
D'man sheep breeding programme in Morocco

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D'man is an important sheep breed of Morocco. It acquires its importance from its exceptional reproductive performances and its high adaptation to the oasian environment. The D'man is known as one of the most prolific sheep breeds in the world (2.2) and one that does not exhibit seasonal anestrus. It is a small sheep with a fine bone structure and a narrow head. Females are characterised by a slightly curved profile. Rams present a convex profile and sometimes a skin fold on the forehead. Presence of horns is an undesirable trait in this breed. The legs of D'man breed are slender and often defective because the animals are raised in confinement, which makes them unsuitable for extensive management on rangeland. The fleece is coarse in texture and of various combinations of one, two or three colours: black, brown or white. Mature ewes and rams are 30-45 kg and 50-70 kg, respectively (Boujnane, 1996).

There are approximately 240 000 head of D'man sheep in Morocco (Ait Hroch *et al.*, 1997; Benlakhhal and Ben Ouardi, 1997). They are found mainly south of the Atlas Mountains in the Draa, Dadès, Ziz and Ghériss valleys. D'man sheep are an essential component of the oasian farming system in Morocco. They convert oasian forages (alfalfa and grasses) and by-products (straw, culled dates and ground date pits) to meat for home consumption (42.5 percent) and cash (Khier, 1987). They also provide manure for intensive oasian agriculture. Herd size in the traditional D'man farm (0.8 hectare) is around ten head (three to four ewes). This size varies with forage availability. Prolificacy and year round breeding constitute important adaptation traits allowing high flexibility and potentially rapid herd increase.

Traditional husbandry of the D'man sheep in Morocco is characterised by low input and minimal attention to flock management. The typical situation of a flock found in the oasian farms is characterised by:

- inadequate barns with no separation between animal categories;
- inadequate nutrition;
- year-round lambing (no grouping);
- frequent mating between related animals;
- young age (< 8 months) and low weight of ewes at first lambing.

Introduction

D'man traditional husbandry

These management practices lead to depressed fertility, high lamb mortality and low growth rates (Darfaoui, 1992).

Developmental history and future strategy

Efforts to improve the management of this breed were started in the late 1970s by INRA (*Institut National de la Recherche Agronomique*) and continued by the same agency along with the two regional agencies for agricultural development in Tafilalet and Ouarzazate (ORMVA: *Office Régional de Mise en Valeur Agricole*). The agronomic and Veterinary Institute Hassan II (IAV Hassan II, Rabat) and the National Agriculture School of Meknes also contributed through research.

Early experimental phase

The first D'man breeding programme was initiated by INRA in the early 1970s (Bouix and Kadiri, 1975). It concerned three herds composed of animals purchased from the region and gathered in three research stations. INRA aimed to conserve the D'man breed, which seemed threatened by droughts and mismanagement and to evaluate its performance under improved management. Selection programmes were initiated in the three stations with the objective of maintaining ewes' prolificacy rate at high levels and increasing lamb growth rate at least to the level of the remaining national breeds. Experimental animals were eartagged and their sires, dams and birth dates were recorded as well as lambs' birth weight and weights at standard ages (10, 30 and 90 days weaning age). These data were utilised for selection, but no adjustments for environmental factors were made.

Results of early experiments showed that with improved nutrition, housing and reproduction, D'man prolificacy was increased from 1.66 to 2.16. In addition, daily weight gain of lambs between ten and 30 days of age and between 30 and 90 days increased from 155 to 175 g and from 145 to 167 g, respectively. Animals produced during that early period by the INRA and the Sekoura station, established in 1972 by the ORMVA of Ouarzazate as a nucleus of a future breeding programme (ORMVAO, 1981), were distributed to selected farmers at a subsidised price. Evaluation of the impact of this action showed an improvement in the prolificacy of traditionally managed ewes (Table 1). The impact of the operation on animal weight gain, however, was not evaluated. Important extension and feed subsidy efforts were invested by ORMVA to improve management of the flocks with distributed animals. Since no genetic gain estimates were made, it is impossible to separate the portion of the increase in the phenotypic traits attributed to genetics and that to the environment. Nevertheless, the positive outcome of this first experimental phase captured the attention of the Ministry of Agriculture and its agencies, as well as interested farmers. The D'man sheep had shown promising production potential, but needed further research and development.

Table 1. Improvement of traditional flock prolificacy as a result of the introduction of improved animals.

