GENETIC & BREEDING

A SIMULATION STUDY TO COMPARE DIFFERENT BREEDING SCENARIOS FOR BLACK BEDOUIN GOAT IN JORDAN

Al-Atiyat R.[1], T. Rewe [2], P. Herold [2] and A. Valle Zárate [2]

[1] Animal Science Department, Mutah University, Jordan.

E-mail: raedatiyat@gmail.com

[2] Institute for Animal Production in Tropics and Subtropics; University of Hohenheim, Germany

ABSTRACT

Recently a national Black Bedouin meat goat breeding program has been carried out in the Agriculture station of Mutah University in Jordan but it has not so far resulted in clear genetic improvement. The most important reason for this failure is the lack of an optimizing breeding program design. The aim of this study is to show results of four different simulated scenarios that evaluate the feasibility of Black Bedouin breeding programs in Jordan using ZPLAN software. The breeding goal was a higher marketing weight of kids at 6 months old, whereas selection criteria were doe milk total and partial, birth weight, weaning weight, dam weight, prolificacy and daily gain. The first Scenario was consisting of two closed tier scheme in which bucks were only disseminating from nucleus to commercial farms. The Second Scenario was also consisting of two tier close nucleus in which dissemination were occurred to both bucks and does into commercial farms. The third scenario was considering open scheme for bucks of two tiers. Finally, the fourth Scenario was consisting of two tier open scheme for both bucks and does disseminating downward to commercial population and importing bucks only from commercial population. Modeling results indicate that overall annual profit of the first scenario was only economically profitable (0.264 € per doe).

INTRODUCTION

Worldwide, different goat breeds produce a variety of products, including milk, meat and fibre (Galal, 2005). In Jordan, several native goat breeds have recently been identified and characterized (Zaitoun et al., 2004, 2005). These breeds are Mountain Black, Desert, Damascus and Black Bedouin (Zaitoun et al., 2005). They vary in their own morphological characteristics, predominant geographical areas and production systems. In general, Damascus and Mountain black goats are large dual purpose breeds reared around towns and countryside. On the other hand, Black Bedouin and Desert goat are meat type breeds which are reared under the harsh desert conditions (Tabbaa and Al-Atiyat, 2009). The Black Bedouin goat is considered a meat type and is the most adapted breed to Jordanian subtropical conditions. It is well known that selection within each goat breed has been practised by farmer, while rarely organized by breeder, who selected primarily for milk yield as well as morphological traits in developing countries (Galal, 2005). In particular, Jordanian farms of Black Bedouin goat individually select animals considering meat production traits (Tabbaa and Al-Atiyat, 2009). However, farmers consider for the low weight on defining their breeding objectives as meat output beforehand while assigning selection criteria for doe and/or buck selection. The use of pre-defined breeding objectives by goat farms is important to increase performance. Recent report revealed that goat farms in Jordan are using more subjective than objective criteria for selecting both bucks and does; however, considerable potential for improved performance can be made by the adoption of objective over subjective selection criteria (Tabbaa and Al-Atiyat, 2009). It is therefore essential that use of proper selection criteria could maximize the genetic improvement of meat goat breeds maintained by Jordanian farmers which also will reflected on economic output of farms.

In the last few years, a national Black Bedouin goat breeding program has been carried out in Agriculture Station of Mutah University in Jordan but it has not so far resulted in clear genetic improvement. The most important reason for this failure is the lack of an optimizing breeding program design. On the other hand, there are many software programs that facilitate optimizing breeding programs of different livestock. ZPLAN is one of these breeding programs which fed with parameters that defined by the user and the software calculates results such as the annual genetic gain for the breeding objective, genetic gain for single traits and return on investment adjusted for costs and profit using a pure deterministic approach (Nitter and Graser, 1994). Using the gene-flow method and selection index procedures, the software enables to simulate different breeding plans for any livestock species. The aim of this study is to show results of different simulated scenarios that evaluate the feasibility of Black Bedouin breeding programs in Jordan using ZPLAN software.

MATERIALS AND METHODS

Institutional framework of Bedouin goat breeding in Jordan

Black Bedouin goat breeding program has been carried out in the Agriculture Station of Mutah University in Jordan. Aiming to identify the institutional support available for Bedouin goat breeding, data regards to pedigree and performance records of the breed are available for time span of almost 8 years. Already available data from records were utilized in different simulation scenarios using ZPLAN software. The required data and traits that were not available from those records were extracted from related published studies and a selective review of literature.

