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A steering frame for the genetic improvement of sheep and goats in Tunisia

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SUMMARY – The genetic heritage of sheep and goats in Tunisia is rich and diverse with a population of around 4 million breeding ewes and 800 thousand breeding goats. Classically, sheep stock consists of 3 suckling breeds and a milking population. Indigenous animals represent the largest nucleus of goats with, in many instances, an apparent influence of the Nubian and Maltese blood. To these local populations, a number of attempts to introduce exotic breeds are recorded such as the Lacaune, Comisana, Brown Black Swiss and D'Man for sheep and Alpine, Damascus, Boër and Black-headed Maltese for goats. This diversity accommodates the heterogeneity of the soil-climate conditions generally arid with irregular seasonal and yearly rainfall. The picture is yet complicated as we evoke the large discrepancies about flock sizes and compositions as well as production practices. More than 80% of the sheep and goat stock are raised in generally mixed (sheep and goats), small-sized flocks under very extensive conditions. Moreover, social-economic mutations have raised new production systems, new consumption trends hence, new objectives of selection. In a situation already marked by the diversity of the production conditions with a further rapid mutation, the definition of breeding objectives is a difficult, not straightforward task. Based on the technical results of breeds characterisation, the present paper develops a number of ideas in relation to the future prospects of sheep and goats genetic improvement bearing in mind the above listed constraints and in the expectation of the social-economic evolutions ahead of this production area.

Key words: Sheep, goats, genetic improvement, Tunisia.

RESUME – "Cadre de direction pour l'amélioration génétique des ovins et caprins en Tunisie". Le patrimoine génétique de la Tunisie en ovins et caprins est relativement riche; on dénombre de l'ordre de 4 millions de femelles ovines et environ 800 mille femelles caprines. Les ovins sont composés de trois races à viande et une population laitière. La population autochtone constitue l'essentiel du troupeau caprin avec une influence apparente de sang nubien et maltais. A ces populations locales s'ajoutent de nombreuses tentatives d'introduction de races exotiques, nous citons en particulier les races ovines Lacaune, Comisana, Brune Noire Suisse et D'Man et les races caprines Alpine, Damasquine, Boër et Maltaise Tête Noire. Cette diversité génétique répond bien à la diversité édapho-climatique de la Tunisie caractérisée par une dominance du climat aride à pluviométries annuelles et saisonnières très irrégulières. La situation se complique si l'on évoque la taille des troupeaux et les systèmes d'élevage. En effet, plus de 80% du cheptel est élevé en petits troupeaux souvent mixtes (ovins et caprins) dans des conditions très extensives. Par ailleurs, les mutations socio-économiques font émerger de nouveaux systèmes d'élevage, de nouvelles habitudes culinaires donc de nouveaux objectifs de sélection. Dans une situation déjà très diversifiée et en plus, en pleine mutation, la fixation d'objectifs de sélection est un exercice qui n'est pas du tout évident. En se basant sur les résultats techniques de caractérisation des différentes races, nous développons dans le présent article une réflexion sur les orientations futures de l'amélioration génétique compte tenu des différentes contraintes sus-citées et en prévision des évolutions socio-économiques qui attendent le secteur.

Mots-clés : Brebis, chèvre, amélioration génétique, Tunisie.

Introduction

In Tunisia, recording of animal performances is more than 30 years old for the sheep population whereas, very few references are available in the case of goats. The type of control is the same as the standard French model though not valorised to the same extent. The valorisation of this control and its adaptation to local conditions remains dependant upon the definition of selection objectives. Meanwhile, profound structural and socio-economic mutations have marked the production systems in Tunisia particularly those related to extensive sheep and goat farming. This paper draws a broad synthesis of the work on the characterisation of sheep and goat breeds in Tunisia, pinpoints breed

differences in relation to the prevailing environment and suggests, in relation to the social-economic situation, a general framework for the definition of selection objectives.

