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SUMMARY - The economic justification for increasing lamb production in semi-intensive Awassi flocks, by introducing the Afec-Awassi strain that carries the Ballele of the FecB (Booroola) locus, was studied, taking into consideration different breeding methods for high prolificacy and different economic environments. In the analysis, the production process was defined as a series of tasks, each of which can be accomplished by one or more alternative techniques. Under the range of economic parameters tested, introduction of the Afec into Awassi flocks managed under semi-intensive conditions would be profitable in most scenarios. The higher the ratio between lamb price and feed costs, the greater the benefit from the use of the Afec. Furthermore, selection of replacements based on the genotyping of ewe lambs for carrying markers linked to the FecB gene is economically justified in all cases.

Key words: Sheep, Awassi, Afec, economic analysis.

RESUME *- "Evaluation économique de la sélection pour une prolificité plus élevée chez les troupeaux Awassi". On a étudié la justification économique de l'augmentation de la production d'agneaux par l'introduction de la souche Afec-Awassi porteuse de l'allèle B du gène FecB (Booroola) dans des troupeaux Awassi semi-intensifs, en considérant plusieurs systèmes d'élevage et des environnements économiques différents. Dans cette analyse, le processus de production a été défini comme une série de tâches à accomplir suivant une ou plusieurs alternatives techniques. Dans l'éventail économique considéré, l'introduction de l'Afec dans les troupeaux Awassi sera profitable dans la plupart des scénarios. Plus le rapport du prix de la viande d'agneau sur celui des fourrages est élevé, plus l'introduction de l'Afec est rentable. De plus, la sélection d'agnelles de remplacement basée sur l'établissement de leur génotype en utilisant des marqueurs génétiques associés au gène FecB est justifiée dans tous les cas.*

Mots-clés : *Ovins, Awassi, Afec, analyse économique.*

Introduction

There are about 200,000 Awassi sheep in the Negev region in the southern part of Israel. Traditionally, Awassi sheep in this region have been kept under extensive conditions by Bedouin tribes, relying on pasture and nomadism. The reduction in open grazing land and the development of alternative sources of income have led a number of sheep owners to adopt semi-intensive management whereby feeding with grains, hay and agricultural by-products has become an integral and important part of the nutrition policy. Improving the nutrition of the sheep under semi-intensive conditions, especially during the mating season, has led to improvements in lamb production (Perevolotsky and Landau, 1991; Ginguld *et al.*, 1995), as can be seen in Table 1.

The Awassi sheep is hardy and well adapted to the region, and its fat tail phenotype is preferred by the local consumer. However, it has a low prolificacy. During the last decade, the B allele of the FecB (Booroola) gene has been introduced into the Improved Awassi through a crossbreeding program (Gootwine *et al.*, 1995). The outcome is a new highly prolific strain of Awassi, named Afec. Afec sheep carry 90% or more Awassi genetic background and are either heterozygous (B+) or homozygous for the Booroola gene. The prolificacy of the Afec B+ is about 2.0 lambs born/ewe lambing, as compared with an average prolificacy of 1.25 for the Awassi (Table 2). Lamb mortality during lambing is higher in Afec then in Awassi (17% *vs* 6%, respectively), giving an advantage of 0.5

lamb born alive for the Afec as compared with the Awassi. Phenotypically, Afec is similar to the Awassi, and early in life differentiation between the Afec and the Awassi is possible by means of molecular markers linked to the Booroola gene (Gootwine *et al.*, 1994).

