUCTION

II.1 PRODUCTION ZONES

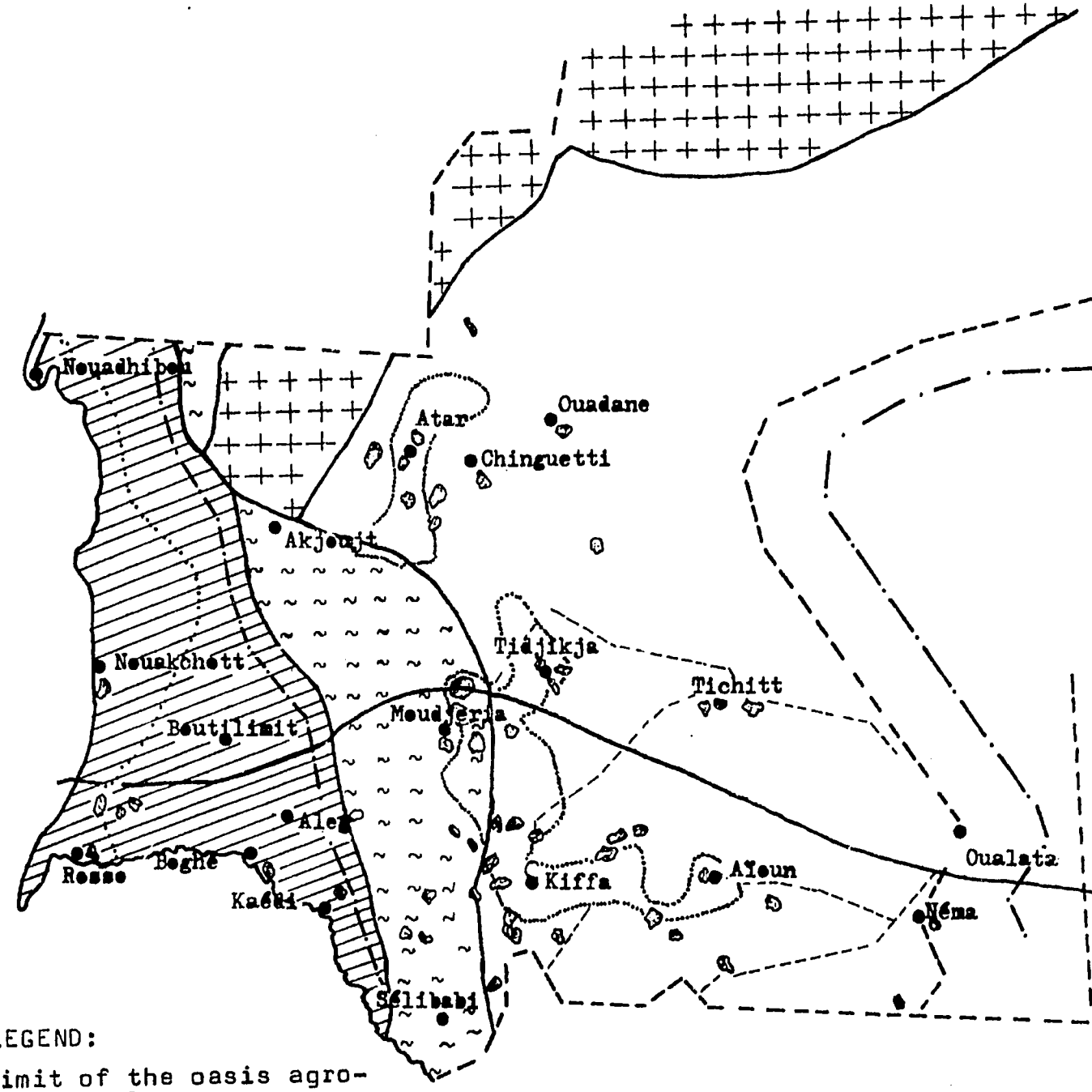
II.1.1 Present-Day Production Zones: Extent and Geographic Distribution (Map No. 5)

As was pointed out in the preceding comments, the principal date-growing zones are located inside and in the vicinity of the main mountainous formations and plateaus, viz. the Adrar, the Tagant, the Assaba and the Affole.

In general, the oases are seen as a string of small palm groves on the alluvial plateaus of the oueds, along the watersheds winding between the fixed dunes or across a plain, a reg or plateau, and also in the floodwater dissipating areas. This character gives the oasis their potential for spreading over a given site; another factor of less importance determining this extension is the length of time the date palms have been under cultivation; in fact, the most extended are found in the oldest date-growing regions and the smallest in the most recent zones. The palm groves are usually spread out lengthwise and very rarely across, such that a palm grove rarely attains 500 m in width.

Thus, the surface area of the palm groves is rather limited on the whole, but there are quite a few of them. The area of a palm grove can vary from 1 to 40 ha, rarely exceeding that size. Counting only the main date-growing zones there are about 310 palm groves, distributed as follows:

Map No. 5. LOCATION OF PALM GROVES IN MAURITANIA



LEGEND:

- Limit of the oasis agro-ecological zone.
- Palm groves
- Approximate limit of the dry slope
- Substratum limit
- Limit of interstratified continental shelf
- Limit of the saline slope
- Crystalline foundation
- coastal sedimentary basin
- Arc des Mauritanides
- Taoudeni Basin

Source: Author's map, based on the underground water resource map. (adapted and updated after P. Munier)

- Adrar: 84 palm groves
- Tagant: 110 palm groves
- Assaba: 70 palm groves
- Affole: 45 palm groves

Counting the palm groves found in other regions, the total number is in the area of 350.

In summary, the date tree population is very spread out across the land, which is enough to hinder the effectiveness of any action. This phenomenon is quite characteristic of the Mauritanian palm groves and inherent of the local physical conditions; it is also worsened by the rapidity with which the palm tree propagates, which takes place at two levels: on the oasis site and in the regions. At present, there is absolutely no restriction or orientation of this propagation, which is disorderly and helps deteriorate the environment; this will be studied in more detail in Chapter VI.1. As concerns the restrictions, there are two examples. The first is that presented by the United States, which, after studying the behavior of the palm in several zones, defined as early as the start of the 20th century, a very specific area for palm tree cultivation, while it has actually begun to be cultivated nearly everywhere in desert zones. The second example is that of Tunisia where, as everywhere else, the creation of an oasis depends on the size of the underground water sources and where the building of water points for this purpose is subject to a technical enquiry and very strict regulations.

Returning to the size of the date tree population in Mauritania, as much from the standpoint of the trees themselves as the area they occupy, until now no global or systematic evaluation has been made: the only census of

note was that conducted by Bouchet in 1958-59, in the framework of IFAC, which only concerned the Adrar; other less important administrative censuses have been made locally in very limited areas. Moreover, no follow-up was made of these censuses, which would permit adequate updating of the results obtained, for we believe that the situation has notably developed. Hence, in this study we shall limit ourselves to an approximate evaluation based on incomplete data (Table No. 4) and on our own field surveys.

In order to make use of these statistics, the idea which first comes to mind is to draw from them the linear growthrates of the date tree population and to project them, but evidently there is not one complete yearly series covering the date-growing zones. We therefore propose to complete some series (1929, 1936, 1949 and 1958) by using the observed growthrates for the fragmentary statistics on each region, the amounts thus factored are underlined in Table 4.

Perusal of these newly calculated series reveals that since 1936, the growthrate for the date palm population has slowed down somewhat. In fact, the growthrate calculated for this entire population was:

- 6.3% between 1936 and 1949
- 5.1% between 1949 and 1958
- 1.5% between 1958 and 1973.

So, although one may question these data and calculations, they do reflect a certain reality, which is generated by socio-economic deterioration linked to the colonial period.

Table No. 4. Partial Statistics on the Size of the Date Palm Population in Mauritania between 1905 and 1961

Region/Department	1905 (1)	1913 (1)	1922 (1)	1924 (1)	1929 (1)	1931 (1)	1936 (1)	1932 (1)	1941 (1)
ADRAR									
- Atar					79000		102099		
- South Atar									
- East Atar			38500		35600		44183		50315
TAGANT									
- Tidjikja				47528	67489		95692		
- Moujeria	305	1000		5505	112562	9226	22442		
- Tichit				20245	18075		14200		
- Rachid					19289		20044		20044
ASSABA					1611		8489	10500	
WESTERN HODH					n.d.		n.d		
GUIDIMAKHA					n.d.		n.d		
BRAKNA					n.d.		n.d.		
TRARZA					n.d.		n.d.		
GORGOL					n.d.		n.d.		
TOTALS					223626		307149		

(1) Based on Reports by cercle commanders, by Munier, 1955.

Table No. 4: cont'd Partial Statistics on the Date Palm Population in Mauritania between 1905 and 1961

Region/Department	1949 (1)	1951 (1)	1958 (2)	1961 (3)	1973 (4)
ADRAR					
- Atar	145000		195863		
- South Atar			169579		
- East Atar	55000		34427		
TAGANT					
- Tidjikja	99423	100000	102100		
- Moujéria	50449	55000	89650		
- Tichit	19184	20000	23780		
- Rachid	21278		22438		
ASSABA	100000	120000	141000	150000	
WESTERN HODH	50000		35000	30000	
EASTERN HODH	n.d.		2600	2600	
GUIDIMAKHA			1000	1000	
BRAKNA	20000		n.d.		
TRARZA			n.d.		
GORGOL			n.d.		
TOTALS	560334		817437	1000000	

(1) IFAC Estimate, P. Munier, 1955
(2) According to R. Bouchet, 1958/59
(3) BDPA, 1967
(4) P. Munier, 1973.

In a nutshell, based on the growthrate observed between 1958 and 1973, the date palm population can be estimated as 1,087,190. This result is debatable, but an attempt has been made to reconstitute the population by region:

- The Adrar: Based on the 1958-59 census, which is relatively reliable, and according to our observations made in the field, the net annual growthrate (taking into account deterioration, drought, desertification, etc.) should be 0.5% between 1958 and 1980, assuming the best, which gives 443,800 palm trees to date.

- The Tagant: According to the IFAC census of 1958, which was made by means of a photo survey on the scale of 1/50,000 and covered the area occupied by the oases, there should have been 1,203.5 ha of palm groves with a density of from 150-200 trees per hectare, or between 180,500 and 240,700 palms. If one accepts the figure of 287,700 proposed by the Tagant agricultural subsector, for 1978-1980, one can compute an average yearly growth of between 0.90 and 2.6% between 1958 and 1980, which seems logical enough based on observations made in this region.

- The Assaba: According to P. Munier, the extension of date-growing (19) has been very dynamic, and he even spoke of "plantation fever". In fact, since its introduction in the region, the palm tree has spread out quickly.

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(19) P. Munier, 1955.

According to various administrative censuses, the palm tree population jumped from 1611 palm trees in 1929 to 10,500 in 1936 and to 120,000 in 1951, an average annual growthrate of over 250%. After 1951, this expansion experienced a slight decline, registering an average rate of 2.5% per year between 1951 and 1961. At present, this expansion continues at nearly the same rhythm, especially after the 1968-73 drought. This extension is apparently favored by the sedentarization of the nomads, whose herds were devastated during this drought. Thus, based on a growthrate of 2.5% per year, which is considered to be an average hypothesis, one can estimate that there are 221,000 palm trees. A more pessimistic hypothesis would allow a rate of 1.5% yielding 192,750 date palms.

- The Western Hodh: Based on data gathered locally, we estimate the palm tree population to be 48,000 in 1980.

- For the remaining regions: Gorgol, Brakna, Trarza and Guidimakha, although there is a relatively insignificant number of date palms, so as not to overlook them, we shall retain the data from 1949, which gives 20,000 palms. Still, it is worth noting that there has been some growth. Just taking the example of the Guidimakha, in the department of Ould Yenge, where the palm tree population is fenced in, during our tour, 30 Zeribas were pointed out to us with an average of 100 trees to a Zeriba, or 3000 date palms, representing an annual growthrate of 10.5% over the 1961 population.

Recapitulating the above in Table No. 5, one comes to a total of between 958,850 and 1,063,800 palm trees.

Table No. 5.

Region	Low Hypothesis	Average Hypothesis	High Hypothesis
Adrar	443,800	443,800	443,800
Tagant	252,300	291,650	331,000
Assaba	192,750	221,000	221,000
Western Hodh	40,000	48,000	48,000
Other Regions	20,000	20,000	20,000
Total	956,850	1,025,100	1,063,800

II.1.2 Future Production Zones

Under present socio-economico-political conditions, date palm propagation continues to be practised everywhere, helter skelter, and without control in the southern third of Mauritania. In our opinion, this phenomenon is due to the total technico-economic independence of the populations involved with respect to the structures now in place, making it difficult to set up any system of control. Thus, we foresee the prolongation of the present situation into the future, with a 1 to 5% annual growthrate of the date palm population under the best assumption. This growth will affect the southern part of the country more than the central region (Tagant) and the north; its impact on date production should be negligible given the rather low level of knowledge about the principle of date palm growing in these regions.

In another connection considering the possibilities in underground water in certain regions and of certain projects under way, it is possible to envision the durable development of artisanal and even semi-modern date palm growing. We cite the case of the project to equip the 36 wells on the Trarza watertable and of the 64 others to be sunk on the same table and on other watertables, most of which are located in the vicinity of major transport routes. To date, no agro-economic or feasibility study has been made but according to the project foreman, the Hydraulics Division, date palm farming should be one of the projects planned on. We take this opportunity to deplore the fact that there has been no socio-technico-economic study for these future areas, and that none has been planned, which in our opinion will have a considerable impact on the social benefits of this project.

Moreover, the possibility has been pointed out of mobilizing the underground water resources in the Taoudeni and in the Dhar of Néma Oulata, which are far from minor, and incidentally, those of the underground watertable of the Aïoun sandstone.

Hence, mobilization of the underground water resources could in the long run make it possible to really boost the oasis subsector.

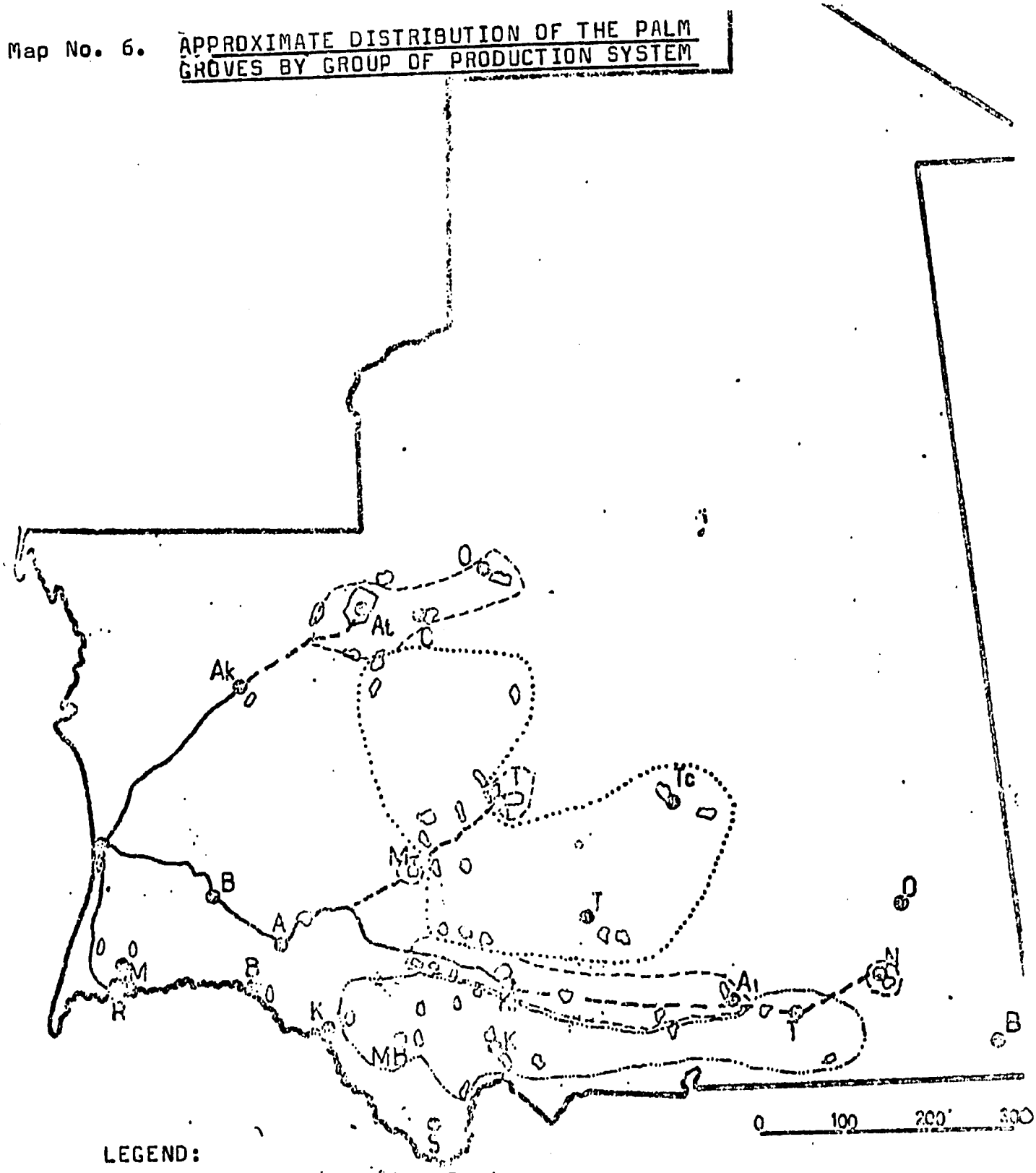
This possibility could only have a beneficial impact by means of a sustained and self-maintained endeavor to aiding its development and through agronomical research, supervision and training, extension, materials, marketing and farming credit.

