Small ruminants in the Near East

Volume III: NORTH AFRICA

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Volume III: NORTH AFRICA

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SHEEP IN MOROCCO
by
F. Guessous, I. Boujenane,
M. Bourfia and **H. Narjisse**

BARBARY SHEEP
by
Gley Khaldi

SOME EXPERIENCES WITH FINN SHEEP IN THE SUBTROPICS
by
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SOME EXPERIENCES WITH FINN SHEEP IN THE SUBTROPICS

by

A.M. ABOUL-NAGA*

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SYMBOLS USED

Ossimi	0
Rahmani	R
Finn	F
Local	L
Barki	B
Finn x Rahmani	FR

Finn x Ossimi	FO
Finn Texel x Awassi	FTA
Finn x Texel	FT
Awassi	AW
Mutton Merino	MM
I1e de France	IDF
Suffolk	SF
Assaf	AS
Romanov	RV
Finn x Mutton Merino	FM
Romanov x Mutton Merino	FM
Romanov x Awassi	RVA
Finn x Awassi	FA
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FOREWORD

The increased demand for meat in the Near East has opened up economic opportunities for indigenous production from small ruminants. Consequently, there is a search for suitable technologies that would result in increased production per animal in rural areas as well as in large or medium-size commercial flocks. This has stimulated research and an increasing amount of data is now being collected on specific problems at specific locations. Some of this information is being reported at national level and a large amount stays in departmental records.

The Technical Consultation of the Near East Regional Research and Development Network on Small Ruminants (Rome, 1986) has emphasized the need for a greater flow of national knowledge and experiences which should be shared by all the countries of the region. The Consultation has recommended that the available information in each participating country should be compiled in a meaningful form and published to give a wide circulation. The priority topics identified for the Network publications are: evaluation of the potential of indigenous genetic resources; evaluation of crossbreeding results; assessment of procedures to increase reproductive output; and research techniques.

The Network publications have so far covered the documentation of potentially valuable indigenous sheep and goat breeds in Cyprus, Egypt, Pakistan and Turkey. A comprehensive compilation of information on Awassi sheep has appeared in No. 57 of this paper series. In the present paper, a detailed description is given of the performance of Moroccan sheep breeds and the Barbary sheep of Tunisia under the prevailing feeding and management conditions. In addition to describing the prevailing environment and feed supply, improvements that could be made in the system are indicated and relevant research results are presented. This provides a greater understanding of the resource base, its current performance and its potential under improved feeding and management.

Crossbreeding to improve fecundity and growth rate has been tried in the region to improve the genetic potential for intensive production. A number of temperate breeds and sub-tropical breeds such as D'Man and Chios have been used. The results.of crossbreeding trials with temperate prolific breeds such as Finn and Romanov are encouraging. However, these need to be looked at carefully before embarking on programmes involving smallholder flocks. The relevant information in this regard is therefore documented in the third part of this paper.

At the request of FAO, Dr. Fouad Guessous and his colleagues Dr. Boujenane, Dr. Bourfia and Dr. Narjisse of the Institut Agronomique et Vétérinaire Hassan II, Rabat, have contributed the part on Moroccan sheep and Dr. Gley Khaldi of the Institut National de la Recherche Agronomique de Tunisie has contributed the part on Barbary sheep. The data on crossbreeding with Finn sheep has been compiled by Dr. Adel Aboul-Naga of the Animal Production Research Institute, Cairo. We are grateful for their valuable efforts and hope that the information provided would be useful to the livestock specialists and the producers in the Near East Region.

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FAO, Rome

Near East Regional Cooperative Network on Small Ruminants Research and Development
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1. Report of the TCDC Workshop on the improved utilization of feed resources for sheep fattening in the Near East, Amman, April 1981.

   English, 1981 : Arabic 1982

2. Intensive sheep production in the Near East, Animal Production and Health Paper No. 40.

   English, 1983 : Arabic 1986

3. Report of the FAO Expert Consultation on Small Ruminant Research and Development in the Near East, Tunis, October 1984.

   English, 1984 : Arabic 1985

4. Small Ruminants in the Near East: Volume I. Selected papers presented at Tunis Expert Consultation. Animal Production and Health Paper No. 54.

   English, 1987

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   English, 1987 : Arabic 1988

6. Sheep and goats in Pakistan. Animal Production and Health Paper No. 56.

   English, 1985

7. Sheep and goats in Turkey. Animal Production and Health Paper No. 60.

   English, 1986

8. Report of the FAO Technical Consultation of the Near East Regional Cooperative Research and Development Network on Small Ruminants, Rome, October 1986.

   English, 1987

9. Small ruminants in the Near East. Volume III. North Africa. Animal Production and Health paper No. ...

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INTRODUCTION

Sheep production plays a key role in Moroccan agriculture. In comparison to other ruminants, sheep are the most important species raised in the country not only in terms of size of the population but also in terms of geographical distribution. Sheep are produced in every region of Morocco regardless of altitude, climate and land utilization. The importance of this production can therefore be assessed at the following levels:

1. Economically, sheep contribute about 25 percent of total red meat consumed in the country and mutton is ranked first by the Moroccan consumer. Consequently, a shortage of mutton on the market will usually have a larger impact on its price compared to beef or poultry. Sheep also produce wool and skins that are essential for the Moroccan handicraft sector.
2. Socially, small ruminants and particularly sheep represent a significant source of income for small farmers and those who do not own land. Because sheep, under traditional conditions, are often raised basically on grazing commonland (range, forest etc.), poor farmers with limited resources are interested in this activity. Sheep production also benefits from available family labour.
3. Ecologically, Morocco, where arid and semi arid land dominates, has very large areas that cannot be cultivated but can be used to raise small ruminants. Sheep in such areas can play a significant role in improving the level of income of the rural population.

As sheep production is not concentrated in one specific area and due to the large variability of natural and environmental conditions within the country, sheep are produced under different systems. Definition of production systems depends upon several factors such as breed, feeding calendar, feed resources, management practices, etc.

Several major breeds have been identified in Morocco. While their characteristics are still being defined, they seem to have large potentialities in terms of reproduction and growth. They are also well adapted to the harsh conditions that prevail during dry seasons and/or dry years.

Feed resources for sheep are dominated by range production and cereal by-products such as straw and stubble. It is not surprising therefore to find cereal production, sheep and range highly integrated at the regional and national levels.

Management practices in different parts of the country are still being studied, but traditional systems for breeding, feeding, housing and marketing largely dominate. Actions to improve some of these practises is now becoming more intensive, but productivity per ewe and year is still low.

Research on sheep nutrition and breeding in Morocco is recent and needs to be strengthened. Little literature has so far been published summarizing available knowledge. This paper will attempt to present this information and to highlight on-going research in these two disciplines.

1. LAND AND CLIMATE

The 1982 census showed that the population in Morocco was 22 million. Nearly 56 percent of this population, representing two million households, depends directly upon agriculture. The nation's agricultural income is generated from diverse sources and the livestock sector contributes 30 to 40 percent. The 12 million rural inhabitants derive their livelihood from 7.8 million ha of cropped land, 5 million ha of forest and more than 20 million ha of arid and semi-arid rangelands. Rainfed agriculture is very common in Morocco and covers 6.8 million ha representing about 87 percent of the cultivated land. This land is mainly cropped into grains or fallowed allowing annual weeds to grow and be grazed as a source of livestock feed. The extent of the different crop commodities is estimated as follows (FAO, 1986):

Grains: 4.7 million ha
Legumes: 0.4 million ha
Forages: 0.3 million ha
Other crops: 0.4 million ha
Fallow: 2.0 million ha.

Morocco has four distinct geographical areas: the coastal plains, the atlas and the Rif mountains, the plateau adjoining these mountains and the Sahara desert. The coastal belt is highly fertile and intensively cultivated into grains and various horticultural products. The topography in this region is gentle and the climatic conditions are favourable. Rainfall exceeds in general 500 mm and the temperature is usually mild all year around. An active dairy sector has been promoted in this region following the recent development of irrigation. Cattle and sheep are also commonly found in mixed herds in the rainfed area of this region where fallow, crop aftermath and residues are the main feed resources.

The continental plains of Tadla and Haouz (Figure 1.1) are to some extent comparable to the coastal plains in terms of agricultural commodities. However, the climatic conditions are harsher with less precipitation, a colder temperature during winter, and warmer temperatures during the summer season. Another feature of these plains is the greater economic importance of the sheep industry. Sheep performance in this area is dictated by the availability of grazing lands which are not cultivated due to low precipitation, shallow or rocky soil and a steep topography that discourage cropping.

The eastern limit of these plains consists of the middle Atlas mountains with an elevation ranging from 1200 to 2400 m. These mountains are subject to cold winters and to varying aridity. Annual precipitation varies from 300 mm in the southern part to over 1000 mm around Ifrane. Vegetation is diverse in these mountains and includes sagebrush rangeland, mountain grassland, and oak, juniper and cedar forests. Sheep are the main source of income in this area.

Figure 1.1 Map of Morocco

The high Atlas mountains divide the Haouz plain from the Moroccan desert and have an elevation which exceeds 4000 m. Annual precipitation and temperature are variable depending on exposure. Hence, the northern slopes are more humid and characterized by a freezing temperature ranging from -15° C to 0° C during four to nine months. Vegetation of this side of the high Atlas is dominated by Quercus, Juniperus, Tetraclinus and Pinus forests associated with an extremely diverse mattoral. The southern slopes are drier and dominated by steppic vegetation including Haloxylon scaparium, Aristida sp, and Helianthemum lipii. Agropastoralism is the main activity in this region where intensive crop production is practised on narrow terraces, while large numbers of small ruminants (mainly goats) rely for their feed on forestland and the summer rangeland existing beyond the timberline.

Further south of the high Atlas is the Moroccan desert. Aridity is severe in this area, where annual precipitation is below 150 mm and the low mean temperature is around 3 to 6° C. Agricultural activities are therefore limited to small oases, where irrigation allows subsistence cropping associated to the raising of a highly prolific sheep breed: the D'Man.

Finally, the high plateaux are an arid area bound in the north by the Mediterranean sea and in the south by the Moroccan Sahara. The degree of aridity obviously varies from north to south. The vegetation in this region is dominated by few low shrubs such as Artemisia herba alba and noaea mucronata and a perennial grass, Stipa tenacissima. Marginal cereal cropping is practised in this area, but the main source of income is generated from sheep raising in a declining nomadic system.

2.POPULATION AND PRODUCTION

2.1 Population

2.1.1 Breed Composition

The sheep population in Morocco is composed of 99 percent native breeds and 1 percent exotic breeds. All sheep are of the thin-tailed type. However, Miegeville (1952) distinguished between three different populations:

- The Berber population found in the Atlas mountains, which includes breeds such as Aknoul, Aït Barka, Ouaouizart, Marmoucha, Aït Mohad and Haute Moulouya.
- The Arabic population located in the eastern and western hills, composed of the Tadla, Sardi, Beni Guil, Tounsit and Zoulay breeds.
- The Syrian population commonly located near the Atlantic coast. This population includes Beni Ahsen, Zemmour, Doukkala and Abda breeds.

2.1.2 Number

The sheep population was estimated at 14.5 million head in 1986 (Livestock Service, MARA, 1986) which places Morocco among the major sheep raising countries In Africa. Table 2.1 Indicates the trend In sheep numbers since 1960.
The change In sheep number Is characterized by three different phases: a growth phase from 1960 to 1971, during which the animal rate of Increase was about 24 percent; a period of stagnation with some minor fluctuations reaching around 15 million head from 1971 to 1980; a decreasing phase from 16.5 million in 1980 to 12.9 million in 1985 following a very severe drought, with a slight recovery in 1986. These fluctuations in sheep numbers are the result of an extensive management system where feed resources depend strongly on climatic conditions.
In addition to the variation between years, sheep numbers vary within the same year. The highest number is recorded in spring, just after the main lambing season; and the lowest number occurs after the summer season during which the number of lambs slaughtered is at its maximum. During a normal year, the difference between the two periods is on average 10 to 14 percent.

2.1.3 Age and sex distribution

The last livestock census shows that 34 percent of the sheep population is composed of lambs of less than 6 months, whereas animals of more than 2 years of age represent 54 percent.
On a national basis the proportion of males to females is about 25 percent and 75 percent respectively. The majority of males (74 percent) is composed of lambs younger than 6 months, whereas the proportion of males of more than 2 years of age is only 7 percent. This imbalance between different age classes is inverted in the female population. Thus, the highest proportion of females (67 percent) includes those of 2 years or

older, among which 22 percent are more than 6 years old, whereas females of less than 6 months of age constitute 23 percent.

Table 2.1: Trends in the national sheep population
(in thousand heads)

Year	Number
1960	13 500.0
1961	13 041.7
1962	10 268.1
1963	9 123.5
1964	10 362.9
1965	11 990.3
1966	12 569.7
1967	13 408.0
1968	14 750.0
1969	16 000.0
1970	16 352.0
1971	16 700.0
1972	16 500.0
1973	16 000.0
1974	16 000.0
1975	14 270.3
1976	14 000.0
1977	14 500.0
1978	15 200.0
1979	15 992.0
1980	16 509.8
1981	15 675.5
1982	10 155.1
1983	12 610.7
1984	11 493.2
1985	12 862.0
1986	14 545.0

(Livestock Service, MARA, 1986)

These data also show that the proportion of breeding ewes is about half of the total population, the culling rate is less than 20 percent, and the average number of breeding ewes per ram in the flock is about 30 ewes.

2.1.4 Distribution by size of flock

In a livestock survey implemented in 1976, average flock size was about 32 sheep. Most flock sizes varied from 51 to 100 sheep, flocks of less than 20 sheep represented 18 percent, whereas those of a size greater than 100 head were 34 percent of the total.

The survey also showed that the total number of sheep breeders was about 520 000. Of these, 85 percent held 45 percent of the total sheep population with a flock size of less than 50 head.

2.1.5 Geographical distribution

Sheep are found throughout Morocco. However, some regions are well known as sheep raising areas such as the Atlas mountains and the eastern and western hills. Figure 2.1 shows the most important sheep areas.
The 1986 livestock census showed that almost 30 percent of sheep were located in four provinces, with the rest spread over the other 36 provinces (Table 2.2)
Figure 2.1: Geographical distribution of Moroccan Sheep

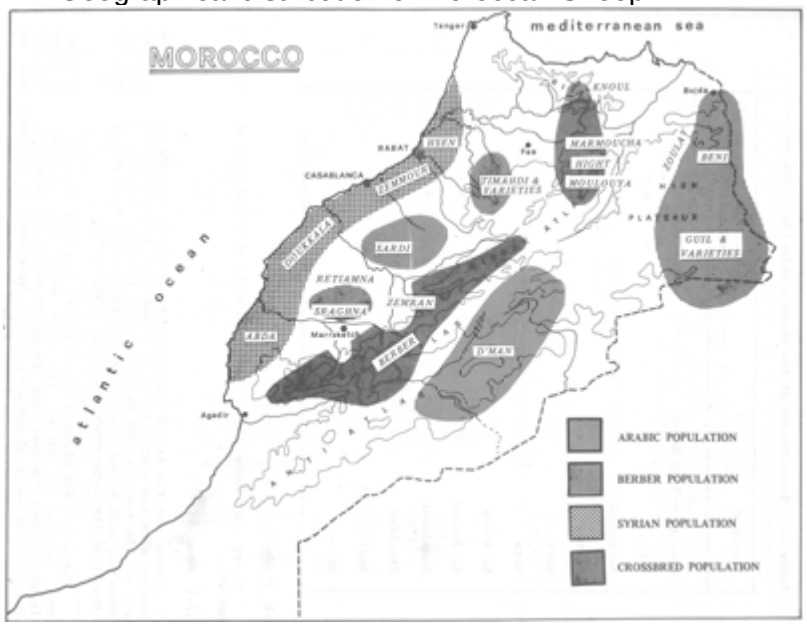


Table 2.2: Distribution of the sheep population in Morocco

nce	Proportion of total

	population (%)
Kenitra + Sidi Kacem	8.3
Settat	6.8
Marrakech	6.7
Meknè's	6.3
Safi	5.6
Taza	4.5
El Kalaa	4.2
El Jadida	4.1
Khemisset	4.1
Khenifra	3.9
Beni Mellal	3.8
Others	41.7

2.2 Production

Sheep contribute significantly to meat, wool and milk production in Morocco.

2.2.1 Meat

Sheep are the second species after cattle to provide people in the country with red meat. Table 2.3 shows that mutton production increased from 45 630 tons in 1960 to 63 000 tons in 1984. However, the trend was irregular, with higher production recorded in periods of drought, mainly as a result of the large number of sheep slaughtered.
There are 878 slaughterhouses either in cities or in the rural areas. Those located in cities are open every day, whereas the rural slaughterhouses are open only the day of the weekly market. In 1985, the proportion of sheep slaughtered in the cities and In the rural areas as recorded by the Livestock Service, was 31.5 percent and 22.5 percent respectively. Almost half of the sheep killed were not recorded because slaughtering occurred either in private houses during ceremonies or religious festivals (Aïd El Kébir), or in some areas not supervised by the Livestock Service.
Average carcass weight of sheep slaughtered from 1962 to 1983 was about 12 kg, ranging from 10.8 kg to 13.7 kg (Table 2.4). Here again, the fluctuations are the result of climatic conditions which affect productivity of grazing lands. The carcass weight of sheep slaughtered in cities is greater than of those killed in rural areas (Table 2.5).

