**CAB Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources** 2006 **1**, No. 014

## Review

# Reproduction and production performance of Moroccan sheep breeds

**Ismaïl Boujenane**

**Address:** Department of Animal Production, Institut Agronomique et Vétérinaire Hassan II, P.O. Box 6202 Rabat-Instituts, 10101 Rabat, Morocco.

**Correspondence:** Email: i.boujenane@iav.ac.ma

**Received:** 9 May 2005
**Accepted:** 16 December 2005

doi: 10.1079/PAVSNNR20061014

The electronic version of this article is the definitive one. It is located here: http://www.cababstractsplus.org/cabreviews



## Abstract

The Moroccan sheep population consists of several breeds. The most important breeds are the D'man, Timahdite, Béni Guil, Sardi, Béni Ahsen and Boujaâd. With regard to reproduction performance, these breeds could be divided into two groups. The D'man breed reaches puberty at an early age, has a long breeding season, a short postpartum anoestrus and a high prolificacy. The other local breeds are not prolific and have a limited breeding season. All the breeds perform similarly in terms of the growth traits. Nevertheless, the Sardi breed has a slightly higher growth rate and good carcass characteristics, while the D'man has a moderate growth rate. Milk yield of local breeds is low, but milk composition is in line with that of other sheep breeds. The milk production is, in general, sufficient to nurse one lamb. Except for the D'man breed that has a low fleece weight, the other breeds have similar and moderate fleece weights. However, wool quality of local sheep is poor.

**Keywords:** Morocco, Sheep, Breed, Reproduction, Growth, Milk, Fleece traits

## Introduction

Sheep breeding in Morocco plays an important economical and sociological role. It provides about 35% of the red meat production, it is encountered in all regions of the country, where it often constitutes the only source of income for farmers and it allows the exploitation of pasture and marginal zones. Furthermore, sheep contribute to the celebration of the Abraham ceremony, as more than 4 million heads are sacrificed each year. Sheep also constitute a cash flow for farmers, contribute to the fertilization of cultivated lands by producing manure, and supply industry and handcraft workers with wool and skins [1].

The objective of this study was to review the reproduction and production performance of the most important Moroccan sheep breeds.

## Sheep Numbers and Products

In general, except during years of drought, the sheep population was more than 16 million heads [2]. Males represented 21.5% and females represented 78.5%, where 2/3 of them were adult females (more than 18 months old).

Sheep are mainly raised for meat production. At present, the annual meat production is in the region of 120 000 metric tons [3]. This production was nearly 70 000 metric tons during the 1970s. Wool production is not too important, it is considered as a by-product, maybe due to its poor quality and price. Milk production from sheep is also not important. Nevertheless, some farmers milk the ewes for their own consumption of the milk.

## Composition Breeds

The Moroccan sheep population is composed of nearly 99% local breeds and 1% exogenous breeds. The local population includes several breeds. Some of these have fixed breed standards and were studied comprehensively. These breeds are D'man, Timahdite, Béni Guil, Sardi, Béni Ahsen and Boujaâd (Figures 1–6) and they represent around 40% of the entire sheep population [4]. Some

**Figure 1** D'man ram.

**Figure 2** Timahdite ram.

**Figure 3** Béni Guil ram.

**Figure 4** Sardi ram.

**Figure 5** Béni Ahsen ewe and lamb.

**Figure 6** Boujaâd ram.

others do not have breed standards and have not been studied at all (Aït Barka, Aït Haddidou, Aït Mohad, Aknoul, Bekrit, Doukkala, El Hammam, Marmoucha, Rahhali, Rehamna-Sraghna, Siroua, Souss, Zemmour and Zemrane). Their numbers are around 2 million heads, and they are mainly located in Atlas Mountains. Animals that were obtained from different crosses constitute the remainder of the sheep population.

## Reproduction

### *Puberty and Age at First Lambing*

Except for the D'man breed that reached puberty at an early age, the other local breeds reached their puberty at a later age (Table 1). The age at puberty, as indicated by the first oestrus, averaged 210 days for D'man ewe lambs, whereas it was higher than 330 days for Timahdite and Sardi ewe lambs. Moreover, the age at puberty was dependent on the birth season of the ewe lamb [14, 18, 23, 37].

In flocks where rams are run permanently with the ewes, the age at first lambing averaged 12 months for the D'man breed and 16 months for the other local breeds (Table 1). However, in stations where rams are introduced for specific mating periods, the age at first lambing is slightly higher, at an average of 22 months. However, for a group of ewe lambs that were mated accidentally, the age at first lambing was 428 days for the Sardi breed [15] and 240 days for the D'man breed [11], indicating that these females reached puberty approximately at the age of 278 days and 90 days, respectively.

The D'man ram lambs showed sexual manifestations at the age of 106.2 days, the first ejaculation occurred at 146 days, and the first spermatozoa were observed at 165.6 days, at a body weight of 19.7 kg. However, Béni Ahsen ram lambs did not show any sexual manifestation at 252 days of age [38].

### *Breeding Season and Seasonal Anoestrus*

As indicated by the spreading out of lambings throughout the year, the D'man breed seems to be sexually active all year round, with a slight decrease from February to April [6, 11, 15, 20, 39]. This characteristic allowed the D'man ewes to lamb on average 1.4 times per year [6, 20, 21, 26]. The breeding season (more than 50% of ewes are in oestrus) for the other local breeds lasted 4–8 months, starting in May and ending in December. The maximum of estruses occurred during the period from July to September [14, 25, 28, 29, 33, 40–43]. Therefore, except for the D'man breed, the other local breeds are generally in seasonal anoestrus during the four months from January to April.

### *Fertility*

The fertility of all the local breeds is similar [44]. It averaged 85, 85, 86, 93, 87 and 98% for D'man, Timahdite, Béni Guil, Sardi, Béni Ahsen and Boujaâd ewes, respectively (Table 2). Moreover, the fertility of local ewes was affected by mating season. The highest fertility was obtained when ewes were mated from July to September [15, 25, 40]. Fertility was also affected by age of the ewes. It was higher for adult than for young ewes [8, 12, 15, 16, 46]. Furthermore, it seems to depend on the breed of the sire [16, 25].

### *Oestrous Cycle and Duration of Oestrus*

The length of the oestrous cycle of local breeds varied from 16 to 21 days [1]. It averaged 17.1 days for D'man, 17.6 days for Timahdite, 18.0 days for Béni Guil, 18.3 days for Sardi and 17.3 days for Béni Ahsen (Table 1). Moreover, the length of the oestrous cycle of adult ewes was shorter than that of ewe lambs. However, there was no difference in oestrous cycle length at different periods during the breeding season [24, 29].

The duration of oestrus averaged 31 hours for D'man ewes, 30 hours for Timahdite ewes and 24 hours for Béni Guil and Sardi ewes (Table 1). It was not affected by the breeding season [24, 29]. However, for the D'man breed, it depended on the age of the ewe, as it averaged 30 hours for adult ewes and 24 hours for young ewes [21]. Oestrus also varied with weight of the ewes. It lasted approximately 31.8 hours for ewes weighting less than 30 kg and almost 36 hours for those weighting more than 40 kg [26].

### *Ovulation Rate*

The ovulation rate of D'man ewes averaged 2.78, varying from 2.50 to 3.05. For Timahdite, Béni Guil and Sardi ewes, it was 1.09, 1.02 and 1.28, respectively (Table 2). The number of ova shed varied from 1 to 8 for D'man ewes and from 1 to 3 for the other local breeds (Table 3). The frequency distribution of D'man ewes that shed 1, 2, 3, 4, 5, 6, 7 and 8 ova represented 16.0, 33.1, 24.8, 16.2, 6.42, 2.76, 0.73 and 0.14%, respectively.

### *Embryo Survival*

The embryo survival, defined as the total number of lambs born per number of corpora lutea on the two ovaries recorded at a service of conception, was 71% for D'man and 91% for Sardi ewes (Table 2). It decreased for D'man ewes as the number of ova shed increased. With 2, 3, 4 and 5 or more ova shed, embryo survival was 92, 82, 69 and 58%, respectively [37]. The site of ovulation (left

**Table 1** Reproductive traits of Moroccan sheep breeds[1]

| Breed | Age at puberty (days) | Age at first lambing (months) | Oestrous cycle (days) | Duration of oestrus (hours) | Gestation Length (days) | Postpartum anoestrus (days) | Lambing interval (days) | References |
|---|---|---|---|---|---|---|---|---|
| D'man | – | – | 17.6 | – | – | – | – | [5] |
| | – | 15.5 | – | – | – | – | 230 | [6] |
| | – | – | – | – | – | 50.0 | 190.0 | [7] |
| | – | 24.1 (30) | – | – | 150.8 (82) | – | – | [8] |
| | – | – | – | – | 151.8 (95) | – | – | [9] |
| | – | 14.0 (48) | – | – | – | – | 192 (41) | [10] |
| | – | 9.4 (11) | – | – | – | 45.0 (72) | – | [11] |
| | – | 13.5 (111) | – | – | – | – | 191 (235) | [12] |
| | – | – | – | – | 151.5 (77) | – | – | [13] |
| | 229 (51) | – | – | – | – | 70 (40) | – | [14] |
| | – | 20.3 (289) | – | – | – | – | 221 (1763) | [15] |
| | – | – | – | – | 148.7 (198) | – | – | [16] |
| | – | – | – | – | – | 56.2 (28) | – | [17] |
| | 212 (16) | – | – | – | – | – | – | [18] |
| | – | 12.0 | – | – | – | – | 195 | [19] |
| | – | 16.0 (99) | – | – | – | – | 258 (165) | [20] |
| | 150 (20) | 17.7 (105) | 16.6 (170) | 30 (239) | 149.5 (180) | 41.8 (49) | 202 (162) | [21] |
| | – | 15.8 (308) | – | – | 150.2 (999) | – | – | [22] |
| | 207 (35) | | | | | 43.0 (24) | | [23] |
| | 219 (23) | – | – | 39 (24) | – | 60.0 (29) | – | [24] |
| | – | – | – | – | – | 53.5 (70) | – | [25] |
| | – | – | 18.0 (38) | – | – | 33.0 (38) | 315 (89) | [26] |
| Timahdite | – | 24.8 (88) | – | – | 147.1 (227) | – | – | [8] |
| | – | 23.0 (165) | – | – | – | – | 330.0 (165) | [27] |
| | – | – | 17.0 (18) | – | – | – | – | [28] |
| | 445 (32) | – | – | 30 (24) | – | 180 (29) | – | [24] |
| | – | – | 18.2 (25) | 30 (55) | 152.5 (10) | – | – | [29] |
| | – | – | – | – | 151.7 (360) | – | – | [30] |
| | – | – | 17.5 | – | – | 57.0 (70) | – | [31] |
| Béni Guil | – | 24.5 (9) | – | – | 149.3 (138) | – | – | [8] |
| | – | 26.1 (642) | – | – | – | – | 372 (1735) | [32] |
| | – | – | 18 (24) | 24 (24) | – | 85.0 (24) | – | [33] |
| Sardi | – | – | 18.7 | – | – | – | – | [5] |
| | – | – | – | – | 149.1 (143) | – | – | [8] |
| | – | – | – | – | 152.0 (78) | – | – | [13] |
| | 330 (77) | – | – | – | – | 86 (231) | – | [14] |
| | – | 24.1 (82) | – | – | – | – | – | [15] |
| | – | – | – | – | 149.8 (617) | – | – | [16] |
| | – | – | – | – | 151.4 (793) | – | – | [34] |
| | 323 (21) | – | – | – | – | – | – | [18] |
| | – | – | 18 (26) | 24 (26) | – | 132.0 (26) | – | [33] |
| | – | 15.7 (335) | – | – | – | – | 258 (315) | [35] |
| | – | – | – | – | – | 58.7 (70) | – | [25] |
| Béni Ahsen | – | 24.9 (9) | – | – | 149.8 (97) | – | – | [8] |
| | – | – | 17.3 (13) | – | – | – | – | [28] |
| Boujaâd | – | – | – | – | 151.4 (1236) | – | – | [36] |

[1]Number of data records in parentheses.

or right ovary) did not have any significant effect on embryo survival [51].

