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Increasing sheep production through litter size in a Moroccan harsh environment

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SUMMARY - In Morocco, there is a need for a high reproductive rate to cope with the growing national demand for meat sheep. Besides the adaptation to the harsh environment of its large breeding area, the Beni Guil showed a potential for twinning in pastoral systems. As an alternative, a synthetic breed with equal contributions of the Beni Guil and the D'man had high reproductive rates in station that need checking by field tests. The experiment should continue to figure out the suitability of these two alternatives to the local environmental conditions of eastern Morocco that is mainly devoted to sheep production.

Key words: Harsh environment, hardy breeds, twinning, litter size.

RESUME - "Augmentation de la production ovine par la taille de la portée dans un environnement difficile marocain". En raison de la demande croissante de viande ovine au Maroc, il y a besoin d'accroître la productivité numérique. En plus de l'adaptation au milieu difficile de sa vaste zone de production, la race Béni Guil a fait preuve d'une production potentielle de jumeaux en élevage extensif. Comme alternative, une race synthétique avec une contribution de la Béni Guil et la D'man à raison de 50% a eu une forte productivité numérique en station, en attendant sa mise à l'épreuve chez les éleveurs. L'expérimentation future aura à déterminer l'alternative la plus appropriée pour des conditions locales données.

Mots-clés : Milieu difficile, rusticité, bessons, prolificité.

Introduction

In Morocco, sheep are usually relegated to poor pastures and must grow and reproduce in stressful environments. The extensive range plateaux of the eastern part of the country form the area of the hardy Beni Guil breed. Under these conditions, ewes can adequately produce only one lamb per litter. Conversely, in the southern oases, the D'man breed evolves and produces in small flocks under intensive care. The differing environments no doubt fostered selection that caused large differences in prolificacy between these two Moroccan breeds.

Reproductive rate as measured by the number of lambs weaned per ewe depends upon litter size and lamb survival. An important recent element has been an interest among eastern flock owners in breeding for increased reproductive rates. Breeders seek twinning in improved pastures to ensure sufficient income. The rationale behind this reasoning is based on likely feed availability during spring, allowing the production of more lambs when the grass is available and the sale of most of them before the dry period of summer. The full benefit of a higher reproduction rate assumes thus the sale of lambs in surplus earlier than traditional practices, to improve product value compared with total input costs.

Within this context, it is logical to develop programs aimed at improving ewe productivity. The present study is a concerted effort to increase sheep production through litter size in some eastern areas of the country, with the assumption that the rearing of twins under range conditions does not cause major problems.

Background to experiment

The number of lambs weaned is a key component in the total weight of lamb weaned per ewe (Bourfia and Touchberry, 1993a,b). Genetic improvement of the rate of reproduction can be achieved either by selection within breed or by means of crossbreeding. Estimates of heritability and heterosis of litter size would suggest that useful responses are possible by selection within breed. Land *et al.* (1983) compared heritability and repeatability along with their published estimates for litter size. These authors considered that non additive sources of variation were not as large as additive parts, resulting in a small heterotic effect. According to these authors, selection is an effective way of improving litter size in sheep with an annual rate of response averaging 1.5%, in spite of the low heritability value of 10% in average. The same authors reported a coefficient of variation (CV) of 30% for litter size and only 12% for the rate of growth. Bodin and Elsen (1989) reported a remarkably high and constant CV for litter size under natural lambing, ranging from 33% to 40% for 32 French breeds of sheep. While it is possible to genetically improve litter size, it remains that rearing multiples may be difficult under harsh environments. Bradford (1985) discussed prolificacy from the viewpoint of adaptation to environmental conditions and management systems, and noticed that extensive systems form most of the total world sheep production. Following feed shortage, Kabbali *et al.* (1992) reported that Moroccan lambs could withstand up to 30% body weight loss with a possibility of recovery when adequate nutrition is available.

Experimental plan

The project is conducted at Ain Guettara (longitude 4°W, latitude 32°55'N), a range station of 5,000 hectares that has the advantage of being at the junction of the areas of D'man and Beni Guil breeds. The climate is semi-arid with hot summers (35°C as average day temperature) and occasional frosts during winters. Ain Guettara station was under a conservation program during 1950's and 1960's. A Beni Guil flock was introduced in 1973 to provide rams to breeders of Beni Guil sheep. A half-bred flock of Beni Guil and D'man was kept under semi-confinement conditions in the north west of Morocco (latitude 34°18'N, approximately 15 km to the east of the Atlantic coast). The crossbred flock moved to Ain Guettara in 1992 to take account of the environment during the development of a synthetic breed. The current stocking rate is less than one ewe per hectare.