Table 2.3: Trends in meat production from cattle, sheep and goats (in tons)

Year	Cattle	Sheep	Goats	% of sheep production

1960	66 010	45 630	23 200	32.4
1961	67 084	45 198	18 270	33.4
1962	67 734	36 899	16 200	29.3
1963	67 795	30 806	20 170	25.0
1964	63 662	33 160	19 302	27.4
1965	72 311	657 38	20 600	28.3
1966	79 162	39 871	20 242	27.7
1967	81 089	42 503	22 127	28.2
1968	77 020	49 853	23 710	32.0
1969	84 606	54 074	25 375	31.5
1970	86 570	36 940	23 200	23.8
1971	90 000	49 000	25 000	28.3
1972	93 000	50 000	26 000	28.0
1973	92 000	50 000	26 000	28.2
1974	90 000	50 000	25 000	28.6
1975	91 500	40 000	25 000	24.3
1976	91 500	40 000	25 000	24.3
1977	95 000	48 000	25 200	27.2
1978	95 000	50 000	25 000	28.0
1979	100 000	50 000	25 000	27.2
1980	107 000	55 000	26 000	27.7
1981	115 000	60 000	28 000	28.1
1982	105 000	45 000	25 000	24.4
1983	100 000	60 000	28 000	30.5
1984	100 000	63 000	20 000	32.1

(Developpement de la production fourragère, MARA, 1986)

The number of sheep slaughtered has varied over the years and also within the same year. A large proportion of sheep are slaughtered during May, June and July because of the occurrence of the dry season when sheep owners must lighten the stocking rate of the rangelands by selling their lambs.

The largest quantity of mutton is produced by young sheep. Thus, 69 percent of production comes from lambs of less than 1 year of age, and 29 percent is obtained from those of 1 to 2 years of age. Usually, adult males are kept for ceremonies and religious festivals.

Most meat production marketed through slaughterhouses comes from males. In 1985, they contributed by 87 percent to total mutton production. Moreover, among the small proportion of females slaughtered, 87 percent were less than 1 year old.

The price of mutton has increased tremendously over the years. It went from 8 Dirhams per kilogram in 1970 to 32 Dirhams per kilogram in 1985. The price of sheep meat varies slightly during the same year; it is higher in autumn and winter than during spring and summer.

2.2.2 Growth

Published literature on sheep in Morocco shows that there is a wide range of values for liveweight at different ages. Weights were recorded at birth and at 30, 60 and 90 days and the average is shown in Table 2.6 of sheep either on stations or in the field.

Table 2.4: Number of sheep slaughtered, total production and average carcass weight

Year	Number of sheep slaughtered	Total carcass weight (tons)	Average carcass weight (kg)
1962	978 347	12 493	12.8
1963	853 526	11 667	13.7
1964	1 209 602	14 946	12.4
1965	887 114	11 199	12.6
1966	1 305 679	15 845	12.1
1967	1 493 016	17 902	12.0
1968	1 879 221	21 381	11.4
1969	1 795 351	19 434	10.8
1970	2 146 926	23 848	11.1
1971	1 938 593	22 453	11.6
1972	1 865 200	22 063	11.8
1973	2 373 656	28 256	11.9
1974	2 098 893	24 322	11.6
1975	2 212 254	25 085	11.3
1976	2 153 077	25 691	11.9
1977	2 288 462	28 217	12.3
1978	2 669 331	33 007	12.4
1979	3 160 509	37 185	11.8
1980	3 097 302	35 026	11.3
1981	4 057 397	45 656	11.3
1982	2 418 474	30 573	11.2
1983	2 858 943	35 224	12.3

(Annuaire Statistique, Ministère du Plan)

Table 2.5: Carcass weight in slaughterhouses of some large cities in 1983

City kg)	Carcass weight
Casablanca	14.5
Rabat	15.5
Marrakech	11.0
All the country	12.0

(Livestock Service, MARA)

Table 2.6: Weight (kg) of lambs at different ages

Breed	Birth weight	Weight at 30 days	Weight at 60 days	Weight at 90 days
Timahdite	2.9	7.1	10.2	13.8
Beni Ahsen	3.2	7.1	10.7	14.1

Sardi	3.6	8.9	13.1	18.6
Beni Guil	3.3	7.8	11.2	14.9
D'Man	2.1	5.9	9.4	12.5

(Ben Lakhal, 1983)

In comparing five breeds raised in the same environment, Ben Lakhal (1983) concluded that the heaviest breed was Sardi and the lightest was D'Man at any age. The average birth weight for the 5 breeds was about 3 kg and the average weight at weaning (90 days) was around 15 kg. These results also show that the average daily gain (ADG) varies from 100 to 150 g.

The weight values found in different locations were generally low. In the harsh region of the anti-Atlas, Boudiab (1981) reported that the ADG from birth to weaning was as low as 53 g.

2.2.3 Wool

Even though the number of sheep is high, total wool production is low. Table 2.7 shows that production decreased from 13 707 tons in 1980 to 9 661 tons in 1984. This decline resulted from drought which affected both the number of sheep sheared and the weight of fleeces.

Most of the wool produced is of the coarse type used for the carpet industry. The fineness of wool of Moroccan sheep varies from 36 to 60 in the UK system which corresponds to a fibre diameter of 25 to 44 u. After cleaning, wool production represents about 45 percent of greasy wool production. This percentage varies from 40 to 75 according to breeds and management system. Table 2.8 indicates fleece weight and wool quality of some native breeds.

2.2.4 Skins

In 1983, total skin production was 4 080 400 pieces. More than half (64 percent) was used in the skin industry, the remainder, mainly obtained from sheep slaughtered in private houses, was used for domestic handicrafts.

2.2.5 Milk

Production and consumption of sheep milk are very low. On the national basis, only 8 percent of shepherds milk their ewes, and all milk produced is for domestic consumption.

Milk production increased slightly from 24 million litres in 1960 to 31 million litres in 1980, indicating an annual increase of 1.4 percent (Table 2.9). The contribution of sheep milk to national milk production is low and averages 4.5 percent. This proportion has also decreased over the years as a result of a tremendous increase of milk production from cattle.

Morocco has no specialized milking breed. However, the results obtained from the main breeds in some experimental stations showed that Timahdite, Sardi and Beni Ahsen may produce better than D'Man and Beni Guil for the same length of lactation (Table 2.10).

Table 2.7: Wool production (tons)

Year	Number of sheep	Number of fleeces	Total production of greasy wool
1980	16 509.8	8 566 854	13 707
1981	15 675.5	7 800 100	12 480
1982	10 155.1	5 497 285	8 796
1983	12 610.7	5 725 823	9 161
1984	11 493.3	6 037 954	9 661

(Laidouni, 1986)

Table 2.8: Fleece weight and wool quality of some breeds

Breed	Fleece weight (kg)	Clean scoured (%)yield	Fineness (UK system)
Timahdite	1.9	60.7	50.1
Beni Ashen	2.6	55.5	54.1
Sardi	2.0	59.8	56.3
Beni Gull	1.9	57.0	53.4
D'Man	1.0	58.2	49.7

(Bourfia, Laidouni and El Hmamsi,1987)

Table 2.9: Trend of milk production from milked cows, goats and ewes (in million litres)

Year	Cattle production	Goat production	Sheep production	
			Amount	% of total production
1960	380	26.3	24.0	5.6
1961	340	23.1	21.7	5.6
1962	300	19.5	18.0	5.3
1963	325	21.5	16.1	4.4
1964	362	21.3	18.3	4.6
1965	377	21.3	20.4	4.9
1966	410	23.0	22.2	4.9
1967	415	25.2	23.7	5.1
1968	458	25.2	23.7	4.7
1969	476	27.0	26.2	4.9
1970	424	26.0	22.0	4.7
1971	464	22.3	17.9	3.5
1972	480	24.0	20.0	3.8
1973	500	23.0	20.0	3.7
1974	480	23.0	18.0	3.4
1975	457	41.7	29.7	5.6
1976	564	41.8	30.0	4.7
1977	620	41.9	30.3	4.4
1978	659	42.6	30.6	4.2
1979	730	42.0	30.9	3.8

1980	780	42.0	31.0	3.6

(Livestock Service, MARA)

Table 2.10: Milk yield and composition of some native breeds

Breed	Milk yield (kg)	Lactation length (weeks)	Fat %	References
Timahdite	141	14	11.9	Kabbali, 1976
Beni Ahsen	111	14	9.9	Kabbali, 1976
Sardi	113	15	4.6	Sefiani, 1980
Beni Guil	98	15	4.3	Sefiani, 1980
D'Man	68	8	6.5	Bendaoud, 1975

2.2.6 Reproduction

Apart from the D'Man breed, which has a very short seasonal anoestrus allowing two lambings per year, all the other breeds have a limited sexual season starting in June and ending in December.

Fertility defined as the percentage of ewes pregnant after mating is about 85 percent. There is almost no difference between breeds on stations or in the field (Table 2.11).

With regard to prolificacy, except for D'Man ewes which give more than one lamb per lambing, those of the other breeds usually give single births. In some other studies, Bouix, Kadiri and Chari (1974) and Khallouk (1987) reported that litter size of D'Man was 2.1 varying from 1 to 7.

2.2.7 Lamb mortality

About 15 percent of lambs born are lost between birth and weaning. However, this proportion varies among breeds according to the flock management system. In comparing lamb mortality of 5 breeds raised in the same environment, Ben Lakhal (1983) reported that the highest mortality (30.6 percent) occurred in the D'Man breed because of the low birth weight of lambs resulting from higher litters, whereas the lowest proportion was recorded in the Sardi breed (Table 2.12).

Table 2.11: Fertility and prolificacy of native ewes

Breed	Fertility (%)	Prolificacy	Area
Timahdite	85	1.06	Gharb
Beni Ahsen	84	1.06	Gharb
Sardi	85	1.09	Gharb
Beni Guil	82	1.02	Gharb
D'Man	77	1.64	Gharb

(Ben Lakhal, 1983)

Table 2.12: Mortality (%) of lambs from birth to 90 days of age

Breed	Mortality	Area
Timahdite	14.6	Gharb
Beni Ahsen	10.8	Gharb
Sardi	10.2	Gharb

Beni Guil	11.6	Gharb
D'Man	30.6	Gharb

(Ben Lakhal, 1983)

3. PRODUCTION SYSTEMS

3.1 Husbandry Practices

3.1.1 Mating

Generally speaking, there is no control over mating and the rams are with the ewes all year around. This practice has been confirmed by Ismaili (1983) in Tadla, by Narjisse et al. (1984) in the high Atlas and by Assal (1978) in the middle Atlas. This practice is dictated by climatic variability and the resulting risk of concentrating lambing at a given period. In addition, the permanent presence of rams in the herds can allow a second lambing for those ewes that had already had an earlier lambing.
This system has however several disavantages. In fact, It is a major constraints to the application of sound husbandry practices because of the great demographic heterogeneity of the herd. Moreover, since males and females are mixed together, there is no control over mating and therefore no selection scheme could be implemented. More recently however some control over mating has been practised by some large livestock owners who separate the rams from the herd in order to avoid lambing in the winter and hence the resulting high mortality risk.
The number of ewes per ram varies greatly from 10 to 64 in the middle Atlas (Narjisse, 1987) and 10 to 79 in Tadla (Ismaili, 1983). A significant proportion of the herds reaching 18 percent in Tadla (Ismaili, 1983) have no ram at all. These are generally small-size herds which are mated with by rams borrowed from neighbours or relatives. With regard to ram selection, this is done primarily on the basis of phenotypic criteria. Fertility, growth performance and quality and quantity of wool are seldom taken into consideration. Another common reproductive problem is low fertility. In a recent survey, it was found that out of 217 rams checked, 22 percent were found to be sterile (Project 608-0145, 1986). The major reproductive problems identified were low sperm motility and cryptorchidism.

3.1.2 Lambing

As a consequence of the permanent presence of males in the herds, lambing occurs all year round. A national survey implemented in 1975 reported however that 78 percent of lambing takes place between October and April. Regional differences are observed and result probably from differences in the breed's seasonal oestrus and seasonal cycle of forage availability. Although, no special care is given to lambs after their birth, they are usually kept indoors for the first weeks of their lives. During this period, they suckle their mothers at night and graze grain plots surrounding the house during the day. The litter size is rarely more than one, except for the D'Man and to some extent the Sardi breeds. The low litter size is generally an objective of the farmers who are not interested in high prolificacy because of the difficulties of raising more than one lamb resulting from low milk production and limited feed availability. Depending on the lambing period, the average weight at birth for the Timahdit breed varies from 2.3 to

3.2 kg (Naitlhou, 1988). Slightly higher lambing weights at birth are observed when lambing occurs during the spring season.

3.1.3 Weaning

Sheep production in Morocco is often under traditional and extensive conditions. There is therefore no set weaning of lambs who are left with the ewes until the latter are completely dried up. Such practice contributes to overgrazing and precludes creep feeding resulting in low growth performance. Hence, the liveweight generally reported at three months of age does not exceed 12 kg, although values of 18 to 23 kg were reported by Bouamar and Kansari (1988) under intensive conditions. On the other hand, the average rate of mortality between birth and three months of age is variable. A low rate ranging from three to seven percent was reported respectively by Bennouna (1980) and Ismaili (1983) in the Tadla region. A higher rate of 18 to 31 percent in the middle Atlas and 51 percent in the high Atlas was recorded respectively by Chami (1982) and Chaarani (1988). These mortalities are mostly caused by undernutrition and cold weather (Ismaili, 1983) and enterotoxemia, enteritis and septicaemia (Chaarani, 1988).
Lamb mortality is not uniform throughout the year. Chaarani (1988) observed that during 1985-86, mortality was 34 percent during the December-February period, while it was only 10 and 12 percent during the autumn and spring season, respectively. This confirms the critical role of cold weather and plane of nutrition in determining the rate of mortality.

3.1.4 Shearing

Wool production is considered a by-product in the sheep industry in Morocco despite the large demand for quality wool stemming from the Moroccan carpet industry. Most of the shearing is performed in May or June when the temperatures are warm and when the demand for labour by other agricultural activities is low. Ram fleeces are generally heavier than those of ewes, the average being 2.4 kg and 1.5 kg respectively.

3.1.5 Fattening

Fattening in feedlot operations is limited to government farms or to some specialized livestock dealers that operate in the vicinity of large cities. Another circumstance where fattening is performed is the "religious mutton celebration" (AÏd El Adha). For this purpose many large livestock owners keep the male lambs of their herd and/or buy many thin males in the market and fatten them during a three to six month period. The animals to be fattened are never castrated for cultural and religious reasons. In fact, male animals are marketed with the testicles intact on the carcass because the demand and prices are higher for male than female animals. The feed usually used in this operation is composed of straw, beet pulp, wheat bran, barley and eventually oil-cake, urea or molasses. Performances achieved in these feedlots are variable depending mainly on the animal's age and the plane of nutrition. Hence, Naïtlhou (1988) undertook various fattening trials

on Timahdit lambs and observed average daily gains ranging from 200 to 240 g/day depending on the feeding system. Meanwhile lambs of the same breed and age exhibited no more than 50 to 80 g/day when grazing was the only source of feed.

3.2 Production Systems

3.2.1 Pastoral System

Sheep production systems in Morocco are classified according to the type of feed resources. Among the prevailing production systems, the pastoral system is characterized by the predominance of forage resources from rangelands (over 50 percent of total feed resources). This production system relates to 36 percent of the sheep population in Morocco. In this system sheep spend from 8 to 12 months on the range and eventually either transhume or move to cropping land where they graze weedy fallow, and/or stubble and other crop residues. As far as sheep are concerned, two main geographical regions form the basis of the pastoral system in Morocco: the middle Atlas and the high plateau divided by the Moulouya basin.