### *Gestation Length*

The gestation length of local breeds was around 150 days (Table 1). It averaged 150.1 days for D'man, 149.8 days for Timahdite, 149.3 days for Béni Guil, 150.6 days for Sardi, 149.8 days for Béni Ahsen and 151.4 days for Boujaâd (Table 1). The gestation length was slightly longer for adult than young ewes and also longer for single than multiple litters. However, sex of lamb did not have any significant effect on gestation length [8, 21, 29].

### *Litter Size*

Except for the D'man breed that had a high litter size, the other local breeds were not prolific and their litter size was low. The litter size of D'man ewes averaged 1.82 varying from 1.46 to 2.44. It averaged 1.05, 1.09, 1.10, 1.11 and 1.14 for Timahdite, Béni Guil, Sardi, Béni Ahsen and Boujaâd, respectively (Table 2). Generally, litter size at birth increased with age of ewes, reaching its maximum at 5 or 6 years old and decreased slightly thereafter. It also varied with season and year of mating [10, 15, 25].

In general, the number of lambs born per ewe lambing varied from 1 to 7 for D'man ewes and from 1 to 3 for the other local breeds (Table 4). For the D'man breed, litters with 1, 2, 3, 4, 5, 6 and 7 lambs represented 37.6, 44.6, 14.2, 2.94, 1.13, 0.10 and 0.01%, respectively. For the other breeds, single litters represented approximately 86.1%, twin litters 13.7% and triplet litters 0.2%.

### *Lamb Mortality*

Information available on local breeds showed that 4–33% of lambs born died before 90 days of age [1, 44]. Due to its high litter size at birth, the D'man breed had the highest lamb losses. Mortality from birth to 90 days averaged 11.0% for D'man, 9.0% for Timahdite, 6.5% for Béni Guil, 8.0% for Sardi, 7.5% for Béni Ahsen and 8.0% for Boujaâd lambs (Table 5). The maximum number of deaths occurred during the first month, and especially during the first 10 days. The proportion of total lamb losses to 90 days that occurred during the first 5, 10 and 30 days represented 43.3, 59.8 and 77.5%, respectively for D'man, 42.5, 45.2 and 71.5%, respectively for Timahdite, 50.0, 73.9 and 75.2%, respectively for Béni Guil, 27.3, 51.9 and 54.0%, respectively for Sardi, and 28.6, 54.4 and 64.3%, respectively for the Béni Ahsen breed.

Lamb mortality was affected by type of birth. It was higher for multiple than single born lambs, mainly due to the lower birth weight of multiple born lambs [6, 11, 15, 46, 81]. Thus, 93.9% of D'man lambs with a birth weight of less than 1 kg died, compared to 0% lambs with birth weights above 4 kg [90]. However, the effect of age of dam and sex on lamb mortality is mitigated.

Abortions and stillbirths were frequent in the D'man breed and scarce in the other local breeds. They represented 4.1 and 8.2%, respectively in the former breed, and less than 1% in the latter group (Table 5).

### *Postpartum Anoestrus*

Several authors reported that the ovarian activity of D'man ewes resumed shortly after lambing, whereas it took several weeks for the other local breeds. The postpartum anoestrus averaged 50 days for the D'man breed and more than 80 days for Timahdite, Béni Guil and Sardi breeds (Table 1). It also depends on the lambing season. The lambing to first oestrus interval was 78.8 days for spring and 40.6 days for autumn lambing Timahdite ewes [31]. On the other hand, 78% of Sardi ewes, managed in an accelerated lambing system, came into heat 43.2 days following the November–December lambing, 35% after 100 days following the January–February lambing, and 30% after 78 days following the May–June lambing [25]. The lambing to mating interval of D'man ewes was 42.8 days following the autumn lambing and 54.8 days following the spring lambing [26].

### *Lambing Interval*

The lambing interval of D'man ewes was generally short, and hence a high proportion of ewes were able to lamb more than once a year (Table 1). It varied from 190 to 350 days with an average of 222 days for D'man ewes. It was less than 7 months for 50% of ewes and 12 months for 81%, allowing an average of 1.4 lambings per year per ewe in the flock [20]. On the other hand, 87.5% of D'man ewes that lambed in spring, lamb again in the following autumn [26]. For the other local breeds, the lambing interval was, in general, longer than 300 days.

## Production

### *Growth Traits*

Generally, the birth weight of local breed lambs varied from 2 to 4 kg. It was slightly lower for D'man lambs, due to their multiple birth type, while it was higher and similar for lambs of the other local breeds (Table 6). Lamb birth weight averaged 2.14 kg for D'man, 3.52 kg for Timahdite, 3.22 kg for Béni Guil, 3.46 for Sardi, 3.55 kg for Béni Ahsen and 3.89 kg for Boujaâd. Birth weight depended on type of birth. Birth weight of D'man lambs born as twins, triplets and quadruplets was 87, 72 and 62% of the weight of singles, respectively [92].

**Table 2** Reproductive performance of Moroccan sheep breeds[1]

| Breed | Fertility (%) | Ovulation rate | Embryo survival (%) | Litter size at birth | Litter size at weaning[2] | Litter weight at weaning[2] (kg) | References |
|---|---|---|---|---|---|---|---|
| D'man | 84.9 | – | – | 1.46 (47) | – | – | [6] |
| | 82.0 (55) | – | – | 1.51 (45) | – | – | [45] |
| | 87.7 (141) | – | – | 1.75 (4299) | 1.53 (1334) | 21.9 (1334) | [46] |
| | – | – | – | 1.74 (2090) | – | – | [47] |
| | 76.7 (189) | – | – | 1.64 (90) | 0.91 | 11.3 | [8] |
| | 91.5 (298) | – | – | 2.03 (273) | 1.74 (273) | – | [9] |
| | – | – | – | 1.84 (1879) | 1.40 (1879) | 20.8 (1879) | [48] |
| | 93.5 (108) | – | – | 2.30 (101) | 192 (101) | | [10] |
| | 88.6 (826) | – | – | 2.18 (732) | 1.78 (732) | – | [12] |
| | 85.0 (89) | – | – | – | – | – | [49] |
| | – | – | – | 1.89 (638) | 1.55 (638)[3] | 23.4 (638)[3] | [50] |
| | – | 2.79 (70) | 73.0 (70) | 2.00 (70) | – | – | [51] |
| | – | – | – | 2.16 (1754) | 1.93 (1754) | 29.7 (1754) | [52] |
| | – | – | – | 1.90 (155) | 1.52 (155)[4] | 16.9 (155)[4] | [53] |
| | 85.0 (103) | – | – | 2.02 (87) | 1.56 (87) | 21.5 (87) | [13] |
| | 82.0 (41) | – | – | 2.06 (32) | 1.47 (32) | 19.4 (32) | [54] |
| | 77.6 (1365) | – | – | 1.58 (2742) | – | – | [15] |
| | – | 2.93 (156) | 77.5 (102) | 2.23 (148) | – | – | [37] |
| | 80.6 (42) | 2.56 (179) | 68.3 | 1.80 (240) | 1.55 (220) | 19.8 (135) | [16] |
| | – | – | – | 1.84 (1895) | 1.39 (1895) | 19.7 (1895) | [55] |
| | – | 2.79 (232) | – | 2.07 (232) | – | – | [18] |
| | 90.0 | – | – | 1.71 (1199) | 1.50 (1199) | – | [19] |
| | 95.0 (79) | – | – | 2.17 (75) | 1.34 (79)[5] | 22.5 (9)[5] | [56] |
| | – | – | – | 1.63 (474) | – | – | [20] |
| | 92.0 (333) | – | – | 2.19 (302) | | | [57] |
| | – | – | – | 1.79 (482) | – | – | [21] |
| | – | 2.88 (179) | – | – | – | – | [58] |
| | – | 2.50 (38) | | | – | – | [59] |
| | – | 2.85 (44) | 66.1 (44) | 1.74 (44) | – | – | [24] |
| | – | 3.05 (20) | – | – | – | – | [60] |
| | 98.5 (130) | – | – | 2.44 (128) | – | – | [25] |
| | 100.0 (55) | – | – | 1.60 (55) | | | [61] |
| | – | 2.79 (372) | – | 1.90 (345) | 1.33 (345)[4] | 13.0 (345)[4] | [62] |
| Timahdite | 94.0 (84) | – | – | 1.05 (79) | – | – | [63] |
| | – | – | – | 1.04 (11952) | – | – | [64] |
| | 85.2 (562) | – | – | 1.06 (394) | 0.77 | 10.7 | [8] |
| | 92.0 (165) | – | – | 1.07 (165) | – | – | [27] |
| | 90.0 (42) | – | – | 1.09 (40) | – | 15.2 (40) | [65] |
| | – | – | – | 1.05 (50) | – | – | [28] |
| | 83.3 (18) | – | – | 1.00 (15) | – | – | [66] |
| | 91.0 (182) | – | – | 1.17 (166) | 1.03 (182) | 20.6 (182) | [56] |
| | – | – | – | 1.07 (1255) | 1.01 (948) | 21.4 (948) | [67] |
| | – | 1.09 (186) | – | – | – | – | [58] |
| | – | 1.09 (47) | – | – | – | – | [24] |
| | – | 1.05 (20) | – | – | – | – | [60] |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 88.0 (616) | – | – | 1.05 (542) | | | [61] |
| | 76.8 (1319) | – | – | 1.03 (996) | – | – | [30] |
| | – | – | – | 1.05 (4229) | 0.99 (4229) | 17.1 (4229) | [68] |
| Béni Guil | 82.5 (354) | – | – | 1.02 (244) | 0.75 | 11.1 | [8] |
| | – | – | – | 1.07 (2737) | 1.02 (2737) | 18.2 (2737) | [69] |
| | – | – | – | 1.08 (2335) | 0.99 (2335) | 16.0 (2335) | [32] |
| | 85.0 (39) | – | – | 1.14 (36) | – | 20.7 (36) | [65] |
| | 95.0 (54) | – | – | 1.00 (52) | 0.89 (52) | 15.8 (52) | [54] |
| | – | – | – | 1.11 (1812) | 1.06 (1812) | 18.0 (1812) | [70] |
| | 95.0 (20) | – | – | 1.00 (19) | – | – | [66] |
| | – | – | – | 1.17 (830) | 1.11 (830) | 18.8 (830) | [71] |
| | – | 1.02 (24) | – | – | – | – | [33] |
| | 86.0 (127) | – | – | 1.12 (113) | | | [57] |
| | 92.0 (103) | – | – | 1.04 (95) | | | [61] |
| Sardi | 85.4 (226) | – | – | 1.09 (241) | 0.83 | 15.5 | [8] |
| | 91.2 | – | – | 1.03 | – | – | [40] |
| | 74.0 (123) | – | – | – | – | – | [49] |
| | – | – | – | 1.03 (2943) | 1.01 (2943) | 22.5 (2943) | [69] |
| | – | 1.06 (85) | 81.0 (85) | 1.03 (85) | – | – | [51] |
| | 77.0 (31) | – | – | 1.14 (26) | – | 19.9 (26) | [65] |
| | – | – | – | 1.10 (308) | 1.04 (308)[4] | 15.1 (308)[4] | [53] |
| | 91.0 (105) | – | – | 1.15 (95) | 0.99 (95) | 19.1 (95) | [13] |
| | 96.0 (48) | – | – | 1.17 (46) | 0.99 (46) | 18.4 (46) | [54] |
| | 91.4 (1211) | – | – | 1.02 (1107) | – | – | [15] |
| | – | 1.30 (539) | 86.5 (152) | 1.22 (621) | – | – | [37] |
| | 85.2 (473) | 1.23 (411) | 95.4 | 1.20 (725) | 1.16 (687) | 18.4 (270) | [16] |
| | 98.0 (811) | – | – | 1.29 (793) | 1.25 (793) | 27.9 (793) | [34] |
| | 100.0 (20) | – | – | 1.20 (20) | – | – | [66] |
| | – | 1.29 (294) | – | 1.09 (294) | – | – | [18] |
| | – | 1.03 (26) | – | – | – | – | [33] |
| | – | – | – | 1.08 (508) | – | – | [35] |
| | 91.0 (162) | – | – | 1.17 (146) | | | [57] |
| | 90.8 (509) | – | – | 1.07 (462) | | | [72] |
| | 87.0 (578) | – | – | 1.26 (503) | – | – | [25] |
| | 92.0 (114) | – | – | 1.01 (105) | – | – | [61] |
| | – | – | – | 1.07 (4840) | – | – | [73] |
| | – | 1.32 (911) | – | 1.17 (962) | 1.04 (962)[4] | 13.9 (962)[4] | [62] |
| Béni Ahsen | 83.8 (284) | – | – | 1.06 (194) | 0.79 | 11.2 | [8] |
| | – | – | – | 1.07 (50) | – | – | [28] |
| | 94.4 (18) | – | – | 1.06 (17) | – | – | [66] |
| | 89.0 (428) | – | – | 1.15 (381) | | | [61] |
| Boujaâd | – | – | – | 1.06 (1316) | – | – | [74] |
| | – | – | – | 1.04 | – | – | [75] |
| | 98.0 (1264) | – | – | 1.29 (1236) | 1.24 (1236) | 26.9 (1236) | [36] |