Herd category	Prolificacy
Improved herd	2.16 - 2.31
Traditionally managed herds including improved animals	1.91 - 2.00
Traditionally managed herds	1.23 - 1.67

Source: ORMVAO (1981)

Beginning in the mid 1980s, the National Sheep Development Plan (*Plan Moutonier*) designated pure-breed husbandry regions and allocated regions for cross-breeding programmes. D'man straight-breeding plans were adopted in both the Draa and Ziz valleys. Cross-breeding experiments were then started by INRA and the Agronomic and Veterinary Institute (IAV Hassan II) in different stations on the west coast and in the Tadla region.

A three-strata plan was adopted in each of the Draa and Ziz valleys in 1986. Each plan was composed of a nucleus, a group of elite-animal multipliers, and the remaining D'man raisers (Figure 1). One association of 70 farmers and six cooperatives composed of a total of 240 adherents, were founded in the Draa and Ziz valleys, respectively. These farmers were organized to establish groups of multipliers of the elite animals produced in the three stations belonging to INRA, the ORMVA of Tafilalet (for the Ziz valley) and the ORMVA of Ouarzazate (for the Draa valley). Cooperative and association adherents were chosen among farmers who were the most open to innovation, had consented to build adequate barns, and most willing to manage their herds according to extension technicians advice. Each cooperative and association group (eight groups) was assigned one technician to monitor their livestock, take records and provide necessary advice. In each of the valleys an engineer (master level) was in charge of the programme and coordinated the work. Improved animals produced by multipliers were to be disseminated to the rest of the non-organized farms. The approach adopted in both valleys for D'man sheep genetic improvement was similar, however, there was very little collaboration between the agencies involved and no exchange of animals between nuclei or among multipliers of the two valleys. Movements of animals took place only within each valley and mainly downward (Figure 1). Association and cooperative adherents within each valley were, however, encouraged to exchange selected animals.

Initiation of a straight-breeding programme in the oasian system

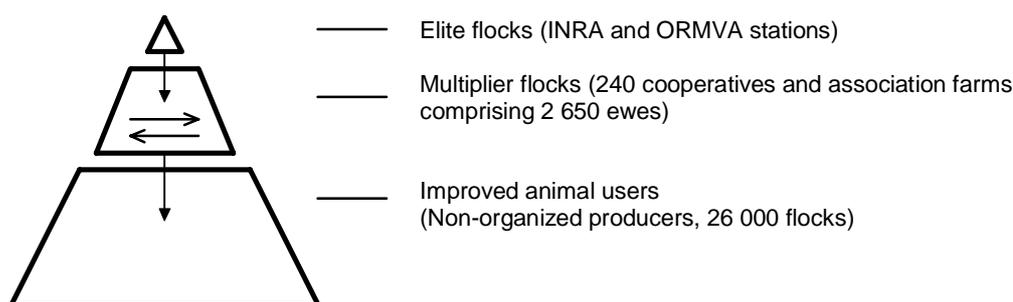


Figure 1. Structure of D'man sheep straight-breeding scheme.

This breeding plan was conducted between 1986 and 1994. Cooperative and Association breeders produced a large number of rams and ewes during that period (12 672). Selection was aimed to improve prolificacy and weight at 180 days and to eliminate horns. In practice, animals were eartagged and selected based on dam prolificacy, phenotype and conformation. There were several attempts to keep weight records for a more accurate selection, at least on the most advanced farms, but the task was difficult and was never done on a regular basis. At the station level, however, selection was carried out on the basis of dam's performance and individual standard weights. No adjustments were made for environmental factors.

A diagnosis of the situation performed by the ORMVA of Tafilalet in collaboration with the INRA and GTZ (Ait Hroch *et al.*, 1997), showed improvement in the D'man performance in cooperative herds (Table 2). Herds of non-organized producers, however, continue to record lower prolificacy and lower growth rates (Table 2). The increase recorded in performance of nuclei and multiplier flocks is due both to genetic progress and improvement in management. To date, attempts have been made to estimate the genetic gains in these animals.

Table 2. Performances of D'man sheep at different levels of the breeding plan.