3.2.1.1 Description of the pastoral system

The high plateau and the Moulouya basin are arid regions receiving from 100 to 250 mm rainfall per year. Sheep raising represents the main source of income in an area of approximately 50,000 km (Eres, 1971) where cropping activities are, to some extent, marginal. A population of 1 100 000 sheep of the Beni Guil breed in the high plateau and the Timahdit breed in the Moulouya basin relies primarily on rangelands for its nutrition with an average of 90 forage units per hectare per year of mainly Artemisia herba alba, Stipa tenacissima and Atripiex halimus in salty soils, in addition to Aristida ciliata in the Moulouya basin. Most of these rangelands are under a collective system, with grazing rights allocated to the tribes over often poorly delimited territories. Nomadism was common in this area following routes of water points and forage availability. This practice is however declining as a result of urbanization and mechanization. In the high plateau, while the irrigated land owned by the household is close to the house, rainfed cropland and grazing land usually lie at a considerable distance from the house. The herd is then supervized by a herder provided with a tent, while the owner's input consists primarily of regular visits to check on the status of the herd. A lack of 'forage is a major issue in this region as indicated by the persistent use of supplements. This is a consequence of the continuing degradation of rangeland and explains the common flock movements toward the western part of the country, especially during drought periods. Herd size in this region is usually low. ERES (1971) concluded that 30 percent of the herds is below 40 ewes. Sheep are in general in mixed herds with goats, although the latter are marginal in the region. Lamb fattening is a common practice in this area. Approximately one fourth of the producers fattens lambs to be sold before "AÏd El Adha". The feed used in these

feedlot operations are alfalfa hay grown in irrigated plots in addition to barley and straw.
The middle Atlas is totally different region. The elevation is higher, and the vegetation more diverse as a result of moister conditions. The native vegetation consists of various low shrubs such as Genista sp., Thymus sp. and Helianthus sp. in addition to perennial grasses such as Festuca sp., Dactyl is, Koelaria, etc. Productivity of these communities ranges from 250 to 400 forage units/ha/year depending on the site and climatic conditions. Agricultural activities include cereals and irrigated orchards in the valleys and an important sheep sector elsewhere. Approximately 75 percent of the area is either forest or rangelands (Projet Moyen Atlas, 1981). The forests are generally government property, while rangelands have a collective status. Transhumance is still alive in this region. Pastoralists move at the end of spring from the drier lowland to the higher mountain grassland and forests, Rangeland degradation and the resulting forage deficit is also a major concern in the middle Atlas. Prevailing stocking rates are estimated between 3 to 4 sheep/ha/year. Such stocking intensities exceed obviously the carrying capacity of these rangelands and explain their poor condition and the low productivity of the grazing animals mentioned earlier. The sheep population of this area is estimated at about 800 000 head most of which are of the Timahdit breed. In this area, the herd size is generally larger than reported in the high plateau reflecting better feeding conditions. Thus, only 35 percent of the herds are below 50 head, while 58 percent of the herds have a herd size between 50 and 300 and 70 percent are over 300 head (FA0, 1986).
Although husbandry practices generally remain traditional, some improvements are being noticed in terms of nutrition and health care as a result of various on—going development projects and the successful extension efforts implemented by the National Society of Sheep and Goats (Association Nationale Ovine et Caprine). The main purpose of this society, which was created in 1966, is to help its members to establish a selection programme and apply sound husbandry practices.

3.2.1.2 Feed Resources

Range forages have been the main source of feed in Morocco for centuries. Recently, following drought and the continuing degradation of land resources, the contribution of range forages has declined while those of stubble, straw, and supplements are increasing. A recent assessment study by FA0 (1986) concluded that the contribution of rangeland and cereal aftermath in meeting the nutritional requirements of sheep ranges respectively from 50 to 80 percent and 10 to 30 percent. Supplements contribute usually around 10 percent. In the high plateau, sheep herds are on the range almost all year round with a tendency to concentrate on Stipa tenacissima rangelands during cool and/or windy weather and to move to areas dominated by sagebrush from spring to late autumn. In this region, supplementation is regularly provided during the nutritionally deficient periods coinciding with summer and parts of the autumn and winter seasons. This supplementation consists generally of barley in addition to hay and straw imported from the neighbouring Sais plain or produced on irrigated plots. Supplementation levels remain however fairly low. The feed

calendar in the middle Atlas is more complicated as a consequence of the ecological diversity of this region. It is usually organized as follows:

September - October	Stubble and fallow
November - June	Lowland ranges
July - August	Highland ranges

The rotation between lowland and highland ranges was strictly regulated by the community until recently. This management practice referred to as "agdal" allowed a rest period of all parts of the range and consequently contributed in maintaining range stability. Its implementation is unfortunately now facing difficulties related mainly to the conflicting interests of different members of the community in addition to disagreement in some cases over borderlines between neighbouring tribes. A comprehensive survey conducted in the Timahdit centre by the Livestock Office in 1982 indicated that range forages account for 58 percent of feed resources, while crop aftermath, fallow, and cultivated forages account for 32 percent. Supplements including barley, beet pulp, wheat bran and molasses cover only 10 percent of animal nutrient requirements. This supplementation is provided either to animals to be sold (lambs and old ewes) or to animals maintained on crop residues, and during the winter period.
An analysis of the feeding system prevailing in the pastoral system reveals the existence of three contrasting periods with variable duration depending on climatic conditions. From February to June range forages are available in adequate quality and quantity to meet the nutrient requirements of grazing animals. During the summer season, except when highland pastures are available (i.e. in the middle Atlas), only mature forages are provided by stubble, fallow and already overgrazed rangelands. In this case, the diet quality is low and rarely exceeds 45 percent digestibility and 6 percent crude protein. Such low diet quality occurring during the mating . period explains the low reproductive performance generally observed in the pastoral system. The third feeding sequence lasts from October to February. During this period, both quantity and quality of forage resources are deficient. Animals are then forced to survive on straw and scarce forage found on the rangeland. The use of supplements is general during this phase. Unfortunately, the amount is rarely sufficient and composition is usually inadequate.

3.2.1.3 Major production

Lamb is the major production of the pastoral system in Morocco. Of the total sheep meat produced in the country, approximately one third comes from the pastoral system. Within this system, the high plateau and the Moulouya contribute 12 percent, another 5 percent is provided by the middle Atlas region (FAO, 1986). There is no set age for lamb sales. For example, a comprehensive survey in the Timahdit area of the middle Atlas indicated that only 20 percent of the lambs sold were at an age less than six months, while lambs sold at ages between 6 and 12 months and 12 and 18 months represented 46 and 31 percent respectively (DPA Meknes, 1982). Milk production from ewes is marginal and totally allocated to self-consumption in Morocco. It is estimated that the proportion of sheep milk produced in the pastoral system represent 27 percent. Wool is considered a by-product of

animal production. Its marketing is rare since the majority of the wool produced (except for the large producers) is kept for domestic use. The following table summarizes the levels of sheep performance in the pastoral system. It appears from this table that these performances are low and reflect the extensive nature of this system.

Indications on sheep performance in the pastoral system in Morocco

Parameter	Level of performance	Source
Reproduction	Fertility rate: 80% Prolificacy rate: 100%	DPA Meknes, (1982)
Milk production	33 1/ewe/lactation	Bourbouze and Donadieu, (1987)
Growth	0-5 months: male 70g/day female 55g/day	Bourbouze and Donadieu, (1987)
Overall productivity	11 kg liveweight/ovine unit/year	FAO, (1986)
	2.2 kg of wool/ovine unit/year	ERES, (1971)

3.2.1.4 Constraints

Excess livestock and resultant overgrazing are major constraints to range rehabilitation and therefore to the improvement of the nutritional status of grazing sheep. These constraints are aggravated by the legal status of the rangelands which leads to the cultivation of these lands by the granting of rights as an attempt at privatization. The encroachment of cropping land into rangeland is in fact substantial (over 200 000 hectares in the high plateau during the last 20 years). It is causing a significant reduction of the area available for grazing and therefore leading to more grazing pressure on the land.

Other constraints are specific to poor livestock management which is reflected by the low productivity of the herd. Particular problems in sheep management and production relate to low quality breeding rams and the absence of mating control. This results in poor selection practices and a fraction of lamb births at periods when the mortality risk is high. The absence of selection and culling is well illustrated by the data collected through the range extension project (Project 608-0145). The staff of this project, rated over 40 percent of 3942 breeding animals examined, as inferior animals or as being incapable of reproduction. Further the absence of early weaning leads the producers to keep the animals on ranges longer than necessary. The lengthy period required for lambs to reach marketable weight contributes to overstocking and therefore degradation of the rangelands.

Deficient animal nutrition, especially outside of the growing season, is a critical problem encountered in the pastoral system. The low nutritional status of the animals is reflected by the significant weight losses (over 30 percent in some years) and consequently a decrease in reproductive capacity.

Animal health care is also a problem facing the development of the sheep sector in Morocco. Parasite control is usually ineffective because of the

producer's insufficient knowledge concerning the right drug to be used and the right timing of animal treatment. The ineffectiveness of animal health care is aggravated by the lack of dissemination to all producers and the usually inadequate disinfection of corrals.
Finally, the present organization of the market does not provide enough incentive for the intensification of sheep production. The existence of a number of intermediary agents and the low price of meat in Morocco contribute to lowering the returns generated from sheep raising.

3.2.2 Agro-pastoral System

This is the main system prevailing in areas producing cereals and legumes for human and animal consumption in Morocco: Gharb, Doukkala, Chaouia, Abda, Sais, Taounate, Khemisset and other irrigated districts (except the Ziz and Draa valleys). Since cereals occupy more than 60 percent of total cultivated land, this system is probably the most important sheep production system in the country. The 1984 data show that cereal producing zones in Morocco contain about 70 percent of the total sheep population (ANPA-ANAPPAV, 1985). This figure clearly illustrates how animal and cereal production is closely related at the national and regional levels.
In this system, farm agriculture provides a major part of the total feed requirements of the flock. This Includes cereal by-products such as straw and stubble, early barley grazing, weeds, fallow, cereal and legume grains, cultivated forages, other by-products etc. Various amounts of feeds can be bought on the market. The contribution of rangeland can be very limited in some cases and much more important in others.
The objective in terms of the feeding calendar in this system is to feed the ewe all the year around with minimum cost feed. This explains why poor quality feed like straw and stubble are largely used. High quality feed such as cultivated forages and grains are used in very small amounts and distributed to ewes during critical periods, i.e. end of pregnancy and/or early lactation. Lambs are very rarely supplemented. Consequently, animals eventhough sold at ages from 6 to 12 months, produce a low carcass weight.
Because in the agropastoral system animals depend heavily on farm production for their feed, flock movements in the cereal-producing zones are usually very limited. This is unlike the pastoral system where nomadism and transhumance are common practices.

3.2.2.1 Description of the system

Two cases are presented to illustrate the sheep feeding calendars under the agropastoral system:

Case 1: Cereal-producing zone under rainfed agriculture: area of Haute Chaouia (Khaldoun, 1986).

Case 2: Irrigated district: Tadla district (Bouhafra, 1987).

a) Haute Chaouia

The Haute Chaouia area is considered as one of the largest rainfed areas in Morocco producing cereals. Average farm size was estimated in 1980 as

8.12 ha varying between 0.4 and more than 100 ha (Benatya, Pascon and Zagdouni, 1983). The soils of the area differ as follows:

- Good quality soils with high rainfall (average of 393 mm/year between 1967 and 1981, ranging from 159 to 664 mm/year). Fallow surface very limited.
- Soils of lower quality with some irrigated land; average rainfall is 314 mm/year, ranging from 150 to 482 mm. Fallow is more important.
- Poor quality soils with very low and variable rainfall. Rangeland and fallows are very important.

In a survey carried out in 1984-85, it was found that 56 percent of total lambing in the area occurs between September and February. Lambs born are called Bekri which means early; the remaining lambs, called Mazouzi which means late, are born between April and June (Khaldoun, 1986).
The feeding calendar for sheep (and cattle) has been surveyed for 14 farms and divided into three periods (Khaldoun, 1986):

- Period 1 from September to January: 12 farms among 14 feed straw during this period. Animals go on range when available; 11 farmers provide concentrates like barley, wheat bran and sugar beet pulp to lambing ewes.
- Period 2 from February to May: 100 percent of sheep flocks graze fallow, range is also grazed when possible. Grazing on barley at an early stage is rare (2 percent of barley fields are grazed during that period). Weeds, taken from cereal fields, are distributed mainly to cattle. No movement of flocks outside the village is reported.
- Period 3 from June to September: All flocks graze stubble but only two flocks continue to go to pasture. The fattening of lambs to be sold at AÏd El Kebir occurs during this period.

Regarding this last period, it was noted that in areas where there is no range, all farmers fatten lambs regardless of farm size and flock size. On the contrary, when the rangeland area becomes more important, large flocks are not fattened. There seems to be more interest in preparing lambs of small flocks for AÏd El Kebir when more concentrate is bought.

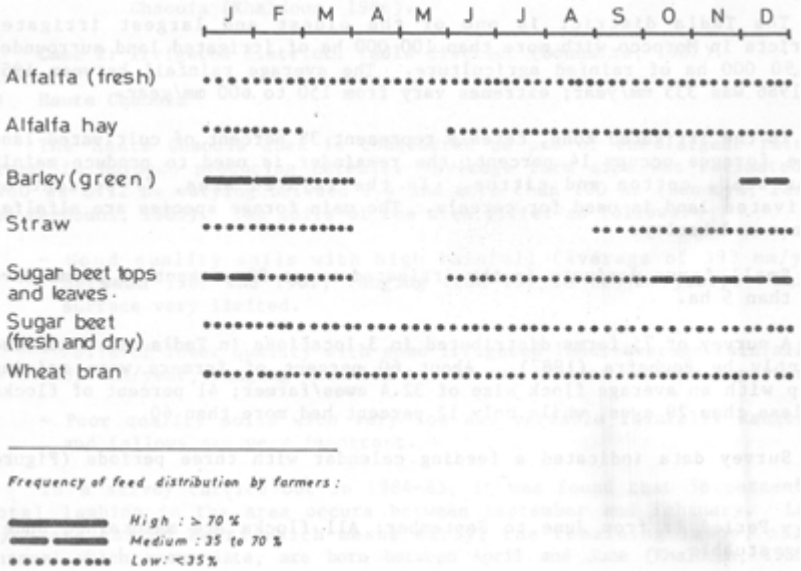
b) Tadla

The Tadla district is one of the oldest and largest irrigated districts in Morocco with more than 100 000 ha of irrigated land surrounded by 190 000 ha of rainfed agriculture. The average rainfall between 1958 and 1986 was 335 mm/year; extremes vary from 150 to 600 mm/year.
In the irrigated zone, cereals represent 38 percent of cultivated land while forages occupy 14 percent; the remainder is used to produce mainly sugar beet, cotton and citrus. In the rainfed area, 77 percent of cultivated land is used for cereals. The main forage species are alfalfa, berseem and barley. Small farms dominate in the irrigated area: 82 percent of farms have less than 5 ha.
A survey of 75 farms distributed in 3 locations in Tadla was conducted recently by Bouhafra (1987). About 60 percent of farmers were raising sheep with an average flock size of 32.4 ewes/farmer; 41 percent of flocks had less than 20 ewes, while only 12 percent had more than 60.
Survey data indicated a feeding calendar with three periods (Figure 3.1):

- Period 1: from June to September: All flocks are maintained under stubble.
- Period 2: from October to February: Rations are based on straw, alfalfa hay, sugar beet tops and leaves, green barley and concentrate. Use of straw is

maximal from November to January. However, the percentage of farmers feeding straw never exceeds 36 percent. Alfalfa hay is used for fattening animals. A maximum of 32 percent of farmers distributes alfalfa hay to ewes in November and December. Sugar beet by-products are used either as dried sugar beet pulp purchased from sugar beet factories or as sugar beet tops and leaves harvested in June and preserved dry for winter. The importance and period of utilization of these feeds are indicated in Figure 3.1, which shows that a large percentage of flocks grazes barley in December, January and February.

Figure.3.1 Sheep feeding calendar in Tadla(Bouhafra.1987)



- Period 3: from March to September: Sheep graze on pastures and fallow. When these resources are not available (very small farms for example), flocks are maintained by grazing around water canals; 31 percent of farmers use rangelands with a peak between March and May. Some farmers can extend this period of grazing until August. Only fattening animals are fed in pens; 20 percent of farmers utilize fallow (owned or rented) in dryland areas close to the irrigated zone.

3.2.2.2 Major feeds

a) <u>Stubble</u>

Throughout Morocco, utilization of stubble by sheep starts immediately after the cereal harvest (May and June) and continues until September or October.

In dryland areas, stubble is used as "vaine pâture" which means that all species and all flocks belonging to a community (i.e. a village) can graze at the same time all cereal fields belonging to the community. A farmer alone therefore has no input either on stocking rate or on period of grazing. However, there is a tendency now in many areas (like Fès for example), at least for large size farms, for stubble to be grazed only by animals belonging to that farm. Another new technique adopted by farmers in areas like Abda and Chaouia consists in renting stubble after manual or mechanical harvesting of grains in order to maximize straw yields. On the

other hand, in irrigated areas, the "vaine pâture" system has not been practised for many years (example of Tadla - Bouhafra, 1987).
Stubble grazing and the mating season very often start at the same time. Grain residues and weeds which remain with the stubble can be a good feed resource for flushing ewes. However, quantity and quality of the available biomass decrease quickly and lead to undernutrition. Problems augment in September and October when the nutrient requirements of ewes increase with the end of gestation. Straw supplementation starts usually at this period. In the Gharb (non-irrigated), farmers seem to feed straw to sheep all the year around (ORMVAG, 1985). However, the percentage of farmers feeding straw starts to increase in September. The same trend has been reported in Tadla and Haute Chaouia.

b) Fallow

Fallow is still important in Morocco, especially in the cereal producing zones. Although figures are very contradictory, many authors agree that fallow occupies about 25 percent of total cultivated land in the country (MARA and FAO, 1986). In 1980-81, fallow represented 18 percent of total cultivated land in Gharb (ORMVAG, 1985); higher percentages were noticed in the non-irrigated zones in comparison to those irrigated. In three locations of Tadla, fallow represented in 1986 only 6.7 percent of total cultivated land (Bouhafra, 1987).
The importance of fallow is partly correlated to flock size and alternative feed resources. In Haute Chaouia, it has been noted for example that sheep are the main species grazing fallow (Khaldoun, 1986); a correlation of 0.76 has been calculated between hectares of fallow and number of head of sheep within farms. Other factors like soil fertility, cereal seed availability and drought can also interfere with fallow size.
In 1985, the Ministry of Agriculture introduced several Australian species of Medicago in dryland areas in substitution of fallow in the cereal-fallow rotation. The success of this operation can dramatically change the sheep feeding calendar and productivity in rainfed zones.
Another change reported recently in Haute Chaouia (Khaldoun, 1986) is hay production from fallow. Hay produced in spring is preserved until winter. Whether this hay is fed to sheep or only to cattle was not specified.

c) Cultivated forages

One of the most striking observations concerning the sheep feeding calendar in irrigated areas is that cultivated forages are very rarely fed to sheep (except for areas of D'Man sheep). In the irrigated district of Gharb for example, only 4 percent of farmers feed berseem (the most important forage of the area) to sheep (ORMVAG, 1985). In Tadla, figures presented previously indicate that alfalfa hay is rarely fed to ewes; fresh alfalfa is distributed to dairy cows only.
The same situation has been reported in the Meknès and Tanger zones where vetch and oat hay (the main hay produced in rainfed areas) are almost absent in the sheep diet (Guessous, 1985).
The almost complete absence of cultivated forages in the sheep diet can be related to the very low forage area in Morocco (280 000 ha in 1983-84, corresponding to 3.6 percent of total cultivated land). Another reason is that farmers consider it more profitable to use cultivated forages for dairy cows than for suckling ewes.

