Impact of Environmental Stress on the Performance of Sheep with Different Mature Sizes and Milk Production Potentials

H. D. BLACKBURN and T. C. CARTWRIGHT. USA
Texas A&M Agricultural Experiment Station
Texas A&M University, College Station, Texas 77843

How sheep of different genotypes produce in different environments is of major importance to livestock producers. An adapted sheep must have the ability to cope with environmental extremes of the locale. Numerous genetic x environmental studies have been designed to examine interactions (King and Young, 1955; Dunlop, 1963; Hohenboken et al., 1976.) However, these studies are limited to the effects of weather conditions which occurred during the course of the experiment. The objective of this study was to document how different genotypes (varying in mature size and potential milk production level) responded to an average year, a drought year, and how they recover from the drought, by using a simulation model.

Materials and Methods

This study utilized the Texas A&M sheep production simulation model (Blackburn et al., 1985). This model simulates the performance of sheep with different genotypes, accounts for the influence of protein and energy in the diet, body stores of lean and fat, body weight change, reproduction, feed intake, wool growth, and offtake from the flock.

A case study for this type of evaluation was a sheep production system in northern Kenya. The environment is arid and prone to drought. Sheep are raised in a nomadic-pastoralist system. Breeding is practiced year round, both meat and milk are the products of the system, and offtake is largely consumed by the nomad. The indigenous breed is the Somali Blackhead which in this study is represented as having a potential mature size of 35 kg and a potential peak day milk production level of 1.30 kg; this genotype will be represented as 35/1.30 in the remainder of this paper.

Validation of the model was successfully performed using forage and animal data collected in the study area (Blackburn, 1984). Simulations were performed on 9 genotypic combinations which included mature sizes of 30, 35 and 45 kg and potential peak milk production of .90, 1.30 and 1.75 kg. Only 35/1.30, 45/1.75, 30/1.75 and 35/1.75 will be discussed. Simulation procedure included initiating flocks of all genotypes with approximately 300 breeding ewes and in steady state. Using actual forage data, collected in the study area, the base year (BY) was simulated. The forage input parameters were then changed, for each genotype, to those which might represent a typical drought. The hypothetical drought year (DY) took place in 2 forms; first, the long rains (February to May) were shortened and the short rains (October and November) were late in starting. The desired effect was to allow ewes a shorter time of recovery from the dry season during the long rains and a longer period of stress during the long dry season. After the one year drought, forage parameters were re-set to be

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equivalent to the base year for 2 recovery years (RY1 and RY2). The alterations in forage pattern allowed the evaluation of genotypes not only in an average year and a severe environment, but also during recovery from the peturbation of the system.

Results

The frequency of live births (FLB) during a year indicates how a flock's performance was effected by the drought (figure 1). The response of all genotypes tested were similar for FLB; therefore, only the patterns of the 35/1.30 are presented. During the base year a steady state had been reached and there was a consistent birth rate during the year (figure 1a). The drought disrupted this pattern causing births to be concentrated in the last 1/4 of the year (figure 1b). When forage conditions improved in RY1 a cluster of births was observed during periods 8 through 13 (figure 1c). This result was due to a flushing of ewes when the higher quality forage became available. By RY2 the initial pattern for FLB was re-establishing itself in the flock (figure 1d), an indicator that the flock was recovering from the DY. These results indicate the responsiveness of a flock to the level of nutrition. It is of interest to note that it took 2 years for the flock to re-establish a FLB pattern similar to that of the BY, which in turn, caused a time lag effect in other performance characters.

Results from the FLB suggest a hypothesis concerning the practice of year-round breeding. These data suggest that a year-round breeding season is a mechanism which allows the flock to better adapt to harsh environmental conditions, by allowing the flexibility to alter the time of breeding so that ewe body condition and forage quality will support the additional nutrient costs of gestation. As conditions improve the ewes will have more opportunities to breed. Therefore it becomes feasible to have 2 lambings per year or 3 lambings in 2 years. In this way the flock will rebuild its numbers at the fastest rate. If this hypothesis is correct, for this type of environment, year round breeding should be continued and encouraged, and not forsaken for a shortened breeding season.