Determinant factors in the choice of selection objectives

Climatic factors

Tunisia has a Mediterranean type of climate with large between and within-year variations in rainfall. The semi-arid, arid and Saharan bio-climatic areas cover more than 80% of the overall territory, receive between 350 and 50 mm of rain throughout the year and the major constraint remains a long dry season. These three bio-climatic areas which roughly correspond to the centre and south of the country, host the largest part of the sheep and goat population. In this large part of the country, the primary production is low varying, in an average year, between 150 and 20 forage units per hectare of non-forestry rangeland (Le Houérou, 1989). The contribution of rangeland in the livestock diet has regressed and the World Bank (1995) estimates this decline to have reached 39% since the sixties. The deficit is compensated by a heavier use of secondary cereals.

Structural factors

Following the breaking-up of pastoral communities over the last decades and the new equilibrium in land tenure and use, different forms of sheep and goat integration to the agricultural household have appeared. The new emerging systems move towards having a high concentration of sheep and goats on small holdings in parallel with a reduction in the flock size not exceeding 20 female units. There is, globally, a trend for the number of sheep owners to increase at an annual rate of 1.15% for the period between 1976 and 1993. These tendencies emphasise, among other things, the success of agricultural policies in terms of livestock safeguarding and preservation hence, attenuating the drawbacks of adverse climatic or sanitary conditions.

Social-economic factors

Since the independence, most agricultural sectors have been largely influenced by the social-economic mutations that the country is experiencing. In livestock production, this is expressed by the changes in production systems and the evolution of the level and type of the consumer demand on animal products. In the large urban areas of the sea coast where the demand on meat is highest, there is a preference for light, low-fat content carcasses.

Sheep and, to a less extent, goats contribute for approximately 50% of the national production of red meat especially out of extensive production systems. Between 1970 and 1992, these systems were able to keep the level of consumption at about 5 kg/capita and their relative stability is now threatened by technical, economic and organisational constraints.

Contribution to the orientation of selection programmes

Meat sheep breeds

Three local breeds make up the essential of meat sheep in Tunisia; these are the Barbarine with its black (BN) and red-headed (BR) strains, the Queue Fine Algérienne (QF) and the Noir de Thibar (NT).

Flock characterisation

In central Tunisia, selection practices during drought years were studied between 1994 and 1995 through surveys that included 414 sheep owners. The study established the difficulty to set up a selection scheme involving small sheep holders and the main conclusions of the study were as follows:

- (i) The culling rate is inversely proportional to the size of the flock. In fact, in small and average-

sized flocks, it is not a removal of unproductive animals that is practised but a reduction in sheep numbers with no replacement taking place at all.

(ii) For this category of sheep owners, the price of the female on the market is the main criterion as far as culling is concerned. This signifies the selling of the best animals resulting from many years of selection. The logic behind genetic improvement is here reversed, the flock production becomes based upon unproductive animals.

(iii) The large flocks or those producing sufficient feeding resources (irrigated farming) keep on adopting usual selection practices particularly the replacement of rams by improved ones.

These modes in relation to the management of genetic resources denote the importance of the short-term market profit and the disadvantages for the farmers to be outside co-operative group-breeding which may generate benefits that are partly genetic and partly operational and promotional.

Breed characterisation

The Barbarine is the best genetically characterised amongst the three meat breeds. Data bases of the flocks in the National Agricultural Research Institute (INRAT) and the Bureau of Livestock and Pastures (OEP) stations were used to study the effects of non-genetic factors on the growth performances at different ages and to estimate genetic parameters of growth traits. Heritability coefficients of most growth traits (Table 1) are similar to those reported in the literature and genetic correlations are positive and much higher as the ages of the concerned weights are closer (Bonaiti *et al.*, 1976; Ben Hammouda, 1985; Djemali *et al.*, 1994; Jmal, 1995). As reported by Abdennebi (1990), estimates of the heritability for conception rate and prolificacy are 0.13 and 0.23 respectively. However, this work on the genetic characterisation concerns only one breed and the limited number of the flocks involved may not be representative of the Barbarine across the country.