3.2.2.3 Major products

Lambs and wool are the two main sheep products in the agropastoral system. No indication of milk production from ewes either for family consumption or for the market has been reported so far.

a) Lambs

- Age and weight

The objective so far has been to produce lambs that can be directly slaughtered. Such animals will usually average between 6 and 12 months of age and 20 to 30 kg of weight.

Data collected in Tadla by Bouhafra (1987) present a better idea on the distribution of lambs sold by age and sex; figures include lambs born on farms and those bought from outside and prepared for AÏd El Kebir. Table 3.1 indicates that males and females represent 60 and 40 percent of animals sold respectively. Among these, 68 percent are between 4 and 9 months old; 25 percent are between 9 and 12 months and only 7 percent are over 1 year. This distribution clearly indicates that lambs are not sold during the suckling phase which usually ends at 4 months of age. Because of their low average daily gain (ADG), lambs must be kept longer on farms in order to reach a better weight. Part of this weight increase will be achieved during the fattening phase (2 to 3 months) when lambs are to be sold at Aïd El Kebir.

- Season

Lambs in Tadla are sold throughout the year with a maximum of 41 percent during AÏd El Kebir (Bouhafra, 1987). Similar results have been reported in Haute Chaouia where a large percentage of young animals is sold in April-May and during AÏd El Kebir (Khaldoun, 1986).

The selling period of young animals is dictated by:

- the need for cash, especially in small farms, to cover family and/or farm expenses. Sheep can be sold when soil preparation or cereal harvesting for example are to be done. They are also sold when seed, fertilizer or feed purchases are necessary.
- Market price.
- Need for cash for one or several members of an association when the flock belongs to more than one person.

Table 3.1 Proportion by sex and age of lambs sold in Tadla

Age (months)	Proportion (%)		
	Males	Females	Total
4-6	5.2	6.3	11.5
6-9	30.3	26.2	56.5
9-12	18.3	7.3	25.6
>12	6.4	1.0	7.4
TOTAL	60.0	40.0	100.0

(Bouhafra, 1987)

b) Wool

Sheep shearing is usually done between April and June. However, in the southern part of the country where higher temperatures start earlier, sheep shearing is done in February-March.

Average wool production per ewe has been estimated at 2.5 kg/year (Jerrari, 1987). Only two-thirds of the wool produced is marketed; the remainder is used for family needs.

3.2.2.4 Major constraints

The main feeding problems in this system usually occur between September and February. In autumn, the contribution of stubble to the sheep diet is very low not only in terms of quantity of available biomass but also in terms of nutritive value. Sheep requirements increase rapidly due to advancing pregnancy and beginning of lactation. The contribution of straw to the sheep diet becomes more important. Because of low levels of supplementation, deficiencies in energy and nitrogen can be severe and lead to low birth weights and low average daily gains of lambs born in October-November (Bekri). When animals start to go on pastures and/or fallow in January, their nutritional conditions improve progressively. Lambs can be marketed starting in March-April.
The situation differs for lambs that are born in spring (Mazouzi). Lambing occurs between February and April when the nutrition of ewes should be correct. However, with the decline of grass production and quality in April-May, lamb growth is rapidly reduced. Mazouzi lambs are consequently marketed at an advanced age and lower liveweight in comparison to Bekri lambs. Ewe body conditions can also be affected which may lead to unsuccessful breeding during the following summer. This situation stresses the need for adequate supplementation of both the ewe and lamb during the spring season. Otherwise, it may be more profitable to have just one good lamb crop per ewe and per year.

3.2.3 Oasis system

This is a specific system, entirely located in the Moroccan oases, mainly Ziz and Draa, but also in other small ones (Goulmima, Tinjdad and Figuig). This system differs from others in several ways:

- Oasis has a very intensive irrigated agriculture. Average farm size is very small: in Draa, 76 percent of farmers have less than 2 ha.
- Alfalfa is the second important crop produced after cereals. In the Ziz valley, this species occupies between a quarter and a third of total cultivated land (AÏt Bihi, 1981; Khiar, 1987) and represents a major feed for sheep.
- D'Man sheep are the only breed available in these areas. Total flock size has been estimated at 40 000 in the Ziz valley (Khiar, 1987), and 100 000 in Draa (Ezzahiri and El Maghraoui, 1985). Average flock size is very small: 71 percent of sheep flocks in Ziz have less than 9 ewes.

3.2.3.1 Description of the system

The feeding calendar indicates two contrasting periods (Figures 3.2 and 3.3):

- Period 1 from March to September: Fresh alfalfa is the major component of the sheep diet. It is fed to 100 percent of farmers in amounts that vary closely with the availability of water for irrigation. In addition, many farmers feed waste

palm dates. Straw is also used in addition to concentrates (barley, bran, sugar beet pulp).

Figure3.2 Sheep feeding calendar in Ziz (Khiar,1987)

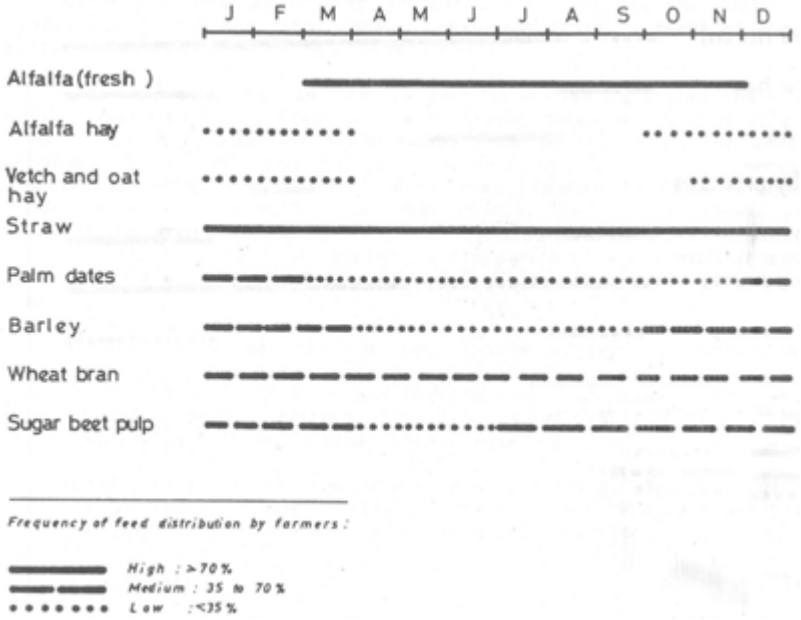
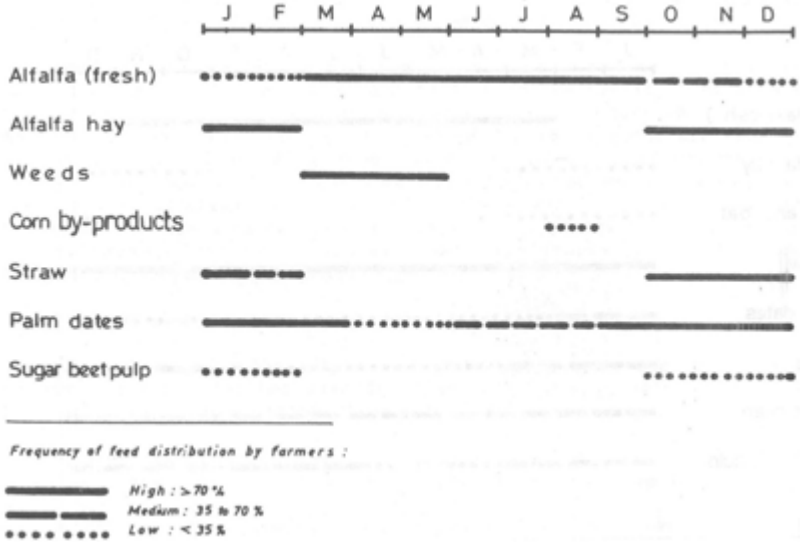


Figure. 3.3 Sheep feeding calendar in Draa (Khiar,1982)



- Period 2 from October to February: Because of lower temperatures, alfalfa growth becomes very slow or stops completely. Fresh alfalfa is scarce. It is then replaced by alfalfa hay fed with straw, waste palm dates and concentrate. Comparison between Ziz and Draa feeding calendars indicates that alfalfa hay is less available in the first area than in the second. Some farmers buy vetch and oat hay.

3.2.3.2 Major feeds

a) <u>Alfalfa</u>

<u>Fresh alfalfa</u>

Alfalfa is the major feed available for sheep in the oasis. Arif (1978) calculated that this forage alone provides 50 percent of the total energy requirements of sheep during a year.

A survey conducted in 1980 in the Ziz valley indicated that farmers harvest alfalfa 5 to 7 times per year between March and October (AÏt Blhi, 1981). Under research station conditions, 8 cuts per year have been achieved (Guessous, Igmoullan and Johnson, 1986). The management and quality of alfalfa production were investigated in 1983 in a survey conducted in the Ziz valley (Guessous et al., 1985). Alfalfa was sampled on 10 farms once a month between April and November. Alfalfa production per year can be very high; average yield per cut varies with season from between 13 and 19 tons of green matter/ha. Data collected also indicated that:

- Alfalfa is harvested at very mature stages. Between June and September, for example, percentages of farmers harvesting alfalfa at early bloom, full bloom and seeding stages of maturity were 10, 63.3 and 26.7 percent respectively (Table 3.2). Farmers seem to pay more attention to alfalfa yield than to quality.
- Alfalfa quality varies with season of growing. Forages produced in summer have a lower nutritive value in comparison to those produced in spring or autumn at the same stage of maturity.

Alfalfa hay

A survey conducted in 1982 in the Ziz valley indicated that 65 percent of farmers produce alfalfa hay (Igmoullan, 1982). Hay is made during summer when the alfalfa rate of growth is at its maximum. It is stored until winter; 40 percent of farmers feed long hay alone while 60 percent chop it manually and mix it with straw.

Although green alfalfa is cut at an advanced stage of maturity, alfalfa hay produced in these areas seems to have a good nutritive value. Analyses of 25 samples indicate average crude protein and crude fibre contents of 16.9 and 27.4 percent respectively (dry matter basis). (Guessous et al., 1985).

Table 3.2: Frequency of stages of alfalfa maturity at harvest in the Ziz valley (%)

Season	Stage of maturity				
	Vegetative	Budding	Early bloom	Full bloom	Seeding
Apr11-May	-	14	29	43	14
June-Sept..	-	-	10	63	27
Oct.-Nov	20	20	10	40	10

(Guessous et al., 1985)

b) Waste palm dates

Palm dates are an important source of income for oasis farmers. In Draa, there are about 1.9×10^6 palm trees that produce between 7 000 and 55 000 tons of palm dates per year (Ezzahiri and El Maghraoui, 1985). Some of these dates, of very poor quality, are used as feed. The percentage of waste dates depends on varieties and ranges between 4 and 100 percent (Khal, 1982).

Waste palm dates are usually sun dried before being stored. They can be fed to animals intact or after grinding. Seeds can also be fed but must be ground previously. Until recently this operation was done manually but grinders have now been introduced, particularly in farmer cooperatives.

Both ewes and fattening lambs can benefit from these by-products. Survey data indicate that fattening lambs can consume as much as 1 kg of whole dates or 0.7 kg of ground seeds per day (Khal, 1982) which are often fed in addition to alfalfa (fresh or dried).

3.2.3.3 Major products

As in the agropastoral system, lambs and wool are the two major sheep products in the oasis system. However, wool contributes little since the D'Man fleece is less developed than that of other breeds.
Khiar (1987) has found that among 100 lambs born in Ziz farms:

- 9.5 died.
- 18.1 are used to replace eliminated ewes and rams.
- 42.5 are slaughtered for family consumption, 80 percent of which are males.
- 28.1 are sold, of which 75 percent are females. Very few animals are sold before 6 months of age and about half of them are older than 12 months when sold.

This distribution represents the major difference compared to the agropastoral situation. The primary objective of sheep husbandry under oasis conditions seems to be to provide farmers with animal proteins needed for the family. On the other hand, in the cereal-producing zones, animals slaughtered on farms represent a small fraction (10 percent of females in Tadla (Bouhafra, 1987) and the percentage of lambs born that are marketed has much more importance.
No indication exists concerning season of marketing and weight of lambs sold.

3.2.3.4 Constraints

Feed availability and quality seem to be the first constraints under this system. Because alfalfa dominates the sheep feeding calendar in these areas, improving its management, productivity and utilization can have a significant impact on sheep production. In fact, much should be done to improve alfalfa management in oasis zones. Several parameters including seed varieties, nature and level of fertilization, water supply, insect control, etc. should be considered and the rate of cutting should be investigated. Quality of forage at harvest in relation to stage of maturity and season must be stressed. This is particularly important when alfalfa is destined to high producing females (pregnant ewes with more than one foetus, suckling ewes). Improving alfalfa management will increase its yield and will allow farmers to preserve more hay for the winter period.
Waste palm dates represent the second most important feed in the area. However, farmers do not seem to be sufficiently aware of their nutritional characteristics. Extension programmes should be developed to explain these aspects to farmers and to teach them how to balance diets based on these by-products.

3.3 Sheep productivity

Several attempts have been made to measure sheep productivity under field conditions and in experimental stations in Morocco. This includes measurement of parameters concerning reproduction, mortality and growth. Since experimental stations are usually under improved flock management, particularly regarding nutritional aspects, productivity measured at experimental stations can be considered as an indicator of potential productivity of breeds. On the other hand, field data, although usually less accurate, can be considered as giving a better estimate of actual sheep productivity. The data presented in this chapter will therefore be based on the latter.

3.3.1 Reproduction performance

Ewe fertility (number of pregnant ewes per number of ewes joined) is relatively high when the summer breeding season is considered alone (Table 3.3). Average fertility ranges from 80 to 95 percent regardless of area, breed or system of production. However, fertility drops quickly during dry years as reported in the eastern part of Morocco in 1969-70.

Table 3.3: Reproductive performance of sheep under different production systems

System	Area	Main breed	Fertility, %	Prolificacy.%	Reference
Pastoral	Eastern	Beni Guil	54	100	ERES, 1970
	Eastern	Beni Guil	96	100	ERES, 1971
	High Atlas	Mountain breed	96	100	Bourbouze, 1976
	Missour	Undetermined	86	102	Assal, 1978
	Anti-Atlas	Mountain breed	84	100	Boudiab, 1981
	High Atlas	Mountain breed	86	100	Chami, 1982
Agropastoral	Gharb	Beni Hsen	82	104	Zari, 1979
	Settat	Sardi	91	103	Bennouna, 1980
	Tadla	Mainly Sardi	96	104	Ismaili, 1983
	Tadla	Sardi	-	109	Drissi, 1983
	Tadla	Sardi	95	107	Bouhafra, 1987
Oasis	Drâa	D'Man	65	146	Arif, 1978
	Ziz	D'Man	85	148	Ait Bihi, 1981
	Ziz	D'Man	93	200	Khiar, 1987

Ewe fertility during the autumn breeding season has not been well documented so far. However, with the exception of the D'Man which can breed all the year around without significant changes in fertility, other breeds are thought to present a low fertility in the autumn, not exceeding 40 percent even during rainy years. This figure is in agreement with the low number of lambs produced per ewe per year 1.3 in Tadla, (Ismaili, 1983). It

is also in agreement with an average interval between lambings that usually varies between 9 and 12 months (Table 3.4).
Prolificacy (number of lambs born per number of ewes lambing) under field conditions is very low, nearly 100 percent, except for the D'Man breed where much higher levels are represented (Table 3.3). Very small variation exists among areas and/or systems of production. This clearly indicates that apart from the oasis system, which is an intensive one, farmers have so far not sought multiple birth ewes.

3.3.2 Lamb mortality

Lamb mortality at birth and during the first 3 months of age ranges between 4 and 16 percent (Table 3.5). Higher levels are found in mountain areas where one third to one half of the lamb crop can be lost during winter.
A large variation can occur within the same area. In Tadla for example, lamb mortality ranged from 0 to 30 percent with a mean of 14 percent (Bouhafra, 1987). Mortality was higher in small flocks.
In the middle Atlas area, mortality between birth and 11 months of age was 17.6 and 31.3 percent respectively in 1984-85 and 1985-86 (Chaarani, 1988). Extremes varied from 7.2 to 72.1 percent. A large variation occurred among farms and years; 50 percent of lamb mortality occurred within the first 3 days after birth. Hyponutrition was listed as the first cause of death, responsible for 25 percent of lamb deaths in 1984-85 and 45 percent in 1985-86. Other reasons were infectious diseases (enteritis, septlceamia, pneumonia, etc.).