II.1.3 The Systems of Production

The complexity of problems stemming from the subsector of oasis agriculture and the necessity of making a rather general analysis have led us to establish a typology of the oases. This typology is sufficient enough for us to make an approximation of the main problems peculiar to this subsector and to foresee appropriate solutions. The criteria adapted have been very global, bearing on the environment (accessibility, importance of economic activity, the antiquity of oasis farming, oasis farming's place in the system of exploitation of the environment, influence of urban areas, etc.). Hence, we have been able to identify 3 major types or groups of production systems (cf. Map No. 6):

II.1.3.1 The first group is that of the production systems in a state of relative disintegration. This disintegration, depending on the case, is due to a deterioration of the physical surroundings (sand taking over erosion, dropping of the underground watertable levels, prolonged drought, etc.) or to a socio-economic change (rural exodus, social mobility, economic mobility, breakdown of an institution, influence of an urban area or of a new access route, etc.). This group is characterized by production spaces which have been exploited since remote antiquity and by intense human activity due to their easy accessibility and to the existence of urban areas that are relatively developed. Principally beidan Moors and secondly haratines constitute the human element of this group. This group of oasis farming is composed of one element of a traditional system of exploitation with three balanced activities - livestock-raising, dryland farming and oasis farming.

Map No. 6. APPROXIMATE DISTRIBUTION OF THE PALM GROVES BY GROUP OF PRODUCTION SYSTEM



LEGEND:

------ 1st Group of Production Systems

..... 2nd Group of Production Systems

-·-·-·- 3rd Group of Production System

——— Principal Transport Routes

Towns

Palm Groves

Presently, this situation has more or less deteriorated to such a degree that a multitude of subgroups or subtypes of production systems are found. Some have been able to maintain their equilibrium (traditional farming), but these are the least common; others have evolved into the artisanal forms integrated into the market or have been able to adapt themselves to the changes in the environment (change in activity, abandonment of farming). In a nutshell,this set of systems is undergoing a complete transformation; it is simmering with diverse trends. As a result of this, it appears offhand that this is the group most open to changes and to making the best of any future action designed to safeguard and rehabilitate oasis agriculture.

The oases which can be ranked among this group are firstly the ancient metropolises, generally speaking (Atar, Chinguetti, Tidjikja, Aïoun, Tichitt, Oulata), and secondly those found near the new transport routes, such as Diouk, Kamour, Guerou, Tintanes, etc. It is not our intention to cite all the oases intthis case, but simply to give a good idea of them.

II.1.3.2 The <u>second group</u> is composed of the production systems in equilibrium with the exploitation of the environment, and in which the oasis is only one element in a rigid system built on the exploitation of grazing lands (breeding), springs (weirs, basins, dikes, Tamourets) and alluvial watertables (palm groves). This group of production systems characterizes a very distinct lifestyle, that of the semi-nomads or transhumants who are found on most of the oases in central Mauritania, among the hardest to get to and located rather far from the main towns with administrative bureaus. The oasis area is made up of

alluvial soils in the fossilized oueds, at the foot of a scarp or nearby a spring. Moorish beidans, chiefly semi-nomadic, constitute the human element; they may or may not practise transhumant livestock-raising during the dry season, depending on the size of the herd; they also practise recession plot farming with weirs or in catchment areas of runoff water in autumn, and retreat to the palm groves during the rainy season for the Guetna. In these systems, it is the practice to entrust the Haratines or slaves with guarding and cultivating the palm groves; companion crops are very rare. Neither is it unusual to find in this group some subtypes of more developed systems under very special conditions.

II.1.3.3 The <u>third group</u> is that of the group of palm groves and oases most recently created, the majority of which are located in the southern third of Mauritania, notably in the Assaba (southern part), the southern part of the Hodhs and in other non date palm growing regions. Oasis activity is new to this group, for it is working into an existing system (agriculture, livestock-raising) or into one which is vanishing (sedentarization of nomads); due to this fact, its place in the system of exploitation of the environment is quite marginal. In these oases, the spatial element consists of oueds and drainage areas, while the human element is mixed, comprising beidan Moors, haratine Moors and Peulhs to a lesser extent. Knowledge of date-growing techniques is almost nil.

It is worthy of note that these three groups, such as they were briefly identified, though different in many respects, have just as many similarities if other, less general criteria are taken into account. These common

characteristics as well as others will emerge as further developments are made.

II.2 THE CROPS

Oasis farming as we have defined it in the introduction owes its name to the existence of the palm tree as the principal crop: this leads to mention the priority of the date crop and then the subjacent crops.

II.2.1 Date Palm Growing

This is a very ancient activity, generally widespread from Mesopotamia to North Africa. This activity apparently reached Mauritania in the 11th century A.B.
As its name implies, this is the crop Phoenix dactylifera Lin, commonly called the date palm.

II.2.1.1 Composition of the Date Palm

Phoenix dactylifera: a monocotyledon of the palm tree family, subfamily or subgroup of the coryphinees (21). There are several species of the phoenix genus, including dactylifera (the date palm), which is the most interesting species from the agronomical point of view. The palm tree is dioecious, which means that it has two separate sexes borne by two separate trees. It is composed of somatic chromasomes. This is a thermophilous species requiring high temperatures for its development and fructification. It is also heliophilous, demanding strong light for its fructification and ripening; low luminosity would encourage the development of the vegetative organs. It depends on photosynthesis, which is needed for production.

(21) According to the classification of Martius and Blume.

The date palm also has certain ecological requirements which were exposed in the first part of this report.

II.2.1.2 Cultivated Varieties

The use of the term "variety" in date tree cultivation is inappropriate because "variety" designates a genetically fixed race or clone which is not the case for the date palm. Actually, in light of its genetic potential, the date palm like all other species of the phoenix genus, is capable of self-hybridizing very easily, so well that all that is called a "variety" is in fact nothing more than a hybrid or a cultivar. Even if a given race is propagated from an offshoot, it still remains that this race was obtained from the seed of berries which are only hybrids.

Returning to the "varieties" cultivated in Mauritania, P. Munier (22) in 1955, compiled a list of the names of 250 varieties, not including the Bafour varieties (23). Although very open to debate, this seems quite possible, since each seed planted can parent a new "variety", especially when it is known that propagation from seeds is quite common in Mauritania.

In the present situation, we have no exact idea of the number of existing varieties, but during our visits to palm groves considered to be representative of others, we took down the names of over 50 varieties, of which about a

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(22) P. Munier, 1955. Le palmier dattier en Mauritanie.

(23) The Bafours are pre-Islam persons or persons who have not converted to Islam.

dozen have come from other unknown "varieties". Considering the clones from the seeds of known "varieties", this number would be around 100. In that respect, it is pointed out that varieties coming from the seeds of other known varieties are distinguished from the latter; the names of such varieties are made up of two words: the first word is "Aalfa", meaning "seed", the second is the name of the original variety. Whenever this variety is unknown, one gives it the name of its place of origin or of the date grower who introduced it, etc.

In addition to these varieties, we have noted several other clones coming from the seeds of dates from the Middle East (Palestine and Irak) imported for food aid programs. These clones were introduced in the past decade and several of them are being produced. We have not listed the names of any of these varieties; the date cultivators settle with calling them by the color of the fresh date, for example: Ahmar (or red) of Palestine, Akdhar (or green) of Irak, etc. Moreover, the names of certain varieties can, in our opinion, include several clones; this is true most notably for those named according to their colors such as Ahmar (red), Asfar (yellow) or Sofr (the yellows), Akdhar (green) or Khdiret (the greens).

In the following, we have listed the names of varieties and clones we came across in the field:

1. Ahmar
2. Tinterguel
3. Oun Araïch
4. Tijib
5. Tiphert
6. Tamazet
7. Médina
8. Meriziga
9. Tiguidert
10. Ahmar Edir
11. Ahmar Djingue
12. Anserghi
13. Tidhel
14. Tenouazidi
15. Ganeb
16. Kdhirette
17. El Bhirette
18. Basbork
19. Eujob
20. Eujbejou
21. Tenejdeft
22. Dermakel
23. Boussoukkar
24. Tinyakour
25. Sikane
26. Sasnet
27. Habs
28. Daram
29. Ahmed Deguen
30. Ajib Ndabagr
31. Sofr Tfilette
32. El Mahboula
33. Te dhel
34. Bouffegous
35. Adaght
36. Bahwa
37. Sumbahra
38. Kalioune
39. Mechmelette
40. Malkheïss
41. Mgadir
42. Bezzoul
43. Tenmenmoud
44. Fuzzer
45. Eddakna
46. Takembat
47. Zraïguine
48. El Aggaba
49. El Amoud
50. Aâlfa Echchagra
51. Aâlfa Safra
52. Aâlfet-Tiguidert
53. Aâlfet-El Haït
54. Aâlfet-Ouadane
55. Aâlfet-El Ackka
56. Aâlfet-Ben Laghlal
57. Aâlfet-Bessberg

Elsewhere in the RAMS survey, only 10 varieties were strongly represented; by order of importance, they are:

. Ahmar	35.3%	of the sample
. Asfar	20.7%	"
. Tinterguel	17.5%	"
. Kdhiret ou Akhdar	10.0%	"
. Oum Araïch	5.5%	"
. Sumbahra	3.8%	"
. Bezzoul	3.1%	"
. Tijib	2.0%	"
. Bahwa	0.6%	"
. Mgadir	0.5%	"

Although this result may be very debatable, still it highlights the most important varieties; the experience of the RAMS survey has shown us that a good number of date farmers do not know the names of the varieties they cultivate, especially in the Assaba and in the southeast, which is enough to invalidate the results.

We have also remarked that the relative importance of the different varieties varies according to the region; hence, for the Adrar, the most dominant varieties are:

. Ahmar	73.0%	of the sample
. Asfar	14.8%	"
. Sumbahra	5.3%	"
. Tijib	3.7%	"
. Tinteguel	2.0%	"
. Others	1.1%	"

For the Tagant:

. Tinterguel	41.8%	of the sample
. Ahmar	19.7%	"
. Kdhiret ou Akhdhar	11.8%	"
. Asfar	9.4%	"
. Oum Araïch	8.6%	"
. Bezzoul	4.3%	"
. Others	4.1%	"

For the Assaba:

. Asfar	43.8%	of the sample
. Kdhiret ou Akhdhar	19.8%	"
. Ahmar	8.7%	"
. Ngadir	6.5%	"

• Tinterguel	5.8% of the sample
• Oum Araïch	5.8% "
• Sumbahra	5.8% "
• Others	3.5% "

In summary, the notion of variety without a systematic way of determining, it has only limited meaning, especially since most of the farmers do not know the varieties, particularly those of the third group of production systems (Chapter II.1.3).

From the viewpoint of consistency, the most common varieties can be classified as: the Ahmar variety, which is soft, the Tinterguel, Asfar and Oum Araïch varieties, which are semi-soft and the dry Kdhiret variety. Based on statements by the date farmers, the Tijib and Tiphert varieties are considered to be the best for taste quality, and the Medina and Ahmar varieties are the most appreciated by consumers and are easily sold; Adagt and Tinterguel are the most productive.

II.2.1.3 Age of the Plantation

In general, the oldest date tree growing areas, such as the Adrar and the Tagant, have the oldest palm groves. According to the sampling made by the RAMS survey team, in which we distinguished 4 age groups, the results were as follows for the whole country:

Age Group	Number of Palm Trees	% of Total
Less than 5 years old	1852	40.3
From 6 to 15	1445	31.4
From 16 to 80	1113	24.2
Over 80	186	4.0
Total:	4596	100%

Overall, these results show that:

- 40% of the date tree population has not yet begun to produce;
- 60% is producing.

This naturally refers only to the female trees. Now, considering the main date palm growing regions (Table 6)

Table No. 6. Distribution of the Date Palm Population by Region and Age of Plantation

Age Group	ADRAR		TAGANT		ASSABA		OTHERS	
	No.	%	No.	%	No.	%	No.	%
Less than 5 years	266	24	168	21.7	580	50.6	838	53.2
from 6 to 14	397	36	204	26.4	315	27.5	529	35.8
from 16 to 80	307	27.8	400	51.8	250	21.8	156	9.9
over 80	134	12.1%	0	-	0	-	52	3.3

one observes that the age structure of the population varies according to the region and takes on a character peculiar to each of the date-growing zones, which is to be expected <u>à priori</u>:

- The Adrar has a moderate amount of young palms (24%) and a relatively high number of old palms (12.1%) are likely to die out, which makes for a rather low or zero rate of renewal, if one takes into account the losses of diverse origin. The level of productive palms is about average (63.8%).

- The Tagant has a relatively well-balanced age group structure for its date palms; one notes the absence of old plantations over 80 years of age, which is the age at which palm tree productivity begins to decline.

- The Assaba and the other regions have over 50% young palms (50.5% and 53.2%), which offers relatively important production potential and promises rapid expansion.

These results can easily be verified in the field. Also, by comparing them to the groups of production systems previously defined, one can conclude that the palm groves and oases of the first group identify most with the palm plantations of the Adrar and, in general, with all the older plantations, for which a renewal and rehabilitation program would prove to be of great help. The oases of the second group identify most with those of the Tagant, whose existing potential could be extended by preventive action against future degradation by aging or other factors. Finally, the third group of the production systems would identify with the palm groves in the Assaba and other regions, characterized by their young age and for which programs of assistance and support in certain areas would allow them to make the best of their potential.

II.2.1.4 Phytosanitary Condition and Protection of the Palm Groves

In Mauritania, several diseases and parasites exist as well as certain pests of the date palm.

II.2.1.4.1 The diseases are all cryptogamic in nature; they cause little damage and do not prove to be of any special economic importance. These diseases are:

+ Inflorescence rot:
This disease is due to a fungus: Manginiella scaetar. It attacks the inflorescences inside the spathe after having penetrated from outside. The first visible symptom is a rust- or brown-colored spot, which appears on the surface of the spathe. This disease, which can be controlled with various anti-fungoids, affects a few trees especially after a thunderstorm during the blooming stage. In Mauritania, considering the weather conditions during the blooming stage, this disease is very rare, appearing very sporadically. Only a few date growers mentioned it to us, using the local name "AJINKER".

+ Palm Tree Brown Scale or Palm Tree Smut:
This disease is caused by Graphiola phoenicis. It is manifested in the form of brown, moldy bumps on the palm folioles, mainly on adult and aged palm leaves. This attack, sometimes considered to be benign, can considerably affect the growth of the palm tree. It is easily controlled with anti-fungoids. In Mauritania, we saw a few minor cases of this disease, and believe that it causes no noticeable damage.

+ The "Hanging Heart" Disease:
This is a cryptogamic disease causing two sorts of rot: one located at the base of the stipe caused by the Thielaviopsis paradoxa, and the other which affects the terminal bud caused by Botryodiplodia theobromae.

The manner in which this disease propagates still is not clear. Its gravity resides in the fact that a tree that has been attacked by it is irreversibly condemned to perish, at least with present knowledge of the disease, which cannot be spotted earlier.