In early summer, mating takes place at night in single sire pens when ewes return from pasture. Identification of lambs is at birth time. Feeding depends on natural grazing. The adjustment of supplemental feed considers forage availability and pasture conditions. Because of the reliance on pasture at Ain Guettara station, feeding varies largely from year to year. Spring has usually the highest rainfall incidence.

Environmental conditions that are related to the climate in the eastern region of Morocco tend to be stressful. In the last decade (between mid-1980's and mid-1990's), annual rainfall at Ain Guettara station ranged from 54 mm (1987/88) to 232 mm (1993/94) with an average of 138 mm. These

seasonal rainfall differences caused a yearly variation in forage availability. The last ten-year period comprised drier years, so that the general flock performance did not increase. In years of drought, there was a large need for concentrate feeding.

Results and discussion

The available statistics in Morocco show a need for a higher reproductive rate to cope with the growing national demand for meat sheep. Twinning is sensitive to feed supply throughout the year, and especially at critical times of the reproduction cycle. The breeding area of Beni Guil sheep is large and extends eastward into Algeria. While no selection for increasing litter size of the Beni Guil breed has so far been applied, an indirect selection against it was the case. Crossbreeding is another way of causing a change in litter size of Beni Guil sheep, through an available prolific breed, the D'man.

Twinning within breed

Selection within breed is a way of increasing twinning while maintaining adaptation to local conditions of the environment. Because of a large variation in observed reproductive performance, the Beni Guil shows a potential for a high incidence of multiple births. In semi-arid areas, the incidence of twinning is highly influenced by climatic effects, especially rainfall, reducing the expression of the trait. In addition, because of carry-over effects associated with the lactational stress of rearing twins, a ewe may produce only a single lamb the next year. Despite this variation, the Beni Guil showed a consistent reproductive performance over years, suggesting a strong genetic component for twinning.

In the flock of Ain Guettara, some Beni Guil ewes were more prone to twinning than others. As shown in Table 1, the percentages of ewes with one set, two, three, and four or more sets of twins were respectively 61.82, 24.24, 10.91, and 3.03%. Twin birth averaged 11.68%, and the mean litter size was 1.11 over a dozen of years.

Table 1. Twinning and its distribution in Beni Guil breed at Ain Guettara range station from 1984 to 1996

	Number	Percentage
Total number of births	2201	
Single births	1944	88.32 ^a
Twin births (TB)	257	11.68 ^a
Total ewes with TB	165	
Ewes with 1 TB	102	61.82 ^b
Ewes with 2 TB	40	24.24 ^b
Ewes with 3 TB	18	10.91 ^b
Ewes with 4 + TB	5	3.03 ^b

a: The percentage is based on total number of births (2201)

b: The percentage is based on total ewes with TB (165)

Genetic improvement in a population results from increasing the frequency of favorable genes. The above performance data provide a basis for selection. In respect to prolificacy, a foundation Beni Guil stock resulted from classifying the ewes according to the number of sets of twins they have produced over their lifetime production. A twinning flock of about fifty ewes was sampled from the

whole Beni Guil flock. The mating of the base ewes will be in summer 1997, using rams born as twins. In the future, selected animals should meet more stringent standards to be part of the selection flock. A ewe must for instance produce twins at its first lambing and maintain an average litter size of at least 150%. According to Turner (1969), ewes which had at least one multiple birth during their first three lambings gave 0.55 more multiple births during the next three lambings than those which did not.

A difference of 4.7 kg in weaning weight (90 days) between singles and twins resulted from the method used for creep feeding, as lambs stayed in barns while their dams grazed during day time. Weak lambs that were more likely born as twins were generally pushed out and obtained little creep feeding. Separation of lambs according to type of birth will undoubtedly improve the current management.

Besides the above discriminatory management, and while no deliberate selection for twinning has taken place so far, an indirect selection against twinning was in effect, given that type of birth was not considered when choosing replacements. At the yearling stage, an expert panel inspected animals for structural soundness, breed faults, and body weight. Being smaller than singles, twins were more likely to suffer from unfair culling under such practices. Based on the method of selection applied so far, the only rescue of twins was their compensatory growth if feeding was not a limiting factor. As shown in Table 2, the chance of selection of a lamb born as twin is only half that of a lamb born as single. This conclusion holds for both sexes.

Table 2. Distribution by sex and type of birth of animals from Beni Guil breed selected at the yearling stage in Ain Guettara range station from 1991 to 1996

Type of birth	Lambs weaned	Percent† selected
Males		
Singles (S)	488	49.0
Twins (T)	184	23.9
S and T	672	42.1
Females		
Singles (S)	472	54.0
Twins (T)	181	23.8
S and T	653	45.6

†The percentage selected is based on the number of lambs weaned

Use of crossbreeding

Besides the method of within breed improvement, crossbreeding is an alternative approach. In comparison with selection, results can be achieved more quickly with crossbreeding. Optimal breed utilization in crossbreeding requires information on both general and specific combining abilities. As compared to synthetic breeds, three tier crossbreeding, with an increased prolificacy of the first cross ewes, has the deficiency of not being a self replacing system.