3.3.3 Growth performance

Growth data presented in Table 3.6 indicate a significant difference between two breeds:

1. High Atlas and anti-Atlas mountain breeds. Lamb growth during the first 3 months is very low (average weight at that age is less than 9 kg). These breeds have a low mature weight (20 to 30 kg for ewes) at nearly three years of age. Such sheep dominate in most areas of Morocco where rangelands have very low levels of productivity.
2. Breeds located in the plains, plateau and the middle Atlas. These are early maturing breeds. Average birth weight is about 3 kg; average weight at 3 months varies between 12 and 19 kg. Mature size is much higher than for previous breeds (40 to 50 kg for a ewe). Most of the agropastoral and a large portion of the pastoral areas are dominated by such breeds.

Table 3.4: Interval between lambings under different production systems

System	Area	Main breed	Interval	Reference

Pastoral	Anti-Atlas	Mountain breed	10 months and 18 days	Boudiab, 1981
	High Atlas	Mountain breed	11 months and 24 days	Chami, 1982
Agropastoral	Tadla	Mainly Sardi	9 months and 9 days	Ismaili, 1983
	Tadla	Sardi	8 months and 15 days	Drissi, 1983
	Tadla	Sardi	9 months and 16 days	Bouhafra, 1987
Oasis	Drâa	D'Man	7 months and 16 days	Arif, 1978

Table 3.5: Lamb mortality at birth and until 90 days under different production systems

System	Area	Main breed	Lamb mortality, %	Reference
Pastoral	Anti-Atlas	Mountain breed	36	Boudiab, 1981
	High Atlas	Mountain breed	51	Chami, 1982
Agropastoral	Gharb	Beni Hsen	11	Zari, 1979
	Settat	Sardi	4	Bennouna, 1980
	Tadla	Mainly Sardi	7	Ismaili, 1983
	Tadla	Sardi	11	Drissi, 1983
	Tadla	Sardi	14	Bouhafra, 1987
Oasis	Ziz	D'Man	16	Khiar, 1987

Table 3.6: Average lamb weight at birth, 30, 60 and 90 days of age under different production systems

System	Area	Main Breed	Lamb weight (kg)				Reference
			Birth	30 days	360 days	90 days	
Pastoral	Anti-Atlas	Mountain breed	1.6	3.3	4.9	6.4	Boudiab, 1981
	High Atlas	Mountain breed	1.8	3.3	5.0	6.0	Chami, 1982
	High Atlas	Mountain breed	1.6	2.5	4.6	8.5	Chraïbi, 1985
Agropastoral	Gharb	Beni Hsen	3.0	7.8	-	12.0	Zari, 1979
	Settat	Sardi	3.5	9.7	14.4	18.8	Bennouna, 1980
	Tadla	Sardi	2.9	6.5	9.3	12.1	Ismaïli, 1983
	Tadla	Sardi	3.1	4.8	7.5	14.1	Bouhafra, 1987

Comparison between growth performance at field level and at experimental stations for the same breeds (see chapter concerning breeds) clearly shows the gaps that do exist between actual and potential performance of sheep in

Morocco. Such differences are mainly related to management which needs to be largely improved.

3.3.4 Overall productivity

Numerous studies have calculated an overall productivity of sheep as growth weight per ewe and per year. This parameter takes into account performance concerning reproduction, mortality, growth, age of lambs at selling, culling percentage, etc.
Average liveweight produced per ewe is around 10 to 12 kg per year (Table 3.7). Sheep productivity seems to be the same for all regions of the country except in 3 areas:

- In the oasis areas, sheep productivity is about 3 times higher than average. This can be related to the better reproductive performance of D'Man but also to the relatively more intensive feeding system prevailing in these areas.

- In the high Atlas and anti-Atlas areas, sheep productivity seems to be lower than average. Part of this can be explained by the slower lamb growth rate reported previously.

- In Tadla, two studies conducted in both rainfed and irrigated districts indicate an average ewe productivity of 27 kg/year (Ismaili, 1983; Bouhafra, 1987). The latter author explains the higher ewe productivity in Tadla by an average lamb crop of 1.3/ewe/year and good lamb performance during the first 3 months. Ismaili (1983) relates this to the fact that farmers, during the early part of lactation, feed their ewes a mixture of straw and hay rich in proteins that is produced on a small scale in the area.

A large proportion of lambs are fattened before they are marketed which increases production of liveweight per lamb. Bouhafra (1987) reported an average weight of males of 17.6, 26.9 and 28.6 kg at 4, 8 and 10 months of age respectively.
This example clearly illustrates how sheep productivity can be rapidly improved if lambs before marketing could be fattened for a short period of time and produce a higher carcass weight.

Table 3.7: Sheep productivity under different production systems

System	Area	Productivity per ewe per year (kg	References

		liveweight)	
Pastoral	Eastern	11.0	ERES, 1972
	High Atlas	8.7 to 10	Bourbouze, 1976
	Anti-Atlas	6.8	Boudiab, 1981
	Middle Atlas	11.4	Projet Moyen Atlas, 1979
	Tetouan	16	Projet Tetouan
Agro pastoral	Bassin du Sebou	13.3	Projet Seboupastoral
	Tadla	25.7	Ismaili, 1983
	Taounate	10.7	Projet Karia-Tissa, 1977
	Settat	11.2	Projet Settat, 1984
	Khemisset	12.0	Projet Khemisset, 1981
	Tadla	28.4	Bouhafra, 1987
Oasis	Draa	26.0	Arif, 1978
	Ziz	31.7	Aït Bihi, 1981

4. SHEEP BREEDS IN MOROCCO

4.1 Introduction

4.1.1 Common breed definitions

Lush (1945) discussed the genetic basis of differences in breeds of farm animals, which can be summarized as differences in mean gene frequencies, average allelic heterozygosity and epistatic gene combinations. For Quittet (1965), animals belonging to the same breed present distinctive external traits and do not show recent marks of crossbreeding. According to Lerner and Donald (1966), a population of farm animals is termed a breed: a) when it has some predominant identifying features, b) when it has a formal association of breeders, or c) when certain government officials acknowledge it as such. For Hill (1971), breed refers to any closed population, members of which can be identified by phenotype or pedigree. Terrill (1979) defined a breed as a population of interbreeding animals having a common ancestry, Isolated either geographically in history or by the breed association in modern times. The latter author reported a classification of 914 breeds of sheep of the world into 16 types plus a miscellaneous group, based on form, function and origin.

4.1.2 Origins and types of sheep breeds In Morocco

Available statistics show that the Moroccan sheep population is almost entirely native. At the end of French colonization, the number of sheep from exotic breeds was 300 000 head, while the total number of sheep was 10 000 000 (Miegeville, 1952). After independence (in 1956), importation was mainly limited to rams for commercial crossbreeding. Hence, the proportion of exotic sheep (mainly of French origin, i.e. Merinos Précoce, Ile de France, etc.) is in the order of 2 to 3 percent.

In Morocco, the breeds of sheep are mainly dual-purpose animals with meat being the most essential product, and wool the next desirable product. Milk is not commonly produced on a commercial basis, but owners may milk ewes for family use. The various sheep types in Morocco fall into the category of "wooled thin-tailed sheep". In Africa, originally, only the Algerian breeds, the Macina sheep in the Niger, and the Dongola sheep in the Sudan share this category with Moroccan breeds (Epstein, 1971).

With regard to breed description and origin, the first comprehensive report on Moroccan sheep was made by Eyraud (1934). The breeds fall into three geographical subgroups, i.e. the Mountain type or Berber, the breeds of the plateau, and the breeds of the Atlantic coast. The first group is considered to be autochthonous, and the other two migrant, with the second group being of Arab origin, and the third of Syrian origin.

Sagne (1956) hypothesized that the "Arab breeds" derived from the "Atlas Mountain breeds" by increasing the size of the animals at lower altitudes, with the original small Berber stock remaining in the mountains. But, in spite of this assumed geographical mechanism of breed formation, Sagne admitted a migration of sheep with finer wool from Asia. However, a

common observation is that Arab tribes brought with them many flocks of sheep and settled in the lowlands of Morocco.
The fact that the breeds of the coastal plains in the west of Morocco are thin-tailed sheep has led authors either to refute their assumed Syrian or Barbary origin (Mason, 1967), or to assume that the fat originally stored in the tail was no longer needed in the new environment (Bourfia, 1987a). The latter hypothesis assumes a migration which is ancient enough to allow for the evolution from a fat-tailed to a thin-tailed sheep.
Another grouping of Moroccan breeds of sheep, made on the basis of wool grades, is worth mentioning. Velu (1934) reported that the wool import companies based in French Atlantic harbours used to categorize wool imported from Morocco into 1) "Wool Aboudia", produced by sheep raised in the northwest of Morocco (Beni Ahsen breed); 2) "Wool Urdighia", from sheep of the western plateau (Tadla and Beni Meskine breeds); 3) "Wool Beldia" of sheep from the plains with several breeds including Doukkala-Abda; and 4) "Wool Beldia" of mountain sheep, with also different types. It should be pointed out that originally wool from the breeds of the eastern plateau (i.e. Beni Gull breed) was exported to France through the Algerian harbour of Oran, and was, hence, assumed to be Algerian wool. Blanic (1921), cited by Velu (1934), was the author who gave the original descriptions of the above categories of Moroccan wool.

4.2 Sheep breeds in Morocco

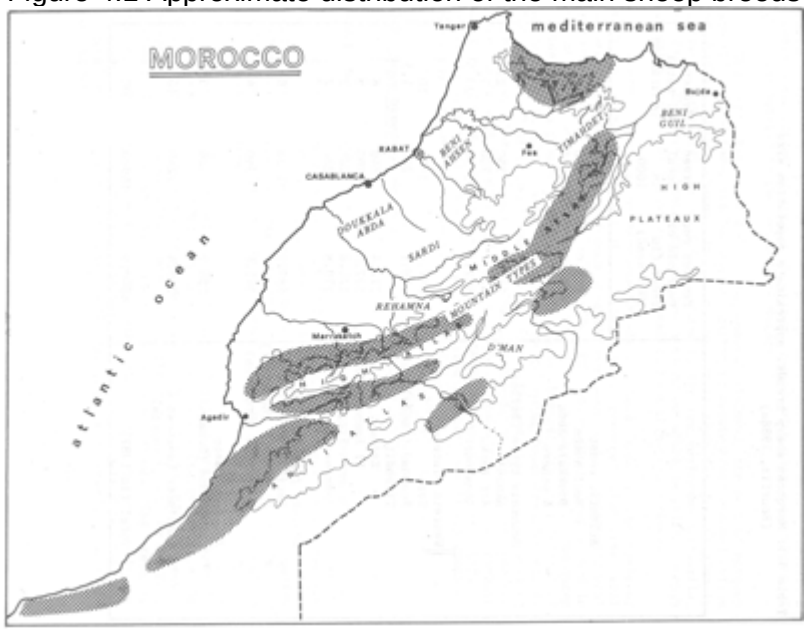
4.2.1 Introduction

An inventory of Moroccan sheep breeds is not an easy task given the need for data that are necessary for the characterization of the breed types. While some data do exist, much of the information is not readily available. However, efforts were made to describe a group of breeds, and some are believed to be still "undiscovered", as was the case for the D'Man breed until recently.
Mason (1969) presented some twenty different breeds of sheep in Morocco, excluding the D'Man. Ministry of Agriculture statistics gave the sheep population size as approximately 14 million head in 1987. Expected numbers for the most common breeds and types as estimated by Bourfia (1988a) are given in Table 4.1 The mapping of the corresponding areas is not yet complete; Figure 4.1 shows roughly the location of breeds without defining area limits for a given breed. Because of the marked geographical effects on breed formation, the breeds are presented according to their natural areas.

Table 4.1: Moroccan sheep breeds: approximate population size (Bourfia, 1988a)

			Females one year old or older (in 1000 head)	Breed total in 1000 head	Percent of total population
Atlantic coast					
	Beni Ahsen		213.0	350	2.5
	Doukkala-Abda & others		854.0	1400	10
Mountain types (Berber)					
	Aknoul		213.5	350	2.5
	Ait Barka		427.0	700	5
	Remainder		1921.5	3150	22.5
Western plateau					
	Sardi		854.0	1400	10
	Boujaad (Tadla)		128.1	210	1.5
	Timahdit				
		Zaian	512.4	840	6
		El Hammam-Azrou	427.0	700	5
	Rehamna-Sraghna		170.8	280	2
	Zemrane		170.8	280	2
Eastern plateau					
	Beni Guil (Harcha & Tounsinnt)		683.2	1120	8
	Zoulay (& Marmoucha)		341.6	560	4
Southern oases					
	D'Man (Dammane)		256.2	420	3
Remainder (unknown & crosses)			1366.4	2240	16
Total (in 1987)			8540.0	14000	100

Figure 4.1 Approximate distribution of the main sheep breeds



4.2.2 Mountain sheep

The Atlas and Rif mountain types (previously known as Berber) are the most ancient and primitive sheep in Morocco, as illustrated on rock paintings of the Stone Age. They are spread over a large and heterogeneous area, i.e. the high Atlas, the middle Atlas, the anti-Atlas, and the Rif. The specific environment and management helped to develop several breeds, but only a few types have been described, i.e. Aknoul, Ait Barka, Marmoucha, Ait Mohad, Tounfite, Ait Hadiddou, Siroua, Guigou, Imin'Tanout, Ouaouizart, etc. Usually, the height and weight of the breeds are a function of the altitude of the mountain range, their exposure to rain or snow, and the possibility to use additional pasture grounds. This flexibility is a reflection of the hardiness of the mountain breeds. Contrary to Algeria, where Sagne (1956) reported that most of the sheep in the Kabyle area were replaced by Arab breeds, Mountain types are still found in Morocco. In spite of their smallness, mountain types are considered to be good mutton breeds, i.e. fine—boned animals with well-muscled thighs, and a dressing percentage ranging from 48 to 50. The largest of the mountain sheep is the Ait Mohad breed in the high Atlas, south of the upper Moulouya valley, in the region of Rich, with a height of 65-70 cm, and average weight of 40 kg for the ram; while the Aknoul breed, to the north of Taza, is a dwarf sheep with a ram weight of 25 to 30 kg. The former breed is characterized by the absence of horns in both male and female. The Aknoul breed has two features similar to the Karakul breed: the lack of the projecting portion of the external ears (i.e. pinna), and the curly fleece of the newborn lamb (Miegeville, 1952; Sagne, 1956). In addition, the Aknoul sheep is completely black, as is the Ait Barka breed found at Demnat, south-east of Marrakech. The size of the Ait Barka sheep is similar to that of the Aknoul (Eyraud, 1934), while the wool is coarser than that of the Aknoul (Miegeville, 1952).

In the Taza district, situated between the Rif and the middle Atlas, the Marmoucha breed with two varieties has been described (Table 4.2), (Eyraud, 1934; Grimpret, 1936). Two other Berber types were found between Rich and the Moulouya valley, namely the Tounfite and Ait Hadiddou, with the latter breed being kept at. higher altitudes. The size of the Ait Hadiddou is smaller than that of the Tounfite, but its wool is finer. The description of the two latter breeds is also given in Table 4.2 after Sacconney (1938).

With regard to the distribution of coat colour in Moroccan Berber breeds of sheep, Ryder and Stephenson (1968) reported that black, white, and variegated sheep represented 20, 20, and 60 percent, respectively.

Table 4.2.: Description of some mountain breeds of sheep (Eyraud, 1934; Grimpret, 1936; Sacconney, 1938)

	Weight	Height	Colour	Horns
Northern Marmoucha	30-35 kg	60-65 cm	Head, neck (and legs) black	Rams horned Ewes polled
Southern Marmoucha	25-30 kg	55-60 cm	All white	Ewes and most rams polled
Tounfite	42 kg	60-70 cm	White with occasional black marks	Long and slim
Ait Hadiddou	37 kg	60-68 cm	White with black spots	Regular size

The Berber fleece is usually coarse, open, with few or no crimps and a staple length in the order of 20-30 cm (Eyraud, 1934). The wool, however, can be of a good quality as in the case of the Siroua breed, south-west of Ouarzazate. From the fleece of the latter breed the famous "carpet of Tazenakht" is woven (Ezzahiri, 1981). It is believed (Bourfia, 1988c) that this breed evolved from the Ait Barka breed by selection on wool.

Further characteristics of fleeces from various Moroccan breeds are given in Table 4.3: (i.e. greasy fleece weight, staple length, fibre diameter, and quality grade), and in Table 4.4 (i.e. kemp, which is commonly regarded as an undesirable fibre in wool).