Referred to as "Takaket" in the vernacular, it has evidently been known for a long time by the Mauritanian date growers. However, to date, it has caused very little damage. Based on one field survey, the mortality rate caused by infestation is between 3 and 5% per year. This disease merits serious research in order to control its propagation and limit its effects.

II.2.1.4.2 As concerns the parasites of the date palm, they are numerous; two of them have proven to be of considerable economic importance in light of the damage they can cause; the date palm mealybug and the spider mite.

+ The mealybug: Parlatoria Blanchardi (Targ).
It is spread throughout all date-growing countries except in the United States, where it has been completely exterminated. This pest is considered to be one of the most dangerous for the date tree. It develops best when there is an abundance of humidity in the air and when there is the lowest amount of direct sunlight. The mealybug feeds on all parts of the date palm (by sucking the sap) and on the fruit, among other things. It thereby weakens the tree, impedes the ripening of the dates and markedly reduces their commercial value. The sensitivity of the date palm appears to depend on

the variety, and some are more sensitive than others (24). According to Munier (25) in 1955, this parasite was found only in the eastern Tagant and in Adrar; now, it has spread across the country - rare are the palm groves that are spared. Attacks are more or less severe, depending on the season and variety.

Mauritanian date tree growers are completely ignorant of ways to control this disease aside from burning, which continues to be practised by some of them.

Outside of this, a research program on the possibilities of biological control was conducted between 1965 and 1973 by J.C. Tourneur et al., in the framework of IRFA (formerly IFAC). This program came up with extremely intriguing results,whose distribution and extension, however, are running into certain practically unsolvable technical problems (Chapter III.3.3). This research was interrupted in 1973 to be taken back up in the same spirit with the reformation of the entomological laboratory of Nouakchott in 1977. Chemical control is possible: the example of the United States confirms this. Furthermore, a whole gamut of pesticides exist, the most effective of which are apparently the organophosphates.

+ The date palm spider mite:
This is the Oligonychus afrasiaticus (Mogregor), which is a type of Acarid of the Tetranychidae family. This mite attacks the young dates as soon as they begin to form by sucking on their nectar. Once the young dates are attacked, their growth and maturation are

(24) FAO, 1980
(25) P. Munier, 1955.

stunted, their color turns to reddish brown and several cracks appear. One of the characteristics of these attacks is the appearance of a fine web on the fruits similar to spiders: this web catches the dust, which in certain regions has earned it the name of "Ghabra" or "dust"; the commonly accepted name in Mauritania is "Taka". Some reactions of the various date varieties to this pest differs, for some are more sensitive to others and the attacks are more concentrated in the dry zones than in the relatively humid ones. This is a formidable pest, so much so that after massive attacks, it considerably depreciates the quality of the dates, to the point that they become unfit for eating.

In addition to the mealybug and the spider mite, there are other parasites causing serious but limited damage. These are chiefly termites, including Microcerotermes diversus silvestri (Isotera: termidae). These species are very small and white, affecting young palm trees and sickly ones in particular, attacking the roots at the stem, the leaves and their bases and sometimes the stalks as well. They can be spotted by the presence of tunnels in the attacked organs. These termites are rampant everywhere in Mauritania; their presence is more or less pronounced according to whether one is in the Sahelian zone or in the desert zone, and according to the local conditions of palm grove care. Cases of palm trees dying because of termites is very irregular. Date cultivators are not familiar with any method of control for these pests, which can easily be controlled by chemical and preventive controle.

Moreover, according to some date farmers, it seems that other parasites exist, probably coleoptera (caterpillars), which attack the stalks and provoke the death of the tree. In fact, according to these same cultivators, when the tree is brought down, enormous larvae crawl out of it; we were unable to verify this, but did observe a network of galleries measuring more than 1 cm in diameter in the heart of the stem wood.

II.2.1.4.3 As concerns pests, there are:

- The migratory grasshoppers: schistocerea america gregaria (Foreskal), which is found everywhere, especially in the Sahelian zone. They cause very little damage due to their small numbers, but quickly become a true danger when there are major invasions.

- Birds, including certain species of thrushes and parakeets, which are found in the Sahelian zone. They attack the inflorescences as soon as they bloom and then pilfer the dates as they develop. Damage caused by these birds are spatially localized, being limited almost entirely to the Assaba and to the southeast.

- Monkeys, which attack the dates at different stages. Their attacks are limited to a few isolated palm groves located in oueds not far from the monkeys' den. Damage is very limited, for beginning in May, the palm groves begin to be populated for the Guetna.

II.2.1.5 Yields

In date tree growing, as is the case for several other crops, the palm tree's yield depends on several factors, including: water, plantation density, light crop care, gardening care techniques, etc. In Mauritania at present, none of these factors has been well provided for or mastered as it should be in light of the special nature of the date crops. It therefore stands to reason that yields can only be mediocre on the whole. Of course, this does not rule out very high peak yields, obtained sporadically. According to our estimates of several plots, the average yield per palm tree is between 25 and 30 kg, but on an individual basis, one finds nearly zero yields (2 or 3 very light stalks) and some yields in the area of 120 kg, with yields of every size in between.

To return to the importance of the above-mentioned factors, we stress that better control of these factors would substantially improve the yield and permit steady production. In that respect, we cite the example of a traditional Tunisian palm plantation, which was replanted by Cruesi (26), and which yielded 85 kg/palm in 1963, 3 years after the onset of the operation; the initial yield was between 30 and 40 kg/palm.

II.2.2 The Companion Crops

On the whole, subjacent or companion crops of date tree growing are of marginal importance in oasis agriculture.

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(26) Centre de Recherche sur l'Utilisation des Eaux Saumatres en Irrigation Tunisia, now CRGR (Centre de Recherche du Genie Rural). (Research Center for the Utilization of Salt Water; Research Center for Rural Engineering).

These crops are fed by irrigation and located on ancient oases near urban areas (first group of the systems of production). In general, an estimated 20% of the date growers are practising this activity within the agro-ecological zones of the oases.

II.2.2.1 Crops Being Cultivated

A wide range of crops are found, with the exception of fruit trees. They are:

- the cereals, including wheat and barley, and sorghum to a minor extent.
- truck farming crops, with a whole gamut of vegetables.
- fodder crops: only alfalfa.
- cash crops, including henna, mint and tobacco.

+ Wheat and barley: Barley is sown at the beginning of November one to two weeks after wheat. Barley is reaped during the month of March and wheat around the end of March-beginning April.

The varieties grown are local, well-adapted to the climate, and are sown together, thereby making a heterogeneous mixture.

From the viewpoint of the area covered, the area of land sown is very small; cultivated plots of land are seen as a set of small strips rarely exceeding 30 m^2 of surface for each. In all, wheat and sorghum, based on our survey cover 21% of the areas cultivated with a total of 22 ha.

+ Sorghum: It is found principally in the Adrar and cultivated by a few date growers of Atar in very small quantities; the varieties grown are Taghalitt (white sorghum) and Bechna (red sorghum), which are large-grained millets with a relatively long maturing cycle. Sorghum is sown near the end of October-beginning of November and can be harvested around the second half of March. From the viewpoint of extension, sorghum represents less than 5% of the companion crops with a total of 3.5 ha.

+ Truck farming crops: These include various vegetables, chiefly comprising: carrots, green beans, tomatoes and on a smaller scale: potatoes, watermelon, turnips, onions, groundnuts, etc.

These crops are grown after the rainy season, between September and March, and can last until the beginning of July.

All of the varieties cultivated are of foreign origin and therefore imported, except the green bean (adlagance), which is a local variety.

As concerns extension, these crops cover - again based on our survey - nearly 71% of the annual companion crops, nearly 74 ha. The carrot, green bean and tomato are the predominant crops, representing over 80% of the vegetables.

+ Fodder crops: There is only one such crop, alfalfa, grown principally in the Adrar. This variety was introduced to the area. In light of climatic conditions, alfalfa grows year-round and can be harvested up to 24 times a year.

It is cultivated as an annual crop over small areas of land. The area it is grown on barely totals 5% of the cover crops, with about 5 ha in all.

+ Cash crops: There are 3 such crops, the most important of which is henna, laucenia inermis. Henna is a perennial species growing in the form of a bush and cultivated for its leaves. The leaves are dried and used as a beauty product in Mauritania and several other countries.

The leaves are usually picked once a month year-round. From the viewpoint of the area it covers, henna is found chiefly in the Adrar, in the Tagant and in Affolé. We were unable to collect exact information on its extension, but according to our estimates, there are at least 150,000 bushes.

Tobacco and mint are apparently very marginal crops. We found little plots of mint and occasionally a few tobacco plants nearly everywhere, but cannot offer any reliable data.

II.2.2.2 Yields

Below, we provide a few figures on the yields of these crops, which are not necessarily representative and were made in the field from a few typical date growers.

+ Wheat and Barley: their yield vacillates between 500 and 2000 kg/ha with a yield of 850 kg/ha being considered average.

+ Sorghum: yields about 1,200 kg/ha.

+ Truck farming crops: their yields vary from 8 to 15 t/ha; the average yield being around 12 t/ha.

+ Alfalfa: yields between 80 and 100 t/ha.

+ Henna: 1.6 kg/bush.

It must be noted that most of the yields were computed based on information from small plots and are therefore only indications. Such yields are quite mediocre if not low, especially when it is known that they are all irrigated. This mediocrity may be explained by an inadequate amount of soil fortifiers (spreading manure), very superficial methods of gardening and also by the lack of expertise in production techniques.

II.3 METHODS OF PRODUCTION AND THEIR PROBLEMS

In this chapter, we propose to report on the production techniques now in use in the oasis subsector, while focusing principally on date growing techniques. This will lead us to a discussion of the various operations which come into play in the production process.

II.3.1 Propagation of the Date Palm

Given its dioecious nature and the importance of its genetic potential (2N: 36 chromosomes), the date palm is capable of self-hybridizing very easily and of producing very heterogenous offspring. This is highlighted by the fact that there is no genetically fixed "variety", so one can only speak of hybrids or rather cultivars.

So, in order to reproduce or propagate any hybrid with the same genotypic make-up, the only way to do so is through

vegetative or asexual production: sexual reproduction only fosters other hybrids, usually inferior to the parents, 50% of which are males.

In Mauritania, two types of propagation are found, practised more or less according to the region:

Propagation by vegetative means is chiefly practised in the most ancient date tree growing regions: in the Adrar, approximately 80% of the dactylferous population was obtained in this manner. In the Tagant, the percentage is about the same; but in other regions, the number of trees obtained in this fashion tends to decline. Instead they are propagated sexually (seeds), which regrettably, is the method used the most. It is worthy of note that the date farmers use the offshoots (27) (or Tenkal) just as much as the suckers (28) (Bamba or Ras El Hmar), which is not normally done in date-growing countries. In fact, in North Africa for example, the suckers, commonly called "Mejnoun" or "fools", are never used for propagation of the date palm, since farmers have learned from experience that offshoots grow much slower than suckers, are capable of changing sex during their lifespan, and are less productive. IFAC is of a different opinion on this subject. After 10 years of observation, it has come to the conclusion that there is no difference between sucker and offshoot. We cannot scientifically prove the contrary, but simply say that 10 years of observation is negligible compared to that of the experience of the date growers, which has been handed down through centuries.

(27) Axillary bud which develops at the base of the stem at soil level.

(28) Axillary bud which develops above soil level.

Another important remark to be made is that Mauritanian date tree growers pay absolutely no attention to the age or size required for a sucker to be transplanted. We have witnessed the propagation of suckers regardless of their size, age, condition or hardiness, which often compromises the renewal rate of the new plantations.

Propagation by means of seeds is very popular in new date tree zones such as the Assaba and in the southeast, where over 60% of the date palm population was obtained by this method. In the Adrar and the Tagant, seed propagation is practised only for certain exceptional or recently introduced cultivars for reasons of diversification and collection.

II.3.2 Planting and Density of Planting.

Planting by the two types of propagation occurs between March and May, when the soil temperature is relatively high. Planting is carried out in pre-prepared holes, set equidistant from one another. The size of the holes is quite small, making the unit volume no greater than 0.5 m^2; no soil improvement of fertilizing of any kind is practised, only occasional sprinkling. The suckers are cut like onions (29) from their weanings. In certain palm groves in the Tagant, in the Assaba and the Hodhs, the suckers or offshoots are almost never planted alone, but 3 or 4 seeds in the same hole.

In the case of seed propagation, 4 to 5 pits are dropped in the same hole.

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(29) That is, all the leaves are cut to the very trunk.

Plantation density varies somewhat from region to region, and within the same palm grove, from one property to another. In the oldest groves, density is quite moderate, being between 150 and 200 palm trees per hectare, and rarely exceeds this level. In the newest plantations, the density is quite high; we have estimated it as an average of 250 trees per hectare. On certain plantations in the Assaba and Western Hodh, the density reaches 400 and 500 trees/hectare; consequently, on the latter plantations, there is overdevelopment of the vegetative organs (palm, leaves) to the detriment of fruit-bearing, which is insignificant; from a distance, the palm tree looks like a veritable bouquet of greens.

Of equal note is the fact that in most palm groves with a high palm tree density, the density of the hole used for planting is moderate, but the problem is that more than one palm is found in the same hole; often as many as 4 or 5 of them. This is one of the main factors limiting the productivity of the palm groves, especially those under irrigation. Date growers maintain that it is better to have several trees in the same hole than just one because, during a dry year, there would be at least one palm tree per hole to survive, or, they say, because there is greater resistance to water runoff during flooding periods or more importantly, because this provides better resistance to violent winds, which might fell an isolated tree. This may be true, especially as concerns runoff or wind, but in fact, the present methods of weaning (or removal of suckers) are such that they seriously weaken the base of the stem and the yield, which is really vulnerable to such effects.

Summing up, we believe that such behavior, stemming from very simple logic cannot be corroborated: an isolated palm

tree resists drought better than a bunch of 5 or 6 palms, for the root system of a single tree would have to prospect nearly the same volume of earth as a bunch. Consequently, the total production of a bunch can only equal that of a single palm for the same quantity of water and nutrients pumped into the soil. Also, assuming equal levels of production, the volume of labor (maintenance, fertilization, trimming, harvest) required by a bunch is much more than that of a single palm tree.

II.3.3 Utilization of Water and Irrigation

II.3.3.1 Utilization of Water

In nearly all the Mauritanian palm groves, water for irrigation is drawn from alluvial underground watertables; with rare exceptions it is drawn from very slow moving springs (or IRIJI in Moor).

In these alluvial beds, water is drawn from wells which are more or less well coffered,depending on their depth. When the water level is very close to the surface (1 to 3 m), the shaft is made of palm tree trunks or of doum. When the table level is rather deep (over 3 m down), the shaft is made of dry stone and rarely constructed. The wells do not have curkstones, with a few exceptions in certain palm groves in the Adrar. They are only utilized during the first two or three years of growth, after which the roots of the young palm trees can reach the alluvial table. Water tables deep underground can only be reached by roots or in the case of companion crops, the wells are in constant use.

One of the characteristics of these wells is their low discharge due on the one hand to the limited resources of the watertables and on the other hand because they are not cleaned out well enough because of a lack of adequate digging and cleaning equipment. As a result, it often happens that a good number of wells dry up at the least drop of the water level. Another factor determining the discharge is whether a well is placed on fissured layers of rock or not, and its position in relation to the oued and therefore to the watertable.

There are 3 techniques for drawing water:

+ The first is the simplest, delou drawing. This technique is practised increasingly less, as it is a painstaking process requiring lots of work. Through this technique, it is possible to pull water for no more than 0.19 ha, according to Bouchet (30). Nowadays, it is chiefly practised in the Assaba and the two Hodhs; in the Tagant it is limited to a few isolated palm groves and is becoming very rare in Adrar; its utilization depends on the depth of the well.

+ The second technique, slightly similar to the preceding one because it also uses the delou, is a method of drawing water with what is called the "Achilal", a type of balancing lever. This technique remains the most widespread in Adrar and in the Tagant. Just like the delou method, the "Achilal" is quite painstaking and also requires quite a

(30) R. Bouchet, 1958-59

bit of labor; it has slightly greater potential than the first technique, and permits deeper drawing with the same amount of labor. Based on our observations, the Achilal permits one to draw water from depths up to 11 and 12 m. One can make a good guess of the depth of a well by taking a quick look at the top end of the Achilal. In order to reach a certain depth, date tree growers adjust the distance between the axis of the well and the fulcrum of the achilal on the ground as well as the height of the fulcrum.