[1]Number of data records in parentheses.
[2]Litter size and litter weight at 90 days per ewe lambing.
[3]Litter size and litter weight at 70 days per ewe lambing.
[4]Litter size and litter weight at 60 days per ewe lambing.
[5]Litter size and litter weight at 90 days per ewe mated.

**Table 3** Frequency distribution (%) of ovulation rate of local ewes

| | | | Ovulation rate | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Breed | Mean | Number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | References |
| D'man | 2.83 | 70 | 14.3 | 27.2 | 28.6 | 21.4 | 8.6 | – | – | – | [76] |
| | 2.80 | 179 | 14.7 | 32.9 | 27.1 | 17.1 | 5.0 | 2.1 | 1.3 | 0.4 | [77] |
| | 2.93 | 156 | 12.2 | 28.2 | 28.2 | 21.8 | 5.8 | 2.5 | 1.3 | – | [78] |
| | 2.48 | 77 | 25.0 | 38.0 | 15.0 | 11.0 | 9.0 | 1.0 | 0.7 | 0.3 | [79] |
| | 2.50 | 38 | 21.0 | 42.0 | 21.0 | 5.3 | 2.6 | 7.9 | – | – | [59] |
| | 2.67 | 128 | 17.2 | 36.8 | 23.4 | 10.9 | 7.8 | 3.9 | – | – | [24] |
| | 3.05 | 20 | 10.0 | 35.0 | 20.0 | 20.0 | 5.00 | 10.0 | – | – | [60] |
| Timahdite | 1.05 | 20 | 95.0 | 5.00 | – | – | – | – | – | – | [60] |
| Sardi | 1.09 | 85 | 90.6 | 9.4 | – | – | – | – | – | – | [76] |
| | 1.30 | 539 | 70.3 | 29.5 | 0.2 | – | – | – | – | – | [37] |
| | 1.26 | 477 | 74.2 | 25.5 | 0.3 | – | – | – | – | – | [16] |
| | 1.24 | 101 | 81.0 | 14.0 | 5.0 | – | – | – | – | – | [79] |

**Table 4** Frequency distribution (%) of litter size at birth of local ewes

| | | | Litter size | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Breed | Mean | Number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | References |
| D'man | 1.74 | 4299 | 40.5 | 46.8 | 11.1 | 1.5 | 0.2 | – | – | [46] |
| | 2.40 | 25 | 20.0 | 36.0 | 28.0 | 16.0 | – | – | – | [80] |
| | 2.03 | 273 | 22.7 | 54.6 | 19.8 | 2.6 | 0.4 | – | – | [9] |
| | 2.30 | 101 | 23.8 | 38.6 | 24.7 | 10.9 | 1.0 | 1.0 | – | [10] |
| | 2.18 | 732 | 27.2 | 39.8 | 23.0 | 8.47 | 1.07 | 0.54 | – | [12] |
| | 1.97 | 70 | 32.9 | 44.3 | 17.1 | 4.3 | 1.4 | – | – | [76] |
| | 2.04 | 240 | 30.2 | 41.2 | 23.7 | 4.1 | 0.4 | 0.4 | – | [77] |
| | 2.11 | 1852 | 26.4 | 43.6 | 23.5 | 5.4 | 0.81 | 0.16 | 0.06 | [78] |
| | 2.02 | 87 | 28.7 | 47.1 | 20.7 | 3.4 | – | – | – | [13] |
| | 1.58 | 2742 | 49.3 | 43.2 | 6.78 | 0.62 | 0.04 | – | – | [15] |
| | 2.24 | 148 | 23.6 | 40.5 | 26.4 | 8.1 | 0.7 | 0.7 | – | [37] |
| | 2.04 | 240 | 30.2 | 41.2 | 23.7 | 4.1 | 0.4 | 0.4 | – | [16] |
| | 1.73 | 77 | 40.0 | 49.0 | 9.0 | 1.7 | 0.3 | – | – | [79] |
| | 1.71 | 1199 | 47.0 | 39.7 | 11.1 | 2.0 | 0.2 | – | – | [19] |
| | 1.63 | 474 | 43.2 | 47.9 | 4.47 | 2.69 | 0.89 | – | – | [20] |
| | 1.89 | 74 | 32.4 | 50.0 | 13.5 | 4.05 | – | – | – | [81] |
| | 1.79 | 482 | 36.7 | 48.8 | 13.5 | 1.0 | – | – | – | [21] |
| | 2.27 | 882 | 18.6 | 47.1 | 25.3 | 7.00 | 1.58 | 0.34 | 0.11 | [82] |
| | 1.84 | 82 | 37.8 | 43.9 | 14.6 | 3.7 | – | – | – | [24] |
| Béni Guil | 1.12 | 2201 | 88.3 | 11.7 | – | – | – | – | – | [83] |
| | 1.07 | 2335 | 93.3 | 6.7 | – | – | – | – | – | [84] |
| Sardi | 1.29 | 34 | 70.6 | 29.4 | – | – | – | – | – | [80] |
| | 1.06 | 85 | 94.1 | 5.9 | – | – | – | – | – | [76] |
| | 1.15 | 95 | 91.6 | 8.4 | – | – | – | – | – | [13] |
| | 1.02 | 1107 | 97.1 | 2.12 | 0.09 | – | – | – | – | [15] |
| | 1.21 | 725 | 78.6 | 21.3 | 0.1 | – | – | – | – | [16] |
| | 1.29 | 101 | 93.0 | 15.0 | 2.0 | – | – | – | – | [79] |
| | 1.29 | 793 | 72.0 | 27.1 | 0.9 | – | – | – | – | [34] |
| Boujaâd | 1.29 | 1236 | 71.3 | 28.4 | 0.3 | – | – | – | – | [36] |

The lamb weight at 1 month, 3 months, 6 months and 12 months of age of local breeds varied approximately from 6.41 to 9.36 kg, from 14.5 to 21.8 kg, from 21.7 to 32.9 kg and from 24.6 to 53.3 kg, respectively (Table 6). The average daily gain from birth to 30 days averaged 139, 158, 166, 202, 185 and 213 g/day for D'man, Timahdite, Béni Guil, Sardi, Béni Ahsen and Boujaâd lambs, respectively. The average daily gain from 30 to 90 days averaged 133, 155, 119, 172, 151 and 190 g/day, respectively. The growth traits were mainly affected by type of birth – rearing, sex and season of birth. Singles were usually heavier than multiples and males were generally heavier than females at all ages.