A diallel cross involving three Moroccan breeds of sheep served as a screening process (Bourfia and Touchberry, 1993a,b). After identification of the most promising breed combinations, the diallel experiment evolved into the creation by interbreeding of a synthetic breed with 50% D'man and 50% Beni Guil background, intended for use under range conditions. As expected the infusion of 50 percent D'man blood increased litter size of the Beni Guil by 50% at the level of the first cross. This

performance remained in advanced generations (F1 through F5), suggesting sustainability of favorable epistatic gene combinations.

The main purpose was the contribution to the improvement of ewe productivity in the east of the country. Because of a possible genotype by environment interaction, pure-bred D'man ewes might have low reproductive performance under harsh conditions. The crossbred animals showed adequate adaptation, as testified by the ability to adapt over time to harsh conditions. The transfer of the crossbred animals from the mild conditions of the north-western coast of the country to the harsh environment of the eastern inland region did not affect their performances.

Average litter size of crossbred ewes was 1.53 and 1.42 in mild and harsh environments, respectively, but the difference between the locations was not significant. The distribution of 1,215 births produced by crossbred ewes was 61.3, 35.2 and 3.5% for single, twin, and triplet (or more) births, respectively. No selection applied before the generation F4. A part of the goal will be consistent litter size from mature ewes with selection against both extremes, seeking a uniform distribution with twin births being the most common group.

Although the relative value per kilogram of fleece wool and lamb meat in Morocco is less than 1:1, the use of the synthetic breeds under harsh conditions highlights the need for improved fleece characteristics by selection for environmental adaptation. Being raised indoors, the parental D'man breed has a light fleece of only one kilogram in average. Although major emphasis will be on ewe productivity, subsequent improvement of the synthetic breed under extensive conditions should secure the adaptation to harsh environment. The side effect on wool, resulting from the use of the D'man as a parental breed, needs further consideration. Culling should reduce the incidence of kemp in wool of the synthetic breed.

Prolific ewes need to have adequate conditions at parturition to minimize perinatal lamb loss. Due to facility limitations in Ain Guettara, the ewe and its lambs were not isolated at birth. As a result, perinatal survival was 97, 94 and 77% for single, twin and triplet born lambs, respectively. Because lambs had access to creep feed whatever their type of birth, single born lambs showed a substantial initial advantage in growth performance, resulting in higher weaning weights (Bourfia *et al.*, 1994).

Consideration needs to be given to the way in which the synthetic breed will be multiplied and further improved. Experimental results obtained in station need checking by field tests. In this regard, multiplication of the new breed is likely to be most rapidly effected by grading-up using synthetic rams, after production of the first cross between the two parental breeds in participating flocks. Such a multiplication procedure is taking place in private flocks near the Ain Guettara station, playing the role of a nucleus in an anticipatory breeding scheme. Ricordeau *et al.* (1992) used a similar approach in France for the dissemination of the INRA-401 that is a synthetic breed of sheep with equal contributions of the Romanov and the Berrichon du Cher.

Conclusion

There is an urgent need for increasing sheep production. During the last three decades, the ratio of human population to sheep numbers in Morocco changed from 1:1 to 2:1 and the population growth was much smaller in sheep. Improvement of reproductive rates of sheep becomes thus imperative. In Morocco, stressful conditions are prevalent in sheep production and especially in the east of the country. There may be areas in eastern Morocco where conditions are so harsh that twinning is not desirable. However, the incidence of multiple births can be raised, at least in areas under the regional program of pasture improvement. Increasing litter size in pastoral areas capitalizes on adequate range management and supplementary feed. Under the grazing conditions of eastern Morocco, the effects of year and season on pasture remain the dominating feature that need to be considered in any genetic improvement program. This supports the need of long term experiments.

Eastern areas of Morocco, with many local variations, are subject to uncertain seasonal rainfall patterns that cause scarcity of forage. Although the presented data are still preliminary, they highlight

alternative options to improve reproductive rates of sheep in suitable locations of the eastern region. Adaptation to arid climates requires compromising levels of litter size, given that the effects associated with poor pasture are likely to affect triplets and twins more than singles. Judging from the limited information available, the Beni Guil breed is responsive to selection for twinning. Another alternative is the use of crossbred animals resulting from equal contributions of Beni Guil and D'man breeds. Further study is required to figure out the suitability of both alternatives to local environmental conditions prevailing in the eastern region of Morocco, which is mainly devoted to sheep production.

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