+ The third technique is motorized pumping, by means of small groups of motor pumps fueled with gasoline. This practice was first begun between 1950 and 1955 in the Adrar. Since then, it has grown considerably and spread to nearly all the date-growing regions. Today, there are nearly 900 motor pumps, distributed as follows:

- Adrar - approximately 800 motor pumps
- Tagant - approximately 78 motor pumps
- Other Regions - approximately 15 motor pumps

The effects of this mechanization were quite beneficial when it was first introduced. In fact, up until 1956, there was a certain intensification of oasis farming (development of the subjacent crops) in the Adrar, with a notable increase in the area of copland; the area being watered rose from 0.2 ha per traditionally pumped well to 1.35 ha per well pumped with a motor pump. Afterwards, in 1958-59 (31), gradually, as the number of motor

(31) Ibid.

pumps grew, the area watered by wells began to decline, falling to 0.8-0.9 ha. Later, around 1965, the wells were overdeepened, subsequent to a relative drop in the level of the underground watertable. At present, one witnesses the general deterioration of the oasis environment, resulting from an excessive dropping of the water level, which provokes the exaggerated sinking of the wells, a reduction in the area watered by the wells, increased mortality in the date palm population due to unsatiated thirst, progressive salinization of the watertable, the deterioration of ground vegetation, the invasion of sand into the palm groves, rural exodus, and so on.

It is true that this situation is not generalized and affects only the region of the Adrar. But if this shows one thing, it is that the vulnerability of the oasis environment and its equilibrium with the desert milieu is immense.

In our opinion, the outcome of such situations are the consequence of the absence of any type of technical control or direction in regard to proper exploitation of the underground watertables; moreover, this control could not exist, or at least would be senseless unless one has an exact idea of its potential. Hence, the immediate necessity of making an accurate evaluation of the alluvial water-bearing strata, at least in the most important oases, proves to be urgent. Unless action is taken in this area, sooner or later such occurrences will take over all the other regions which have chosen this mechanization. In the present state of things, it is the Tidjikja oued and its vicinity, including 200 ha of palm groves which seems the most vulnerable.

Finally, we note that recently, the outline of a control system for the importation of motor pumps in the Adrar has been drawn up; the agricultural sector is in charge of this task. We can make no judgement of it, but only remark that this is an isolated action whose benefits will be very limited without a well thought out action program touching all aspects of the problem.

II.3.3.2 Irrigation

In general, irrigatior is only for the young palm tree plantations (first 2 or 3 years) and the companion crops. Adult plantations are only irrigated in relatively rare cases for artisanal or "commercial" farming, and incidentally in the presence of subjacent crops.

There is virtually only one method of irrigating Mauritanian palm groves. Irrigation is practised by submersion:water pumped by "Achilal" or by motor pump is usually collected in small earthen basins, as concrete basins are rare (there are only a few in Adrar); then, the water is carried by dirt ditches to the plots to be irrigated. We were able to find a few rare cases in the Adrar where metal channels were used.
We have no comments to make on this technique, for it is apparently well-adapted; losses from infiltration or evaporation are minor given the generally small size of the plots and the short distance the water must run through the ditches. In the case of delou drawing, one does not usually find basins or ditches; rather the water is carried directly to the base of the palm tree or to the plot where a crop is being grown.

As concerns the frequency of irrigation, traditionally, the palm tree is watered 36 times a year on the average. The cycle of irrigation is 4-5 days for the subjacent crops and varies between 3 and 7 days for the date palm, according to the season.

We were unable to collect any precise information on the dosage of irrigation. We simply note that the dosage depends on the method of pumping the water; when it is drawn with the delou, the dose applied is around 35 liters per palm tree, or 5 delous of 7 liters each. When drawing by means of the Achilal, the dose can be as much as 60-80 liters per palm; in the case of the motor pump, the dosage is estimated as approximately 100 liters per date palm. It is evident that based on the theory of 36 waterings per year and 150 palm trees per hectare, the water brought in does not exceed 5,500 m^3/ha/yr. Furthermore, even if the quantities of water absorbed by the underground watertable are taken into consideration, which we believe cannot surpass 6500 m^3/ha (32), the quantity of water would be 12,000 m^3, which is insufficient compared to the needs of the palm tree. This shortage can only be made up in part by yearly rainfall. But is must be noted that in the case of palm groves that are not irrigated - which are the most numerous - the shortage is even greater. This is the main factor behind the generally low yields.

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(32) We have assumed that the palm tree can absorb all the water stored in the plot of soil underneath, which is 1.5 to 8 m deep. We have allowed for a useful porosity of 10% for the rock layer. This underlying layer is fed by groundwater at a continuous hypothetical rate of 1 cubic meter per hour.

II.3.4 Pollinization

The palm tree is dioceous, meaning that the male flowers and the female flowers are borne on two different palm trees. Theoretically, and under certain conditions, natural pollinization by the action of the wind should take place without the help of man. But the variability of the conditions of each palm grove (climatic conditions, different maturation of flowers, genetic heterogeneity of the subjects, distribution of male palm trees in the palm grove, etc.) make natural pollinization very fickle. For this reason, in date tree cultivation, the two sexes are brought together by artificial means.

In Mauritania, pollinization (Djenkir) is carried out as the flowers begin to bloom. This is done by the hand and is relatively simple: two strands of male flowers are placed inside a cluster of female flowers. This operation is generally executed each time that a new inflorescence appears, and once for each stalk, which is not enough.

The selecting of male trees (Macine) is often done hit or miss, and no attention is paid to which one is chosen; however, certain date growers in Adrar and in Chinggetti in particular have, it would seem, noticed the superior quality of the dates from some male palms and because of this, have proceeded to save their preferred pollen from year to year.

This phenomenon of recognizing the superior nature of certain pollens proves to be true, and is known by the name of "Metaxenia". In fact, it was Nixon (1926) who, after a series of remarkable experiments, showed that pollen of different origins behave differently, not only with regard

to the size of the berries (phenomenon known as "xenia"), but also to the size of the dates and their period of maturation.

The technique for conserving pollen consists of drying the male inflorescence in the shade and then burying it in the soil to keep it. Before being used, the inflorescence is moistened slightly.

Such practices among the date growers, although there are only a handful of them, are encouraging, but just the opposite can be said for the majority of the date growers, notably those in the new date tree growing zones such as the Assaba and in the south in general.

Actually, date farmers in these regions know very little about the problems related to pollinization (selecting the male, best time for pollinization, conserving the pollen, etc.)and because of this, they often produce parthenocarpic fruits; in other words, fruits which have not been fertilized and are worthless.

In conclusion, we note that there is a substantial number of male palms in the Mauritanian palm groves. We were able to obtain an idea of their number through the RAMS survey. For our entire sampling, which covers 4 agro-ecological zones, the male palm trees represent 6.3% of the dactyliferous population, which is excessive compared to the accepted standard in other date-growing countries, which is only 3%. In addition, the disparities between the various zones in this respect are enormous; for the agro-ecological zone of the oases, the level of males is

around 8.6%, for the rainfed farming zone (southeast) it is about 18.44%. For the zone with recession plot farming, which overlaps greatly with the oasis zone, the level for males is 3% and only 1.5% for the pasturage zone. Moreover, this level could be interpreted not only as an indication of the lack of know-how in date farming techniques but also as a means of obtaining an idea of how quickly the date palm is spreading out in the zones. Zones with acceptable ratios between male and female trees presuppose propagation by suckers, as such propagation can only take place slowly because of the constraints of obtaining the suckers. In a zone where this same ratio is exaggerated supposes propagation by seeds, which can be carried out quickly, for there are no constraints on the availability of pits.

II.3.5 Maintenance and Care of the Crops

In truth, there is very little of any maintenance or care of the crops. These are reduced to a few casual operatations: the soil is not cleared off, tilled, or fertilized except in the case of companion crops, which are limited to certain areas; the palm trees are only trimmed when, during the harvest, the leaves risk bothering the pickers or when there is some need for green or dried palm leaves. Plots are only enclosed for young plantations or for companion crops, or when the area around the palm grove is often frequented by shepherds; suckers and offshoots are cut off only in order to be transplanted or sold, etc.

Thus, most of the palm groves in Mauritania appear to be in a state of abandon; the soil is either piled up or pulverized with no structure whatsoever, and often covered

with the debris of dry palm leaves, stalk spikes, dead suckers or palm trees, etc., which constitutes an environment extremely favorable to the development of termites and other harmful xylophagous insects. The palm trees seem to be in agony, and there are always two or three crowns of dried-up leaves hanging down (lower leaves); numerous are the trees partially uprooted by winds or extremely weakened at the base of the stem, etc. We shall not linger on this description, for there are just as many factors that can only keep down the productivity of this heritage, which is very dear to the Mauritanians.

Such a situation is not as drastic as one would think, and in our opinion, it is not without some rationality especially when one has a good understanding of the way in which the systems of production function. On the whole, one cannot expect any major changes, at least not for quite a long time. These problems can be approached only where the systems of production show that they have started to evolve favorably. If we return to the major groups of production defined earlier, one can say that the first group appears to think the most about measures that aim at minimizing the technical constraints in question.

To conclude, we stress once again that only the subjacent crops are receiving crop care, such as preparation of the soil, organic fertilization, weeding, adequate irrigation, etc. Pest treatment, when possible, is often reduced to a few dustings with insecticides (HCH), so that damage caused by other parasitic fungoid or viral infestations are sometimes quite important.

Minimizing this set of technical problems would require major actions in the production process, as well as in informing and training the date growers, improving and reinforcing supervision, socio-professional organization, and financial assistance.

II.3.6 The Harvest

"Harvest time for dates in Mauritania is designated by the term GUETNA. This term does not correspond to the concept of harvest, but to that of the tent (or Guitoune). This substantive could be translated by the paraphrase: the time when one pitches his tent in the palm grove." (33)

Hence, most non-urban palm groves always have little huts or gourbis scattered around here and there, or are overlooked by small hamlets sitting on the high spots (dunes, hills, etc.). Except during the GUETNA, the palm groves appear to be deserted, but these hamlets give the appearance of a regular countryside. This superstructure is set up to take in a large population coming to move in for the harvesting period. On the largest palm plantations, of easy access, there is even a small trade center (34), where the people can stock up for everyday needs (tea, suggar, etc.), and where, during each GUETNA, important negotiations and transactions take place.

The GUETNA period lasts for a rather long time, and its duration depends partly on the region and partly on the occupations of the people involved. Actually, the

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(33) P. Munier, 1955
(34) This involves a small group of shops.

GUETNA begins as soon as the dates have reached the stage of botanical ripeness, or the "bleh" stage. This stage is reached at slightly different times according to the region. The populations may begin to move into the palm groves long before this time, notably in the case of farmers who own the groves, who have already finished the crop season (April, May); nomad breeders, owners or not, move in long afterwards, just before the start of the rainy season; the civil servants, businessmen and others settle in last. So, the dates begin to be consumed well before they are botanically ripe - these are still-green dates which fall to earth (physiological or other reasons). Then, it is the most mature dates which are either picked one by one or forced to fall by shaking the stalks and are eaten or sold at high prices. Finally, the real harvest comes. Picking is done rather carelessly; the stalks are cut and thrown on the bare ground. Some more guileful growers use sheets to keep the dates from becoming soiled.

The end of the GUETNA usually falls at the end of August, when the dates are physiologically ripe; but south of the 350-400 mm isohyets, it ends earlier to avoid the rainy season. It must be pointed out that in the town oases, the notion of GUETNA is losing its social importance more and more, and tends to be substituted by the town markets: such is the case for Atar, Tidjikja, Kiffa, etc. Here one sees the start of a change in behavior of both the date growers and the consumers, a change which would be wise to anticipate further by giving it desired orientation.

II.4 THE MEANS OF PRODUCTION

In this chapter, we have examined the importance of the means or factors of production in oasis agriculture, and the extent to which these factors are combined in oasis farming to foster production. This leads us to establish budgets for the principal types of production to serve as a synthesis of this chapter.

II.4.1 The Land

As everyone knows, in farming, the land is the primary factor of production. In oasis farming, taking into account the ecological demands of the date palm, which is the sine qua non element of this activity, cultivable land is very rare. Moreover, it seems that in Mauritania, of all the cultivable land, only oasis soils can belong to an individual or be the object of purchase or sales transactions.

In reality, given the climatic, soil (cf. Chapter I.1.2, Climate Conditions) and socio-economic conditions, oasis farming can be practised nearly everywhere; but it so happens that the availability of the sites is determined by the size of the water reserves.

At present, it is judged that nearly all of the land having a natural potential for oasis agriculture is being cultivated: future potential resides in the mobilization of underground watertables other than those of the alluvial strata.

In terms of their physical setting, palm groves are strung along like beads within the same type of natural terrain, such as alluvial terraces along wadis, the edge of water courses snaking between stabilized dunes, across a rag, etc. These types of terrain usually have natural boundaries (an escarpment, a dune, a wadi bed, etc.) and their size may vary from a few hectares to several dozen hectares. The land, which was once collectively owned, has been divided into family units, which are now the units to be developed, directly or indirectly. For this reason, the best-maintained groves consist of a well-defined zone of parcels fenced off by "Zeribas".

The field research for this study revealed that the area enclosed by these "zeribas" is generally several areas and usually include 24 to 36 palm trees. Each owner has an average of 2.5 "zeribas" comprising 60 to 90 date palms. There are, however, some owners who claim to own several hundred and even a thousand date palms. This may be true, but in rare cases. It may very well be that in such cases, the trees belong to a tribal division or to a clan rather than to one individual.

As concerns farming the land, there are two methods of development: direct and indirect.

For direct development, the land is farmed:

- either by the owner himself and his family; this is rare in the Adrar and in the Tagant, but very frequent in the Assaba and other regions;
- or by servants; this is found less and less in the Adrar and the Tagant and does not exist elsewhere.

Having access to the land in the case of direct development is granted automatically when one belongs to a traditionally date farming tribe, or by means of colonization and the improvement of new zones or by the purchase of date farming land, the latter case which is still rare.

For indirect development, which is the most widespread, there are several forms of association/land sharing, for which we shall list the most important:

- Sharecrop leasing or the sharecrop contract, which binds the landowner (usually a Moor) to the farmer (usually a Hartani). It obliges the owner to furnish the plot of land and the wells, and the Hartani to furnish the plants. Once the palm trees begin to produce, after about 5 years, the palm grove is divided into two equal parts, except in the Adrar, where the sharecropper receives only one-third of the grove.
- A second type of association/land sharing involves the upkeep of the palm grove: "The worker (Hartani) must water the palm grove 36 times per year, encircle it with hedges, cut off dried palm leaves hanging from the trunks, pollinate the trees, collect the fruit when it is ripe. In payment, he receives one-fifth of the harvest.(35)"
- A third form of association/land sharing relates to the crops grown along with the palm tree, i.e. mainly wheat and barley; the Hartani is responsible for all work and cultural methods; he is paid in ways varying greatly from one region to another. The diversity of these methods of

(35) C. Toupet, 1975

compensation only reveals the various ways in which palm grove development is viewed.

The forms of association/land sharing are found almost exclusively in the most ancient of the date-growing regions, that is, in the Adrar and the Tagant.

II.4.2 Labor

Labor, the second factor of production, is generally of a temporary nature in oasis agriculture, except in the urban oases, where the pace of work is more continuous because of the companion crops.

For direct development, the land is worked according to the case:

- by a permanent family-based labor force; this is rare, and found in the first group of production systems, especially on plantations where companion crops are raised;
- by a permanently salaried laborer. This case is quite frequent in the first group of production systems.
- by a temporary family-based work force; this is the case for most of the palm groves in the Assaba and in the southeastern region, belonging to the third group of production systems.
- by slave-servants; this type, becoming increasingly rare, is found chiefly in the Adrar and the Tagant.

In the case of indirect development, it is the sharecropper himself, most often a Hartani, who does most of the labor and is helped by some members of his family.

In light of the somewhat specialized nature of oasis labor, most of the work is done by men. Some Haratins have their little boys help out, notably to climb the most difficult trees. The woman participates in the work only to pick the henna leaves or sometimes to supervise certain work.

Labor time varies according to the system of production. In table No. 7 which follows, we have made a few gross estimates based on our field observations, for most represented types of farming.