**Table 5** Lamb mortality of Moroccan breeds (%)[1]

| Breed | Abortions | Stillbirths | Mortality rate | | | | | References |
|---|---|---|---|---|---|---|---|---|
| | | | 0–1 days | 0–5 days | 0–10 days | 0–30 days | 0–90 days | |
| D'man | – | – | – | – | – | – | 14.0 (88) | [6] |
| | – | 2.9 | – | 1.5 (68) | – | – | 6.1 (68) | [45] |
| | – | – | – | – | – | – | 6.50 (6205) | [46] |
| | – | – | – | – | 13.9 | 18.5 | 30.6 (143) | [8] |
| | | 1.22 (233) | – | – | 6.13 (230) | – | 11.4 (230) | [9] |
| | | | | | | | 15.5 | [10] |
| | – | 13.9 (1598) | – | – | 3.27 (1376) | – | 4.29 (1376) | [12] |
| | – | – | – | – | – | 2.0 (129) | 4.0 (129) | [85] |
| | – | – | – | – | – | – | 17.0 (195) | [53] |
| | – | – | – | – | – | – | 10.0 (166) | [13] |
| | – | – | – | – | – | – | 20.2 (4354) | [15] |
| | – | – | – | – | 21.0 (381) | – | 22.8 (381) | [86] |
| | – | 8.77 (2051) | – | – | – | – | 16.8 (1871) | [19] |
| | – | 11.0 (342) | – | – | – | – | 33.0 (142) | [56] |
| | – | 2.6 (464) | – | – | 2.3 (464) | – | 9.3 (464) | [20] |
| | – | – | – | 1.5 (857) | 6.65 (857) | – | 15.7 (857) | [21] |
| | 4.10 (5994) | 6.96 (5748) | | 2.65 (5348) | | 4.26 (5348) | 5.4 (5348) | [87] |
| | – | – | – | 6.19 (210) | – | 10.5 (210) | 14.8 (210) | [61] |
| Timahdite | – | – | – | – | 7.2 | – | 7.2 | [63] |
| | – | – | – | – | – | 4.0 (11633) | 5.5 (11633) | [64] |
| | – | – | – | – | 6.6 | 10.1 | 14.6 (63) | [8] |
| | – | – | – | – | – | – | 7.0 (44) | [65] |
| | – | 3.0 (211) | – | – | – | – | 13.0 (211) | [56] |
| | – | – | – | – | – | 17.0 (752) | 23.0 (752) | [57] |
| | – | – | – | 4.06 (419) | – | 6.44 (419) | 9.55 (419) | [61] |
| | 0.62 (1454) | – | – | – | – | – | – | [30] |
| | – | – | | – | – | – | 15.0 (4671) | [68] |
| Béni Guil | – | – | – | – | 6.5 | 8.3 | 8.8 (95) | [18] |
| | – | – | – | – | – | – | 7.8 (2961) | [69] |
| | – | – | – | – | – | – | 4.0 (2354) | [88] |
| | – | – | – | – | – | – | 5.0 (37) | [65] |
| | – | – | 2.00 (957) | 4.00 (957) | – | 6.00 (957) | 8.00 (957) | [71] |
| | – | – | – | 4.67 (107) | – | 5.61 (107) | 9.35 (107) | [61] |
| Sardi | – | – | – | – | 6.3 | 6.3 | 9.9 (94) | [8] |
| | – | – | – | – | – | – | 3.1 (3032) | [69] |
| | – | – | – | – | – | 2.0 (139) | 4.0 (139) | [85] |
| | – | – | – | – | – | – | 6.0 (28) | [65] |
| | – | – | – | – | – | – | 25.0 (191) | [53] |
| | – | – | – | – | – | – | 12.0 (100) | [13] |
| | 0.08 (1145) | 0.08 (1144) | – | – | 2.27 (1143) | – | 5.15 (1143) | [15] |
| | – | – | – | – | 5.5 (328) | – | 7.0 (328) | [86] |
| | – | – | – | – | – | – | 7.0 (1024) | [34] |
| | – | – | – | – | – | – | 9.89 (546) | [35] |
| | 1.96 (509) | – | – | – | 7.9 (493) | 8.4 (493) | 15.8 (493) | [72] |
| | – | – | – | 2.61 (115) | – | 5.22 (115) | 9.56 (115) | [61] |
| | – | – | – | – | – | – | 3.0 (3038) | [89] |
| Béni Ahsen | – | – | – | – | 4.1 | 5.1 | 10.8 (75) | [8] |
| | – | – | – | 2.00 (401) | 3.8 | 4.49 (401) | 6.98 (401) | [61] |
| Boujaâd | – | – | – | – | – | – | 8.0 (1588) | [36] |

[1]Number of data records in parentheses.

### *Lamb Production*

Litter size at 90 days varied from 1.39 to 1.93 for D'man ewes and from 0.77 to 1.25 for ewes of the other local breeds (Table 1). Litter weight at 90 days averaged 22.8, 17.9, 17.5, 23.1, 15.9 and 26.9 kg for D'man, Timahdite, Béni Guil, Sardi, Béni Ahsen and Boujaâd ewes, respectively. The maximum lamb production at 90 days (80.5 kg) was realized by a D'man ewe. The maximum lifetime lamb production was also recorded by a D'man ewe that weaned a total of 393 kg lamb [103]. Litter size and litter weight at weaning varied with age of ewe and season of lambing [10, 32, 67, 68].

**Table 6** Weight and average daily gain (ADG) of local lambs[1]

| Breed | Birth weight (kg) | Weight at 30 days (kg) | Weight at 60 days (kg) | Weight at 90 days (kg) | Weight at 180 days (kg) | Weight at 365 days (kg) | ADG 0–30 (g/day) | ADG 30–90 (g/day) | References |
|---|---|---|---|---|---|---|---|---|---|
| D'man | 2.38 (142) | 6.35 (126) | – | 15.45 (128) | 25.6 (116) | – | 140 (126) | 151 (128) | [91] |
| | 1.71 (77) | 6.73 (77) | – | 11.6 (77) | 15.1 (77) | 18.4 (77) | 167 (77) | 81 (77) | [6] |
| | 2.40 (37) | 7.30 (37) | 13.7 (37) | 19.7 (37) | – | – | – | – | [45] |
| | 2.05 (5976) | 6.19 (2108) | 11.4 (1983) | 14.9 (2646) | 20.7 (872) | – | 135 (2108) | 121 (1842) | [46] |
| | 1.88 (3084) | – | – | 12.7 (1682) | – | – | – | – | [47] |
| | 2.10 (143) | 5.90 (64) | 9.40 (63) | 12.5 (50) | – | – | 121 (63) | 112 (50) | [8] |
| | 2.54 (233) | – | 8.12 (233) | 18.2 (233) | | | 172 (233) | 168 (233) | [9] |
| | 2.10 (3440) | 6.03 (3046) | – | 13.1 (2723) | – | – | 131 (3046) | 114 (2723) | [48] |
| | 2.3 | 6.8 | – | 17.1 | 33.5 | – | 150 | 172 | [10] |
| | 2.49 (1596) | 7.08 (1330) | – | 16.7 (1317) | 26.5 (1307) | – | – | 161 (1317) | [12] |
| | 2.76 | 7.74 | – | – | – | – | – | – | [50] |
| | 2.34 (1689) | 6.93 (1689) | – | 16.2 (1689) | 24.9 (1689) | – | 157 (1689) | 153 (1689) | [92] |
| | 2.34 (129) | 6.44 (117) | 10.4 (115) | 12.7 (114) | 22.7 (111) | 27.3 (49)[2] | – | – | [85] |
| | 2.42 (159) | 6.47 (159) | 11.4 (160) | 16.8 (159) | – | – | – | – | [53] |
| | 2.69 (135) | 6.27 (135) | – | 14.3 (135) | – | – | 124 (135) | 132 (135) | [13] |
| | 2.52 (38) | 6.78 (35) | – | 13.8 (34) | – | – | 146 (35) | 116 (34) | [93] |
| | 2.45 (252) | 6.54 (162) | – | 12.9 (121) | 15.0 (124) | 27.7 (52) | 134 (162) | 105 (121) | [15] |
| | – | – | – | 11.8 (136) | 20.9 (136) | – | – | – | [94] |
| | 2.65 (87) | – | – | 17.3 (87) | – | – | – | 162 (87) | [56] |
| | 2.53 (550) | 6.22 (471) | – | 14.2 (463) | – | – | 131 (471) | 132 (463) | [57] |
| | 2.65 (55) | 7.5 (55) | – | 15.8 (55) | – | – | 161 | 138 | [61] |
| | 2.20 (414) | 5.86 (338) | 9.31 (325) | 12.2 (238) | 20.8 (145) | 27.9 (59)[2] | – | – | [62] |
| Timahdite | – | 8.60 (18285) | – | – | – | – | – | – | [95] |
| | 3.60 (11632) | 9.04 (11913) | – | 19.0 (9162) | – | – | – | – | [64] |
| | 2.90 (179) | 6.70 (75) | 10.2 (70) | 13.8 (55) | – | – | 127 (75) | 113 (55) | [8] |
| | – | – | – | – | 21.0 (173) | – | – | – | [27] |
| | 3.60 (10370) | 9.58 (10370) | – | 18.8 (10370) | – | – | – | – | [96] |
| | 3.26 (44) | – | – | 15.7 (43) | – | – | – | – | [13] |
| | 3.25 | 9.15 | – | 15.5 | – | – | 197 | 107 | [28] |
| | 3.46 (4) | 9.15 (4) | – | 18.1 (4) | – | – | – | 149 | [66] |
| | 3.53 (130) | 7.19 (130) | – | 12.8 (130) | 22.7 (130) | – | 122 (130) | 93 (130) | [97] |
| | 3.69 (544) | 9.27 (544) | – | 20.0 (544) | – | – | – | 179 (544) | [98] |
| | 2.94 (196) | – | – | 17.3 (196) | – | – | – | 172 (196) | [56] |
| | 3.72 (522) | 9.51 (522) | – | 20.0 (544) | – | – | – | 181 (522) | [99] |
| | 3.23 (1373) | 8.6 (1057) | 17.2 (724) | 19.5 (1026) | – | – | 184 (1018) | 184 (1023) | [67] |
| | 3.51 (195) | 9.6 (195) | – | 19.1 (195) | – | – | 202 (195) | 150 (195) | [61] |
| | 3.15 (217) | 10.4 (214) | 14.4 (214) | 18.0 (176) | – | – | 263 (214) | 135 (176) | [30] |
| | 3.23 (4054) | 7.80 (4543) | – | 16.1 (4273) | – | – | 146 (3994) | 145 (4235) | [68] |
| Béni Guil | – | 7.90 (2372) | – | – | – | – | – | – | [95] |
| | 2.86 (21) | 6.77 (21) | – | 14.1 (21) | 27.0 (20) | – | 139 (21) | 122 (21) | [91] |
| | 3.30 (218) | 7.80 (103) | 11.2 (96) | 14.9 (87) | – | – | 148 (102) | 119 (87) | [8] |
| | 3.26 (2811) | 8.49 (2811) | – | 16.6 (2811) | – | – | – | – | [69] |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 3.13 (2226) | 8.15 (2226) | – | 15.3 (2226) | – | – | 167 (2226) | 119 (2226) | [88] |
| | 3.56 (37) | – | – | 18.9 (36) | – | – | – | – | [13] |
| | 2.78 (54) | 7.33 (51) | – | 15.0 (50) | – | – | 156 (51) | 128 (50) | [93] |
| | 3.40 (12) | 8.03 | – | 15.2 | – | – | – | 120 | [66] |
| | 3.39 (957) | 8.77 (920) | – | 15.9 (902) | – | – | 177 (920) | 119 (902) | [71] |
| | – | – | – | 13.5 (38) | 23.1 (38) | – | – | – | [94] |
| | 2.70 (82) | 6.71 (53) | – | 14.2 (53) | – | – | 132 (53) | 123 (53) | [57] |
| | 3.1 (78) | 8.1 (78) | – | 15.4 (78) | – | – | 168 (78) | 121 (78) | [61] |
| | – | 9.16 (10630) | – | – | – | – | – | – | [100] |
| Sardi | – | 9.55 (2314) | – | – | – | – | – | – | [95] |
| | 2.92 (27) | 6.73 (26) | – | 13.5 (26) | 28.0 (26) | – | 134 (26) | 111 (26) | [90] |
| | 3.60 (256) | 8.90 (142) | 13.1 (135) | 18.6 (86) | – | – | 171 (142) | 151 (86) | [8] |
| | 3.50 (10) | 10.0 (113) | 14.5 (113) | 19.2 (113) | – | – | 200 (10) | 150 (113) | [40] |
| | 3.36 (2965) | 9.81 (2965) | – | 21.2 (2965) | – | – | – | – | [69] |
| | 3.36 (139) | 8.18 (138) | 12.1 (138) | 15.0 (136) | 22.7 (134) | 30.3 (62)[2] | – | – | [85] |
| | 3.46 (28) | – | – | 18.6 (28) | – | – | – | – | [65] |
| | 3.31 (160) | 7.96 (160) | 12.7 (160) | 17.6 (160) | – | – | – | – | [53] |
| | 3.40 (2970) | 9.80 (2970) | – | 21.2 (2970) | – | – | 215 (2970) | 190 (2970) | [101] |
| | 3.34 (92) | 6.95 (92) | – | 16.6 (92) | – | – | 127 (92) | 150 (92) | [13] |
| | 3.17 (54) | 8.06 (47) | – | 16.5 (46) | – | – | 164 (47) | 142 (46) | [93] |
| | 3.58 (126) | 9.08 (87) | – | 17.8 (58) | 26.9 (99) | 33.6 (284) | 182 (87) | 146 (58) | [15] |
| | 4.10 (1024) | 10.9 (956) | – | 22.5 (947) | 35.7 (95) | 58.6 (88) | 224 (956) | 194 (947) | [34] |
| | 3.92 (13) | 9.56 | – | 17.0 | – | – | – | 124 | [66] |
| | 3.87 (74) | 7.27 (74) | – | 12.8 (74) | 23.5 (74) | – | 112 (74) | 93 (74) | [97] |
| | 2.81 (136) | 7.35 (73) | – | 15.1 (73) | – | – | 149 (73) | 128 (73) | [57] |
| | 3.38 (420) | 6.96 (445) | 11.3 (427) | 18.1 (407) | – | – | 116 (380) | 186 (407) | [72] |
| | 2.97 (90) | 9.0 (90) | – | 16.7 (90) | – | – | 201 (90) | 128 (90) | [61] |
| | – | 9.03 (4265) | – | 18.0 (2144) | – | – | – | 144 (1879) | [73] |
| | 3.36 (456) | 8.06 (427) | 12.7 (425) | 15.5 (323) | 22.8 (226) | 29.0 (107)[2] | | | [62] |
| Béni Ahsen | 3.20 (175) | 7.10 (84) | 10.7 (78) | 14.1 (68) | – | – | 131 (84) | 115 (68) | [8] |
| | 3.25 | 9.65 | – | 16.3 | – | – | 213 | 111 | [28] |
| | 3.50 (13) | 7.90 | – | 13.9 | – | – | – | 99 | [66] |
| | 3.82 (235) | 10.0 (235) | – | 19.7 (235) | – | – | 205 (235) | 162 (235) | [61] |
| Boujaâd | – | 9.38 (654) | – | – | – | – | – | – | [95] |
| | – | 8.75 (7054) | – | – | – | – | – | – | [102] |
| | 3.89 (1588) | 10.3 (1455) | – | 21.8 (1448) | 32.9 (159) | 53.3 (157) | 213 (1454) | 190 (1447) | [36] |