Table 1. Comparison of extensive and semi-intensive sheep production systems in the Negev region

	Extensive	Semi intensive
Hoggets lambed under two years of age (%)	0	36
Lambing rate (lambings/year %)	80	115
Average prolificacy (lambs born/ewe lambing)	1.03	1.20
Annual milk production (l)	50	120
Grazing period (mo)	9	9
Annual feed supplementation:		
Dry matter (kg)	150	350
Energy (Mcal)	385	900
Crude protein (kg)	17	50

Table 2. Prolificacy (lambs born/ewe lambing, mean+s.e.) up to the 5th parity of contemporary Afec B+ and Awassi ewes identified as such by means of two molecular markers linked to the FecB locus

	Parity				
	1	2	3	4	5
Afec B+					
Prolificacy	1.6 ± 0.1	1.9 ± 0.1	2.1 ± 0.1	2.4 ± 0.1	2.3 ± 0.1
Triplets and more (%)	10	27	33	46	38
Awassi					
Prolificacy	1.2 ± 0.1	1.2 ± 0.1	1.3 ± 0.1	1.5 ± 0.1	1.6 ± 0.1
Triplets and more	-	-	-	-	-

Afec in semi-intensive flocks

Replacing the Awassi of the semi-intensive flocks by the Afec can be a way to genetically improve lamb production in those flocks. It is assumed that the desired genotype in the commercial semi-intensive flocks will be the Afec B+ and not the Afec BB, which may be too prolific. The most efficient, least expensive and quickest way for replacing Awassi with Afec would be massive artificial insemination of Awassi ewes with Afec BB semen and selection as replacements only their progeny which result from these inseminations. The limiting rate of substitution of the Afec for the Awassi would be the internal replacement rate of the flocks. If this rate is about 25%, artificial insemination for four successive years would be needed to complete substitution of Awassi by Afec in the semi-intensive flocks. Subsequently, Awassi rams would be used for breeding, and half of their

progeny would be Afec B+. Selection of only Afec ewe lambs as replacements can be done by using the already available genetic markers. Alternatively, replacement ewe lambs would be selected at random, leading to a decrease in the Afec frequency in the flock. Frequent insemination with Afec BB semen might restore the frequency of Afec B+. The expected annual lamb productions in extensive Awassi flocks, in Awassi flocks kept under semi-intensive management, and in flocks where the Afec B+ is introduced and is maintained over years, either by selecting genotyped ewe lambs or by inseminations every six years with Afec BB semen, are presented in Fig. 1. As can be seen, replacement of Awassi with Afec can increase lamb production up to 40%.

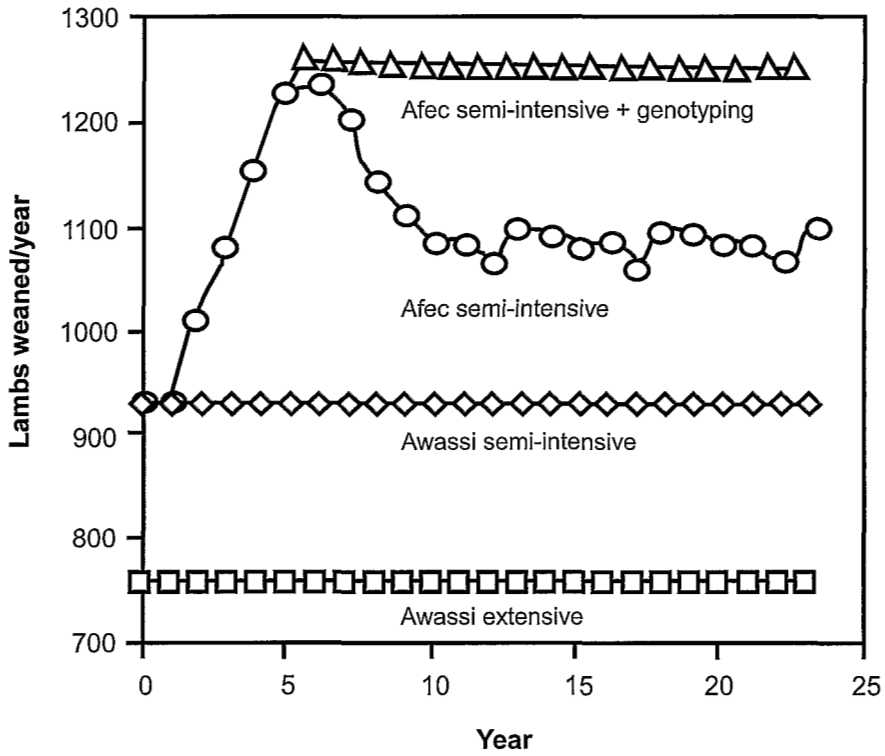

Fig. 1. Lamb production/year in a flock of 780 Awassi or Afec ewes.