As we have pointed out, these values are chiefly indicative in nature. Also, we have reduced the number of types drastically; otherwise, we would not have been able to be conclusive, since our typological study is not particularly interested in the oasis-type farms in themselves, but in the big farming groups.

As concerns the scheduling of work in oasis farming, for the companion crops, work is spread out between the months of October and May (cool, dry season) and for date-growing between the months of February and August (hot, dry season). In this context, an important remark must be made about labor in the oases, particularly concerning date tree growing; it concerns the nature of the work, which cannot be postponed. Accordingly, pollination, irrigation or harvesting, for example, cannot be put off until later, but must be executed on time; the same holds true for companion crops, as sowing and irrigation can only be deferred at the risk of losing the yields.

Table No.7. Labor Time in Various Types of Cultivation
(Unit: 1 day of work)

System of Production	1st Group		2nd Group	3rd Group
Method of Irrigation / Nature of Labor	Mechanized Irrigation	Achilal Irrigation	Achilal Irrigation	Delou Irrigation
DATE PALM GROWING	1 ha	200 palm trees	1 ha 200 palm trees	1 ha : 250 palm trees
-Soil Preparation and Planting (36)	2	2	2	2
-Irrigation (37)	0.5	2	12	10
-Pollination	25	25	20	20
-Trimming, harvesting	30	30	24	24
-Caretaking	15	15	25	30
-Protection	2.5	2.5	2	5
-Other	5	5	2	0
Subtotal	80	81.5	87	92
COMPANION CROPS	0.6 ha	0.1 ha	Negligible	0
-Soil Preparation and Fertilization	12	2	-	
-Sowing, Thinning	8	1.5	-	
-Hoeing, Weeding	20	3	-	
-Irrigation	35	25	-	
-Harvesting	15	3	-	
-Other	4	1.5	-	
Subtotal	94	36	5	
Grand total	174	117.5	92	92

(36) This standard was considered in order to account for plantation renewal and extension.
(37) For irrigation of young plants only.

So, on this basis, and considering the information presented in this report on the extension of the different oasis activities (date palms and companion crops), one can estimate that oasis farming entails nearly 410,000 days of work per year, of which 388,000 are devoted to date farming and 22,000 to companion crop care.

Considering the breakdown of these days during the calendar year and the non-deferrable nature of most of the labor, an oasis laborer can practice date palm care for no more than 150 days per year; due to this, the number of jobs provided by the oasis would be about 2,600 (including 150 days working on the companion crops at the rate of 150 days a year).

This employment, as it now stands, would only represent about 12.5% of the agricultural employment in the agricultural-ecological zone of the oases, and 2.5% nation-wide.

Through date growing alone, this same agro-ecological zone provides an average of 35% of the total value of the agricultural production of the whole country.

II.4.3 Operating Capital

The factors of production in oasis farming, aside from the land and human labor, are generally small, even insignificant. To obtain a concrete idea, we have tried to answer the following questions:

What factors are necessary in the present situation in order to produce dates, or dates and vegetables for example, while having:

- available land and labor force;
- or an existing, productive palm grove and labor force.

The answer is that in the first case, one must have:

- date seedlings (suckers, offshoots) or at least date pits, and vegetable seeds (optional);
- water for sprinkling and therefore a well and a means of drawing the water;
- tools for preparing the soil, carrying out farming methods, and some maintenance work on the palm tree (trimming, cutting stalks, etc.).

In the second case, one must have:

- vegetable seeds (optional);
- farmworking tools.

One can see that in the simplest, most general case, it is enough to have a little money to pay for the tools and seeds; the suckers can be replaced by the date pits, which cost nothing; the wells can be sunk in a few days, and the method of drawing the water can be the most rudimentary kind.

In reality, farming capital is highly varied, depending on the production system. It is in the first group of production systems that one finds the best-equipped farms: constructed and well-kept up wells, mechanized drawing,

farm buildings (small storehouse), etc. This supposes ample available funds; moreover, the owners of such operations are usually merchants, civil servants, or big livestock breeders.

In the second group of production systems, the operating capital is relatively modest; this capital is generally taken from livestock raising profits to finance the palm grove (purchase of suckers, building of wells and achilals, purchase of tools).

It is in the third group that operating capital is the most rudimentary, corresponding to the most simplified case.

In conclusion, we believe that a general remark about the work tools used in the palm groves would be useful. Usually, oasis farming does not require many tools, but demands well-adapted ones which, to date, Moorish date growers either do not have or do not know about. The trimming, cutting off of stalks or weaning of suckers or offshoots are currently being done with chopping tools, such as the machete and with the help of simple knives by using sawing motions. The tools are awkward to use and require very close work. Furthermore, "the shocks received by the tissue are infinitely dangerous, causing deep trauma, very harmful to the palm trees, especially the young ones." After such work, the base of the palm looks very choppy, with very irregular incisions, making it difficult and hazardous to climb the tree.

In all other date-growing countries, this work is usually conducted with sharp, smooth-bladed instruments or mounted with very fine-toothed saws, with instruments derived from the sickle or shears, such as the Mezbra, a

sort of long-handled open pruning knife, with fine teeth, or with American shears.

For the companion crops, the same problem arises, even though in the framework of its project, "Truck-Farming Crops", the Department of Agriculture distributed equipment as gifts in the beginning years, its effects have been limited. In fact, beginning with the 1979-80 season, the gifts were stopped and replaced by cash sales. This made many farmers reluctant, and they backed off because of the obligation to pay.

II.4.4 Operating Budgets

In order to study budgets, we have distinguished three general types of cultivation determined mainly by criteria related to the means of production; in reality, there are many more than 3 types of cultivation, but identifying all of them would require a special study.

These three types summarize the principal groups of systems of production previously identified (see Chapter II.1.3). Their characteristics and budgets can be broken down as follows:

II.4.4.1 Principal Characteristics of the Types of Production Studied

The principal characteristics of the types of production comprised in this study are presented in Table 6. The first kind (I) corresponds to the first group of systems of production; it includes the most intensive systems of cultivation (relatively speaking). Two subtypes have been

distinguished, based on means of obtaining water.

The second type (II) corresponds to the second group of systems of production; it is very similar to subtype Ib.

The third type (III) corresponds to the third group of systems of production.

Table 8. Principal Characteristics of the Types of Cultivation Studied

System of production	1st Group		2nd Group	3rd Group
	Type Ia	Type Ib	Type II	Type III
Grove density	200 trees/ hectare	200 trees/ hectare	200 trees/ hectare	250 trees hectare
Subjacent crops	0.6 ha	0.1 ha	0.14 ha	0 ha
Proportion of male trees	3%	3%	3%	1[illegible]%
Young unproductive trees	24%	24%	22%	54%
Trees in early stages of production	36%	36%	26%	36%
Fully productive trees	40%	40%	52%	10%
Means of obtaining water	mechanical (motor pump)	Achilal	Achilal	Delou
Mode of development	direct	indirect	indirect	direct

II.4.4.2 Assumptions

In order to establish operating budgets, we have established a certain number of assumptions which we have

presented in Table 9 (following).

Table 9. Principal Assumptions in Establishing Operating Budget

Types, Sub-types Assumptions	Type I	
	Ia	Ib
Infrastructure	2 wells and 2 basins built for an initial cost of 30,000 UM to be paid off over 30 years. Zeribas (enclosures) worth an initial 7,500 UM to be paid off over 5 yrs.	3 dry stone wells worth an initial 18,000 UM to be paid off over 30 years. 3 basins of beaten earth worth an initial 3,000 UM to be paid off over 5 yrs. Zeribas: see Ia
Means of obtaining water	1 gasoline-powered motorpump (5 HP); initial value 60,000 UM to be paid off and renewed every 10 yrs.	3 "Achilals", initial value 4,500 UM to be paid off and renewed every 7 years.
Development	Direct: 5,000 UM paid monthly to a permanent worker.	Indirect: use of a farmer as follows: The crop of 1 adult tree plus 1 branch of fruit from each productive tree. Also: 50% of subjacent crops
Production	Young tree: 0 kg. Tree in early stages of production: 14 kg. Tree in full production: 27.5 kg. Subjacent crops: 10 tons/ha.	Young tree: 0 kg. Tree in early stages of production: 14 kg. Tree in full production: 27.5 kg. Subjacent crops: 8 tons/ha.

Table No. 9. (cont'd) Principal Assumptions in Establishing Operating Budgets

Types, Sub-types/ Assumptions	Type II	Type III
Infrastructure	3 poured concrete wells worth an initial 10,500 UM to be paid off over 30 years. 3 basins of beaten earth worth an initial 3,000 UM to be paid off over 5 years. Zeribas: see type III	3 poured concrete wells worth an initial 10,500 UM to paid off over 30 years. Zeribas: initial value: 3,500 UM to be paid off over 5 years.
Means of obtaining water	same as Ib	1 delou and a rope worth 500 UM to be paid off every 3 years
Development	Indirect: use of a farmer paid as follows: The crop of 1 adult tree plus 1 branch of fruit from each productive tree. Also: 100% of subjacent crops	Direct: family labor used
Production	Same as Ib	Young tree: 0 kg. Tree in early stages of production: 14 kg. Tree in full production: 27.5 kg.

II.4.4.3 Budgets

The following operating budgets have been drawn up based on the characteristics of the different types of date-growing identified and the assumptions made about production

Type Ia	Quantity (kg)	Unit Price UM	Cost UM
i. Advance on Crops			
-Date Palm Cultivation			
.Pesticides	negligible	-	-
-Companion Crops			
.seeds	-	-	4,500
.fertilizer	-	-	-
.manure	5 tons	500	2,500
.carburant, lubricant	-	-	3,500
.other items (10%)	-	-	1,050
Total			11,550
ii. Operation and Upkeep			
.Zeribas	-	-	750
.motorpump	-	-	3,000
.Achilal	-	-	-
.tools	-	-	1,000
.wells and basins	-	-	650
.other items (10%)	-	-	540
Total			5,940
iii. Depreciation			
.Zeribas	-	-	1,500
.Motorpump	-	-	6,000
.Achilal	-	-	-
.wells and basins	-	-	1,000
.grove	-	-	1,350
.various and unforseen items (10%)	-	-	985
Total			10,835

	Quantity (kg)	Unit Price (UM)	Cost UM
iv. Labor			
-Family			
.date palm cultivation	-	-	-
.companion crops	-	-	-
-Wage Labor			
.date palm cultivation	80 days	-	
.companion crops	94 days	-	
Total	174 days	-	60,000
v. Gross Product			
.dates	3,200	35	112,000
.vegetables	6,000	25	150,000
.palm leaves (4 per productive tree	592 units	2.5	1,480
Total			263,480
vi. Gross Added Value (v-i-ii)	-	-	245,990
vii. Net Added Value (vi-iii)	-	-	235,155
viii. Net income (vii-iv)	-	-	175,155
ix. Profit			175,155
Type Ib			
i. Advance on Crops			
-Date Palm Cultivation			
.Pesticides	negligible	-	-
-Companion Crops			
.seeds	-	-	1,100
.fertilizer	-	-	-
.manure	1 ton	-	500
.carburant, lubricant	-	-	-
.other items (10%)	-	-	160
Total			1,760

	Quantity (kg)	Unit Price (UM)	Cost (UM)
ii. Operation and Upkeep			
.Zeribas	-	-	750
.Motorpumps	-	-	-
.Achilal	-	-	300
.tools	-	-	600
.wells and basins	-	-	600
.other items (10%)	-	-	225
Total			2,475
iii. Depreciation			
.Zeribas	-	-	1,500
.Motorpumps	-	-	-
.Achilal	-	-	650
.wells and basins	-	-	900
.grove	-	-	1,350
.various and unforseen items (10%)	-	-	440
Total			4,840
iv. Labor			
-Family			
.date palm cultivation	-	-	-
.companion crops	-	-	-
-Wage Labor			
.date palm cultivation	81.5 days	-	18,300
.companion crops	36.0 days	-	10,000
Total	117.5 days		28,300
v. Gross Product			
.Dates	3,200 kg	35 UM/unit	112,000
.vegetables	800 "	25 UM	20,000
.palm leaves (4 per productive tree)	592 units	2.5 UM	1,480
Total			133,480
vi. Gross Added Value (v-i-ii)	-	-	129,245
vii. Net Added Value (vi-iii)	-	-	124,405
viii. Net Income (vii-iv)	-	-	96,105
ix. Profit	-	-	96,105

Type II	Quantity (kg)	Unit Price (UM)	Cost (UM)
i. Advance on Crops			
-Date Palm Cultivation			
.Pesticides	-	-	-
-Companion Crops			
.seeds	-	-	150
.fertilizer	-	-	-
.manure	-	-	-
.carburant, lubricant	-	-	-
.other items (10%)	-	-	-
Total			150
ii. Operation and Upkeep			
.Zeribas	-	-	350
.Motorpumps	-	-	-
.Achilal	-	-	100
.tools	-	-	450
.wells and basins	-	-	300
.other items (10%)	-	-	120
Total			1,320
iii. Depreciation			
.Zeribas	-	-	700
.Motorpumps	-	-	-
.Achilal	-	-	650
.wells and basins	-	-	800
.grove	-	-	1,350
.various and unexpected items (10%)	-	-	360
Total			3,960
iv. Labor			
-Family			
.date palm cultivation	-	-	-
.companion crops	-	-	-
-Wage Labor			
.date palm cultivation	87 days	-	18,600
.companion crops	5 days	-	2,800
Total	92 days		21,400

	Quantity (kg)	Unit Price (UM)	Cost (UM)
v. Gross Product			
.dates	3,480 kg	35 UM/unit	121,800
.vegetables	112	25 UM	2,800
.palm leaves (4 per productive palm tree)	604	2,5 UM	1,510
Total			126,110
vi. Gross Added Value (v-i-ii)	-	-	125,140
vii. Net Added Value (vi-iii)	-	-	121,180
viii. Net Income (vii-iv)	-	-	99,780
ix. Profit			99,780

Type III

i. Advance on Crops			
-Date Palm Cultivation			
.Pesticides	-	-	-
-Companion Crops			
.seeds	-	-	-
.fertilizer	-	-	-
.manure	-	-	-
.carburant, lubricant	-	-	-
.other items (10%)	-	-	-
Total			0
ii. Operation and Upkeep			
-Zeribas	-	-	350
-Achilal	-	-	-
-tools	-	-	350
-wells and basin	-	-	175
-other items (10%)	-	-	85
Total			960

	Quantity (kg)	Unit Price (UM)	Cost (UM)
iii. Depreciation			
.Zeribas	-	-	700
.Achilal	-	-	-
.wells and basins	-	-	350
.grove	-	-	1,400
.various and unexpected items (10%)	-	-	245
Total			2,695
iv. Labor			
-Family			
.date palm cultivation	92 days	165	15,180
.companion crops	-	-	-
-Wage Labor			
.date palm cultivation	-	-	-
.companion crops	-	-	-
Total	92 days	165	15,180
v. Gross Product			
.dates	1,600	35	56,000
.vegetables	-	-	-
.palm leaves (4 per productive tree)	380	2.5	950
Total			56,950
vi. Gross Added Value (v-i-ii)	-	-	55,990
vii. Net Added Value (vi-iii)	-	-	53,295
viii. Net Income (vii-iv.B) (family income)	-	-	53,295
ix. Profit (viii-iv.A)	-	-	38,115

An analysis of these budgets shows that in all cases, wages, are quite attractive and profits are good, as shown by the following table: (table 10).

Table 10. Operating Budgets: Summary of Main Conclusions

Criteria / Types	Effective working days	Income to labor	Daily Wage for Labor (UM/day)	Profit UM
Type Ia	174	60,000	345	175,155
Type Ib	117.5	33,330	283	96,105
Type II	92	21,400	232	99,780
Type III	92	15,180	165	38,115

It must be added that such results cannot be obtained until the palm grove is fully productive. This is possible after the 14th year for groves started from offshoots and even later for plantations started from pits; in other words, these results are not possible until the "grove capital" has been fully constituted. Thus, profit, which is the major outcome, is essentially derived from the capital invested in the grove (case of types Ib, II, III). As for type Ia, which is the most developed, profit is determined almost in equal proportions by:

- the labor and capital represented by the grove;
- the labor and capital represented by the methods of cultivating associated crops.

In any event, one must remember that from a financial point of view, these two activities are extremely attractive in that they yield substantial monetary income, even considering the high rate of consumption by owners and laborers

(see Chapter III). One must keep in mind the fact that these two activities can complement each other: indefinitely because one can financially support the other.