[1]Number of data records in parentheses.
[2]Females only.

**Table 7** Fattening performances and carcass characteristics of local lambs[1]

| Breed | ADG during fattening (g/day) | Feed intake (kg dry matter/animal) | Feed efficiency[2] | Age at slaughtering (days) | Weight at slaughtering (kg) | Hot carcass weight (kg) | Dressing % | Kidney fat (g) | Mesenteric fat (g) | References |
|---|---|---|---|---|---|---|---|---|---|---|
| D'man | 142 (10) | – | – | – | 31.4 (10) | 14.9 (10) | 47.4 (10) | 256 (10) | – | [104] |
| | 230 (43) | – | 6.7 (43) | 171 (43) | 34.8 (43) | 16.4 (43) | 46.9 (43) | 116 (43) | – | [13] |
| | – | – | – | – | – | 11.3 (24) | 49.5 (24) | 180 (24) | – | [93] |
| | – | – | – | – | – | 10.7 (32) | 48.1 (32) | – | – | [94] |
| | 196 | – | – | – | – | – | – | – | – | [105] |
| Timahdite | – | – | – | – | – | 11.6 | – | – | – | [27] |
| | 176 (20) | 0.78 (78) | 6.2 (78) | 159 (20) | 25.8 (20) | 12.2 (20) | 48.2 (20) | 203 (20) | 545 (20) | [106] |
| | 165 (16) | – | – | 298 (16) | 35.1 (16) | 17.8 (16) | 49.2 (16) | – | 570 (16) | [97] |
| | 209 | – | – | – | – | – | – | – | – | [105] |
| | – | – | – | – | 29.6 (15) | 13.8 (15) | 46.8 (15) | – | – | [30] |
| Beni Guil | 215 (20) | 1.03 (94) | 5.5 (94) | 159 (20) | 29.1 (20) | 13.6 (20) | 47.7 (20) | 256 (20) | 752 (20) | [106] |
| | – | – | – | – | – | 14.1 (24) | 48.5 (24) | 260 (24) | – | [93] |
| | – | – | – | – | – | 14.2 (10) | 46.7 (10) | – | – | [94] |
| Sardi | 201 (20) | 0.89 (87) | 4.7 (87) | 159 (18) | 28.4 (18) | 13.5 (18) | 48.2 (18) | 214 (18) | 740 (18) | [106] |
| | 147 (9) | – | – | – | 38.1 (9) | 18.1 (9) | 47.5 (9) | 173 (9) | – | [104] |
| | 213 (50) | – | 6.6 (50) | 171 | 29.5 (50) | 14.0 (50) | 47.2 (50) | 99 (50) | – | [13] |
| | – | – | – | – | – | 16.6 (23) | 49.0 (23) | 160 (23) | – | [93] |
| | 283 (154) | 1.36 (154) | 4.87 (154) | 168 | 45.5 (154) | 23.2 (154) | 50.9 (154) | 295 (154) | – | [34] |
| | 178 (16) | | | 275 | 36.6 (16) | 17.8 (16) | 49.6 (16) | | 500 (16) | [97] |
| Boujaâd | 280 (184) | 1.30 (184) | 4.7 (184) | 171 | 44.8 (184) | 22.4 (184) | 50.0 (184) | 298 (184) | – | [36] |

[1]Number of data records in parentheses.
[2]The feed efficiency is defined as the quantity of feed (kg) divided by total weight gain (in kg).

### *Carcass Traits*

Fattening performance and carcass characteristics depended on several factors, of which duration of fattening and weight at slaughtering were the most important (Table 7). In general, during a fattening period of 1–3 months, average daily gain of lambs varied from 142 to 283 g/day, feed intake from 0.78 to 1.36 kg dry matter/animal/day and feed efficiency from 4.7 to 6.7. When the slaughtering occurred around the age of 6 months, weight at slaughtering varied from 25.8 to 45.5 kg and hot carcass weight varied from 12.2 to 23.2 kg. Dressing percentage, kidney fat and mesenteric fat varied from 46.7 to 50.9%, from 99 to 298 g and from 545 to 752 g, respectively.

### *Milk Production*

Moroccan local ewes are not milked; their milk is used to nurse lambs. Depending on length of lactation (8–15 weeks) and method of estimation (oxytocin or weighing lambs before and after suckling), the milk production of local ewes varied from 40 to 132 kg. Milk composition varied from 14.3 to 21.0% for dry matter, from 5.79 to 9.55% for fat, from 5.13 to 5.65% for protein and from 5.05 to 5.28% for lactose, respectively. The energy contained in milk from local ewes varied from 1099 to 1419 kcal/kg (Table 8).

### *Wool Production*

The fleece weight of local sheep varied from 1.0 to 3.5 kg (Table 9). It averaged 1.0, 1.88, 1.68, 1.93, 2.61 and 3.40 kg for D'man, Timahdite, Béni Guil, Sardi, Béni Ahsen and Boujaâd, respectively. Wool of local sheep was of a poor quality. Fineness varied from 49.1 to 58.1 spin count, fibre length from 6.15 to 9.64 cm, fibre diameter from 25.4 to 26.9 micron-metre and kemp score from 1.36 to 3.34 (on a scale varying from 0 to 6).

## Conclusion

Morocco has rich sheep genetic resources. However, some breeds have a well-defined set of breed standards and their performances are known. Others are neglected and at risk. The first step that should be taken is to protect these breeds from extinction and to characterize them. Reproduction performances of the main local breeds are, in general, moderate, whereas their lamb growth rates are relatively low. The reason for this is that 99% of the flocks depend on poor pasture for their nutrition. Therefore, to increase sheep productivity in