Table 4.3: Classification and fleece characteristics of Moroccan breeds of sheep

(1) Original values from Aldebert (1955)

(2) Values from Abdelali (1988)

* Staple length value from Eyraud (1934)

	Greasy fleece wt (kg)	Staple length (cm)	Fibre diameter (micron)	Quality count
Atlantic coast				
Beni Ahsen [1]	2.5	11.0	30	50-60s

	Doukkala-Abda [1]	1.7	12.0	32	46-50s
Eastern plateaux					
	Beni Guil (Harcha) [1]	2.0	7.5 *	32	46-56s
	Beni Guil [2]	1.8	7.0	27	50-56s
Western plateaux					
	Tadla [1]	1.5	9.5	30	50-56s
	Boujaad [2]	2.0	6.0	26	56-60s
	Beni Meskine [1]	1.6	6.7	30	50-58s
	Sardi [2]	1.8	6.4	26	54-58s
Mountain types (Berber)					
	Marmoucha [1]	1.3	18.0	45	44-46s
	Guigou [1]	1.3	15.5	40	46-50s
Southern oases					
	D'Man [2]	0.9	6.7	26	48-54s
Intermediate types					
	Sraghna [1]	1.5	12.0	31	50-56s
	Timahdit [2]	2.1	9.6	32	46-54s

Table 4.4: Importance of kemp in fleeces from Moroccan breeds
A) Classification of Moroccan breeds with regard to kemp
(Aldebert, 1955)

Breeds of sheep		
Satisfactory	Less satisfactory	Unsatisfactory
Beni Ahsen [1]	Zemmour [1]	Zoulay [2]
Tounsint [2]	Doukkala-Abda [1]	Tadla [3]
Beni Meskine [3]	Beni Guil (Harcha) Imin'Tanout [4]	Marmoucha [4]
	Sraghna [5]	Guigou [4]
		Zaian [5]

B) Amount of kemp in some Moroccan breeds
(Bourfia et al, 1987; using a scale of 0 to 6,
with 0 being no kemp and 6 being a maximum)

Breed	Number ewes	kemp score (0-6 scale)
Beni Ahsen [1]	162	1 - 2
Beni Guil [2]	269	1 - 2
Sardi [3]	284	1 - 2
Timahdit [5]	210	1 - 3
D'Man [6]	336	3 - 5

(1) Atlantic coast breeds

(2) Eastern plateaux breeds

(3) Western plateaux breeds

(4) Mountain breeds

(5) Intermediate types

(6) Southern oases breed

4.2.3 Plateau breeds

They are categorized into eastern and western plateau types.

4.2.3.1 Eastern plateau

The eastern plateau types, generally known as the Beni Guil breed, are moderately large sheep, hardy and good walkers; the head and legs are bare and generally brown. They are commonly classed into three varieties, namely Harcha, Tounsint, and Zoulay.

a) Harcha variety

Usually considered as the prototype of the Beni Guil breed, the Harcha variety is the tallest and the heaviest. The name "Harcha" came from the variation found in the fleece containing fine and coarse staples; the quality grade of staples from the same fleece may vary from 46 to 56s (Eyraud, 1934). In earlier times, the production of Beni Guil lambs was primarily for export, because of the high quality of its meat. The Beni Guil was exported to France (Bordeaux, Marseilles) under the name of the Small Oranian (le Petit Oranais), and especially males of approximately 18 months with a liveweight of 40-42 kg, dressing out at 50 percent, and with well muscled thighs (Eyraud, 1934). These exports continued until the early 1970s.

b) Tounsint variety

The Tounsint variety is found north of the breeding area of the Harcha, and is in fact a sub-variety of the Harcha with a more homogeneous fleece, but the quality grade is on average lower than that of the Harcha (Eyraud, 1934; Aldebert, 1955).

c) Zoulay variety

The Zoulay variety in the region of Outat El Haj, Guercif, and Midelt, is derived by crossing Tounsint and Berber types of the upper Moulouya valley. It is of smaller size and the fleece is coarser. The horns are small and are sometimes absent; the frequency of polled males (called "Fartas") is in the order of 10 percent.

The main characteristics of the eastern plateau breeds are summarized in Table 4.5, and further fleece features are given in Table 4.3 and Table 4.4

Table 4.5: Characteristics of eastern plateau breeds
(Values from Eyraud, 1934 and Aldebert, 1955)

	Ram weight (kg)	Ram height (cm)	Fleece weight (kg)	Staple length (cm)	Quality count
Harcha	50-55	70-75	2.0	7.5	46-56
Tounsint	50-55	70-75	2.0	7.5	50-56

Zoulay	40-42	65-70	1.7	15.0	40-46

It should be pointed out that Geoffroy Saint Hilaire (1920) described only two varieties in the eastern plateau, namely the Angad and the Beni Guil. The author's description of the Beni Guil variety is similar to that given above for the Harcha type, while the Angad variety of a smaller size, and with a coarser fleece and smaller horns, resembles the Zoulay type.

4.2.3.2 Western plateau

The western plateaux comprise mainly two breed types, namely Tadla and Beni Meskine:

a) Tadla

The Tadla breed is found on the plateau of Kasba Tadla and Oued Zem. Following cultivation of most of the pastureland of the breeding area, purebred Tadla sheep are declining in numbers. Tadla are the largest sheep in Morocco; the ram may weigh more than 100 kg, and may exceed 100 cm in height (Miegeville, 1952). The horns are heavy and a single horn may weigh 0.5 kg (Eyraud, 1934). The colour of the fleece is yellowish white.

b) Beni meskine

The Beni Meskine breed is smaller than the Tadla as shown in Table 4.6 and its fleece has less kemp (Table 4.4). Its breeding area is to the west of that of the Tadla, in the region of El Brouj. A variety of Beni Meskine breed with spectacles and a black nose evolved into the Sardi breed (Eyraud, 1934). Further fleece characteristics for western plateau breeds are given in Table 4.4 and 4.5

Table 4.6: Size and slaughter characteristics of western plateau breeds
(Values from Eyraud, 1934)

	Height of rams (cm)	Weight of males of 18-20 month (kg)	Dressing percentage
Tadla	85 - 90	50 - 55	48
Beni Meskine	75 - 80	45 - 50	50

4.2.4 Breeds resulting from crossing plateau and mountain types

Because of transhumance and the restricted pasture grounds due to cultivation, animals of the Tadla breed were crossed with mountain breed types, and this gave rise to new varieties such as Zaian, El Hammam-Azrou, Rehamna-Sraghna, and Zemrane.

4.2.4.1 Zaian

Its area is bound to the west by Zaers, to the north by Oulmes, to the east by El Hammam, and to the south by Khenifra (Eyraud, 1934). As shown in Table 4.7, the Tadla breed had a marked influence on the Zaian with regard to height and weight, but the wool of the breed remained coarse.

4.2.4.2 El Hammam-Azrou

As we go further to the east, the influence of the Tadla breed becomes less important in crosses. The El Hammam-Azrou variety reflects more the mountain type characteristics. Table 4.7 shows that the animals are shorter and lighter than the Zaian; the fleece is also coarser.

4.2.4.3 Rehamna-Sraghna and Zemrane

The well-known pasture ground of El Hadra in the region of Rehamna and Sraghna (north-east of Marrakech) has helped to combine the Tadla and the Berber breeds into the Rehamna-Sraghna and Zemrane varieties.

a) Rehamna-Sraghna

Table 4.7 shows that the Rehamna-Sraghna variety reflects the large size of the Tadla breed and the good conformation of the Atlas Mountain breeds with a higher influence from the former. The quality of wool is also satisfactory (Table 4.3).

b) Zemrane

The Zemrane variety, which is closer to the mountain variety, and in particular to the Ait Barka breed in the region of Demnat, is less influenced by the Tadla breed and the animals are shorter and lighter; young rams of 15-18 months weigh only 30-35 kg. The fleece of the Zemrane is also coarser than that of the Rehamna-Sraghna (Eyraud, 1934).

Table 4.7: Characteristics of intermediate types
(values from Eyraud, 1934)

	Location *	Adult ram height (cm)	Adult ram weight (kg)	Young ram weight (kg)
Zaian	North	75 - 80	65 - 70	45 - 50 (1)
El Hammam	East	70 - 75	46 - 50	42 - 45 (2)
Timahdit	East	65 - 70	45 - 48	38 - 42 (1)
Rehamna-Sraghna	South	80 - 85	60 - 65	45 - 50 (3)

* Location with respect to the breeding area of the Tadla breed

(1) Young rams 18 months old

(2) Young rams 18-20 months old

(3) Young rams 15-18 months old

4.2.5 Atlantic coast breeds

On the Atlantic shore, rather different breed types are found with mainly the Doukkala-Abda in the south and the Beni Ahsen in the north. The animals have a long neck with a dewlap, and prominent shoulders. The height at withers is similar to that of the Tadla breed, but their weight is lighter; this results in poorer conformation. The colour is commonly white with, in general, a black or pale brown head.

4.2.5.1 Beni Ahsen

Based on the available literature, and by direct observation of registered animals, Bourfia (1987a) estimated the height, weight, and length of Beni Ahsen animals (Table 4.8).

Table 4.8: Weight, height, and length of the Beni Ahsen breed

	Ewe	Ram
Height at withers (cm)	70 (3)	80 - 100
Liveweight (kg)	42 (5)	65 - 80
Body length (cm)	95 (5)	' 100

(Standard deviations are given between brackets)

Beni Ahsen male lambs born as single from mature dams weigh 4 kg at birth, 22 kg at weaning (3 months), and 34 kg at 6 months, and dress out at 45-50 percent (Bourfia, 1987a). Fleece characteristics are summarized in Table 4.3 and 4.4.

Purebred Beni Ahsen are found on the banks of the Sebou river as far as Mechraa Bel Ksiri in the north-east, and the Atlantic shore in the south-west. The Beni Ahsen should not be confused with the Zemmour type found in the south-east in the region of Tiflet, with a less developed dewlap and a coarser fleece (Table 4.4), or with the Kerkoub type which has a smaller size, shorter ears, and a coarser wool (Bourfia, 1987a).

4.2.5.2 Doukkala-Abda

Purebred Doukkala-Abda animals are found on the coastal plains in the west of Morocco as far as the Oum-Errabia river in the north, and the Tensift river in the south. They are lighter than the Beni Ahsen, the ram weight being in the order of 50-55 kg (Eyraud, 1934), and the fleece is coarser (Table 4.3 and 4.4).

4.2.6 Oases breed(s): the D'Man (Demmane)

From the early 1970s, and especially from the early 1980s, the D'Man breed has been studied extensively, and its possible use for the intensification of lamb production in Morocco or other countries has generated considerable interest. Contrary to reports so far recorded, the D'Man breed was not "discovered" in the early 1970s. The general survey conducted in 1962 in Morocco, pointed out that "the ewe fecundity was variable from one region to another, and attained on average 62 percent in the cereal crop areas, and 115 percent in the southern oases".

The D'Man breed is located in the oases, south of the high Atlas in the valleys of Draa (south-west), Ziz (south-east), and Dads (between the two regions). This geographical distribution probably created different varieties within the D'Man which for now is considered as the same breed. The D'Man is not a range sheep. The animals are kept in complete confinement and always in very small numbers (1 to 5). Alfalfa, green or as hay, culled dates, etc. are brought to the sheep daily.

The name D'Man, or rather Demmane as suggested by the National Association of Sheep and Goats, which is closer to the right pronunciation,

came from the general black colour of the breed, although animals can be black, brown, white, or variegated.
Both male and female are polled, and the neck sometimes carries wattles. However, wattles are also observed in other breeds, but with a smaller frequency (Bourfia, 1988b). The wool is of poor quality, generally only covering the back (Table 4.3).
Results are accumulating which characterize the D'Man for the type and traits of economic importance. The D'Man ewe is essentially aseasonal with a possibility of achieving two lambings per ewe per year. The litter size at birth averages 2, and the total lamb weight at weaning (3 months) produced by the D'Man ewe amounts to approximately 70 percent of its own weight which is estimated to be in the order of 30-35 kg (Bourfia, 1987b). The use of the D'Man in crossbreeding presents a rapid means of increasing efficiency of lamb production in Morocco.

4.3 Discussion

4.3.1 Present breed organization

The Flock Books of the breeds are managed by the National Association of Sheep and Goats, known in short as ANOC. In a survey made by Bourfia (1987, unpublished) for the Sheep and Goat Commission for the European Association of Animal Production, registered ewes and corresponding flocks were presented (Table 4.9).

Table 4.9: Number of ewes registered in Morocco and corresponding breeds and flocks in 1987

Breed	Number of flocks	Number of ewes	Portion registered (%)
Timahdit	123	56638	6.0
Beni Guil	88	15235	2.2
Sardi	40	13511	1.6
Boujaad	34	5000	3.9
Total	285	90384	1.2

The "portion registered" given in the right-hand column is obtained by dividing the number of ewes in Table 4.9 by that given in Table 4.1 Plans are being made to include the D'Man breed in the scheme, extend the scheme to more animals within the breed, and open a Flock Book per breed. A nucleus scheme for the Timahdit breed is expected to be created by the end of 1988 in order to start a progeny testing programme. It would seem that the sheep industry is finally becoming organized!

4.3.2 History of breed evaluation

For efficient sheep breeding the first task is to document local breeds, and the first report on this matter was made by a group of Australian experts invited by the colonial French administration to evaluate Moroccan sheep at the beginning of 1919. As reported by Geoffroy Saint Hilaire (1920), the

group of experts was favourably impressed by the potential of sheep breeds in Morocco.

In the early 1930s, a sheep experimental station was created at Ain Djemaa, south of Casablanca. The results obtained for growth traits for Moroccan breeds were compared to data obtained in France at that time as summarized in Table 4.10 and 4.11 (Velu, 1934). The conclusion drawn from the comparison was that Moroccan sheep breeds occupied an honourable position.

Table 4.10: Liveweight (kg) of lambs from Moroccan and French breeds from birth to 9 months
Values from Velu (1934)

		Early maturing French breeds	Tadla breed (	Beni Meskine breed Morocco	Berber breeds)	Late maturing French breeds
Birth	: Male	4.500	4.051	3.883	2.415	4.000
	Female	4.000	3.566	3.616	2.223	3.500
1 Mo	: Male	12.000	11.175	10.244	5.133	9.250
	Female	10.000	9.888	6.333	6.625	7.100
2 Mo	: Male	19.500	19.350	16.922	11.677	14.500
	Female	16.000	16.416	16.316	10.310	10.700
3 Mo	: Male	27.000	25.475	23.266	16.433	19.750
	Female	22.000	20.466	19.366	14.580	14.300
4 Mo	: Male	34.500	31.012	29.866	20.244	25.000
	Female	32.000	25.188	11.175	19.080	17.900
5 Mo	: Male	42.000	39.012	25.416	23.277	30.250
	Female	38.000	29.300	33.544	22.010	21.500
6 Mo	: Male	49.500	43.087	29.700	26.944	35.500
	Female	40.000	33.116	37.464	23.820	25.100
7 Mo	: Male	52.300	44.667	32.866	29.755	38.200
	Female	42.400	35.983	38.644	25.610	26.600
8 Mo	: Male	58.100	48.225	35.250	30.987	40.900
	Female	44.800	37.133	42.437	26.710	27.600
9 Mo	: Male	61.400	49.466	43.188	31.820	43.600
	Female	47.200	37.500	37.350	27.387	29.600

Table 4.11: Growth rate (kg/day) of lambs from Moroccan and French breeds from birth to 9 months
Values from Velu (1934)

		Early maturing French breeds	Tadla breed (	Beni Meskine breed Morocco	Berber breeds)	Late maturing French breeds
Birth - 3 Mo						
	Male	0.250	0.238	0.215	0.155	0.175
	Female	0.200	0.187	0.175	0.137	0.120

3 Mo - 6 Mo						
	Male	0.250	0.194	0.167	0.116	0.175
	Female	0.200	0.140	0.150	0.102	0.120
6 Mo - 9 Mo						
	Male	0.110	0.078	0.063	0.054	0.090
	Female	0.080	0.048	0.049	0.039	0.050

Table 4.12: Performance of D'Man, Beni Guil, and Sardi breeds of sheep studied in the 1970s and early 1980s (Bourfia, 1987b)

Breeds							
		D' Man		Beni Guil		Sardi	
Traits		Mean	N	Mean	N	Mean	N
Fertility %		82	13	87	2	81	7
Prolificacy		190	15	103	2	112	7
Mortality %	(1)	20	15	11	2	11	6
Birth weight	F	2.2	7	3.1	4	3.5	6
	M	2.4	7	3.1	4	3.6	6
90 days weight	F	14.7	5	15.6	4	17.5	5
	M	16.8	5	17.0	4	18.6	5
ADG1 (2)	F	137	7	139	4	174	6
	M	154	7	168	4	178	6
ADG1 (2)	F	138	5	135	4	150	5
	M	158	5	143	4	166	5

(1) Total mortality from birth to weaning (90 days).
(2) Average daily gain from birth to 30 days (ADG1), and average daily gain from 30 to 90 days in grams/day (ADG2). The weights are given in kg for birth and weaning weights.
N Number of reported studies.
F Female lamb.
M Entire male lamb.

Mention should be made that the period of colonization by France and Spain (i.e. 1912-56) included two world wars with all the severe consequences for the occupied country. At independence, native breed organization was minimal, because trained personnel, relevant technology (computers etc.), documentation on work, already done, and finance were in short supply. In the early 1970s extensive work on breed characterization was again initiated.