II.4.5 Conclusion

In the present situation, it is evident that production is determined mainly by the combination of land and labor. Technical capital is hardly used, except in the presence of companion crops. This is clear in the case of the share-cropping arrangement in which the worker can obtain his own palm grove through his labor.

The productivity of labor in oases seems to be one of the highest in Mauritanian agriculture. In effect, as seen above (paragraph II.4.2) oasis agriculture includes only 2.5% of total agricultural employment but produces 35% of the value of agricultural production. This level of productivity means that oasis agriculture is the best paid and probably the most profitable traditional rural activity.

A priori, the combination of labor and operating capital is far from optimal; an intensification of jobs on the oases combined with greater operating capital would contribute to increasing work output to a relatively high level.

In North African countries, the standard amount of labor spent in the palm groves is in the neighborhood of 250 days per ha for date growing alone, while in Mauritania, it barely reaches 85 days. This examples does not necessarily need to be followed to the letter, considering Mauritanian conditions, but it can serve as an inspiration to give the importance that is due to farm work and to care for the palm grove properly.

II.5 PROPERTY/LAND LAWS AND THEIR EFFECTS ON PRODUCTION

A very common observation that anyone can make when visiting oases is that the best plots, which are cultivated intensively, are those farmed by their owners. Such farms are rather rare.

When trying to see who these owners are, one discovers that they are either bidane Moors or haratine Moors; in most cases, Moor bidanes acquired their property by purchasing it or through their membership to one tribe or another, while Moor haratines obtain property through their work (share-cropping contracts).

One may wonder why such farming is so unusual. C. Toupet (38), in discussing the legal status of oasis agriculture, provides a partial answer as follows:

"The importance to the palm groves in Moorish society is such that customs bearing on collective or individual property of cultivable land are applied with much more implacable rigidity than for recession plots. While certain tribes such as the Kounta may make exceptions, and sell a plot of palm trees to an outsider, the tribes specialized in date growing absolutely refuse to do so. In order to protect the rights of the group and to prevent an outsider from owning property, these tribes have taken up the habit of changing their palm groves into Habou belongings" (39), or in the Mauritanian sense of the word, into unassignable common property, for which usufruct is the only durable transacation possible.

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(38) C. Toupet, 1975

(39) Ibid.

This institution is in fact widespread among the ancient Mauritanian palm tree plantations, but does not seem to have as great an effect on the recent date-growing areas such as the Tagant and others. As a consequence, it maintains the property within the family and is its protection against breaking it up. Another consequence is that the practice of the habous does not permit the palm groves to be kept well, or to be extended; the reason is that the usufructuaries are not motivated to cover the necessary expenses for such operations. This may be true, but, in our opinion, it is not the main reason behind poor maintenance. In fact, family ownership of the land, which is exercised in the framework of tribal ownership, is only rarely coupled with direct farming by the owner; most of the work is carried out by haratines, paid in very different ways, or by servants (abids). Evidently, with or without habous, palm grove tenure submits to the same customs and does not involve supplementary costs, especially when it is known that this type of tenure is most often compensated in kind plus part of the product.

As concerns the problem of palm grove extension and development, since this institution principally affects the ancient date-growing zones, some of which have suffered degradation and desertification, in a way, it is a good protection for the latter against disorderly expansion.

However, the habou practice can place serious obstacles before the date grower's initiatives to innovate or rationally develop a palm grove; such cases can be found in the urban oases, where the set of circumstances are favorable to such options. Such obstacles should certainly crop up more for

future programs and development projects in the date-growing zones, especially the oldest among them.

Furthermore, the gravity of this phenomenon is accentuated by the absenteeism and indirect farming of the palm groves (different sharecropping) which are almost a general rule, so much so that one loses sight of them because they constitute a sort of "backdrop".

Generally speaking, it can be said that property rights in the palm groves, due to private property barriers and the survival of collective egoism (tribalism), seriously curbs the evolution and development of the systems of production. Technical innovation and private enterprise run up against both objective constraints due to the realities of each zone and the character of the systems of production, but also against much less objective constraints due to the weight of customs and tradition in Moorish society. These last constraints are the most stifling. Overcoming them is a necessary condition, but not enough for establishing a development process through projects, action programs or plans.

II.6 COMPARISON WITH OTHER PRODUCTION IN THE RURAL SECTOR

In general, oasis agriculture in Mauritania cannot be disassociated from the other activities of the rural world. In fact, it is very unusual to find a family earning its income or making a living from the palm grove plot alone.

Oasis agriculture, which benefits from the underground watertables on the alluviums and from springs, came to round out an agro-pastoral production system based on the

exploitation of sylvo-pastoral resources (livestock raising) and of surface-waters (recession weirs, dissipation zones, etc.). Its integration into this system is both spatial and economic; it is spatial insofar as it contributes to a relatively optimal usage of the natural environment; it is economic by the fact that it constituted a choice of farming activity for capitalizing or re-investing the small surplus or savings that could be made from agro-pastoral activity; it also contributed to building traditional interregional trade channels whose object was to trade the date products from the oases for cereals produced in the regions of the Senegal River or of southeast Mauritania.

At present this system continues to take shape and reproduces itself on the one hand (second and third groups of production systems), but also to disintegrate, on the other hand (first group of production systems), subsequent to changes which have affected elements of space and environment in general. In the systems which are falling apart and through the examples we have been able to examine, oasis agriculture is beginning to integrate into commercial activities and continues to be a choice sector for investment for those who remain attached to it.

II.7 CONCLUSION

It is apparent from studying this third part that date farming is the predominant activity in the oasis and that companion crops are of only marginal importance, relatively speaking.

II.7.1 Date Growing

This date growing is characterized on the whole by:

II.7.1.1 The exaggerated diversity of the plant material utilized:

This diversity has its merits and its limitations. Actually, it shows considerable genetic potential for a future program of selection or for creating new varieties or extremely interesting cultivars. On the other hand, from the beginning, it is a very heterogeneous product with very low market value. Furthermore, this diversity is indicative of the limited knowledge of date-growing principles, or perhaps of a certain state of mind of the Moorish date growers.

II.7.1.2 The relative young age of the plantations, which results in rapid proliferation to the detriment of very poor plant material. This is worsened by the insufficient technological know-how of the date farmers.

II.7.1.3 The poor phytosanitary state of the palm groves, which greatly affects their productivity and the quality of their products. This condition is the consequence of a near-total absence of protection due to a certain amount of ignorance and to inadequate means of every kind.

II.7.1.4 Very limited productivity due, in addition to the factors enumerated above, to the inadequate methods of production. This inadequacy is the result of weak productive factors as well as a near-total absence of the involvement of existing structures in production.

II.7.1.5 A certain precarious nature of the oasis milieu consistent with a misappreciation of its resources and arbitrary exploitation.

II.7.1.6 Rudimentary means of production, in which the land and labor play the principal roles. This is stressed even more by the special nature of Moorish social organization. The result is a barrier to any attempt to develop.

II.7.2 Companion Crops

In addition to their marginal place in the production system, which is quite normal besides, given their relatively recent introduction, companion crops are composed nearly exclusively of annual crops, and one notes the total absence of fruit tree growing.

Development of these crops is in turn affected by a certain number of problems, such as:
- inadequate methods of production;
- insufficient means of involvement of the structures in place;
- small scale of production.

In summary, these are the general characteristics of this oasis agriculture, characteristics giving rise to a certain number of constraints to the development of the sub-sector. These constraints prove to be more or less objective according to the production system under consideration.

In the second group, the systems of production continue to be reproduced with difficulty. Oasis farming helps maintain a certain equilibrium in the exploitation of the environments

as well as in employment of the available work force.

In the third group of systems of production, where oasis farming is relatively new, this group, due to the importance and predominance of other activities (breeding and dryland farming), which saps most of the available work force, contributes to the integration of feminine and child labor in the palm grove and also helps to develop certain natural resources unexploited until now.

Chapter III. PREVIOUS AND CURRENT PROJECTS AND ACTIONS

In this part of the study we will present the results of a critical examination of existing documentation in the area of oasis farming.

III.1 CRITICAL EXAMINATION OF EXISTING DOCUMENTATION: PREVIOUS AND CURRENT PROJECTS AND ACTIONS

As we have already pointed out, to date, this sub-sector has only enjoyed sporadic actions somewhat isolated in time, most of which were not followed up. Below, we shall provide a list of the previous actions as well as those presently under way.

III.1.1 Previous Actions

III.1.1.1 The experimental date-growing station in Kankossa:

Created in the early 1950's by the Institut Français de Recherches Fruitiers d'Outre-Mer (IFAC-French Institute of Research for Overseas Fruit Cultivation). This station operated for over 15 years and was "laid to rest" around 1970 after the Kankossa pond dried up, and probably for other

reasons unknown to us. It was "one of the few centers in the world devoted to the date palm (40)." According to the authors cited in the footnote, work conducted at this station permitted the researchers to:

- quickly devise with a minimum of doubt, methods of biologically controlling the mealybug (41);
- reveal the importance of irrigation and its rhythm;
- show the effectiveness of using fertilizer on blooms to increase yields. It was possible to determine the exact doses of fertilizer to be used and the appropriate stages in which to apply them.
- determine which parasitic fungi attack the palm tree;
- discover the first symptoms of a serious "cycas"- type of rot;
- implement, after conducting meticulous tests at the station, commercial packaging of dates (ATAT);
- encourage the planting of several thousand date trees by the population which came to live in Kankossa.
- be capable of supplying from then until now a large quantity of selected crops to permit palm grove expansion in Kiffa and Kankossa, and,
- obtain other results in other areas.

III.1.1.2 Census of the crops in the Adrar (42)

This census was taken of all palm groves in the Adrar and shows the status of their operations in a relatively concise manner.

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(40) Lossois and Laville, 1969

(41) Parasitic insects of the homoptera family which feed on the palm tree (see Chapter II.2.1.4.2).

(42) R. Bouchet, 1958-59.

III.1.1.3 An aerial survey of the palm groves

This survey was carried out in 1958 by an IFAC team for the purpose of taking an inventory of the palm groves: a count of 50,000 was accepted.

III.1.1.4 Operation Palm Grove Protection of Atar

Financed by the FAC (43) and executed by the IFAC, this operation started in 1960 and continued up until 1970. It was composed of three parts:

- Renovation of the palm groves
- Pest control, Adrar-Tagant
- Contribution to hydraulic activity.

According to the activity reports that we were able to consult, the following actions were recorded between 1967 and 1969:

- The installation of a pilot plant for packaging dates in Atar, which operated for three seasons under the management of UCCA(44), with the assistance of IFAC, and closed down at the end of the 1969 season. This plant packages 55,229 tons of dates out of 67,954 tons accepted (average margin: 19%). Of the 55,229 tons packages, 18.67 tons were not sold (1969 season) and were finally lost by UCCA. UCCA made profits for all three seasons, for a grand total of 6,462,000 frs CFA, or 1,292,000 UM.

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(43) Fond d'Aide à la Coopération

(44) Union des Coopératives Agricoles de l'Adrar.

- Hydraulic activity (during the three seasons)
  - 47 wells were improved
  - 2 wells were dug
  - 326 motors and 183 pumps were repaired.

- Fertilization: 612 palm trees in 1968 and 547 palm trees in 1969 were affected by this action.

- Pest Control:
  - Chemical control: 6000 palms were treated against spider mite attacks (in Taka) and 61,980 against the mealybug during the three crop years.
  - Biological control of the mealybug; several releases of predatory coccinellidae were made in several zeribas scattered among the different palm groves.

III.1.1.5 Aside from these projects a few other minor actions, studies and surveys, worthy of note are each isolated in time. To cite only the most important of them, they were:

- The distribution of some 40 motor pumps in Tidjikja in 1978 as a gift from USAID.
- Soil reconnaissance study of the Kankossa region with a view to extending the palm groves, executed in the framework of activity at the Kankossa station in 1958.
- A study on the redevelopment of the watertables of Atar and Tidjikja.
- Mission for evaluating the status of UCCA, conducted by an expert from BIT in 1968.
- Reconnaissance mission in Adrar with an aim to the "rejuvenation of the palm groves and the survival of its populations", made in March 1975 by a group of experts.

III.2 ACTIONS PRESENTLY IN PROGRESS

III.2.1 Phytosanitary protection of the palm groves

This involves reactivating the entomological laboratory of Nouakchott for the control of date palm mealybug, which attacks the palm, by means of breeding and distributing the coccin.
This project is financed by FAC (10 million UM). It was begun in 1977 and should last four years. In another connection, the laboratory was to have begun breeding coccinellidae in 1980, with a first batch of 150,000 units.

III.2.2 Integrated development of the oases

The object of this project is to renovate the oases in order to increase agricultural production, reduce the deterioration of the environment and upgrade health and living conditions of the inhabitants of the oases.

This project is still under study; it should soon get off the ground with financing from USAID for $US 6,600,000. The target area for implementing this action is the Assaba.

III.2.3 Rural development of the Tagant Region

This project assesses the situation in the region from all aspects of the rural environment. It proposes measures essentially englobing the following themes:

- agriculture and environment (extension, research, water conservation, activities on the palm plantations, environment, agricultural services, etc.

- social infrastructure
- physical infrastructure
- hydraulic infrastructure

In principle, this project is in the preparatory stage of execution under the management and planning of SONADER.

III.2.4 Action Program for Biological Control in the Assaba

This mission, conducted by palm tree specialists in 1977, focused on the extent to which the date palms were infested by the mealybug and the presence of useful insects such as the coccinellid.

III.3 COMMENTS

We have all too many comments to make about most of these actions. True, it is easy to criticize, but that is not our purpose in this report. To be brief, we shall make a distinction between three general types of actions:

1 - The research programs

2 - The isolated actions and missions

3 - Projects for integrated development.

III.3.1 The Research Programs

These programs can be reproached for being unrealistic and forever misreading the real problems of development. In fact, not to mention the principal actions which have caused the waste of a great deal of ink and paper and which have cost dearly, we note the attempt to control the mealybug biologically, the industrial packaging of

dates and the genetic studies of the palm tree, which, from our viewpoint, are aberrations if not outright absurdities.

The theme of biological control was taken up in a very lackadaisical manner,when it is actually a very complex subject. In other countries with date cultivation, it has always been set aside, while saying that perhaps in the future, biological control can be foreseen, since excellent cures for these extremely harmful pests are known.

The argument used by researchers in Mauritania was that chemical control is expensive - which has not been proven - and that Mauritanian date farmers know nothing about it, which makes no sense whatsoever because knowledge can be acquired.

There has always been talk about the balance between the mealybug and the coccinellid, but never about the balance between the coccinellid and its parasites or predators, including:

- a type of sporozoan which feeds off the coccinellid by reducing its fertility; based on several IFAC reports the level of infestation has averaged 20%.
- the praying mantis, which eats coccids; according to these same reports, one mantis eats 8 coccids a day.
- certain types of spiders which weave webs between the leaves and hunt the coccinellidae, etc.

Moreover, from the technical standpoint, in order for the coccinellid to survive during the hot dry season, the most critical period, a favorable microclimate must be created for it on the plot by planting crops associated with the palm tree. This appears a little utopic when one is well-acquainted with the production systems in the oases and when one has an idea of the water problem during the hot and dry season.

Researchers speak of "planting the smallest amount of crops to a zeriba so as to contribute the smallest amount of humidity needed for the insects to survive during the hottest time of the year (45)". It is easy to say that this is not being realistic.

Researchers have shown that "400 coccinellae" are ample for one plot of 50 to 100 trees", (46) or about one-third hectare or one Zeriba. Based on this, if one should wish to treat only half of the palm groves or about 2,000 ha and supposing that the coccinellae released continue to live in total harmony with the environment, and since the capacity of the entomological laboratory of Nouakchott is only about 150,000 crops per year, it would require 18 years given that there were companion crops in all the Zeribas, numbering 6,000.

In conclusion, it must be pointed out that "this biological control has been very seriously misunderstood and often unjustly criticized by the date growers or

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(45) Fall Ahmed Moloud, January, 1977.

(46) J.C. Tourneur, R. Hugues and A. Pham, 1976.

different authorities, who do not want to make the effort to come to its defense by starting with growing a simple patch of mint at home; biological control is not a miracle product which will eliminate the mealybug in Mauritania; its goal is to allow one to live with the parasite in the best possible conditions." (47)

These same date growers have always asked us, during our field investigations, about the possibility of providing them with treating products and teaching them the new methods.