**Table 8** Milk production of local ewes[1]

| Breed | Method[2] | Length (weeks) | Milk yield (kg) | Dry matter (%) | Fat (%) | Protein (%) | Lactose (%) | Energy (kcal/kg) | References |
|---|---|---|---|---|---|---|---|---|---|
| D'man | WBAS | 8 | 65.7 (18) | 16.2 (18) | 4.18 (18) | 5.38 (18) | – | 928 (18) | [107] |
| | Oxytocin | 12 | 102 (42) | – | – | – | – | – | [45] |
| | Oxytocin | 8 | 67.8 (16) | – | – | – | – | – | [108] |
| | WBAS | 12 | 113.9 (70) | – | – | – | – | – | [109] |
| | Oxytocin | 10 | 81.2 (24) | – | 7.34 (12) | – | – | – | [110] |
| | WBAS | 8 | 61.2 (44) | – | – | – | – | – | [13] |
| | WBAS | 8 | 63.3 (88) | 13.9 (88) | 5.91 (88) | 5.08 (88) | – | 1291 (88) | [111] |
| Timahdite | Oxytocin | 12 | 79.1 | – | – | – | – | – | [63] |
| | WBAS | 14 | 78.7 (20) | 17.0 (20) | 5.90 (20) | 4.85 (20) | 5.10 (20) | 1029 (20) | [112] |
| | WBAS | 12 | 57.9 (23) | 19.0 (23) | 7.97 (23) | 5.23 (23) | – | 1237 (23) | [113] |
| | Oxytocin | 12 | 78.0 (31) | 20.8 (31) | 7.47 (31) | 7.09 (31) | 5.39 (31) | 1313 (31) | [114] |
| | WBAS | 14 | 93.7 (16) | – | – | – | – | – | [115] |
| | Oxytocin | 14 | 132.6 (16) | 23.4 (16) | 11.5 (16) | 5.05 (16) | – | 1564 (16) | [115] |
| | WBAS | 8 | 38.1 (14) | – | – | – | – | – | [116] |
| | WBAS | 10 | 72.1 (16) | – | – | – | – | – | [117] |
| | Oxytocin | 14 | 143.1 (16) | 24.4 (16) | 11.9 (16) | 5.10 (16) | – | 1631 (16) | [117] |
| | WBAS | 10 | 70.4 (42) | – | – | – | – | – | [118] |
| | Oxytocin | 12 | 123.4 (42) | – | – | – | – | – | [118] |
| Béni Guil | WBAS | 12 | 56.1 (26) | 20.1 (26) | 8.45 (26) | 5.45 (26) | – | 1311 (26) | [113] |
| | WBAS | 8 | 40.3 (14) | – | – | – | – | – | [116] |
| | Partial suckling | 15 | 97.9 (32) | 16.4 (32) | 4.34 (32) | 5.64 (32) | 5.05 (32) | 927 (32) | [119] |
| Sardi | WBAS | 12 | 57.4 (27) | 21.1 (27) | 8.80 (27) | 5.37 (27) | – | 1370 (27) | [113] |
| | Oxytocin | 10 | 68.5 (31) | – | 8.33 (11) | – | – | – | [110] |
| | WBAS | 8 | 39.4 (12) | – | – | – | – | – | [116] |
| | WBAS | 8 | 61.8 (58) | – | – | – | – | – | [13] |
| | Partial suckling | 15 | 112.7 (32) | 16.9 (32) | 4.64 (32) | 5.76 (32) | 5.13 (32) | 964 (32) | [119] |
| Béni Ahsen | WBAS | 12 | 60.8 (31) | 19.8 (31) | 8.83 (31) | 5.21 (31) | – | 1351 (31) | [113] |
| | WBAS | 14 | 81.0 (16) | – | – | – | – | – | [115] |
| | Oxytocin | 14 | 132.1 (16) | 22.1 (16) | 10.6 (16) | 4.95 (16) | – | 1495 (16) | [115] |
| | WBAS | 10 | 70.9 (16) | – | – | – | – | – | [117] |
| | Oxytocin | 14 | 111.4 (16) | 22.3 (16) | 9.90 (16) | 5.50 (16) | – | 1475 (16) | [117] |
| | WBAS | 10 | 64.4 (30) | – | – | – | – | – | [118] |
| | Oxytocin | 12 | 113.7 (30) | – | – | – | – | – | [118] |

[1]Number of data records in parentheses.
[2]WBAS=Weighing lambs before and after suckling.
[3]Injection of 5 IU of oxytocin at each milking.

**Table 9** Fleece characteristics of Moroccan sheep[1]

| Breed | Fleece weight (kg) | Fineness (spin count) | Fibre length (cm) | Fibre diameter ($\mu$m) | Kemp score (from 0 to 6) | References |
|---|---|---|---|---|---|---|
| D'man | 0.98 (817) | 50.8 (749) | 6.71 (214) | 25.4 (155) | 3.60 (749) | [120] |
| | 0.95 | – | – | – | – | [6] |
| | 1.01 (296) | 48.4 (296) | – | – | 2.32 (296) | [121] |
| | 1.02 (370) | 49.7 (336) | – | 29.4 (32) | 3.68 (336) | [122] |
| Timahdite | 2.13 (320) | 49.4 (303) | 9.64 (75) | 31.6 (116) | 1.82 (303) | [120] |
| | 1.50 (165) | – | – | – | – | [27] |
| | 2.02 (146) | 47.5 (146) | – | – | 1.71 (146) | [121] |
| | 1.90 (237) | 50.1 (210) | – | – | 1.99 (210) | [122] |
| | 1.69 (223) | – | – | – | – | [30] |
| Béni Guil | 1.83 (330) | 53.8 (342) | 7.12 (54) | 26.6 (110) | 1.49 (342) | [120] |
| | 1.75 (162) | 51.0 (162) | – | – | 0.94 (162) | [121] |
| | 1.95 (271) | 53.4 (269) | – | 28.5 (23) | 1.46 (269) | [122] |
| | 1.44 (569) | – | – | – | – | [84] |
| Sardi | 1.84 (961) | 56.2 (872) | 6.43 (166) | 25.3 (195) | 1.49 (872) | [120] |
| | 2.03 (1430) | – | – | – | – | [34] |
| | 1.78 (431) | 53.3 (431) | – | – | 1.04 (431) | [121] |
| | 1.99 (321) | 56.3 (284) | – | 26.5 (16) | 1.76 (284) | [122] |
| Béni Ahsen | 2.64 (176) | 54.3 (167) | – | – | 1.99 (167) | [120] |
| | 2.56 (88) | 49.6 (88) | – | – | 1.78 (88) | [121] |
| | 2.60 (169) | 54.1 (162) | – | – | 1.88 (162) | [122] |
| Boujaâd | 2.04 (81) | 58.1 (116) | 6.15 (117) | 26.2 (72) | 1.40 (117) | [120] |
| | 3.47 (1698) | – | – | – | – | [36] |

[1]Number of data records in parentheses.

Morocco, it is essential to improve their management and to establish selection programmes for their genetic improvement.

## References


1. Boujenane I. Les Ressources Génétiques Ovines au Maroc. Actes Editions, Rabat, Morocco; 1999.
2. MADRPM Enquête Elevage. Effectifs des bovins, ovins et caprins (octobre–novembre 2003). Direction de la Planification et des Affaires Economiques, Rabat, Morocco; June 2004.
3. MADRPM Filière viandes rouges en chiffres. Direction de l'Elevage, Rabat, Morocco; 1998.
4. MADRPM Présentation des résultats du recensement général de l'agriculture de 1996. Direction de la Planification et des Affaires Economiques, Rabat, Morocco; 1998.
5. Ankit M. Evaluation de l'activité sexuelle en périodes de post-partum et de transition vers la saison sexuelle chez des brebis de races D'man, Sardi et leurs produits de croisement. Thèse Doctorat Vétérinaire, I.A.V. Hassan II, Rabat, Morocco; 1992.
6. Arif A. La place actuelle et les voies d'amélioration de la production ovine dans le système de production de la vallée de Draâ. Mémoire 3ème Cycle Agronomie, I.A.V. Hassan II, Rabat, Morocco; 1978.
7. Barki L. Contribution à l'étude de la race D'man. Analyse des structures ovines dans les zones de Goulmima et Jorf. Mémoire de Fin d'Etudes, E.N.A., Meknès, Morocco; 1974.
8. Ben Lakhal M. Interprétation des performances de croissance et de reproduction des ovins de races locales conduites en races pures et en croisement à la Ferme d'Application du Gharb. Mémoire de 3ème Cycle Agronomie, I.A.V Hassan II, Rabat, Morocco; 1983.
9. Ben Lakhal M, Benazzou H, Ezzahiri A. Résultats de sélection des ovins D'man la station ovine de Skoura. Proc. Séminaire sur l'Elevage Ovin D'man, Ouarzazate, Morocco; 1980. p. 47–69.
10. Bouix J, Kadiri M. Un des éléments majeurs de la mise en valeur des palmeraies: la race ovine D'man. Options Méditerranéennes 1975;26:87–93.
11. Bouix J, Kadiri M, Chari A. Performances de la race ovine D'man des palmeraies du Sud Marocain. Al-Awamia 1974;52:47–66.
12. Bouix J, Kadiri M, Chari A. Performances enregistrées dans les troupeaux pépinières de la race ovine D'man. Al-Awamia 1974;52:67–97.
13. Boujenane I, Roudies N, Benmira A, El Idrissi Z, El Aouni M. On-station assessment of performance of the DS synthetic and parental sheep breeds, D'man and Sardi. Small Ruminant Research 2003;49(2):125–33.
14. Boukhliq R. Variations saisonnières de l'âge à la puberté, de la cyclicité sexuelle et de l'anœstrus post-partum chez les brebis de races D'man, Sardi et de leurs produits de croisement. Thèse de Doctorat Vétérinaire, I.A.V. Hassan II, Rabat, Morocco; 1986.
15. Boutgayout, My M. Bilan de reproduction et contrôle de croissance de la race D'man à la SODEA et SOGETA, et la race Sardi à la COMAGRI. Thèse de Doctorat Vétérinaire, I.A.V. Hassan II, Rabat, Morocco; 1980.
16. Chafik A. Analyse génétique de la taille de portée et de ses composantes chez les brebis D'man, Sardi et leurs croisées.

Mémoire 3ème Cycle Agronomie. I.A.V. Hassan II, Rabat, Morocco; 1986.

17. Chami M. Etude de la physiologie de l'anœstrus post-partum chez deux races ovines D'man et Timahdite et leurs produits de croisement. Thèse de Doctorat Vétérinaire, I.A.V. Hassan II, Rabat, Morocco; 1981.

18. Derqaoui L. Onset of puberty and development of reproductive capacity in D'man and Sardi breeds of sheep and their crosses. Doctorat es-Sciences Agronomiques, I.A.V. Hassan II, Rabat, Morocco; 1992.

19. Dolle V, Saidi L. Prospection de l'élevage en palmeraie: Oued Rheriss, Oued Ferkla, Oued Reg et Sud d'Alnif. Etude de l'élevage ovin D'mane de ces palmeraies. Al-Awamia 1980;60:157–220.

20. El Fakir A, El Yamani A, Oudkhir A, Bouzoubaâ K, Derouich A. Performances de reproduction des ovins de la race D'man chez les éleveurs de la vallée de Draâ. Rapport Stage de Développement. I.A.V. Hassan II, Rabat, Morocco; 1979.

21. Harrouni M. Etude de quelques paramètres de reproduction chez la brebis D'man dans son berceau. Thèse Doctorat Vétérinaire, I.A.V. Hassan II, Rabat, Morocco; 1977.

22. Khallouk M. Analyse génétique des performances de reproduction et déterminisme héréditaire de la taille de portée chez la race D'man. Mémoire 3ème Cycle Agronomie, I.A.V. Hassan II, Rabat, Morocco; 1987.

23. Lahlou-Kassi A. Comportement sexuel et fécondité de la brebis D'man hors de son berceau. Proc. Séminaire sur l'Elevage Ovin D'man, Ouarzazate, Morocco; 1980. p. 87–98.

24. Lahlou-Kassi A, Marie M. Sexual and ovarian function of the D'man ewe. In: Land RB, Robinson DW, editors. Genetics of Reproduction in Sheep. Butterworths, London, UK; 1985. p. 245–60.

25. Lahlou-Kassi A, Berger YM, Bradford GE, Boukhliq R, Tibary A, Derqaoui L, *et al.* Performance of D'man and Sardi sheep on accelerated lambing. I. Fertility, litter size, post partum anoestrus and puberty. Small Ruminant Research 1989;2:225–39.