Table 1. Heritabilities of growth traits of lambs of the Barbarine breed

Weight at		Average daily growth between					Reference
Birth	30 days	70 days	90 days	10-30 days	30-70 days	30-90 days	
0.09	0.25	0.18	0.22	0.19	0.12	0.21	Ben Hammouda (1985)
0.01	0.04	–	0.04	0.06	–	0.04	Khaldi <i>et al.</i> (1987)
0.26	0.19	0.27	0.32	0.15	0.24	0.31	Djemali <i>et al.</i> (1994)
0.08	0.07	0.07	0.03	0.02	0.02	0.02	Djemali <i>et al.</i> (1994)
0.06	0.19	0.16	0.18	0.22	0.22	0.28	Ben Gara and Rouissi (1996)

Diversity of objectives

An analysis based on the average performances of more than 420 flocks of the three main meat breeds (BN-BR, QF, NT) was carried out in an attempt to identify between and within-breed behaviour differences in relation to the environment. Results on dam reproductive and lamb mortality performances are comparable for all breeds (Table 2) except the slightly higher prolificacy in the case of the NT. Similarly, comparable growth performances are recorded for the three breeds (Table 3).

Variations in breed behaviour in relation to the environment were assessed by the difference between the ADG 10-30 (average daily growth between 10 and 30 days of age) and ADG 30-70 (average daily growth between 30 and 70 days of age) calculated by sex and type of birth of the lamb and analysed according to year, region, sector of production, station, flock and the breed. In contrast to European breeds, ADG 10-30 is very often higher than ADG 30-70 and it was anticipated that their difference is indicative of the dam suckling ability under very extensive conditions.

Ten components were identified through a preliminary analysis in principal components (Table 4) and the first five accounted for more than 87% of the overall variation. These components identified the

following main sources of variation: (i) the sex and type of birth; (ii) the region and the sector of production; (iii) the breed and the station; (iv) the year; and (v) the flock.

Table 2. Conception rate, prolificacy and lamb mortality of the meat producing sheep breeds in Tunisia

	Conception rate (%)			Prolificacy (%)			Lamb mortality (%)		
	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
BR (270) [†]	88.5	55.9	99.6	111.9	100.5	135.4	3.0	0	11.2
BN (88) [†]	87.6	46.2	97.1	113.1	101.4	139.5	2.1	0	2.5
NT (43) [†]	83.3	47.6	98.7	132.2	102.0	173.2	5.0	0	15.6
QF (29) [†]	89.3	63.9	98.8	118.1	103.5	153.8	2.7	0	10.5

[†]Number of flocks [source: Performance Recording Scheme 1996, 1998 and 1999 (OEP)]

Table 3. Growth performances of lambs of the meat producing sheep breeds in Tunisia[†] [source: Performance Recording Scheme 1996, 1998 and 1999 (OEP)]

	Liveweight at 70 days of age (kg)				Average daily growth between 10 and 30 days of age (g)				Average daily growth between 30 and 70 days of age (g)			
	SM	TM	SF	TF	SM	TM	SF	TF	SM	TM	SF	TF
BR	17.0	12.9	15.9	12.1	193	140	183	133	174	138	160	129
BN	17.6	13.6	16.3	12.9	197	146	186	139	184	151	167	142
NT	16.6	14.0	15.4	13.1	172	144	162	134	182	162	169	150
QF	17.0	13.4	16.0	12.7	189	143	178	135	174	143	161	133

[†]SM = single males; TM = twin males; SF = single females; TF = twin females.

Table 4. Analysis in principal components of the variability of growth traits of lambs of the meat producing sheep breeds in Tunisia

Eigen Values		Factor pattern > 0,42											
%	Cumulative %	Environment								(ADG 30-70) – (ADG10-30)			
		Var. axis	Year	Region	Sector	Station	Flock	Breed	SM	TM	SF	TF	
37.55	37.55	1							0.47	0.48	0.47	0.48	
18.83	56.38	2		-0.60	-0.59	-0.43							
12.98	69.36	3				-0.47		-0.73					
9.72	79.08	4	-0.85										
8.60	87.68	5					-0.81						
4.38	92.06	6			-0.68	-0.54							
3.08	95.14	7		-0.68				0.42					
2.43	97.57	8							-0.47	0.51	0.50	0.42	
1.36	98.93	9							-0.65		0.62		
1.07	100	10								-0.63		0.65	

Furthermore, an analysis of variance lends more support to this finding (Table 5) and the region, the sector of production and the breed are the major causes of observed variation. Some interaction effects are also significant. These results indicate the effect of a typically Mediterranean climate very

unsteady in time and space and highly determinant of the quantity and quality of available vegetation on pastures.