Population structure and selection groups

A total doe population of 78,000 in five southern governorates of Jordan was used to simulate four goat breeding scenarios of two (close and open) tier nucleus program (Table 1). The size of the breeding unit with performance and pedigree recording was set at 10% (7,800 cows). The breeding unit modelled was disseminated and it was assumed that the herds were under the same environmental and management unit with natural mating in the breeding and commercial units. The available data are milk total, milk partial, birth weight, weaning weight, daily gain, dam weight at calving, prolificacy and marketing weight at 6 month-old. Table 1 shows goat population, production performance, investment and economic parameters that were used in different simulation scenarios.

Breeding objective, selection criteria and index information

The breeding objective of meat goat was to maximise meat output at 6-month old male and female kids as optimal sale weights on pastures with supplementation. Table 2 shows traits considered in estimating economic value of the breeding objective. The economic value for the breeding objective trait was recalculated based on a re-integrated bio-economic model developed by Rewe *et al*. (2006).

Tables 3 and 4 show genetic and phenotypic parameters used in this study. The estimates of genetic and phenotypic parameters were from the literature and as much as possible confined mainly to tropical goat (West African goats - Bosso et al, 2007, Dwarf goats - Draa goats - Odubote I.K., 1996, Draa goats - Boujenanea and El Hazzab, 2008, Emirati goats - Al-Shorepy et al, 2002).

Modelling different scenarios of Bedouin goat breeding schemes

The computer programme ZPLAN was used to evaluate the different scenarios for goat breeding programme. The first Scenario was a two closed tier scheme in which bucks were only disseminating from nucleus to commercial farms. Table 5 shows the transmission matrix for the breeding programme with 10 selection groups and four selection groups for this scenario. The Second Scenario was also consisting of two tier close nucleus in which dissemination were occurred to both bucks and does into commercial farms. The transmission matrix for the breeding program of 12 selection groups is shown in Table 6 for this scenario.

Table 1. Input parameters for modelling the breeding programs of Black Bedouin goat

Variables	Variable levels
Population parameters	
Population size	78,000
of does in breeding unit	10%
of does in commercial unit	75%
Biological parameters	
Average kidding intervals (year	1
Kidding rate	1.1
Pre-weaning survival rate	93%
Productive lifetime buck in breeding herd	3 years
Productive lifetime for does in breeding herd	3.5 years
Productive lifetime for buck in commercial herd	3 years
Productive lifetime for does in commercial herd	4 years
Buck survival rate in both	85%
Doe survival rate in both	85%
Age at first kidding for sires in breeding herd	2.5 years
Age at first kidding for dams in breeding herd	2.0 years
Age at first kidding for sires in commercial herd	2.5 years
Age at first calving for dams in commercial herd	2 years
Cost of investment parameters (EURO)	
Investment period cost (year)	10
Doe record for total milk yield	0.2
Doe record for partial milk yield	0.2
Record of birth weight	0.15
Record of weaning weight	0.2
Record of dam weight	0.25
Record of prolificacy	0.50
Recordof weight gain of kids?	0.50
Fixed costs per year (EURO)	
(management=150,000 and support staff = 2,000)	170,000

Table 2. Cost used in estimation of breeding value of marketing weight.

	Euro
Fixed costs	3,90
kidding interval	365,00
kidding rate	1,10
Survival rate	0,85
Post wening survival rate	0,90
Doe survival rate	0,90
Doe weight	60,00
Milk yield	670,00
Dressing percentage	0,48
Consumed meat percentage	0,70
Replacement rate per doe per year	0,20
Weaning age in days	90,00
Sale age in days	180,00
Age at first kidding in days	730,00
Constant for maintenance requirement cost	0,35
Constant for production requirement cost	0,35
Birth weight	3,50
Weaning weight	16,00
Daily gain (g)	0,15
Sale weight for males	40,40
Sale weight for females	35,35
Price of feed	0,20
Energy content in feed mix	2,00
Energy content in pasture	2,00
Energy content in concentrates	1,00
Percentage of milk fat in total milk	60,00
Labour cost per animal	2,00
Veterinary costs per animal	0,20
Reproduction costs per cow	0,50
Total Marketing costs per year	100,00
Price of kilogramme meat	7,00
Economic Value	***1,45***

Table 3. Phenotypic standard deviations and phenotypic correlations among selection criteria (lower case letters) and breeding objective (upper case letters) applied to the three ZPLAN simulations.