26. Raymond F. Observations sur l'anœstrus post-partum des brebis de race D'man. Hommes, Terre et Eaux 1978;28:45–51.

27. Bouamrani F. L'élevage ovin au Maroc: performances et possibilités de la race ovine 'Timahdite'. Thèse Doctorat Vétérinaire, Ecole Nationale Vétérinaire de Lyon, France; 1977.

28. Bourbouze A. Les troupeaux ovins de race locale de la Ferme d'Application de l'Institut Agronomique et Vétérinaire Hassan II. Bilan des activités de 4 ans. Hommes, Terre Eaux 1974;12:97–110.

29. Marie M, Lahlou-Kassi A. Etude de quelques paramètres de la reproduction des brebis de race Timahdite. Hommes, Terre & Eaux 1977;25:23–9.

30. Masbah A. Projet de standard de la race ovine 'Timahdite'. Mémoire de Fin d'Etudes, E.N.A., Meknès, Morocco; 1973.

31. Raymond F. Observations sur l'anœstrus post-partum des brebis de race Timahdite. Hommes, Terre & Eaux 1979;32:85–93.

32. Boujenane I, Mharchi A. Estimation des paramètres génétiques et phénotypiques des performances de reproduction des brebis de race Beni Guil. Actes de l'Institut Agronomique et Vétérinaire Hassan II (Maroc) 1992;12(4):5–13.

33. Dewulf M, Lahlou-Kassi A. Seasonal sexual activity and post-partum anoestrus in two Moroccan breeds of sheep: Beni Guil and Sardi. Animal Reproduction Science 1986;10:99–104.

34. Chikhi A, Boujenane I. Caractérisation zootechnique des ovins de race Sardi au Maroc. Revue d'Elevage et de Médecine vétérinaire des Pays tropicaux 2003;56(3–4):187–92.

35. Drissi M. L'élevage ovin dans le périmètre irrigué du Tadla: Perspectives et performances de reproduction. Thèse de Doctorat Vétérinaire, I.A.V. Hassan II, Rabat, Morocco; 1983.

36. Chikhi A, Boujenane I. Performances de reproduction et de production des ovins de race Boujaâd au Maroc. Revue d'Elevage et de Médecine vétérinaire des Pays tropicaux 2003;56(1–2):83–8.

37. Bradford GE, Lahlou-Kassi A, Berger YM, Boujenane I, Derqaoui L. Performance of D'man and Sardi sheep on accelerated lambing. II. Ovulation rate and embryo survival. Small Ruminant Research 1989;2:241–52.

38. Benseghir A. Contribution à l'étude de la fonction sexuelle mâle de deux races ovines Marocaines: D'man et Beni Hsen. Thèse Doctorat Vétérinaire, I.A.V. Hassan II, Rabat, Morocco; 1978.

39. Lahlou-Kassi A. Etude comparée de la dynamique folliculaire cyclique chez des brebis haut et bas taux d'ovulation: races D'man et Timahdite. Thèse Doctorat es-Sciences Agronomiques, I.A.V. Hassan II, Rabat, Morocco; 1982.

40. Bennouna K. Caractéristiques démographiques et performances pondérales de la race Sardi dans la région de Guisser. Mémoire 3ème Cycle Agronomie, I.A.V. Hassan II, Rabat, Morocco; 1980.

41. Chaarani B, Robinson RA. Sheep flock productivity and management in Meknès province, Morocco. Small Ruminant Research 1992;8:1–12.

42. Dkhiss M. Introduction de l'œstrus à contre saison chez la brebis à l'aide d'implants de progestérone. Thèse de Doctorat Vétérinaire, I.A.V. Hassan II, Rabat, Morocco; 1978.

43. El Garmai A. Les contraintes au système d'élevage ovin dans la Commune Rurale de Ain Beni Mathar (Oriental). Mémoire 3ème Cycle Agronomie, I.A.V. Hassan II, Rabat, Morocco; 1989.

44. Boujenane I, Boudiab A, El Aich A. Performances de production des races ovines locales marocaines. Actes de l'Institut Agronomique et Vétérinaire Hassan II (Maroc) 1982; 2:24–48.

45. Behba A. Estimation de la production laitière des brebis des brebis D'man 'Méthode à l'ocytocine'. Mémoire de Fin d'Etudes, E.N.A., Meknès, Morocco; 1975.

46. Ben Ahmed S. Evaluation des performances de croissance et de reproduction de la race ovine D'man en station et dans d'autres élevages des vallées Draâ et Dadès. Mémoire 3ème Cycle Agronomie, I.A.V. Hassan II, Rabat, Morocco; 1991.

47. Benjelloun O. Schéma de sélection de la race ovine D'man dans les vallées de Draa et Dadès. Mémoire 3ème Cycle Agronomie, I.A.V Hassan II, Rabat, Morocco; 1994.

48. Ben-Ouardi K. Evaluation des performances de croissance et de reproduction de la race D'man au niveau des noyaux de sélection de Skoura et de Tinzouline. Mémoire 3ème Cycle Agronomie, I.A.V Hassan II, Rabat, Morocco; 1995.

49. Boujenane I, Bradford GE. Genetic effects on ewe productivity of crossing D'man and Sardi breeds of sheep. Journal of Animal Science 1991;69:525–30.

50. Boujenane I, Kansari J. Lamb production and its components from purebred and crossbred mating types. Small Ruminant Research 2002;43(2):115–20.

51. Boujenane I, Bradford GE, Famula TR. Inheritance of litter size and its components in crosses between the D'man and Sardi breeds of sheep. Journal of Animal Science 1991;69:517–24.

52. Boujenane I, Kerfal M, Khallouk M. Genetic and phenotypic parameters for litter traits of D'man ewes. Animal Production 1991;52:127–32.

53. Boujenane I, Chafik A, Benbihi M. Heterosis retained in different generations of inter se mating between D'man and Sardi sheep. Journal of Animal Breeding and Genetics 1999;116:151–9.

54. Bourfia M, Touchberry RW. Diallel cross of three Moroccan breeds of sheep. II. Reproductive performance and productivity of pure breed ewes. Journal of Animal Science 1993;71:882–7.

55. Chakir M. Schéma de sélection de la race ovine D'man dans les vallées de Draa et Dadès. Mémoire 3ème Cycle Agronomie. I.A.V. Hassan II, Rabat, Morocco; 1994.

56. El Fadili M, Michaux C, Detilleux J, Leroy PL. Comparison of five crossbreeding types involving Timahdit, D'man and improved terminal sire breeds of sheep: ewe reproduction, lamb survival and growth performance. Animal Science 2000;71:435–41.

57. Ellouzi C. Etude de la reproduction et de la croissance de trois races ovines marocaines et de leurs croisées. Mémoire 3ème Cycle Agronomie, I.A.V. Hassan II, Rabat, Morocco; 1988.

58. Lahlou-Kassi A. Seasonal variation in oestrus and ovarian activity of two Moroccan breeds: D'man and Timahdite. Proceedings of 9th International Congress of Animal Reproduction and Artificial Insemination, Madrid, Spain; 1980.

59. Lahlou-Kassi A, Marie M. A note on ovulation rate and embryonic survival in D'man ewes. Animal Production 1981;32:227–9.

60. Lahlou-Kassi A, Schams D, Glatzel P. Plasma gonadotrophin concentrations during the oestrous cycle and after ovariectomy in two breeds of sheep with low and high fecundity. Journal of Reproduction and Fertility 1984;70:165–73.

61. Lamraoui A. Bilan de croissance et de reproduction des ovins de races locales de la Ferme d'Application du Gharb. Thèse de Doctorat Vétérinaire, I.A.V. Hassan II, Rabat, Morocco; 1979.

62. Nacir O. Estimation des paramètres génétiques des performances de reproduction et de croissance chez les races D'man et Sardi. Mémoire 3ème Cycle Agronomie, I.A.V. Hassan II, Rabat, Morocco; 1987.

63. Arbaoui MS. Production laitière et croissance des agneaux de brebis Timahdite. Mémoire de Fin d'Etudes, E.N.A., Meknès, Morocco; 1980.

64. Asrary M. Analyse des performances et évaluation génétique des ovins de race Timahdite dans les UREO de la SNDE et les troupeaux de sélection. Mémoire 3ème Cycle Agronomie, I.A.V. Hassan II, Rabat, Morocco; 1992.

65. Boujenane I, Berrada D, Mihi S, Jamai M. Reproductive performance of ewes and preweaning growth of lambs from three native Moroccan breeds mated to rams from Moroccan and improved breeds. Small Ruminant Research 1998;27:203–8.

66. Chouli A, Oukelmoun M. Contribution à l'étude de croissance et des carcasses des races ovines marocaines conduites en races pures et en croisement. Mémoire 3ème Cycle Agronomie, I.A.V. Hassan II, Rabat, Morocco; 1983.

67. El Kihal E. Analyse des performances de croissance et de reproduction chez la race Timahdite à l'UREO de Sidi Aissa. Mémoire 3ème Cycle Agronomie, I.A.V. Hassan II, Rabat, Morocco; 1990.

68. Tijani A. Analyse des performances de croissance et de reproduction chez les ovins de race Timahdite dans l'UREO de Sidi Aissa et les troupeaux de sélection. Mémoire 3ème Cycle Agronomie, I.A.V. Hassan II, Rabat, Morocco; 1990.

69. Boujenane I, Chami A. Effects of inbreeding on reproduction, weights and survival of Sardi and Beni Guil sheep. Journal of Animal Breeding and Genetics 1997;114:23–31.

70. Chaira W. Amélioration de la productivité de la brebis Béni Guil par apport du sang D'man. Productivité de la brebis Béni Guil pure et des brebis F1, F2 et F3 issues du croisement D'man×Béni Guil. Mémoire 3ème Cycle Agronomie. I.A.V. Hassan II, Rabat, Morocco; 1994.

71. Dennoun S. Amélioration des productions de la race Beni Guil par utilisation du croisement avec la race D'man. Mémoire 3ème Cycle Agronomie, I.A.V. Hassan II, Rabat, Morocco; 1993.

72. Laghlabi M. Etude des performances de la race Sardi à la Ferme de Sélection Ovine des Kra Kra. Impact de cette ferme sur l'amélioration de la race. Mémoire 3ème Cycle Agronomie, I.A.V. Hassan II, Rabat, Morocco; 1980.

73. Lanaia R. Détermination et correction des effets des facteurs non génétiques influençant les performances des ovins de race Sardi des troupeaux encadrés par l'ANOC Mémoire de 3ème Cycle Agronomie, I.A.V. Hassan II, Rabat, Morocco; 1995.

74. Boujenane I. Rapport de la convention No. 4332 DE/DPA/SAG relative à l'analyse des données du contrôle de performances. MAMVA – I.A.V. Hassan II, Rabat, Morocco; 1995.

75. Chentouf M, Boulanouar B. Conduite de la reproduction des ovins dans une zone semi-aride du Maroc. EAAP Publication 2000;94:255–9.