Parameter	Station flocks	Co-operative flocks	Non-organized flocks
Lambing interval (days)	240	210	250
Fertility rate (%)	95	92	86 - 97
Young Mortality rate (%)	9	12	16 - 25
Prolificacy (%)	227	212	153 - 186
Weaning weight (kg live weight)	20	14	10

This phase of establishment of the straight-breeding programme resulted in increased interest among farmers as well as public agencies and national professional associations such as the ANOC (*Association Nationale Ovine et Caprine*) in D'man sheep breeding. Until 1994 elite animals were produced in the three stations in both valleys. After that date, the ORMVA of Tafilalet closed its station for managerial reasons and the ORMVA of Ouarzazate transferred its station to be managed by the Draa valley D'man Breeders Association. At the present time only two stations (nuclei) continue to exist, the INRA station in the Ziz valley and the Sekoura station in the Draa valley. Each station raises approximately 80 to a 100 ewes. As a result of this first phase, multipliers in both valleys evolved in three different categories. The first category consists of farmers (10 percent) who specialise in D'man breeding and who raise between 30 and 70 ewes per flock. An intermediate category consists of farmers who raise ten to 30 ewes. The third category (50 percent) consists of farmers who continue to adhere to a cooperative or to an association to benefit from subsidised feed, but for diverse reasons (i.e. insufficient funds, unavailability of space to build a barn) never succeeded in initiating selection in their small flocks.

A drawback in the programme was that the non-organized farmers, who represented more than 90 percent of the D'man sheep raisers, continued to be ignored by the development agencies and benefited very little from animals produced by multipliers. The lack of concern for these non-organized farmers has been the most significant weakness in the D'man sheep breeding and development programme implementation to date. According to the Agricultural Investment Code, selected and subsidised rams and ewes are raised at least four years by their producers (multipliers) or sold to other farmers. However, most of the improved animals ended up at the slaughterhouse or as a sacrifice on the Aid Al Adha (Moslem holiday) instead of improving non-organized farmers' flocks. No monitoring was conducted to determine the proportion of these animals maintained at the multiplier level or that disseminated, as initially planned, in the non-organized farms.

The *Association Nationale Ovine et Caprine* (ANOC), created in 1967, is a non-governmental organization in charge of organizing sheep and goat genetic improvement programmes and contributing to the development of the sheep and goat industry at national level in Morocco. In 1997 the ANOC was monitoring 27 groups composed of 1 500 sheep and goat producers. The total number of sheep raised by the ANOC breeders was approximately 550 000 head (307 400 ewes), belonging to six national breeds (Timahdit, Beni Guil, Sardi, Boujaad, Beni Hassan and D'man). The work of the ANOC with goats is in its inception. Only 80 goat breeders raising 2 000 does, associated in two groups, were monitored by the Association at the end of 1997 (ANOC, 1997).

Intervention of the ANOC

Interest by the ANOC in D'man sheep started in 1994. Before that date, small herds of D'man represented little potential in the eyes of this Association. The results of the development work accomplished by the ORMVA agencies and the INRA lead to the appearance of farmers specialised in D'man sheep breeding and to the emergence of flocks of medium size (ten to 60 ewes). Both factors encouraged ANOC to start a selection programme in the largest and best managed herds (45 in the Ziz valley and 15 in the Draa valley). The ANOC objectives for this programme were to produce highly performing rams and ewes for increasing meat production in the oasis system and to augment prolificacy in the cross-breeding programmes. ANOC organized two groups, one in each valley. The two groups consisted of 135 producers. ANOC now carries out selection in 60 of the herds adhering to its programme based on the same criteria as previous ORMVA agencies. The same number of animals are selected and subsidised each year. It is important to note that ANOC's involvement in the breeding programme has initiated exchanges of animals among breeders in the two valleys. The exchanges are most prevalent at the multiplier category level. ANOC has today become a part of the D'man sheep straight-breeding structure that continues to run with a slightly increased efficiency than before. It has chosen to invest its efforts in selection, leaving ORMVA agencies and INRA to concentrate on improving flock management on the farms, diffusing the genetic progress within the base flocks and conducting research programmes.

ANOC also plans to establish a multi nucleus breeding system by producing elite animals in the most advanced flocks on the basis of indexes expressing the combination of dam lifetime performance and individual lamb performance. For this reason ANOC technicians have recently started keeping more accurate and regular weight records in five flocks in the Draa valley and five flocks in the Ziz valley. ANOC feels that this work is necessary and that nuclei flocks should be managed by private farmers as is the case for the other national sheep breeds.