Some of the results from the latter period are summarized in Table 4.12

4.3.3 Origin and evolution of Moroccan sheep breeds

4.3.3.1 Beni Guil

Originally, only the Harcha and Tounsint varieties were recognized by the National Association of Sheep and Goats (ANOC) under the name of "Beni

Guil" breed. However, at the present time, this may include some Zoulay animals following the official recognition of a larger area for the Beni Guil breed (Official Bulletin, number 3768 of January 1985).

4.3.3.2 Tadla

Owing to the cultivation of pasture grounds, the area of the Tadla breed became restricted, and most of the animals of the breed were used in crossbreeding with Berber types. Bourfia (1988c) suspects that the remainder of the Tadla is what the ANOC recognizes as the "Boujaad" breed (see Tables 4.1 and 4.3).

4.3.3.3 Timahdit

The El Hammam-Azrou variety also included the Timahdit, which had a smaller size (Table 4.7) and was distinguished by a black head and neck (Eyraud, 1934 and Miegeville, 1952). However, at the present time, both Zaian and El Hammam-Azrou are considered to be the same breed by the National Association of Sheep and Goats (ANOC) under the name of "Timahdit", and only the animals with a brown face are recognized as belonging to the breed. It is worth mentioning that not only has the Tadla breed contributed to the development of the Timahdit breed, but the Beni Guil breed has also played a role (Bourfia, 1988c).

4.3.3.4 Sardi

The neat whiteness of the Sardi breed and its open spiral-shaped horns known in the region as "Chatbi" (Bourfia, 1988b) led to the use of the Sardi breed as the preferred sheep in celebrating the Abraham event, since the prophet Mohammed used for the occasion "two white and horned rams". Such a high demand for the Sardi pattern probably played a major role in increasing the area of the Sardi breed by grading-up by crossing with the Tadla breed, since the Sardi pattern colour is dominant (Bourfia, 1988c).

4.3.3.5 Atlantic coast breeds

The fattening trials for the Atlantic coast breeds conducted in the 1920s and 1930s were less successful; and because of the demand of the market for export at that time, it was concluded that the Atlantic coast lambs were less desirable for mutton production. As a result, the Atlantic coast breeds, and in particular the Beni Ahsen in the rich area of Gharb, are decreasing in numbers as purebreds. Bourfia (1987a) suggested a plan to preserve the Beni Ahsen breed which contributed in the past to the Merino sheep. Epstein (1971) reported that in medieval times, Moroccan sheep were used in Spain as breeding stock for wool improvement. Unless concrete steps are taken, the Beni Ahsen breed might disappear in the near future.

4.3.3.6 D'Man

The hairy fleece, the small size, and the colour pattern of the fleece led Mason (1980) to suggest an important contribution to D'Man ancestry from the forest hair sheep of West Africa, and in particular the Fouta Djallon breed of the Cameroon. However Mason (1980) himself recognized that despite the similar colour pattern, the Barbados Blackbelly breed and its assumed ancestor from the Cameroon have a clearly different prolificacy. The same applies to the D'Man, and Bourfia (1988c) suggests a more likely contribution from a Moroccan breed to the development of the D'Man.

4.4 Conclusion

Efforts should be made to preserve the native breeds which, with our advancing knowledge of their genetic potential, can be better utilized in the future. The concern is not simply that the Atlantic coast breeds, including the Beni Ahsen will be lost, but that potentially valuable Berber breeds will be genetically diluted through indiscriminate crossbreeding.
In addition to the breeds described above, many other different types of sheep can be found all over Morocco, occasionally localized in a small area or region. Some of these types can have an interesting feature as was the case for the D'Man breed. The point at issue is not so much the conservation of native breeds of sheep per se, but the genetic evaluation and appropriate utilization of these breeds in Morocco as well as in other interested countries.

5. RESEARCH

5.1 Research in nutrition

Undernutrition is one of the main limiting factors for sheep production in Morocco with deficiencies in energy, nitrogen, minerals and vitamins. Shortage of feed and/or the low quality of available feed are the main reasons. Consequently, during the first 10 years research on sheep nutrition has focused on two aspects:

- Improvement in the utilization of local feeds. Priority has been given to stubble, straw and other by-products which represent a major source of feed under the agropastoral system.
- Evaluation of nutrient requirements of local breeds.

A substantial portion of the sheep nutrition research programme has been supported by the Small Ruminants Collaborative Research Support Programme (SR-CRSP) which was initiated in Morocco in 1982.

5.1.1 Research on stubble and straw

5.1.1.1 Stubble

Research on stubble has focused on several aspects:

1. Stubble biomass and its fluctuation with cereal species (barley, hard wheat, soft wheat) and period of grazing.
2. Chemical composition and digestibility of feed of sheep grazing stubble, with particular reference to stocking rate, period of grazing and physiological stage of ewes.
3. Sheep intake under stubble grazing.
4. Supplementation of grazing ewes during breeding and gestation phases.

Preliminary results on stubble have been recently published (Guessous et al., 1987; Outmani et al., 1988).

5.1.1.2 Straw

Improvement of straw nutritive value through chemical treatment is the objective of this programme. As anhydrous ammonia is not marketed in Morocco, research has been oriented toward urea treatment. Trials started in 1987 and preliminary results were reported by Benslimane (1988).

5.1.2 Research on by-products and forages

5.1.2.1 By-products

Research has so far focused on four by-products: waste palm dates and sugar beet, citrus and caroub pulp. The first two feeds are largely used by

sheep and cattle while the last two continue to be partly exported. These by-products have in common a high energy value and a low nitrogen content. Research conducted has paid attention to:

- Nutritive value of by-products when introduced in different proportions in the sheep diet.
- Utilization by fattening lambs in balanced rations.
- Possibilities of supplementation with non-protein nitrogen.

Available information has been summarized by Rihani, Guessous and El Fadili, (1985), Rihani, Guessous and Berrami (1988) and by Guessous, El Hi1all and Johnson (1988).

5.1.2.2 Alfalfa

Under prevailing production systems, sheep depend very little on cultivated forages except in the oasis zones where alfalfa represents the major feed. Alfalfa yield, composition and digestibility were investigated in 1982 and 1983 in a research station in the Ziz valley. Farm samples were later collected in Ziz and Draa.
Collected information has led to recommendations concerning alfalfa management and utilization and to adapted tables of feed composition (Guessous et al, 1985).

5.1.3 Nutrient requirements of local breeds

A few trials have been conducted to estimate nutrient requirements of Moroccan local breeds.
Energy maintenance requirements for Timahdit, D'Man and crossbred males have been estimated by Kabbali (1986). Energy growth requirements for lambs on normal or compensatory growth plans have also been investigated by the same author. Other experiments attempted to describe milk production and quality for suckling ewes and to establish regressions between milk consumed and average daily gain of lambs (Zari, 1979).

5.2 Research in breeding

Introduction
Even though some experiments were carried out during the colonization period, sheep breeding research in Morocco is very recent and started in the 1970s. The main purpose was the characterization of native breeds with regard to their standard and performance. However, these studies did not cover all native breeds, but only those numerically important and with a good potential. After this first step, some selection and crossbreeding experiments followed.
This chapter will first report results obtained by research workers concerning performance of different breeds and then present the findings of recent selection and crossbreeding experiments.

5.2.1 Reproduction and production performance

Among the Moroccan breeds, the D'Man has been the most studied mainly owing to its exceptional reproductive potential.

5.2.1.1 Age at first lambing

Results obtained from the D'Man breed either in the field or on experimental stations are reported in Table 5.1 These results show that D'Man females lamb for the first time between 12 to 15 months. In Tabouassamt station at Rissani (Ziz valley), Bouix, Kadiri and Chari (1974) reported that some ewe lambs lambed accidentally at 8 months of age, indicating that the D'Man ewe is already cycling at 3 months old.
In the experiment carried out in Skoura station at Ouarzazate, Harrouni (1977) found that the first oestrus in the D'Man breed occurred between 132 and 160 days after birth. Age at puberty seems to be affected by season of birth. In comparing ewe lambs born in July and November-December at the Gharb station, Lahlou-Kassi (1980) showed that the former reached puberty between 110 and 220 days of age, whereas the latter reached it between 169 and 292 days after birth.
Table 5.1: Age at first lambing (days) of D'Man ewes

Mean	Range	Area	References
400	-	Achouria	Bouix, Kadiri and Chari (1974)
530	317-730	Skoura	Harrouni (1977)
466	-	Draa	Arif (1978)
480	240-730	Draa	El Fakir et al . (1979)
610	298-720	Marrakech	Boutgayout (1980)
730	600-840	Gharb	Ben Lakhal (1983)
308	210-999	Achouria	Khallouk (1987)

Age at first lambing of other native breeds generally varies between 20 and 24 months (Ben Lakhal, 1983). The main reason for this delay is that most lambings occur in November which do not allow ewe lambs to reach puberty the following sexual season, and hence their mating is postponed.
Comparing ram lambs of D'Man and Beni Ahsen breeds, Benseghir (1978) showed that the former reached puberty at 165 days of age, whereas the latter had not reached it at 252 days.

5.2.1.2 Post-partum anoestrus

Several authors reported that the ovarian activity of the D'Man breed takes on average 45 days after lambing (Bouix, Kadiri and Chari,1974;Harrouni, 1977; Khallouk, 1987). This exceptional performance allows D'Man ewes to be mated during lactation and to have two crops per year.
In an experiment carried out at the ENA station at Meknès, Raymond (1979) found that only 50 percent of Timahdite ewes were in heat 80 days after lambing.

5.2.1.3 Lambing interval

Except for D'Man ewes which have a short lambing interval of about 7 months (Bouix, Kadiri and Chari, 1974; Harrouni, 1977; Arif, 1978; El Fakir

et al., 1979; Boutgayout, 1980; Khallouk, 1987), all the other local breeds have a lambing interval of about 9 months.

5.2.1.4 Sexual season

The sexual season is very limited for all native breeds, but the D'Man. For the Timahdite breed, Marie and Lahlou-Kassi (1977) showed, from an experiment carried out in the Gharb station, that the sexual season lasted average 6.6 months, while Dkhissi (1978) found that for Beni Ahsen ewes it lasted 9 months. For these breeds, the sexual season usually starts at the end of May. On the other hand, ovarian activity of the D'Man breed stretches over all the year with a slight decline in March (Boutgayout, 1980; Lahlou-Kassi, 1980).

5.2.1.5 Length of oestrus cycle and duration of oestrus

The average length of the oestrus cycle of D'Man ewes is 17 days (Harrouni, 1977) and 18 days (Lahlou-Kassi, 1980). Likewise, for Timahdite ewes, the length of the oestrus cycle was found to be 18.2 days (Marie and Lahlou-Kassi, 1977) and 17 days (Raymond, 1979).
On the other hand, the duration of oestrus is about 30 hours and seems similar for both D'Man (Harrouni, 1977) and Timahdite (Marie and Lahlou-Kassi, 1977).

5.2.1.6 Fertility

Results obtained from different breeds either in the field or in experimental stations showed that fertility of native breeds is in general satisfactory and similar (90-95 percent) (Lamraoui, 1979; Boujenane et al., 1982; Ben Lakhal, 1983). In the study by Bouix, Kadiri and Chari, (1974), fertility was found to be 100 percent for D'Man ewe lambs of 1 year old.
In addition, effect of age of ewes on fertility was studied by Ben Lakhal (1983) and Chafik (1986). In these studies, fertility increased with the ewe's age.
The effect of breed of ram on fertility of ewes was studied by Lahlou-Kassi et al. (1988) at the Tadla station. In this experiment, Sardi ewes were mated either to Sardi or D'Man rams. Fertility of ewes mated to D'Man rams was significantly higher than that of ewes mated to Sardi rams (Lahlou-Kassi et al., 1988).
Moreover, fertility is influenced by the season of mating. In the experiment by Bouix et al . (1977), the fertility of D'Man ewes mated in summer was higher than that of ewes mated in autumn.

5.2.1.7 Prolificacy

Several studies showed clearly that the D'Man is the most prolific breed in Morocco. The lowest litter size (1.58) reported for this breed was found by Arif (1978) in a survey carried out in the cradle of the breed at Draa valley, and the highest (2.67) was reported by Bouix, Kadiri and Chari, (1974).
From an analysis of 1 852 performances gathered in two stations at Ziz,

Khallouk (1987) found that litters of 1, 2, 3, 4, 5, 6 and 7 lambs represented 26.4, 43.6, 23.5, 5.4, 0.81, 0.16 and 0.06 percent respectively with an average of 2.09.
The average litter size of Timahdite, Sardi, Beni Guil and Beni Ahsen is low and varies from 1 to 1.10 (Bourbouze, 1974; Lamraoui, 1979; Bennouna, 1980; Laghlabi, 1980; Zari, 1979; Ben Lakhal, 1983). However, in the experiment carried out at the Tadla station, Chafik (1986) showed that under good management conditions, the litter size of Sardi ewes was 1.20. The same result was obtained by Lamraoui (1979) for Beni Ahsen ewes.
The effects of environmental factors on litter size were investigated by Ben Lakhal (1983), Chafik (1986), Khallouk (1987) and Nacir (1987). They concluded that age of ewes and year of lambing were the most important factors.

5.2.1.8 Ovulation rate

Laparotomy and laparoscopy techniques have been used in the Gharb and Tadla stations to assess the ovulation rate of some breeds. In the experiment carried out in the Gharb station, Lahlou-Kassi and Marie (1981) found that the ovulation rate of D'Man ewes was 2.50.
In comparing the ovulation rate of D'Man and Sardi ewes raised in the Tadla station, Boujenane et al. (1988a) found averages of 1.23 and 1.32, and 2.56 and 3.21 for Sardi and D'Man respectively. In addition, they reported that the ovulation rate of Sardi ewes varied from 1 to 3, whereas that of D'Man ewes ranged from 1 to 8.

5.2.1.9 Lamb survival

Available information on lamb survival of various sheep breeds shows that 15 to 20 percent of lambs die before weaning at 90 days (Bouamrani, 1977; Lamraoui, 1979; Bennouna, 1980; Laghlabi, 1980; Zari, 1979; Ben Lakhal, 1983; Chikhi, 1986). However, lamb survival of the D'Man breed is lower mainly because of their light birth weight which is the result of the higher litter size (Bouix, Kadiri and Chari, 1974; Arif, 1978; Boutgayout, 1980; Ezzahiri, Benazzou and Ben Lakhal, 1980). In the experiment carried out at the ENA station at Meknès, Fergani (1980) reported that the lamb mortality of the D'Man breed was 0, 16, 26 and 53 percent for single, twin, triplet and quadruplet litters respectively.

a) Milk production

Milk yield and composition have been estimated for the most important native breeds. However, results reported showed that milk yield varied according to method of estimation and length of lactation.
In two different investigations carried out in the Gharb station, Kabbali (1976) and Bouila (1977) compared milk yield and composition of Timahdite and Beni Ahsen ewes. The results of these studies showed that Timahdite ewes produced more and had a higher fat percentage than Beni Ahsen ewes.
Using the method of partial suckling, Sefiani (1980) showed in an experiment carried out at the Gharb station that milk yield and composition of Sardi ewes were higher than those of Beni Gull females.

Battar (1983) studied the milk yield of Timahdite, Beni Ahsen, Sardi and Beni Guil ewes rearing single lambs. Milk yield estimated by weighing lambs before and after suckling during 12 weeks was 60.5, 57.9, 57.4 and 56.1 kg for Beni Hsen, Timahdite, Sardi and Beni Guil respectively (Table 5.2).
Milk production of D'Man ewes was studied by Behba (1975), El Kabbach (1977), Fergani (1980) and Asserrhine (1984). The authors found that it was slightly low.

Table 5.2 Milk yield and composition of native breed ewes

Breed	Milk yield (kg)	Dry matter (%)	Fat (%)	Protein (%)
Sardi	57.4	21.1	8.80	5.37
Beni Guil	56.1	20.1	8.45	5.45
Beni Ahsen	60.5	19.8	8.83	5.21
Timahdite	57.9	19.0	7.97	5.23

(Batter, 1983)

b) Growth traits

Results of growth performance are the most reported in the Moroccan literature related to sheep breeding (Boujenane et al., 1982). However, the majority of the authors were interested in pre-weaning growth and only few had extended their study beyond weaning.
From the body of results given in Table 5.3, it appears that average birth weight of Timahdite, Sardi, Beni Ahsen and Beni Guil lambs was 3.5 kg, whereas that of D'Man lambs was lower and about 2.6 kg.
In addition, body weights at 30 and 90 days were similar for all breeds but D'Man, and were on average equal to 8.5 kg and 17.5 kg respectively. The weight of D'Man lambs at 30 and 90 days was about 6 kg and 15 kg respectively.
Average daily gains were satisfactory and ranged on average between 150 and 200 from birth to 30 days, and between 100 to 150 g from 30 to 90 days. Nevertheless, it seems that lambs of the Timahdite, Beni Hsen and Sardi breeds gained slightly more than those of the Beni Guil and D'Man breeds.
The study of post-weaning body weights carried out at the Tadla station showed that the significant difference in pre-weaning growth traits between Sardi and D'Man lambs stopped at 6 and 12 months old (Chikhi, 1986; Nacir, 1987).