	Phenotypic standard deviation	B Wt	W. Wt.	D. G	M.Y	Partial milk yield	Prolificacy	Dam Wt	MARKT Wt
Birth wt	0.6	1.00							
Weaning Wt.	1.5	.55	1.00						
Daily gain	0.16	.25	.60	1.00					
Milk yield	6.5	.13	.09	.40	1.00				
Partial milk yield	0.28	.30	.35	.40	.41	1.00			
Prolific.	0.16	.30	.25	-.25	.35	.00	1.00		
Dam wt	4.5	.26	.25	.00	.30	.30	0.0	1.00	
MARKT Wt	4.0	.00	.00	.00	.00	.00	0.0	.00	1.00

Table 4. Heritabilities and genetic correlations among selection criteria (lower case letters) and breeding objective (upper case letters) applied to the three ZPLAN simulations.

	Hr.	B.Wt	W. Wt.	D. G.	M.Y.	Partial M. Y.	Prolificacy	Dam Wt.	M.Wt.
Birth wt	0.38	1.00							
Weaning Wt.	0.33	.45	1.00						
Daily gain	0.16	30	.40	1.00					
Milk yield	0.36	00	.10	.15	1.00				
Partial M.Y.	0.27	-.10	-.13	0.00	.65	1.00			
Prolificacy	0.12	.03	.42	-.25	.62	.25	1.00		
Dam Wt	0.41	.05	.46	.00	.05	-.15	.00	1.00	
MARKT Wt	0.40	.45	.37	.00	.00	0.10	.00	0.54	1.00

Table 5. Transmission matrix of the breeding plan with 10 selection groups.

Tier		Nucleus		Commercial	
		B	D	B	D
Nucleus	B	1. BN>BN	2. DN>BN		
	D	3. BN>DN	4. DN>DN		
Commercial	B	5. BN>BP		6. BP>BP	7. DP>BP
	D	8. BN>DP		9. BN>BN	10. DP>DP

B = buck; D = doe; N = nucleus, P= commercial population

Table 6. Transmission matrix of the breeding plan with 12 selection groups.

Tier		Nucleus		Commercial	
		B	D	B	D
Nucleus	B	1. BN>BN	2. DN>BN		
	D	3. BN>DN	4. DN>DN		
Commercial	B	5. BN>BP	6. DN>BP	7. BP>BP	8. DP>BP
	D	9. BN>DP	10. DN>DP	11. BN>BN	12. DP>DP

B = buck; D = doe; N = nucleus, P= commercial population

On the other hand, third scenario was considering open scheme of two tiers. The nucleus was disseminating only bucks downward to commercial farms and importing bucks from commercial population upward. The details of the transmission matrix for the breeding programme with 12 selection groups are shown in table 7. Finally, fourth Scenario was consisting of two tier open scheme where bucks and does were disseminating downward to commercial population and importing bucks only from commercial population upward. Table 8 shows the transmission matrix for the breeding programme with 14 selection groups.

Table 7. Transmission matrix of the breeding plan with 12 selection groups.

Tier		Nucleus		Commercial	
		B	D	B	D
Nucleus	B	1. BN>BN	2. DN>BN	3. BP>BN	4. DP>BN
	D	5. BN>DN	6. DN>DN		
Commercial	B	7. BN>BP		8. BP>BP	9. DP>BP
	D	10. BN>DP		11. BN>BN	12. DP>DP

B = buck; D = doe; N = nucleus, P= commercial population

Table 8. Transmission matrix of the breeding plan with 14 selection groups.

Tier		Nucleus			Commercial	
		B	D		B	D
Nucleus	B	1. BN>BN	2. DN>BN		3. BP>BN	
	D	4. BN>DN	5. DN>DN		6. BP>DN	
Commercial	B	7. BN>BP	8. DN>BP		9. BP>BP	10. DP>BP
	D	11. BN>DP	12. DN>DP		13. BN>BN	14. DP>DP

B = buck; D = doe; N = nucleus, P= commercial population

RESULTS AND DISCUSSION

The annual genetic gains and economic merits of different scheme of the marketing weight for goat performance are given in Table 9. Generally, the annual genetic response was high for all breeding scheme representing similar values of the annual monetary genetic gain. For example, in Scenario 2, 3 and 4, values of both annual genetic gain and annual monetary genetic gain were very close (Table 9). A comparison of the annual monetary genetic response of scheme 1 with other schemes shows very little difference in the monetary response indicating that there is little benefit of including female into close nucleus and /or open nucleus. The lowest annual monetary genetic gain was obtained in scenario 4, where bucks' genetic material was disseminated downward and upwards in open nucleus scheme. The low annual genetic gains may be explained by the small population size of nucleus that leads to a high fixed costs (e.g Scenario 2, 3 and 4), and the low selection intensity (data are not shown). On the other hand, the highest annual monetary genetic response was obtained in scenario l which had only bucks sent into commercial farms.