76. Boujenane I. Inheritance of reproduction traits in crosses between the D'man and Sardi breeds of sheep. Ph.D. Dissertation. University of California, Davis, USA; 1989.

77. Boujenane I, Chafik A, Bradford GE, Berger YM. Taille de portée et ses composantes chez les brebis D'man, Sardi et D'man x Sardi. 3ème Congrès Mondial

de Reproduction et Sélection des Ovins et Bovins à Viande 1988;2:657–60.

78. Boujenane I, Khallouk M, Kerfal M. Paramètres génétiques des performances de reproduction des brebis de race D'man. 3ème Congrès Mondial de Reproduction et Sélection des Ovins et Bovins à Viande 1988;2:653–6.

79. Chafik A. Effets d'hétérosis sur les performances des ovins de différentes générations du croisement entre les races D'man et Sardi. Thèse de Doctorat es-Sciences, Université Chouaib Doukkali, El Jadida, Morocco; 1994.

80. Benbihi M. Analyse des performances des ovins de différentes générations de croisement entre les races D'man et Sardi. Mémoire de 3ème Cycle Agronomie, I.A.V. Hassan II, Rabat, Morocco; 1994.

81. Ezzahiri A, Benazzou H, Ben Lakhal M. Premier bilan de la vulgarisation des géniteurs D'man. Proc. Séminaire sur l'Elevage Ovin D'man, Ouarzazate, Morocco; 1980. p. 70–80.

82. Kerfal M, Lberji A. Potentiel de reproduction et de croissance de la race ovine D'man. In: Boulanouar B, Matthess-Guerrero A, Morkramer G, editors. Rapport Annuel 1996, INRA Maroc- Programme Viandes Rouges, Rabat, Morocco; 1997. p. 74–83.

83. Bourfia M, Benlekhal A, Essaadi A. Increasing sheep production through litter size in a Moroccan harsh environment. Options Méditerranéennes, Série A 1997;33:175–80.

84. Mharchi A. Analyse génétique des performances de reproduction et de production des ovins de race Beni Guil à la Ferme de Sélection Ovine d'Oued Isly à Oujda. Mémoire 3ème Cycle Agronomie, I.A.V. Hassan II, Rabat, Morocco; 1991.

85. Boujenane I, Bradford GE, Berger YM, Chikhi A. Genetic and environmental effects on growth to one year and viability of lambs from a crossbreeding study of D'man and Sardi breeds. Journal of Animal Science 1991;69:3989–98.

86. Chikhi A. Interprétation des performances de croissance et de mortalité des ovins de races D'man, Sardi et leurs croisées. Mémoire 3ème Cycle Agronomie, I.A.V. Hassan II, Rabat, Morocco; 1986.

87. Kerfal M. Etude du potentiel de la race ovine D'man. Travail présenté en vue de l'obtention du grade d'Ingénieur en Chef, INRA, Rabat, Morocco; 1995.

88. Boujenane I, Mharchi A. Estimation des paramètres génétiques et phénotypiques des performances de croissance des agneaux de race Beni Guil. Actes de l'Institut Agronomique et Vétérinaire Hassan II (Maroc) 1992;12(4):15–22.

89. M'Zian S. Analyse génétique des performances de croissance et de reproduction de la race Sardi à la Ferme de sélection ovine de Kra-Kra. Mémoire de 3ème Cycle Agronomie, I.A.V. Hassan II, Rabat, Morocco; 1994.

90. Berger YM, Bradford GE, Essaadi A, Johnson DW, Bourfia M, Lahlou-Kassi A. Performance of D'man and Sardi sheep on accelerated lambing. III. Lamb mortality, growth and production per ewe. Small Ruminant Research 1989;2:307–21.

91. Analla M. Analyse des performances de croissance des agneaux des races Sardi, D'man et Beni Guil et leurs croisés. Mémoire 3ème Cycle Agronomie, I.A.V. Hassan II, Rabat, Morocco; 1987.

92. Boujenane I, Kerfal M. Estimates of genetic and phenotypic parameters for growth traits of D'man lambs. Animal Production 1990;51:173–8.

93. Bourfia M, Touchberry RW. Diallel cross of three Moroccan breeds of sheep: I. Lamb growth and carcass traits. Journal of Animal Science 1993;71:870–81.

94. Echiguer M. Croissance post-sevrage et caractères d'abattage des agneaux D'man et Beni Guil. Mémoire 3ème Cycle Agronomie, I.A.V. Hassan II, Rabat, Morocco; 1988.

95. Aït-Bihi N, Boujenane I. Contrôle de performances des ovins en milieu difficile: Cas du Maroc. Options Méditerranéennes A 1997;33:67–72.

96. Boujenane I, Kansari J. Estimates of (co)variances due to direct and maternal effects for body weights of Timahdite sheep. Animal Science 2002;74(3):409–14.

97. El Fadili M. Croissance avant et post-sevrage et performances d'abattage des agneaux de pères Timahdit, Sardi, Mérinos Précoce et D'man. Al-Awamia 1995;91:71–81.

98. El Fadili M, Michaux C, Boulanouar B, Leroy PL. Environmental and genetic effects on growth in Timahdite and crossbred lambs in Morocco. Revue d'Élevage et de Médecine vétérinaire des Pays tropicaux 2000;53(1):75–83.

99. El Fadili M, Michaux C, Detilleux J, Leroy PL. Genetic parameters for growth traits of the Moroccan Timahdit breed of sheep. Small Ruminant Research 2000;37:203–8.

100. Sessouki K. Etude génétique des performances de croissance des ovins Béni Guil encadrés par l'ANOC. Mémoire de 3ème Cycle Agronomie, E.N.A., de Meknès, Morocco; 2003.

101. Boujenane I, M'Zian S, Sadik M. Estimation des paramètres génétiques et phénotypiques des caractères de croissance des ovins Sardi. Actes de l'Institut Agronomique et Vétérinaire Hassan II (Maroc) 2001;21(3):177–83.

102. Chikhi A. Caractérisation des ovins de race Boujaâd en station et chez les éleveurs sélectionneurs. Doctorat es-Sciences Agronomiques, I.A.V. Hassan II, Rabat, Morocco; 2002.

103. Boujenane I. The D'man. In: Fahmy MH, editor. Prolific Sheep. CABI Publishing, Wallingford, UK; 1996. p. 109–20.

104. Boujenane I, Araba A, Bradford GE. Croissance post-sevrage et caractères de carcasses des agneaux de races D'man et Sardi et leurs croisés avec les races à viande. 41ème Réunion Annuelle de la F.E.Z., Toulouse, France; 1990. p. 1–15.

105. El Fadili M, Michaux C, Detilleux J, Leroy PL. Evaluation of fattening performances and carcass characteristics of purebred, first and second cross lambs between Moroccan Timahdite, D'man and improved meat rams. Animal Science 2001;72:251–7.

106. Boujenane I, Berrada D, Mihi S, Jamaï M. Performances d'engraissement et caractéristiques des carcasses d'agneaux issus du croisement des brebis de races Timahdite, Sardi et Béni Guil avec des béliers de races à viande (Fattening performance and carcass characteristics of crossbred lambs from ewes of Timahdite, Sardi and Béni Guil breeds and meat-type rams). Actes de l'Institut Agronomique et Vétérinaire Hassan II (Maroc) 1996;16:29–38.

107. Asserrhine M. Production laitière des brebis D'man et Timahdite conduites en race pure ou en croisement et croissance des agneaux produits. Mémoire 3ème Cycle Agronomie, I.A.V. Hassan II, Rabat, Morocco; 1984.

108. Bendaoud M. Influence d'une insuffisance énergétique en fin de gestation sur les performances d'agnelage de la brebis D'man. Mémoire de Fin d'Etudes, E.N.A., Meknès, Morocco; 1976.

109. Boujenane I, Kerfal M. Estimation de la production laitière des brebis D'man. Al Awamia 1992;78:145–55.

110. Boujenane I, Lairini K. Milk production and percentage fat of D'man, Sardi and crossbred ewes. Small Ruminant Research 1992;8:207–15.

111. El Maarouf MA. Production laitière des brebis D'man pures et croisées et croissance de leurs agneaux. Mémoire 3ème Cycle Agronomie, I.A.V. Hassan II, Rabat, Morocco; 1986.

112. Barkok A. Contribution à l'étude quantitative et qualitative du lait de la brebis de race Timahdite. Mémoire de Fin d'Etudes, E.N.A., Meknès, Morocco; 1973.

113. Battar M. Utilisation des béliers Sardi et Beni Guil sur les brebis Timahdite, Beni Hsen, Sardi et Beni Guil. Etude de la production laitière des brebis en relation avec la croissance de leurs agneaux. Mémoire 3ème Cycle Agronomie, I.A.V. Hassan II, Rabat, Morocco; 1983.

114. Benoudifa M. Production et composition du lait des brebis Timahdite. Mémoire de Fin d'Etudes, E.N.A., Meknès, Morocco; 1980.

115. Bouiala M. Etude de la production laitière et de la croissance des agneaux chez les races Timahdite et Beni Hsen. Mémoire 3ème Cycle Agronomie, I.A.V. Hassan II, Rabat, Morocco; 1977.

116. Boujenane I, Berrada D, Mihi S, Jamaï M. Production laitière des brebis de races Timahdite, Sardi et Béni Guil en race pure et en croisement (Milk production of Timahdite, Sardi and Béni Guil ewes in purebreeding and crossbreeding). Actes de l'Institut Agronomique et Vétérinaire Hassan II (Maroc) 1996;16:11–8.

117. Kabbali A. Etude de la production laitière et de la croissance des agneaux des brebis Timahdite et Beni Hsen. Mémoire 3ème Cycle Agronomie, I.A.V. Hassan II, Rabat, Morocco; 1976.

118. Zari Y. Bilan de trois années d'essai sur la production laitière des brebis Timahdite et Beni Hsen. Mise en place d'un contrôle de croissance des agneaux dans la région de Moghrane. Mémoire 3ème Cycle Agronomie, I.A.V. Hassan II, Rabat, Morocco; 1979.

119. Sefiani M. La productivité laitière et l'aptitude à la traite des races ovines Sardi et Beni Guil. Mémoire 3ème Cycle Agronomie, I.A.V. Hassan II, Rabat, Morocco; 1980.

120. Abdelali A. Contribution à l'estimation des facteurs de correction des effets du milieu pour les caractères lainiers. Mémoire 3ème Cycle Agronomie, I.A.V. Hassan II, Rabat, Morocco; 1988.

121. El Hmamsi M. Caractéristiques lainières des races ovines locales et de leurs croisés aux Fermes d'Application du Gharb et du Tadla. Mémoire 3ème Cycle Agronomie, I.A.V. Hassan II, Rabat, Morocco; 1986.

122. Laidouni MS. Etude des caractéristiques de laine des principales races ovines locales et de leurs croisés. Mémoire 3ème Cycle Agronomie, I.A.V. Hassan II, Rabat, Morocco; 1986.