Table 5. Analysis of variance of the variability of growth traits of lambs of the meat producing sheep breeds in Tunisia

Source of variation	df	(ADG 30-70) – (ADG 10-30)			
		SM	TM	SF	TF
Year (Yr)	2	NS	**	*	**
Region (Rg)	13	***	***	***	***
Sector (Se)	4	NS	NS	*	NS
Breed (Br)	3	NS	NS	NS	NS
Yr × Rg	11	*	**	**	**
Yr × Se	7	*	*	*	**
Yr × Br	6	NS	NS	NS	NS
Rg × Se	10	**	***	**	***
Rg × Br	15	NS	NS	NS	NS
Se × Br	4	NS	NS	NS	NS
R ²		0.55	0.56	0.58	0.58

***P < 0.001; **P < 0.01; *P < 0.05; NS = P > 0.05.

In conclusion to this analysis, the following elements are raised:

(i) The breeds perform differently (Fig. 1). The ADG 30-70 is higher than the ADG 10-30 in the case of the NT while the opposite is recorded for the other breeds. In some instances, the BN behaves like the NT breed.

(ii) A north-south gradient (Fig. 2) with more favourable climatic conditions in the north, harsher towards the south and for which, the Barbarine is best adapted by differentiating the BN and the BR strains (Ben Hammouda, 1981). From the north to the centre-west (Fig. 3), the conditions remain favourable north of the "Dorsale" chain of mountains

(iii) Differences between sectors of production suggest differences in management practices or in the genetic potentials.

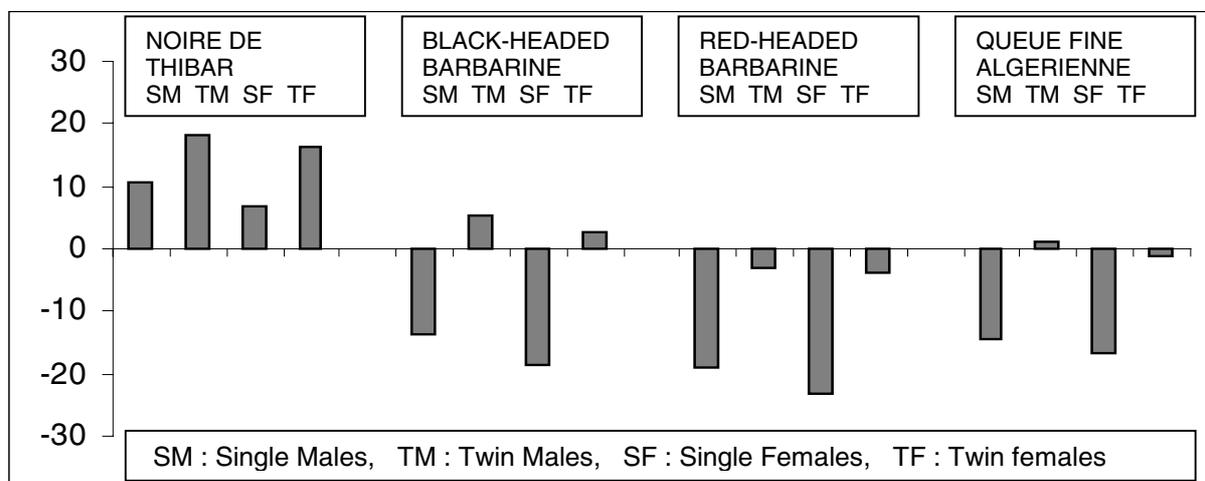


Fig.1. Variability of lamb growth performances (ADG 3070 – ADG 1030) according to breed.