Financial support and policy development

Several agencies have contributed to the financial support of the D'man sheep breeding programme, including the Ministry of Agriculture, via ANOC, ORMVA of Tafilalet, ORMVA of Ouarzazate, INRA and ANOC. Funding comes from a Government budget, NGOs (ANOC) or through loans facilitated by International funding institutions to local or national agencies. Additional investments are needed to ensure for continuous development of the D'man breeding sector. Better coordination among participating agencies and institutions to make the best use of available funds will provide improved opportunities for more achievements.

Encouragement for selection has been accomplished by subsidies offered by the Agricultural Investment Code (CIA: *Code des Investissements Agricoles*). Until 1988 financial assistance amounted to Dh150.00 per head (males and females alike), but was only offered to winning animals in a

few organized competitions. Important subsidies were, however, offered for purchasing genetically improved animals. These subsidies accounted for 30 to 35 percent of the price of the sheep, males and females, purchased respectively, by individual farmers or cooperative members. These percentages were 20 and 35 percent for goats. In all cases, the CIA fixed maximum financial assistance to Dh 1 500 per small ruminant. After 1988 the legislature directed financial assistance to encourage production of genetically improved animals instead of their purchase. Now the CIA offers Dh 700 and Dh 500, respectively, for rams and ewes produced by breeders in cooperatives and Dh 450 and Dh 400 for those not belonging to a cooperative (Dh 1.00 = US\$0.10). This substantial subsidy of the production of selected animals, in addition to a subsidy of 50 percent of the price of the most concentrate feeds and/or total payment to the breeders for transport, led to an increase in the number of farmers joining cooperatives and associations (from 310 to 520) and to an improvement in their flock management.

The primary reasons for introducing the currently adopted D'man sheep breeding scheme were to preserve and develop the breed and to valorise the improved animals initially produced in the public stations. For the designers of the scheme, the best approach to achieve these goals was to multiply the already improved animals in organized farms and disseminate them into mass flocks. The existence of the two regional agencies for agricultural development facilitated the initiation of the breeding scheme. ORMVAs are governmental entities endowed with financial autonomy and benefit from important funds and qualified staff. Since being implemented, the programme has been maintained by organized breeders who find it profitable and by Government agencies and NGOs convinced that D'man sheep can contribute more significantly in regional as well as national food security.

D'man flock size in the traditional oasian farm is small. This feature is a handicap to the sector's development, especially to selection. However, many producers have been willing to increase their flock size and to adopt D'man breeding as their primary activity. Financial assistance has helped make the operation economically beneficial, but few breeders chose to continue the genetic improvement of their flocks without presenting their animals to the selection committee. These producers realised that they could earn more money selling their animals at younger ages than keeping them a whole year to receive the benefit from the financial assistance. With proper management, the D'man straight-breeding scheme seems acceptable to all breeder categories, but more effort is needed to expand its benefits to the base flocks.

Selected breeding scheme and its maintenance

Future perspectives

At this stage, it is necessary to evaluate the scheme and its strategy of implementation, starting from the choice of the traits on which to apply selection. For instance, instead of selecting ewes on their own litter size and lambs on the average litter size at birth of their dams, selection on the basis of the number of lambs weaned per ewe could be more profitable. The number of lambs weaned per ewe is determined not only by litter size at birth, but also by fertility, number born and also viability, as this latter parameter is generally high and variable in this breed. Selection for liveweight at 90 days, instead of 180 days was shown by Boujnane and Kerfal (1990) to have a large effect on other growth traits as a result of their high positive genetic correlation. Estimates of genetic gains must be isolated from environmental ones, especially at the nucleus level in order to evaluate the genetic progress achieved by selection. Estimating genetic gains at the multiplier flock level may be more difficult to achieve, due to the great variability in their management practices and to the difficulties to maintain accurate and regular records. It could be initiated in a second phase.

The present two nuclei system (one in each valley), is probably more effective than a numerous nuclei system, preferred by ANOC. The two nuclei will be easier to control. The base flock in both valleys does not exceed about 80 000 ewes and therefore does not require multiple nuclei to produce the necessary number of rams. The two nuclei could be managed by private breeders, with the Government providing monitoring assistance at least for the next decade, until the system can be maintained independently.