The scenario that ranked highly for total return per unit did not rank the same in profit per animal. As an example, scenario 1 and 2 had lowest and similar value for total return, but scenario 1 ranked first for profit per unit. This was probably due to the low costs for recording marketing weight in scenario 1 (Table 9). However, the difference in profit per unit between this scenario and the others was due to extra recording cost of the marketing weight trait on bucks and does.

Table 9. Genetic gain, generation interval, cost and profit per year for marketing weight of goat

	The 1st Scenario	The 2nd Scenario	The 3rd Scenario	The 4th Scenario
Genetic gain/Year	0.2331	0.2382	0.2372	0.2382
Monetary Genetic gain/Year	0.338	0.345	0.344	0.345
Mean generation interval	3.585	3.583	3.583	3.583
Return total /unit	0.955	0.328	0.955	0.328
Return /trait/unit	0.955	0.328	0.955	0.328
Costs total /unit	0.691	15.432	2.741	15.432
Fixed costs	0.216	13.689	1.429	13.689
Costs/ dam	0.048	0.962	0.192	0.962
Variable costs	0.427	0.782	1.119	0.782
PROFIT / UNIT	**0.264**	**-15.105**	**-1.786**	**-15.105**

Comparing results indicate that overall annual profit of the first scenario, in which bucks were only disseminating from nucleus to commercial farms, was economically profitable (0.264 € per doe). On the other hand, the overall annual profit for other scenarios were negative reflecting that these schemes are economically not profitable. Similar results were reported by Roessler et al 2009 for breeding scheme of market-oriented smallholder pig production.

CONCLUSION

Economic efficiency and increased annual genetic gain in black Bedouin meat goat breeding program in Jordan are possible. Comparing of various breeding scenarios showed economic potential for increasing profit only when bucks were imported into commercial population. The overall annual profit of this profitable scenario was 0.264 € per doe.

REFERENCES

Al-Shorepy S.A. , G.A. Alhadrami, K. Abdulwahab,. (2002). Genetic and phenotypic parameters for early growth traits in Emirati goat Small Ruminant Research, 45:217–223

Bosso N.A. M.F. Ciss´e, E.H. van der Waaij, A. Fall, J.A.M. van Arendonk (2007) Genetic and phenotypic parameters of body weight in West African Dwarf goat and Djallonk´e sheep. Small Ruminant Research 67 271–278

Boujenanea I., El Hazzab A., (2008). Genetic parameters for direct and maternal effects on body weights of Draa goats. Small Ruminant Research 80 16–21

Galal, S., 2005. Biodiversity in goats. Small Ruminant Research 60, 75–81.

Holcomb, G.B., 1994. A Small-Scale Agricultural Alternative: Dairy and Meat Goats. USDA Cooperative State Research Service. The Office for Small-Scale Agriculture,Washington, DC.

Nitter, G., Graser, H.-U. (1994): ZPLAN – a PC program to optimize livestock selection programs. Proceedings 5th World Congress on Genetics Applied to Livestock Production, 22, 77-78.

Odubote I.K. (1996) Genetic parameters for litter size at birth and kidding interval in the West African Dwarf goats. Small Ruminant Research 20:261-265

Rewe T. O. Indetie D.,2 Ojango J. and Kahi A., (2006) Breeding objectives for the Boran breed in Kenya: Model development and application to pasture-based production systems. Animal Science Journal 77, 163–177

Zaitoun, I.S., Tabbaa, M.J., Bdour, S., 2004. Body weight, milk production and lifetime twining rate of the different goat breeds of Jordan. Dirasat 31, 143–149.

Zaitoun, I.S., Tabbaa, M.J., Bdour, S., 2005. Differentiation of native goat breeds of Jordan on the basis of morphostructural characteristics. Small Ruminant Research 56, 173–182.

Roessler, R., Herold, P., Willam, A., Piepho, H.-P., Thuy, L.T., Valle Zárate, A., 2009. Modelling of a breed group recording scheme for market-oriented smallholder pig producers in Northwest Vietnam. Livestock Science 123 (2009) 241–248.

Tabbaa M. and Al-Atiyat R. 2009. Breeding objectives, selection criteria and factors influencing them for goat breeding in Jordan. Small Ruminant Research, 84: 8–15