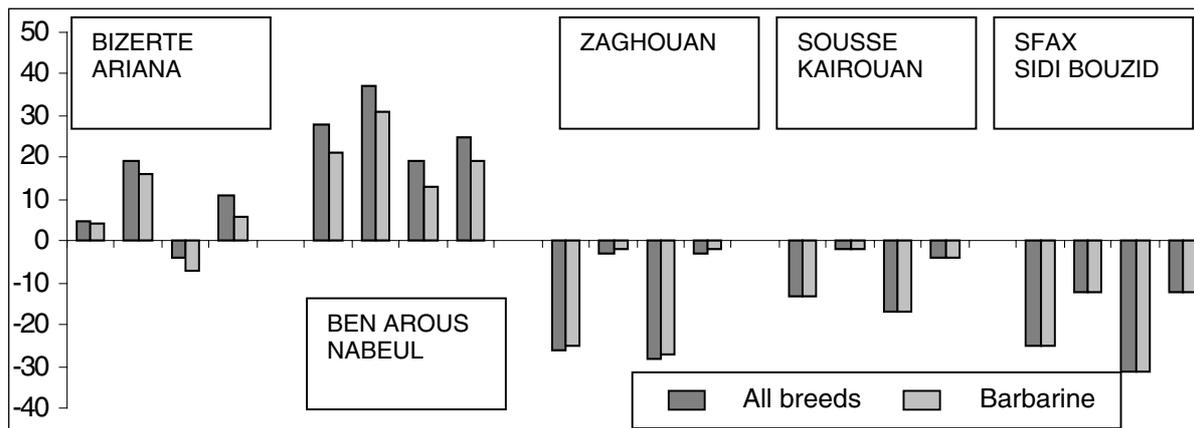


Fig. 2. Variability of lamb growth performances (ADG 3070 – ADG 1030) according to region (north-south gradient).

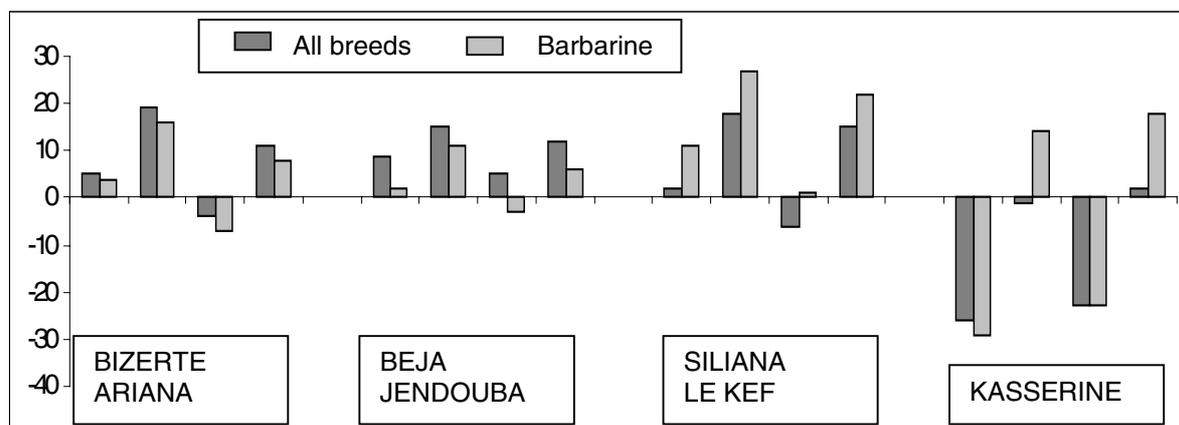


Fig. 3. Variability of lamb growth performances (ADG 3070 – ADG 1030) according to region (north-centre west gradient).

All these observations sustain the hypothesis of adopting different selection objectives and related methods of animal performance recording.