Economic assessment

Success of breeding for higher prolificacy in semi-intensive units by replacing Awassi with Afec may depend not on the adaptability of the Afec to the management conditions, as those conditions are controlled by the producer, but rather on the economic environment in which the flock is operating. To exploit the biological potential of the Afec fully, higher expenses for feeding have to be considered and increases in lamb production would have to compensate for those and also for other expenses related to the introduction of the Afec, including the price for insemination, which is not commonly practiced in the semi-intensive flocks. Economic analysis of the introduction of Afec into semi-intensive flocks was carried out using the Morphological Box approach (Spharim and Ungar, 1995). This approach, which is backed by a specially designed computer program, enables a variety of technology variants to be compared and their economic fitness to be evaluated under different economic environments. In the analysis, the Net Present Values (NPV) generated by a flock of 1000 ewes over 25 years under four different combinations of genotype and management were compared. The four combinations were: Awassi sheep under extensive management, Awassi sheep under semi-intensive management, Awassi sheep in semi-intensive management replaced by Afec (maintained fully as Afec B+ by genotyping for molecular markers of ewe lambs), and the last system partially maintained as Afec B+ by frequent artificial inseminations every six years. The economic environments that were investigated included ranges of prices for feed and for lambs, different costs for each AI intervention, assuming a fixed price of $10 for genotyping, a range of interest rates from to 8% and the additional supplementation of 50 kg of dry matter food for the Afec.

Results of selected analyses are presented in Table 3.

Table 3. Net present value (NPV) generated by a flock of 1000 ewes over 25 years under different economic environments. Four technologies were examined: (i) Awassi under extensive management (Aw-ex); (ii) Awassi under semi-intensive management (Aw-s.int); (iii) Awassi under semi-intensive management replaced by Afec, with repeated insemination with Afec BB semen (Af-ins); (iv) Awassi under semi-intensive management, replaced by Afec with marker assisted selection for Afec (Af-gn)

Feed price ($/ton)	Live meat price ($/kg)	Price ratio	AI costs ($)†	Interest Rate	NPV ($1000)				Difference ($1000)
					Technology				
					Aw-ex	Aw-s.int	Af-ins	Af-gn	
200	4.3	21	-	8	493	579			86
200	4.3	21	16	8		579	647		68
160	4.3	27	16	8		838	938		100
280	4.3	15	16	8		60		162	102
160	2.5	16	16	8		45		67	22
200	3.0	15	16	8		3		40	37
200	4.3	21	16	8		579		752	173
160	4.0	25	16	8		695		870	175
160	4.3	27	16	8		838		1047	209
120	4.0	33	16	8		955		1165	210
80	3.0	37	16	8		781		924	143
200	4.3	21	16	8		579		752	173
200	4.3	21	16	5		743		1013	270
200	4.3	21	16	8		579		752	173
200	4.3	21	21	8		579		734	155
200	4.3	21	16	8		579		716	137

†Including hormonal synchronization

Conclusions

Under the range of economic parameters tested, introduction of the Afec into Awassi flocks managed under semi-intensive conditions would be profitable in most scenarios. The higher the ratio between lamb price and feed costs, the greater the benefit from the use of the Afec. Furthermore, selection of replacements based on the genotyping of ewe lambs for carrying markers linked to the FecB gene would be economically justified in all cases.

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