Table 5.3 Growth traits of native breed lambs

Breed	Sex	Birth weight (kg)	Weight 30d (kg)	Weight 90d (kg)	ADG 0-30d (g)	ADG 30-90d (g)	References
	M	4.2	10.2	19.3	225	173	Bouila, 1977
T	F	3.2	9.3	16.8	208	137	
i	M	3.3	10.2	18.9	204	109	Bourbouze,1974
m	F	3.2	9.3	17.7	190	103	
a	M	3.6	10.0	19.6	243	160	Kabbali, 1976
h	F	3.5	9.0	16.6	196	127	
d	M	3.7	9.6	20.7	213	171	Lamraoui, 1979

i	F	3.3	8.6	18.1	190	143	
t	M	3.7	10.3	20.4	235	168	Zari, 1979
e	F	3.4	9.0	17.4	200	140	
	M	3.0	6.8	13.0	130	151	Ben Lakhal, 1983
	F	2.9	6.6	14.4	125	150	
B	M	3.8	9.2	19.1	206	152	Bouila, 1977
e	F	3.5	9.3	16.6	192	129	
n	M	3.4	10.9	22.5	222	100	Bourbouze, 1974
i	F	4.6	10.7	20.5	204	101	
	M	3.9	10.5	20.4	215	173	Lamraoui, 1979
A	F	3.7	10.2	18.6	194	151	
h	M	3.7	10.3	20.0	231	162	Zari, 1979
s	F	4.0	9.8	17.7	206	132	
e	M	3.3	7.4	14.5	134	120	Ben Lakhal, 1983
n	F	3.1	6.7	13.5	126	106	
B	M	3.1	8.9	16.4	194	125	Lamraoui, 1979
e	F	3.1	8.3	15.3	173	117	
n	M	3.6	8.2	16.8	148	147	Sefiani, 1980
i	F	3.4	7.7	15.6	105	144	
	M	2.9	8.1	18.6	164	176	Tampier, 1977
G	F	3.0	6.6	17.6	146	164	
u	M	3.5	8.4	16.1	167	126	Ben Lakhal, 1983
il	F	3.1	7.2	14.0	133	115	
	M	2.1	8.5	14.3	206	100	Arif, 1978
D	F	1.7	5.8	10.7	136	81	Lamraoui, 1979
i	M	2.9	6.9	13.6	158	143	
M	F	2.5	7.1	14.2	163	134	Ben Lakhal, 1983
a	M	2.2	6.1	12.2	125	104	
n	F	1.9	5.3	12.0	111	125	Nacir, 1987
	M	2.2	5.6	12.9	113	122	
	F	2.1	6.1	11.6	133	92	Bennouna, 1980
	M	3.8	10.3	20.1	202	163	
S	F	3.2	9.9	18.3	200	141	Laghlabi, 1980
a	M	3.5	7.2	18.6	119	191	
r	F	3.3	6.8	17.8	113	180	Lamraoui, 1979
d	M	2.6	9.5	17.0	119	129	
i	F	3.4	9.5	16.8	203	126	

	M	4.3	10.3	19.9	216	195	Sefiani, 1980
	F	4.0	9.0	17.4	180	155	
	M	3.7	8.9	18.0	176	151	Ben Lakhal, 1983
	F	3.5	8.8	17.8	171	150	
	M	3.5	8.5	16.6	167	135	Nacir, 1987
	F	3.2	7.6	14.4	147	113	

Several authors studied the effect of environmental factors on growth traits and showed that weight of males exceeded that of females at any age. In addition, lambs from young dams were lighter than those from mature ewes. Lambs born as singles grew faster than those born or reared as multiples (Bourbouze, 1974; Bouix et al., 1977; Lamraoui, 1979; Essaidi, 1984; Chikhi, 1986; Nacir, 1987).

c) Wool production

Wool characteristics have been studied since 1985. Two studies were conducted by El Hmamsi (1986) and Laidouni (1986) in which they compared fleece weight and wool characteristics of various breeds. Results presented in Table 5.4 show that the highest fleece weight was performed by the Beni Ahsen breed, while the D'Man breed produced the lightest fleeces. The average wool yield was similar for all breeds and equal to 60 percent. In addition, Laidouni (1986) reported that the finest wool fibres were produced by the Sardi breed and the coarsest wool was found in the D'Man breed.

Table 5.4 Fleece weight and wool characteristics

Breed	Fleece weight (kg)	Clean wool yield (%)	Fineness (UK system)	Occurrence of kemp
Timahdite	1.90	60.7	50.1	1.99
Sardi	1.99	59.8	56.3	1.76
Beni Ahsen	2.60	55.5	54.1	1.88
Beni Guil	1.95	57.0	53.4	1.46
D'Man	1.02	58.2	49.7	3.68

(Laidouni, 1986)

5.2.2 Improvement through purebreeding and selection

In 1981, the Livestock Service of the Ministry of Agriculture proposed a programme for sheep improvement. This programme defined the standards of the Sardi, Beni Guil, Timahdite and D'Man breeds, and divided the Moroccan territory into areas of purebreeding and crossbreeding. According to this programme, the areas of purebreeding correspond to the cradles of the most important breeds. Thus, the eastern hills, western hills, Draa and Ziz valleys and middle Atlas and vicinity are the areas where the Beni Guil, Sardi, D'Man and Timahdite breeds respectively must be raised as purebred. Crossbreeding, either between native breeds or between exotic and native breeds, is only allowed outside of these areas. The programme also suggests some exotic breeds to be used as ram breeds. These are Ile de France, Berrichon de Cher, Suffolk, Merinos Précoce,

Causse du Lot and Noir du Velay. In order to provide rams to sheep breeders, flocks of exotic purebreeds are raised in some crossbreeding areas.

In addition, selection is attempted in purebred flocks. Every year, a commission of 4 to 5 experts visits some flocks and does some selection. However, animals are not judged on their genetic values, but only on their phenotypic performance according to criteria such as:

- Conformity to breed standards
- Genetic abnormalities
- Conformation
- Body weight
- Fleece characteristics.

Selected animals are ranked in four classes: super, first, second and third category, and entered in the Moroccan Flock Book. The number of rams entered in the Flock Book since 1982 is indicated in Table 5.5

Table 5.5 Number of rams entered in the Flock Book

Year	Beni Guil	Timahdite	Sardi	Ile de France Berrichon du Cher Mérinos Précoce	Causse du lot	Noir duVelay
1982	102	287	78	328	48	23
1983	69	384	130	278	38	20
1984	79	602	110	349	60	48
1985	74	486	119	425	69	35
1986	94	367	144	419	81	41

(Benlakhal and Kabbaj, 1987)

Furthermore, inside the cradle of each breed, there are one or two stations in which a nucleus flock is maintained for breed selection and to safeguard the breed. At present, the Ministry of Agriculture has seven stations:

- Oujda station) Beni Guil
- Missour station)
- Sidi Aissa station) Timahdite
- Telt station)
- Kra-Kra station Sardi
- Tinzouline (ex-Skoura)) station) D'Man
- Achouria station)

In addition to these stations, other purebred flocks are raised in the experimental farms (Gharb and Tadla) of Hassan II Agronomy and Veterinary Institute, National School of Agriculture and National Agronomy Research Institute.

To our knowledge, only two selection experiments have been carried out on the D'Man breed in the Tabouassamt-Achouria and Skoura stations by Bouix, Kadiri and Chari, (1974) and Ben Lakhal, Benazzou and Ezzahiri, (1980) respectively. However, the improvement observed in these flocks was not more than the result of culling the less productive animals in the

initial flock. Thus, Bouix, Kadiri and Chari (1974) reported an improvement in litter size of 0.20 to 0.25 lambs born after one year of selection at spring lambing, and 0.40 lambs at autumn lambing. In the study of Ben Lakhal, Benazzou and Ezzahiri (1980), selection was aimed at the improvement of body weight. Animals were selected on their weight at 6 months and on conformation. Data were analysed for each lambing season within sex and type of birth, and animals were selected from each class. Results of this study, carried out from 1974 to 1980, were an increase of 0.5 and 4.1 kg in birth weight and weight at 90 days respectively, and an improvement of 0.70 and 0.39 lambs born from young and mature ewes respectively.

Even though genetic parameters are necessary for selection programmes, only those of some traits in D'Man and Sardi breeds were estimated. Tables 5.6, 5.7, 5.8 and 5.9 show heritability and repeatability estimates for some reproduction and growth traits. From these estimates, it appears that heritability of reproduction traits is very low, which indicates that selection will lead to low genetic gain. On the other hand, their repeatability was also small which indicates that culling must be based on more than one performance.

Assuming that growth traits were dam characters, Nacir (1987) showed that repeatability of body weights increased as the age of lamb increased.

Genetic and phenotypic relationships between reproduction traits in the D'Man breed and growth traits in the Sardi and D'Man breeds were estimated by Boujenane, Khallouk and Kerfal (1988b) and Nacir (1987) respectively Table 5.6 and Table 5.9.

Table 5.6: Estimation of heritability, phenotypic and genetic correlations (1)

	LSB	LWB	LSW	LWW
Litter size at birth	.04±.04	.81	.61	.59
Litter weight at birth	.73	.10±.05	.45	.66
Litter size at weaning	-	-	.01±.04	.47
Litter weight at weaning	.34	.43	-	.03±.04

(Boujenane, Khallonk and Kerfal 1988b)

[1] Heritability on diagonal, phenotypic correlations above diagonal and genetic correlations below diagonal.

Table 5.7: Repeatability estimates of reproduction traits

Trait	Breed	Repeatability estimate	Standard error
Ovulation rate	D'Man	027	.06
Sardi	.17	.04	
Litter size at birth	D'Man	.15	.06
	Sardi	.05	.04
Litter size at weaning	D'Man	.04	.07
	Sardi	.05	.04
Litter weight at weaning	D'Man	.19	.07
	Sardi	.16	.04

(Nacir, 1987)

Table 5.8: Repeatability estimates of body weights

Trait	Breed	Repeatability estimate	Standard error
Birth weight	D'Man	.31	.05
	Sardi	.30	.06
Weight at 30 days	D'Man	.10	.05
	Sardi	.10	.06
Weight at 60 days	D'Man	.02	.05
	Sardi	.28	.07
Weight at 90 days	D'Man	.00	.06
	Sardi	.20	.06

(Nacir, 1987)

Table 5.9: Phenotypic correlations between body traits of Sardi (S) and D'Man (D)

Traits	Birth weight		Weight 30 days		Weight 60 days		Weight 90 days		Weight 180 days	
	S	D	S	D	S	D	S	D	S	D
Weight 30 days	.43	.58								
Weight 60 days	.32	.39	.74	.79						
Weight 90 days	.34	.36	.69	.75	.79	.90				
Weight 180 days	.33	.31	.50	.45	.60	.50	.72	.61		
Weight 365 days	.39	.26	.25	.44	.44	.56	.44	.65	.62	.59

(Nacir, 1987)

5.2.3 Improvement through crossbreeding

Crossbreeding experiments carried out in different stations involved either native breeds or exotic and native breeds.

In a diallel cross involving Timahdite, Beni Ahsen, Beni Guil, Sardi and D'Man breeds, Chouli and Oukelmoun (1983) reported that lambs sired by Beni Ahsen or Sardi rams had higher body weight at any age and better average daily gain than lambs of other breeds of ram (Table 5.10). In addition, they reported that among ram lambs slaughtered at 70 to 90 percent of mature weight, Beni Guil and D'Man purebreds had the highest fat deposition and mesenteric fat, whereas crossbred lambs sired by Beni Ahsen or Sardi had the fattest carcasses. This study also showed that Beni Guil and Sardi purebred lambs and Beni Ahsen x Beni Guil, Beni Ahsen x Sardi and Sardi x Beni Guil were the most well muscled.

In the crossbreeding experiment involving Sardi and D'Man breeds carried out in Tadla station, Boujenane et al. (unpublished data) showed that body weight of lambs of Sardi, 3/4S 1/4D, Fl, F2, 3/4D 1/4S and D'Man genotypes decreased as the percentage of D'Man genes increased. Individual and maternal heterosis were -6.6 percent and 2.1 percent, -3.0 percent and 1.3 percent and -0.9 percent and 5.8 percent for birth weight, weight at 30 days and weight at 90 days respectively.

The comparison of Fl ewes to their parental Sardi and D'Man breeds showed that the heterosis of litter size and ovulation rate was 1.4 percent and -0.5 percent respectively (Boujenane et al., 1988a).
Milk production of D'Man and D'Man x Timahdite (DxT) ewes was studied by Asserrhine (1984). The results of this study showed that D'Man ewes rearing singles, twins or triplets produced, in 13 weeks of lactation, 78, 89 and 113 kg of milk respectively, whereas (DxT) Fl ewes rearing singles and twins produced 65 and 80 kg respectively. In addition, fat percentage was 3.77 and 4.45 for D'Man and (DxT) Fl ewes respectively.
Table 5.10: Body weights and carcass characteristics of native breeds and their crossbred lambs

	T	H	G	S	D	TH	TG	TS	HG	HS	GS	DT	DH	DG	DS
Birth weight	3.5	3.5	3.5	3.9	-	3.9	3.7	3.6	3.7	3.9	3.7	3.4	3.3	3.3	3.3
Weight 30 days	9.1	7.9	8.0	9.6	-	10.0	8.5	9.5	8.9	9.6	9.2	8.8	9.1	7.6	8.5
Weight 90 days	18.1	13.9	15.2	17.0	-	18.7	15.4	18.0	16.8	17.2	16.7	16.9	18.5	15.3	16.7
ADG 30-90	149	99	120	124.	-	153	114	138	130	131	126	135	156	129	136
Fat deposition (%)	1.50	1.12	2.10	0.93	.76	1.32	1.73	1.32	1.54	2.12	1.49	1.45	1.26	1.72	1.28
Mesenteric fat (%)	3.30	2.17	3.14	2.01	.6	2.91	3.68	3.07	3.29	2.17	2.98	3.57	2.44	3.06	3.47

(Chouli and Oukelmoun, 1983)
In the experiment carried out in a well-managed private flock at Settat, Tampier (1977) compared growth performance of Beni Guil purebred lambs and Ile de France x Beni Guil crossbred lambs. The results of this study showed that purebred and crossbred lambs were 18.2 kg and 24.2 kg at 90 days of age respectively. The average daily gain at 10-30 days and 30-90 days was 156 g and 170 g respectively for Beni Guil lambs, and 228 g and 229 g respectively for Fl lambs.

5.3 Research in range management

5.3.1 History of range management research in Morocco

Research in range management is quite recent in Morocco. Before 1968 rangelands attracted primarily foresters and European plant ecologists. Most of these scientists were active researchers in Moroccan institutions such as the Phytoecological Station of the National Institute of Agricultural Research (INRA), the Cherifian Institute of Science (ISC) and the Forest Experiment Station of the Direction des Eaux et Forêts. During this period, attention was focused exclusively on the plant component of rangelands, while grazing activity was not investigated. Research performed within this period consisted primarily of vegetation inventory, mapping, and the examination of plant community/environment interactions. This work led to the establishment of a large-scale vegetation map of Morocco (Emberger,

1939) complemented by smaller scale maps for some Moroccan regions (Ionesco, 1965; Ionesco and Stefaneosco, 1967). Investigations on relationships between environmental variables, such as climate and soil, and plant communities were also published by Brignon and Sauvage (1962), and Pujos (1962), and Negre (1959).

5.3.2 Present range management research structure in Morocco

Despite the magnitude of the rangeland problems and the tremendous opportunities for research needed to solve these problems, research and funding are still in their early stages. At present, research results related to management of range resources come mostly from researchers in educational institutions, mainly the Institute of Agronomy and Veterinary Medicine, Hassan II (INAV), the National School of Agriculture (ENA), and the National School of Forestry (ENFI). A few other scientists concerned with research on plant physiology, ecology and taxonomy hold positions in various colleges of science located in Marrakech, Rabat, Fès and Oujda, in ISC and in INRA.

Research accomplished so far in the field of range management has been implemented primarily at four experiment stations located in the middle Atlas region (Sidi Aïssa and Timahdit), in the arid high plateau (Ain Beni Mathar), and in the Moulouya (Talsinnt and Boumia).

The topics covered by this research include vegetation inventory, determination of productivity and carrying capacity of different range sites, studies on feeding behaviour of sheep and goats, and on the feasibility of different management practices and supplementation schemes.

Data on seasonal and yearly variations of productivity and nutritive value of Artemisia herba alba, Stipa tenacissima and various grassland sites of the middle Atlas mountains have been collected over the last ten years at the Timahdit, Sidi Aïssa, Boumia, Talsinnt and Ain Beni Mathar stations. Diet composition and diet quality of sheep and goats as affected by season of use and stocking rate have been examined at the Timahdit, Sidi Aïssa and Ain Beni Mathar stations. Vegetation response to different grazing intensities was also investigated at Timahdit and Ain Beni Mathar stations. The performance of introduced forage species and the effects of fertilizer applications were tested at the Timahdit and Sidi Aïssa stations as well as at other sites throughout the country. Basic synecological and ecophysiological studies, including a study of the physionomy, structure and distribution of the flora in the southern slopes of the high Atlas mountains and an investigation on Artemisia herba alba population dynamics, as affected by environment and management, were also implemented.

Studies concerning revegetation of forested grazing lands, the effect of thinning of oak-woodland tree cover on production of wood and forage products, the response of native vegetation to grazing treatments, and the effect of various land use treatments on watershed values have been conducted on forested lands.

Forage selection work is continuing for both pasture and rangeland situations, while sociological studies have always accompanied rangeland. research and development efforts in Morocco.

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