One of the consequences of this biological control was Decree No. 69046/MPDR/AGR dated 1/16/69, which instituted the protection of useful insects planted in the palm groves to fight against the date tree mealybug wherever they appear.

The actual breeding of the coccinellid is somewhat complicated. Reproductive coccinellae must be nourished in the laboratory on mealybugs that must be imported from the U.S.A. and which can only live on European watermelon or on a variety of Moroccan gourd which must be imported or grown locally.

In our opinion, it is these elements which only undermine/hinder biological control such as it is now being conducted.

As for industrial packaging of dates, this activity is widespread in all date-growing countries with all its problems, but industrial packaging implies an industrial-

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(47) Fall Ahmed Moloud, January, 1977.

scale or at least artisanal date-growing, which is not the case here. Actually, this involves a traditional system of operation; industrial packaging would demand extensive action from the actual production systems, which has not been the case in Mauritania.

Now, as concerns genetic research, it is a well-known fact that since science has taken an interest in the date palm,no real study or genetic selections has been made, due to the slowness of the process. No variety of palm tree has been genetically isolated to date, and cultivars are still being reproduced from offshoots.

III.3.2 Isolated Actions and Missions

There have been many of these, often making the same analyses, the same suggestions. We are not criticizing the analyses and suggestions in themselves, but we question their usefulness when nothing has been planned to carry out these suggestions or to expand on them.

Furthermore, certain, more concrete actions such as the distribution of motor pumps in Tidjikja, were ineffective. In fact, nothing had been planned for the maintenance and reparation of that equipment, so that as things stand now, the least breakdown causes a break in irrigation, thus jeopardizing the successful cultivation of the crops.

III.3.3 Projects for Integrated Development

On the surface, these actions should be the most promising, since they take a relatively broad approach,

touching on all aspects of the rural world and motivated by a practical and realistic frame of mind. However, attention must be focused on the importance to be given to the follow-up stages of these projects, especially for those which were poorly defined.

Chapter IV. MARKETING AND STORAGE

In this chapter, we have presented the products and by-products and a few of their technical characteristics, their use, and the problems presented in storing or selling them.

IV.1 PRODUCTS AND BY-PRODUCTS, AND THEIR USE

IV.1.1 The Date

The fruit of the date tree and the tree's "raison d'être" is a berry-type of fruit. Some of its characteristics such as its shape, colour, consistency and composition, or its varietal traits, particular to the variety, and others such as its size, marketing qualities, etc., are largely determined by the methods of production and the conditions of cultivation.

From the viewpoint of chemical composition, the date is composed of glucids, water, protids, limpids, tanin, pigments, mineral salts and a few vitamins. This composition, as well as the proportions of the various elements vary depending on the stage of maturity; its soft, semi-soft or hard consistency is determined by the ratio of water to glucids.

From the viewpoint of its food value, the date has high energy and nutritional value; engravings found in the tombs of Pharaohs and writings in the Kobt ruins bear solid witness to this. Its wealth in valuable mineral salts has earned it the name of "Menjem", or "mine" in certain regions, and it has the reputation of being a complete food.

From the viewpoint of its energy value, the date supplies an average of 283 calories (48) per 100 grams of pulp; this value varies between 260 and 306 calories according to the variety.

From the viewpoint of vitamin content, date flesh contains vitamins whose quantity varies according to the variety. As an example, the following data summarize the vitamin content of the "Deglet Nour" date (49).

- Ascorbic acid (C)	. . . . .	5 mg per 100 g/date mea
- Thiamine (B_1)	. . . . .	0.06 "
- Riboflavine (B_2)	. . . . .	0.05 "
- Nicotinic acid (PP)	. . . . .	0.5 "
- Pantathemic acid (group B)	. . . . .	0.24 "
- Pyridoxine (B_6)	. . . . .	traces
- Active carotenoids (A)	. . . . .	0.05 "

Mauritanian dates are similar to any other dates, but their caloric and vitamin content seem to be among the most mediocre. Table 11 (below) gives an idea of the composition of Mauritanian dates.

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(48) Passat, F.F., 1971

(49) Randouin, cited by Munier, 1973.

Table 11. Composition of Mauritanian Adrar Dates in Different Stages of Development (per 100 grams of flesh)

	Yellow Dates "Bleh"	Yellow Dates "Turning"	Red Dates "Bleh"
Water (gr)	62.6	53.9	70.1
Proteins (gr)	0.97	1.08	1.21
Lipides (gr)	0.6	0.08	0.10
Glucides (gr)	35.13	48.32	27.22
Cellulose (gr)	1.44	1.29	2.29
Ashes (gr)	1.2	1.12	1.37
Calcium (mg)	72.5	47.5	83.5
Phosphorous (mg)	102.0	125.0	111.0
Iron (mg)	1.64	1.48	1.72
Total carotenoids (in I.U.)	419.0	103.0	441.0
Vitamin C (mg)	13.0	14.0	14.0
Energy Value in Calories	144.9	180.3	114.6

Source: P. Munier, 1973, according to ORANA: Organisme de Recherche sur l'Alimentation et la Nutrition-Africaine, 1966.

The lack of data on other type of dates in the same stages of development makes comparison impossible. One can see that in the "Bleh" stage, in which vitamin content is the highest, the number of vitamins is limited. As for the "Turning" stage, which is an advanced stage of ripening, energy value is scarcely more than 260 calories at the end of maturation. Nevertheless, this energy value remains

always greater than that of other fruits. As an example, the following data summarize the relative caloric value of several fruits known in Mauritania.

- Banana:	97	calories	per	100	gr	of	flesh
- Lemon:	43	"	"	"	"	"	"
- Orange:	48	"	"	"	"	"	"
- Pear:	61	"	"	"	"	"	"
- Grape:	81	"	"	"	"	"	"
- Tomato:	22	"	"	"	"	"	"

IV.1.2 Dates in Mauritania and their Uses

Dates can be harvested at different stages of maturity depending on how they are used and on eating habits.

In Mauritania, they begin to be harvested and consumed as soon as they are botanically mature, at the fresh date state, or "Bleh". In this stage, in order to be consumed, the dates must have just been picked, or they will quickly lose their moisture and wrinkle up, and their taste qualities depreciate. This is one of the factors limiting their utilization at this stage, especially because the Moors know of no other uses. In certain date-growing countries, the fresh dates are pulverized into vinegar (acetic acid), and 24 hours later, they are transformed into a paste, washed and eaten. This operation is effected only domestically.

So, a good part of the product is harvested at this stage. According to literature on this subject, between 30 and 50% are consumed in this way; according to our field survey, this level should be approximately 40.5% for the date-growing zones on the whole.

Usually, these dates are eaten on the spot in the palm grove by the populations coming in during the "Guetna", including owners and non-owners. The latter purchase or receive as gifts, depending on the case, the part they consume. Furthermore, when conditions permit it, part of the harvest is placed on the local or regional market. Usually, the part sold in this manner is very small, except in the urban palm groves. For all of Mauritania, based on our survey, 54% of the "Bleh" harvest are sold between the palm groves and the markets.

Later on, the harvest continues when the dates are physiologically or commercially ripe. "Dates thus harvested are spread out to dry on palm leaf beds for several days, where they are exposed to attacks by flies or butterflies, which depreciate their quality enormously."

The dates are then packed or piled into different types of containers (goatskins, sacks) depending on their consistency, to be stored or sold; they receive no treatment in particular for removing insects, sorting, etc. Again based on our survey, approximately 40% of the mature dates are marketed.

It must be pointed out that in the southernmost palm groves, nearly the entire production is harvested during the "Bleh" stage in order to avoid the rainy season; dates harvested in this manner are partly consumed and the rest placed in sacks or skins under tightly packed conditions because of the heavy masses, to the point where the dates break open, and they are kept this way until they mature.

Briefly, the situation can be summarized as follows:

- Quantities consumed
  as "Bleh" (fresh dates): 18% of production
  as ripe dates: 36% of production

- Quantities sold
  as "Bleh": 22% of production
  as ripe dates: 23% of production

Thus, the total self-consumed quantities apparently represent 54% of production; those sold, or the remainder, represent 45%. It must be noted that selling is carried out at two levels: one part is sold, usually on the stalk, within the palm grove itself to the nomads and others who have come for the "Guetna", and the remainder is sold in the local, regional and interregional markets. We were unable to obtain a sufficiently exact idea of the size of this type of sale, but we have estimated it to be at least 10% of the locally sold product; therefore, assuming the best, the quantities entering the market channels should represent 35% of total production. By using the figures proposed in this report for the extension of the palm groves, the rate of productive palm groves, the number of male trees and the average yields, the date production should be approximately 16,600 tons, utilized as follows:

- Privately consumed as "Bleh" 3,000 tons
- Privately consumed as ripe dates 6,000 tons
- Sold as "Bleh" 3,700 tons
- Sold as ripe dates 3,900 tons

These levels vary slightly from one region to the other. That part sold is generally higher in the urban palm groves. The privately consumed part is higher in secluded palm groves and in the younger ones.

In another connection, the regional distribution of date production can be evaluated as follows (Table No.12), keeping in mind the different data put forward.

Table No. 12: Regional Distribution of Date Production

Production Region	Self-Consumed Product (T)	Product Sold (T)	Total Production	
			Tons	%
Adrar	4320	3600	7920	48
Tagant	2900	2450	5350	32
Assaba	1400	1200	2600	16
Western Hodh	260	250	510	3
Other Regions	120	100	220	1
Total	9000	7600	16600	100

IV.1.3 Products of the Companion Crops and Their Uses

Production of the companion crops is dominated by vegetable production, and secondly other products: alfalfa, henna, and cereals.

Our estimates of the major products have given the following results:

- vegetables: 890 tons, of which about 90% are produced in Adrar. An average of 35% of the products are self-consumed and 65% are sold.
- alfalfa: 450 tons, of which 50% are used on the farm and 50% sold.
- wheat and barley: 19 tons, of which about 75% are used for private consumption and 25% sold.
- sorghum: 4.2 tons, 75% of which are used for private consumption and 25% sold.
- henna: 240 tons, 20% of which are used for private consumption and 80% sold.

By using the results of the sampling taken during our survey, production of the companion crops is broken down as shown in Table 13 for the 1978-79 campaign. We note that this provides just a few broad guidelines of this breakdown, given the fact that most of the companion crops are annuals and their extension is subject to variation from one year to the next.

Table No. 13. Regional Distribution of Companion Crop Production

Production / Region	Wheat/ Barley (t)	Sorghum (t)	Alfalfa (t)	Vegetables (t)	Henna (t)
Adrar	18	4.2	450	870	n.d.*
Tagant	1	-	-	n.d.	n.d.
Assaba	-	-	-	n.d.	n.d.
Western Hodh	-	-	-	14	n.d.
Other Regions	-	-	-	-	n.d.
Total	19	4.2	450	884	240

*not determined

IV.1.4 By-Products and Their Uses

The date palm provides a certain number of by-products, which are: wood from the stalk, palm leaves, branches, nuts, the heart, and sap, which can be sold at a high price or not, depending on how they are used, to habits, to their quantities, and also according to economic conditions.

In Mauritania, several usages are known for some of its by-products such as its wood and palm leaves.

IV.1.4.1 Palmwood, though of a very mediocre quality, is widely used for different purposes, especially in zones where no other large supply of other wood exists. It is utilized as the frame in house construction, as the prop when building wells or Achilal. These uses are rather limited because palm trees are felled very rarely and only dead palm trees are used for one reason or another.

IV.1.4.2 Palm leaves are used much more than wood due to their abundance. They are used whole to build hedges around the lots (Zeribas).

The rachis is used to make ceilings, bed tickings (Khabta or Tchegal). Cut into thin strips which are then woven together by interlacing with fine strips of leather dyed by the women, they are used to make lovely mats.

Of all these uses, the last is the most interesting for household pocketbooks. In fact, it allows rather

substantial income (50) and capitalizes on feminine labor. However, one cannot use just any palm leaves, but only those of the young palm trees. For this reason, one sees over-cropping of these trees, which compromises the balance between vegetation and fructification.

In summary, one can see that the economic importance of by-products remains limited to the production zones. However, their effect in the oasis cannot be neglected, due to the fact that they permit some odd money to come in, however small it may be, and to lessen the strain of the human element on the scarce woody vegetation there is in the oasis surroundings, in that it is substituted by the by-products of the date palm.

IV.2 STORAGE

One of the characteristics of the date is that it is one of the most sensitive to the special storing conditions. In Mauritania, even though storage most likely involves very small quantities of dates, it is still very precarious and does not take into account their sensitivity to various out-side elements. In fact, as we have seen, depending on their consistency, dates are piled into sheepskins or goatskins or packed into sacks full of filth, insect grubs, sand and dust, etc. These containers are then stored with no particular care at all in ordinary places, exposed to the effects of changes in temperature or humidity and to the attacks of different predators. Furthermore, these storing techniques never consider the degree of the physiological maturation of the

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(50) Each rachis can yield 4 strips, sold at 40 UM in units of 100, so the palm leaf brings in 2.5 UM.

date at the time of storage; in this way, mature dates are treated the same as others in the Bleh or intermediary stage.

While at present this has practically no effect on the local consumption of dates because of the critical food situation in the country, and while it causes no notable losses in the products since only limited quantities are stored for relatively short periods, such will certainly not hold true in the future, especially if there is a desire to increase production, for the tastes and demands of consumers do evolve. To this is added the growing trend to integrate dates into the market as a result of increasing sedentarization and urbanization. This trend would demand some adaptation of the methods and of tools utilized to the new situations and realities of the market.

Offhand, in the present stage of things, the rational preserving and storage techniques applied in other date-growing countries would run into some obstacles in Mauritania, in light of certain peculiarities of date production here.

On the one hand, there is the problem of the utilization of production and that part which should be stored; does it really require storage justifying durable actions in that area? On the other hand, there is the problem of the geographical distribution of this production among the different palm groves or groups of palm groves, of which there is a substantial number.

These are questions with very evident answers as things stand now. If is sufficient to draw conclusions from the example of the IFAC's experience in the Adrar as far as the

industrial processing of dates is concerned (Chapter III.1).

However, in the middle term and supposing a notable rise in date production, through programs involving the systems of production, the problem of storage and handling the harvest would have to be examined at all costs so that one can foresee solutions well adapted to the new systems of production.

With respect to the products of the companion crops, notably the vegetables, they are not stored or preserved at all since they are always eaten or sold fresh. However, despite of the low volume of production, some problems come up in the disposal of the products and risk halting production.

IV.3 MARKETING

The dates are sold in loose piles or on the stalks when they are fresh or in the Bleh stage; mature dates, depending on their consistency, are sold in lots in containers, packaged loose in small plastic bags, or in big lots. Sales are made by weight, per kilogram.

The price of the product varies from one region to the other, and also depends on its ripeness. (See Table 14).

IV.3.1 Domestic Marketing

For the dates domestic marketing takes place on two levels: on the first level, it occurs in the palm grove itself, during the "Guetna". The main buyers are the nomads or semi-nomads or others who have come for this purpose; one also can find a few merchants especially in the most accessible palm

groves. The sale is made on foot (on the stalk), per palm tree; the price is discussed between the buyer and the seller and varies from 1,200 to 4,000 ouguiyas depending on the size of the tree, which is quickly evaluated beforehand. This type of sale is chiefly practiced in the somewhat secluded palm groves. We were unable to obtain an exact enough idea of the quantities sold in this manner, but we estimated them to be between 10 and 15% of production.

On the second level, the dates are sold in the town markets. Most of the product sold in this manner comes from urban palm groves, in addition to nearby groves with easy access. The buyers include consumers as well as merchants, who practise some arbitrage by selling dates in towns without palm groves.

IV.3.2 Foreign Marketing

It must be noted that there is a third level of date marketing: foreign countries. However, because of the absence of data, no conclusions can be drawn on this subject. The literature on dates indicates the existence of north-south trade routes which concern the exchange of dates and salt for cereals in certain areas of the river valley and southeastern Mauritania. One can well imagine that some of this trade takes place on the borders and beyond them.

A 1968 SEDES study (51) mentioned that 2.5% of dates marketed in 1967 were exported, amounting to 300 tons. This quantity is certainly regulated exports and there are probably

(51) Les échanges commerciaux en Mauritanie, 1968.

many more dates exported without government control. At the end of the 1960's the IFAC organized exports of dates to Senegal, but information on this activity is missing.