Milking sheep

The Sicilo-Sarde breed population has experienced, through the last decade, a considerable reduction. The number of breeding ewes is now estimated to be no more than 26,000. The breed is used for both milk and meat production. Market considerations are behind this choice as the Sicilo-Sarde lamb, despite its poor body conformation, is marketed earlier than lambs of other breeds hence, benefiting from higher selling prices. This advantage needs to be strengthened by an improved planning of mating, creep-feeding and weaning and should not cast doubt upon milk production as the main objective of selection for this breed. This is backed by the existence of the traditional (in Beja) or industrial (in Mateur) cheese manufacturing although further development requires a better organisation and screening of new markets.

The local goat population

Goat production in Tunisia is generally confined to marginal areas in mixed flocks with sheep. This

dominant production system has rendered performance recording and monitoring very difficult to carry out except for a reduced number of experimental flocks. Very few references are therefore available on the genetic ability of the local goat and its genetic improvement was mainly undertaken through crossing with imported exotic breeds. Most crossbreeding programmes whether in the north or in the south had an integrated, system-adapted approach. The main features of this approach are:

(i) The local goat need to be preserved in the very difficult areas where feeding resources are scarce or difficult to use.

(ii) If an improvement of the production environment is achieved, crossbreeding increases productivity when carried out within a controlled framework.

(iii) The crossbreeding alternative should be regarded as one step of a fully organised production scheme particularly in the case of milk improvement.

(iv) The introduction of pure exotic breeds, if considered, need to be restricted to very intensive production systems following thorough evaluation and after having ensured the turnover of their products.

In the north, the crossbreeding programme of the local goat ended without reaching the assigned objectives. In the south, particularly inside the oasis, the crossbreeding programme initiated by the Institute of Arid Lands (IRA) was more conclusive. The alpine breed was shown to better improve growth and milk performances (Table 6) and the IRA research programme led to a development project where the improvement of goat milk production through crossbreeding is a corner stone. The project seems to have sufficient arguments to support its objective of milk production intensification (Rekik and Prevost, 1995) even though important questions still need to be answered:

(i) The choice of the project to develop milk production causes a reduction in the income from meat selling and introduces changes on the organisation of the management system. These points need to be carefully studied and taken into account.

(ii) Even if the IRA results confirm the superiority of the alpine cross-breeds in milk production, a selection programme targeting the local population is essential bearing in mind the genetic diversity within this population and its place in the traditional oasis system.

(iii) Arbitrary crossing of the local goat with the alpine should be avoided. A prior definition of the level of crossing and the practical measures to achieve it are key elements for the success of the crossbreeding scheme.

Table 6. Milk production performances of local and cross-bred goats (Ben Hammouda *et al.*, 1989)

Genotype	Number of animals	Duration of lactation (days)	Milk production (kg/day/female)
Local	83	136	0.63
F1			
Alpine × Local	54	134	0.93
Damascus × Local	5	138	0.63
F2			
Alpine × Local	11	133	0.87

The rapid development of tourism in the south offering new prospects for the expansion of the goat milk market (Rekik and Prevost, 1998), the encouraging results of the genetic improvement programme and the necessity to develop animal productions in the oasis are strong arguments in favour of sustaining the development of a system based on the production, the processing and the marketing of goat milk with the involvement of local professional organisations.

Conclusion

The genetic diversity of the small ruminant population in Tunisia, beyond its preservation, must be developed while ensuring that every breed thrives in harmony within its appropriate environment. The more favourable areas of the north are suited for the Noir de Thibar and the black-headed strain of the Barbarine breeds. The breeding of the dairy population should be based upon increasing the milking ability of the Sicilo-Sarde breed and improved management practices are required to further benefit from the interesting market conditions for the early weaned lambs. In the centre and the south, breeding should be focused on the dam suckling ability. Crossbreeding should only be conceived under intensified production systems or to reduce the importance of the fat tail in the particular case of the Barbarine breed. As to the local goat population, crossbreeding with exotic breeds, especially in the south, seems to be irreversible. A performance recording scheme is essential to monitor the crossbreeding and to generate references for a preservation plan of the autochthonous population. Meanwhile, the principles of quantitative genetics are no longer the unique way to promote livestock breeding at a time where concern is made about biological and labelled products. These are difficult goals to achieve individually, getting together is the only way to success in animal genetic improvement programmes.

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