Since the start of the programme and to maximise the breeders' benefits from selection subsidy, the national sheep selection committee, composed of ANOC, INRA and Government agents (ORMVAs in the case of D'man), has been maximising the number of selected animals. It is time to select fewer genetically high quality animals and make sure they benefit from the breeding programme. It is time to think about organizing the so called non-organized farmers into genetically-improved-animals-users associations. The main constraints that have limited any progress in this category of flocks is their small size. It is easier to start by organizing farmers owning at least four to five ewes to ensure that the activity is meaningful to the farmer and that he is ready to invest some time and money to improve his flock productivity. These associations will help use improved rams in a collective manner, which will require lambing grouping and will consolidate their efforts to benefit from better feed and product marketing prices. Their organization will also help them gain more technical assistance from specialised agencies.

Before 1988, the Government subsidised the purchase of genetically improved animals, now, it encourages their production. It is time to think about reintroducing some kind of encouragement for improved animal users, especially sheep and goats. Such a change will assure the proper

dissemination of the genetic progress achieved in nuclei and multiplier flocks. To ensure the success of the plan, important consideration should be given to human resources. Training of the staff involved in this programme as well as the breeders and their assistants is necessary to achieve the fixed goals. Engineers and technicians require more knowledge in animal genetic improvement and electronic data processing, whereas breeders and their assistants could benefit from training on proper flock management and record keeping.

Based on work at several sheep research stations in the country, it was concluded that the D'man breed transmits its high prolificacy in an additive fashion in crosses with a less prolific breed (Table 3). Therefore, by varying the proportion of D'man inheritance, it is possible to set mean litter size at any desired level between that of non prolific breed (1.0) and that of the D'man (2.2). Furthermore, D'man also seems to transmit its early puberty, high fertility and long breeding season in a dominant fashion, resulting in cross-bred ewe performance in the traits superior to that of other local breeds, Sardi, Timahdit or Beni Guil sheep breeds (Bourfia, 1986; Boujnane *et al.*, 1991; El Fadili and Leroy, 1997).

Several two-breed (one-step) or three-breed (two-step) crossing programmes involving the D'man and one of the major local breeds (Timahdit, Sardi, Beni Guil), in addition to a meat ram (Ile de France, Mernos Precosse or Causses du Lot) as a terminal sire have been tested in research stations. In general, results have been promising (Table 3). Use of D'man sheep in cross-breeding to increase litter size in the private industry are practised in many cereal/sheep farming areas in Morocco. However, data are lacking on the number of these farms, their cross-breeding plans or performance achievements.

Cross-breeding plans

Table 3. Prolificacy of D'man cross breeds.

Author	Cross breed	Prolificacy
- Boujnane <i>et al</i> , 1982	F ₁ (D'man * Sardi)	155
- Benlakhhal, 1983	F ₁ (D'man * Timahdit)	146
- Chafik, 1986	¾D'man * ¼ Sardi	179
	F ₁ (D'man * Sardi)	155
- Chemsy, 1988	¾D'man * Beni Guil	166
	F ₁ (D'man * Sardi)	171
- El Fadili and Leroy, 1997	TS* * F ₁ (D'man * Sardi)	163
	TS * F ₁ (D'man * Timahdit)	178

*Terminal sire = Meat breed rams (Ile de France or Merinos Precosse).

The most consistent work accomplished in this regard is the achievement of a significant step towards the formation of a synthetic breed ($\frac{1}{2}$ D'man, $\frac{1}{2}$ Beni Guil) as a result of the collaborative work between the Agronomic and Veterinary Institute Hassan II and the Ministry of Agriculture (Bourfia *et al.*, 1997). The new breed is claimed to be adapted to the harsh environment prevailing in high plateaus alfa (*Stipa tenacissima*) and white sagebrush (*Artemisia herba alba*) steppes, which is the same area presently occupied by the Beni Guil breed. This cross-breeding programme was initiated in 1992 in the Missouri research station and the continued for the last seven years. Bourfia *et al.* (1997) confirms that prolificacy of the new breed averages 1.42 and growth performance is intermediate between those of D'man and Beni Guil. According to Bourfia (1999), more work is planned to stabilise prolificacy in the 1.2 - 1.3 range, improve weight gain and test the adaptation of the new breed in different areas, other than the Missouri station.

It is clear that D'man sheep have the potential to increase meat production in Morocco and in the world. D'man can contribute both as a pure-breed in confined conditions (Oasis system for instance) or as a source for prolificacy improvement in cross-breeding schemes. However, a definition of clear and accurate objectives, adoption of an adequate strategy and accomplishment of harmonious collaborative work among the partners in this industry (research and development agencies and professional associations) are essential if these goals are to be achieved.

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