Today, certain Mauritanian businessmen do their own exporting, mainly to Senegal, and, according to some observers, it is possible to find fresh Mauritanian "bleh" dates in certain Senegalese markets during the "Guetna".

According to the FAO Yearbook of Commerce, exports are estimated to have been between 1,300 and 1,500 tons annually between 1977 and 1980.

It is certain that date exports have not yet been even summarily studied. Given present-day conditions of date production, exports are at best a marginal activity. This would not be the case if the oasis agriculture subsector were to be developed. It would seem possible to export dates to the CEAO (West African Economic Community) countries at least. In effect, according to the FAO (52), the member countries (excepting Mauritania) import a considerable volume of dates each year, approximately 2,000 tons. These dates appear to be mainly French re-exports rather than imports from neighboring countries, such as Mauritania. Thus, these imported dates are a luxury item and are problably very expensive. In the author's opinion, the most important possibility for exporting Mauritanian dates is to the CEAO countries. This possibility should be seriously studied

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(52) Annuaires FAO du Commerc, 1977, 1978, 1979.

because it could serve as a stimulus to the development of oasis agriculture and thus contribute to efficient and rapid progress toward food self-sufficiency and economic independance in the widest sense.

IV.3.3 Producers' Prices

Producers' prices vary from one region to another and according to the degree of ripeness of the fruit.
Table 14 (see below) presents average prices cited by date growers during the RAMS survey.

Table 14. Average Prices for Dates in Different Regions for the 1978-79 Crop Year

Category of date Region	"Bleh" Dates	Ripe Dates
AEZ II 2nd Region	33.3 UM/kg	35 UM/kg
AEZ III 4th Region	50 UM/kg	45 UM/kg
AEZ IV 2nd, 3rd, 7th Regions	23.8 UM/kg	39.6 UM/kg
All Regions	30.5 UM/kg	37 UM/kg

(Unit: UM/kg)

It must be pointed out that these are the average values, and are chiefly indicative, but in the same region, we have observed that the prices vary greatly, probably depending on the quality of the dates. By this is chiefly implied their appearance; whether they have been attacked

or not by spider mite or mealybug, and if they are relatively clean or not. Thus, in the Adrar, for example, prices vary 10 and 50 UM a kilo for Bleh and between 10 and 130 UM a kilo for mature dates. Finally, it appears that the prices in the main production zones partially reflect quality and in other, secondary production zones such as in the 4th region, they reflect rarity above all. We say "partially" because it appears that the precocity of the harvest also plays a role in determining prices.

For the companion crops:

- The cereals and alfalfa are sold locally;
- The vegetables are generally sold locally in light of their small amount, except in the Adrar, where a good portion is exported to other centers such as Zouerate, Nouadhibou and Nouakchott. In this regard, one notes that in the Adrar, considering the small scale of production and the lack of effective organization in marketing and disposal of the product, vegetable production has reached the point where it can go no farther under the present conditions. In fact, existing structures such as the Union of Farming Cooperatives of the Adrar, which has not functioned normally since 1970, due to their small means and the absence of guidance, exist only in name. Only a few merchants with plenty of capital succeeded in making money from their production and profit from the others' weaknesses.
- Henna, being a non-perishable product and easy to keep, poses no problem for marketing.

In conclusion, it can be said on the whole that if at present there are no serious problems in selling the products from the oasis, especially for the date, which until now is highly

valued on the market, this should not hold true in future, especially with continued growth in production. The methods and techniques of marketing, especially as concerns presentation and handling of the date, must keep up with the evolution of tastes and demands; already, one notes, in the considerable variation of prices for the dates in the market and through the populations' change in behavior towards the "Guetna" in the urban oasis, the start of a subtile change in these demands.

Chapter V TRAINING AND RESEARCH

In this chapter, we will take a very brief look at the different institutions intervening in the area of training and agronomical research; then, we shall examine the extent to which they are incorporating the production process into oasis farming through the agents they train and through the research programs, by accentuating the qualitative aspects in particular.

V.1 PRESENT STATUS OF TRAINING AND RESEARCH (53)

At present, three institutions exist in Mauritania which are involved in training and agronomical research:

- The Ecole Nationale de Formation et de Vulgarisation de Kaédi (ENFVA) *:

This is a public administrative establishment aided by an FAO/UNDP project. This school offers two types of training:

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(53) WAEC.

* State School for Training and Agricultural Extension of Kaédi.

- training of rural economy monitors;
- training of foremen for work in the rural areas.

Subjects taught in this establishment cover crop production, crop protection, forestry, extension and rural economics.

- The Centre Nationale de la Recherche Agronomique et du Développement Rural (CNRADA) in Nouaédi*:

This is a public administrative establishment and financially autonomous. It is in charge of organizing, executing and distributing all research work concerning agriculture and the promotion of agricultural production in general.

It is endowed with many duties, ranging from experimentation to training, economic studies and pre-extension work. The latter vocation has not been able to be fully elaborated until now, considering the number of national researchers.

In theory, it disposes of three branches:

- the date-growing station of Kankossa;
- the entomological laboratory of Nouakchott;
- the fruit station of Rindio in the Senegal River Valley.

At present, the CNRADA programs concern two systems of production, which are:
- the cultivation of the date palm in oasis farming, notably regarding crop protection (biological control);
- the irrigated cultivation of fruit trees in the southern part of the Senegal River Valley.

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* National Center for Agronomical Research and Rural Development.

- The Centre Nationale de l'Elevage et de la Recherche Véterinaire (CNERV)*

This center has the same statute as CNRADA: its activities mainly concern animal health, feed crop production and sheep raising.

V.2 INTEGRATION OF TRAINING AND RESEARCH INTO OASIS FARMING

The aspect of integrating training and research has been examined on different levels, which are:

- at the producers' level;
- at the level of supervision and extension;
- at the level of agronomical research.

V.2.1 At the Producers' Level

The problem of training farmers in oasis farming has never been broached until now. This, in our opinion, is a very delicate problem and cannot be effectively approached without being well-informed about the systems of production now in place. In fact, the abundance of these systems make it so that training needs could never be identical everywhere, and it would not be directed at the same type of date farmers.

As we have seen, these systems differ spatially, in their human factors, etc.

Thus, in setting up training programs and awareness programs necessary to the support of development actions,

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* National Center of Animal Husbandry and Veterinary Research.

these realities must be taken into account. It must also be pointed out that for such programs bringing the sought-after results, certain problems concerning land tenure and the relations between landowners and cultivators should be solved beforehand.

V.2.2 At the Level of Supervision and Extension

At present, supervision in the production zones is assured by the sectors and subsectors of agriculture. The latter are directed by very average management who, for the most part were trained by ENFVA. Usually, the head of the sector is a foreman for Rural Economy Works; most often, he is assisted by rural economy monitors and by skilled workers who are simply former cultivators.

The main tasks assigned to these officers are, in principle: technical supervision of the cultivators and spreading new and adapted techniques. But in reality, nothing like this happens, especially with respect to oasis farming. The reason is that there is a pile of problems, which we summarize while making the following observations:

- Quantitatively speaking, these officers are very few in number, such that most of the time, they are absorbed in administrative tasks, distributing seeds and selling supplies.
- Qualitatively speaking, the training they were indoctrined with in oasis farming and particularly in date-growing, appears to be very theoretical in nature, so much so that they cannot have a clear and practical idea of the problems.

- The insufficiency of material and logistical means is such that these officers are barely familiar with their assigned areas and their problems.

- The extension work that they practise is not at all what it should be, although they are generally motivated by good will. In fact, no theme or topic of extension is studied beforehand or determined for the method of distribution or material to be given to the farmer. Also, even though these themes exist, a minimum of means and working tools will be needed, which at present are lacking.

We have nothing to criticize about these officers; we believe that a good part of extension work should be carried out by very high level experts working on a regional scale or, failing that, on a national scale. These experts, while conducting agronomical research, should devise simple themes and propose methods and appropriate vehicles for their distribution. These themes should be derived from problems presented at the grassroots level, among the farmers.

- We add that in the present situation, the supervision and extension officers do not receive much credit from the farmers; even if the latter do come into contact with them often, it is perhaps for an immediate interest. This problem of a credibility gap, which is perhaps psychological, could be due to:

- the fact that some of the agents are doubted by the farmers because of their precarious material situation or their social status;
- the independent status and spirit which the farmers have towards structures in general.

- Another point no less important than the others, is the material motivation of the officers. Realistically speaking, why should one want to have an officer make tours in the field if he is not motivated even symbolically, when he could remain in the comfort of his office and earn the same salary?

In short, therein lies an endless series of problems which can only be reduced through a global approach incorporating all aspects of the big problem in production, those aspects being technical, legal, economic, and so on. To solve the problem of training would inevitably require that the other problems be solved.

V.2.3 At the Level of Agronomical Research

Agronomical research, in our opinion, constitutes one of the most important links in the production process. It is first of all the responsibility of agronomical research to know, to understand and analyze the systems of production in regard to their spaces and potential; secondly, it is also the responsibility of agronomic research to propose, based on its results, whatever is technically possible and feasible. It is through extension programs that one works to propagate these proposals.

In the present state of agronomical research in Mauritania, other than numerous research programs bearing on the animal husbandry sector and on the subsector of irrigated crops, there is a program concerning the systems of production in the palm grove, but it focuses solely on the aspect of oasis protection through biological control.

It must be admitted that, in light of their considerable economic importance, at least in the middle term for irrigated crops, it is completely logical that these two activities should be the focal point of interest in research and monopolize foreign aid in this area somewhat.

To concentrate all efforts on using biological control or chemical control does not guarantee a maximum return; for focusing programs of improvement on one particular problem among so many others is the same as ignoring the real problem of the oases.

We will not linger on this subject, but shall simply point out that while this biological control has proven to be technically possible, it does have its limits and will meet up not only with subjective barriers but also much more objective ones (cf. Chapter III.1); in our opinion, research should concentrate its efforts on an approach that is simultaneously global, integrated and very down-to-earth about the problems in the oases and in the rural sector in general. Moreover, research on special technical problems could be conducted with the collaboration of the regional FAO project for research on the date tree in Irak, of which Mauritania is a member.

In conclusion, concerning the subject of training and research, there is a loss to be made up for in the domains of:

- Training. This activity must be adapted to the realities of Mauritania, because it is not enough to give a simple course in date-growing. Training should include a practical component which could involve:

- field trips to major date-growing areas at particular times of the year.
- short, on-site practica in one or more palm groves set aside for the agricultural school. These sites would be branches of the school and would serve for teaching and for agronomic research. It is worth noting that there are quite a few groves belonging to the government which have been practically abandoned (Aïoun, Moudjéria, Kankossa, Atar). Therefore, in order to improve this training, it would be worthwhile to give specialized knowledge to a certain number of extension agents. The latter would be recruited preferably from among agents who come from date-growing regions.

- Research: Focussed on the central problems of development and realities in the field, it should examine all technical and socio-economic aspects of date-growing, such as:
  - date-growing techniques and technologies, means of improving them and adapting them to development needs.
  - the economy of oasis production and how it fits into the overall economic activity of rural development.
  - establishing selection criteria for appropriate vegetation for the various date-growing zones as well as possibilities of improving them.

The examination of these different topics should lead eventually to perfecting appropriate and disseminable themes or models that research would make available to the extension services after completing field work and preliminary evaluation. Extension work, which would be responsible for diffusing these themes and models, would allow for the a posteriori evaluation of research outputs and eventually their improvement.

Chapter VI. THE OASIS AND THE ENVIRONMENT

In this chapter, we have attempted to reveal the main factors encouraging the degradation of the oasis environment in general, and to see how one might prevent or even combat such phenomena.

VI.1 FACTORS ENCOURAGING DEGRADATION

As defined earlier, the oasis is an ecosystem in balance with desert environment, which equilibrium is maintained by the presence of the date palm, which, among other things, requires a certain level of human activity. Also, the cultivation of the date tree or farming in the oases in general, can be the only activity of the human factor just as much as it be the principal or secondary component in the exploitation of the environment among other, usually complementary components. For example, in the first case, one can point out most of the semi-artisanal palm groves of North Africa, and in the second case, the Mauritanian palm groves. Thus, through this observation, one can deduce offhand that an oasis depends largely on the level of human activity both inside and outside the oasis, excluding the other factors of the physical surroundings.

Here again, we cite two rather extreme examples; the first is that of an oasis in the region of the Oued in Algeria, where nearly every day, probably for centuries, the cultivators must clear the area of sand several meters high which has silted in overnight.

The second example is that of "the basket" in Nefta, in Tunisia, where, probably for more than a century, the

date growers, in their ardent concern to preserve their heritage, have overdeepened the palm groves so that they can collect water from the spring, located in the middle of the palm grove, and whose piezometric level drops lower and lower with time: in fact, this is why it is called "the basket".

One can see from these two examples that only human activity, by overusing the vegetation cover in the first case and overuse of the water table in the second case, is at the source of these two phenomena of deterioration, which have reached more or less irreversible stages. One can also see that this same human activity, by becoming aware of the gravity of the situation, could remedy such situations or slow down the time they take to come about according to the degree of reversibility of the phenomenon.

Now, if we return to Mauritania and make a tour of some of the palm groves, what do we find?

- Some palm groves threatening to disappear after the drop in the level of the underground water table. The climate and the drought are being blamed for this, but one forgets that the number of motor pumps has beenmultiplied by at least 50 between 1958-59 and 1980. What happens? The wells are overdeepened. Such is the case of several palm groves in the Adrar (Tazagrez, Taouaz, Ksar toichane, etc.).

- Palm groves completely buried by sand and others in the process of being buried. The climate and the drought are blamed, but one loses sight of the few giant acacias remaining, remnants of the past, in whose shade an entire caravan can escape the burning heat of the sun. What is being done? Absolutely nothing. This is the case of the

group of oases in Chinguetti. In effect, practically all of the palm groves to the west of Chinguetti have disappeared. We were fortunate to see some vestiges of palm groves, which testify to a prosperous past. What the local people say about this subject is hard to believe unless one sees the palm grove of the former village of Chinguetti. The grove is irrevocably condemned and is now in its last days. The same is true of much of the Houitat grove northwest of Tidjikja and several groves in the Aoujeft group in Adrar. The examples cited here are only the ones we were able to see but there are certainly many other examples that are more or less threatened.

- Other palm groves around which beneficial vegetation is beginning to disappear to give way to less useful species such as calotropis procera, a sign of soil sterility. This species should one day disappear in turn, for it is appreciated by some people for making hedges or Zeribas.

- Some palm groves well-preserved on the whole. Some are palm groves in the hollow of fixed dunes which are apparently very vulnerable to certain phenomena of erosion: the others are the palm groves of fossil oueds, completely imprisoned between mountainous residue. The reason is that these groves benefit from human activity only periodically, and they are often secluded; also, those of the oasis oueds enjoy some natural protection.

In summary, it is unnecessary to search further to understand the reasons or rather the reason for the deterioration of the oasis environment or of the environment in general. "In the northern Sahara it is man who has created the desert: the climate is only a supporting factor. Moreover the

phenomena of deterioration or desertification are intermittent in time and space. They vary in time with the reappearance of periods of droughts, reaching a culminating point. On the other hand, these phenomena are stopped in the course of a series of years with unusual (levels of) rainfall. They vary in space with the density of the populations and of their livestock, which are in turn linked to the availability of water. Paradoxically, spaces where the water resources are relatively important, suffer the most acute occurrences. (54)"

VI.6 STEPS TO BE TAKEN

The nature of the factors degrading the environment is the difficulty of making a satisfactory judgement of their degree of reversibility or irreversibility. Some authors never use the term "irreversibility", but prefer to speak of slow or quick reversibility or of great or small potential for reversibility under natural conditions.

So, each case should be examined on its own, based on the prevailing physical conditions; one could make a judgement based on fixed objectives and the means available, of whether actions to speed up the reversibility process or at least to stop the phenomenon, are justifiable.

But, an ounce of prevention is worth a pound of cure: good prevention would require:

- In depth knowledge of the environment and an understanding of the factors of degradation. This implies rather strict control of the endangered resource.

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(54) H.N. Le Houerou, 1975.

- Taking into consideration the impact of various environmental projects before implementing them, and the devise of simple techniques of prevention.

- Making the concerned population aware of the gravity of these phenomena.

- The perfection, within reason, of systems of awarding and encouragement, in addition to other measures.

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