In this production system, meat and milk are the major products obtained from sheep. The production of these products varied between genotypes and across time and are presented in table 1. Offtake of average lamb weight/ewe and average dairy milk/ewe/day decreased, due to the DY, but was lowest in RY1. This time-lag effect is a result of the changing FLB, since the lambs born in the DY exited the system in RY1. These results indicated that lambs born in the DY had depressed growth and were not able to compensate in RY1 before exiting the system. Two genotypes, 30/1.75 and 35/1.75, showed little or no recovery from the DY indicating that they are not well suited to this environment. Interpretation of data not presented here indicated that the milk potential of 1.75 kg/d is too high for the 30 and 35 kg mature sizes. However, it would appear that the combination of 45/1.75 has merit and could be considered as a viable alternative genotype for this production system.

Production of dairy milk/ewe/day was at its lowest point in RY1 for most genotypes. Comparing the ratio of RY2 to BY as a measure of recovery the 30/1.75 and 35/1.75 were lowest compared to 35/1.30 and 45/1.75; .86 and .81 vs .93 and .94, respectively.

Production efficiencies can be considered indicators of total flock productivity. Efficiency of protein and energy production were examined and expressed as ratios of output/input (table 2). For all genotypes time-lag effects existed causing the most severe impact of the drought to be seen in RY1. The 35/1.75 was most severely effected by the DY and did not show any recovery. This result was largely due to high lamb mortality.

Conclusions

By using a dynamic simulation model it was possible to evaluate the response of genotypes, varying in potential mature size and potential peak day milk production, in a fluctuating environment. Flock productivity decreased in the DY and a further decrease in RY1 was observed in most traits studied. It was determined that the time-lag effect seen in RY1 was primarily due to the disruption in the FLB. These results indicated that 35/1.30 and 45/1.75 genotypes were best suited to the drought prone environment. The 30/1.75 and 35/1.75 were consistently the least productive. Their low productivity was due to a mismatch of potential mature size and potential peak day milk production. This indicates the importance of correctly matching genetic potentials when considering introduction of new genotypes into varying production systems.

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TABLE 1. AVERAGE OFFTAKE PER EWE OF DAIRY MILK AND LAMB, KG

	Genotype			
Item	30/1.75[a]	35/1.30	35/1.75	45/1.75
Dairy milk/day				
Base year	.14	.14	.16	.17
Drought year	.11	.14	.13	.15
Recovery year 1	.13	.13	.11	.14
Recovery year 2	.12	.13	.13	.16
Offtake of lamb				
Base year	6.1	11.3	9.9	13.6
Drought year	4.4	9.0	7.1	11.5
Recovery year 1	3.3	4.7	5.3	6.7
Recovery year 2	2.6	8.8	6.2	13.2

[a] Genotypes expressed as mature size/milk potential

TABLE 2. EFFICIENCY OF PROTEIN AND ENERGY PRODUCTION AS RATIOS OF OFFTAKE TO FLOCK CONSUMPTION

	Genotype			
Item year	30/1.75[a]	35/1.30	35/1.75	45/1.75
TPRO/DM[b]				
Base year	.0072	.0087	.0085	.0095
Drought year	.0071	.0094	.0083	.0100
Recovery year 1	.0068	.0074	.0072	.0077
Recovery year 2	.0070	.0087	.0070	.0098
TEN/EDM[b]				
Base year	.0496	.0526	.0547	.0557
Drought year	.0529	.0565	.0541	.0596
Recovery year 1	.0505	.0554	.0522	.0548
Recovery year 2	.0524	.0541	.0455	.0566

[a] Genotypes expressed as mature size/milk potential

[b] TPRO = summation of protein from animal offtake and milk by each flock; DM = dry matter consumption of each flock; TEN = summation of energy from animal offtake and milk by each flock, EDM = energy from the dry matter consumed by each flock.