Soumis le : 25/12/2015
Forme révisée acceptée le : 15/11/2016
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Nature & Technology

Goat breeding in the rural district of Chemini (Algeria)

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Abstract

The Kabyle goat breed represents 10.52% of the total Algerian market (3.8 million heads). A survey of 69 farmers has been carried out in order to characterize it and its breeding in the district of Chemini. The questions focused on household agricultural activities, including breeding of goats, cattle, sheep, rabbits, chicken, turkeys, honeybees and the production of olive oil and figs. The goat morphobiometric characterization was based on 18 corporal measurements. The Hierarchical Cluster Analysis (HCA) of the farm structures defined four groups of farms, variance between groups accounting for 55.7% of total variability. The average number of goats in groups 1 to 4 was 7.2±2.8, 11.1±3.5, 22.3±1.4 and 3.4±1.0, respectively. Group 3 consists of older farmers (67 years old or over) not practicing arboriculture. They also have the largest numbers of sheep (48.67), rabbits (50.83), chicken (48.33) and turkeys (42). Group 4 was the group of young farmers (39 years old or less), more dedicated to cattle breeding, the production of olive oil and figs. The 18 morphobiometric variables were significantly higher in males than in females. The Kabyle goat is small(Height at withers) andwith long hair than female. Its ears are drooping, its convex profile has a slightly pronounced nasal split and its dress color ranges from dark brown to black. This adapted genetic resource should bea key in the development of a local production, based on a strong commitment of farmers inside a breed association, for the production of specimens corresponding to a standard, to be determined collectively.

Keywords:Bejaia (Algeria); Household agricultural activities; local goat characterization

1. Introduction

In Algeria, livestock consist mainly of dairy cattle, poultry and sheep[1-4]. Despite numerous programs aiming at developing the sector in the recent years, production performances are still unsatisfactory. Therefore, the competitiveness of local production remains poor and national demand for animal products is met by imports.

Kabylie is a coastal mountainous region of Algeria, spreading over about 7 administrative departments[1], among which the departments of Bejaia and Tizi-Ouzou hold a central role both culturally and economically. With nearly 4 million inhabitants, Kabylie represents 12% of the national population. The unemployment rate in this region is estimated at over 20%, which is higher than the national average rate of about 11%. Although agribusiness and intensive poultry production are rapidly growing in the region, the traditional agricultural economy of the region, which is based on arboriculture (figs and olives in particular) and livestock, remains the backbone of local development. Due to the Mediterranean sub-humid climate, Kabylie enjoys some of the best-irrigated lands of the country, offering a significant potential for mountain farming and forestry exploitation. Olives and figs have been cultivated in Kabylie for centuries, and are the bases of family farming systems. Other agricultural activities, such as cereals, pulses, fruits and market gardening, represent secondary food products. Nevertheless, agriculture and animal production is not attractive to young generations, which tend to migrate to the rapidly growing city of Bejaia.

[1]*wilaya*

In this context, goat breeding presents some potential for rural development. Indeed, it represents an alternative way of dairy and meat production, being better suited than cattle to mountainous conditions and requiring lesser investment costs. In Algeria, goats are estimated at 3.8 million heads in total including 2.2 million adult females. With 400 000 heads, the Kabylie region harbors about 10% of the national herd [1].In general, the goat population in Algeria is highly heterogeneous, due to frequent crosses between breeds or a relative lack of breed management. This makes the distinction between goat breeds difficult. In continuation of works on local goat breeds characterization in Kabylie[5-8],this paper attempts to characterize the goat population and the typology of the farms involved, in the rural district[2] of Chemini, of the department of Bejaia.

2. Material and methods

2.1. Study area and sampling

Cheminiis a district and municipality in the department of Bejaia, in Algeria, situated at 60 km southwest of the city. Chemini is located in the Western of the wilaya of Bejaia, at 140 km West of Algiers. The surface area of Chemini is 39.04 km². In 2008, the population was 36766 inhabitants distributed amongst 64 villages.

The department covers a mountainous region with peaks reaching 1896 m. However, except the corridor formed by the Soummam valley and on the coastal plains, the majority of villages are located at about 1000 m of altitude. The soil of the region is generally siliceous and shows low fertility. In the department, the rural district of Chemini includes four local areas covering about 100 km^2 and counting 36800 inhabitants (368 inhabitants per km²), which is about 3.7% of the total population of the department of Bejaia.

The collection of data involved a sample of 69 goat breeders (22 women and 47 men),distributed overthe four areas of the district of Chemini: Akfadou (18), Chemini (21), Souk Oufella (17) and Tibane (13). Interviewees were smallholders selected in collaboration with a local veterinary practitioner.

2.2. Data collection

2.2.1. Interviews with farmers

The face-to-face interviews were of a structured type. The questionnaire included both close-ended and open-ended questions. It successively focused on the socio-economic profile of the farmer, his agricultural activities, and practices in local goat breeding. Open-ended questions concerned the history of the household and of the farm.

2.2.2. Morphobiometric study

Animals used for morphobiometric characterization were exclusively adult ones (72 females and 23 males over 15 months of age). The visited households were informed the day before to prepare their animals in order to make them available for measurements through confinement and tethers. Body measurements (quantitative traits) were carried out by three technicians using Lydthin stick, tape measure and Vernier calipers. 17 body measurements were recorded: head length, ear length, neck length, body length, trunk length, pelvis length, hip width, ischium width, chest size, chest depth, chest width, height at withers, height at back, height at sacrum, side depth, hair length and tail length.

2.3. Statistical analysis

All statistical analyses were performed using the Statistical Analysis System software [9].Socio-economic data about interviewees, their farms and practices were first analyzed through the calculation of descriptive statistics (frequencies, median, minimum, maximum, means, and standard error). Spearman correlation coefficients were calculated between the numbers of the different animal species and crop trees owned, and between those and the age of the farmer. Quantitative variables about agricultural activities of households (number of goats, cattle, sheep, rabbits, hens, turkeys, beehives, olive and fig trees) were then submitted to principal component analysis (PCA) (proc factors, procprincomp). A hierarchical classification (HC) (proc CLUSTER), using Ward's algorithm, was performed in order to achieve the overall farm typology. Following completion of PCA and HC, the Kruskal-Wallis one-way analysis of variance(proc npar1way) has been carried out to investigate the effect of the typological group variable (determined by HC) on the composition of the farms: number of animals by species, number of hives, olive and fig trees.

[2] *daira*

Morphobiometric data were also described statistically and differences according to sex were sought through variance analysis (proc GLM). A linear prediction model for live weight was chosen and estimated, according to a stepwise SAS procedure (proc stepwise)[9].

3. Results

3.1. Socio-economic profile of the surveyed households

The median age of the interviewed farmers was 62 years old (maximum 68, minimum 28). Agriculture was the main activity of 54.5% of the surveyed men and of all interviewed women. The sample also included 11 male retirees (25.0%). Education level was generally low. Two women were illiterate (both older than 65 years) while all men had a minimal education level of primary study certificate.

Table 1
Animal species, olive and fig owned by farmers interviewed

Species	Livestock (n)	Animal number				
		Mean	Median	Max.	Min.	CV
Goat	69	9.42	9	24	2	57.87
Cattle	40	21.82	12	92	1	113.88
Sheep	59	16.57	12	79	1	100.41
Rabbit	35	33.80	35	66	2	41.51
Hen	54	22.24	20	50	2	57.24
Turkey	20	29.50	28.50	58	11	40.80
Bee hives	30	12.07	9	24	2	59.72
Olive	63	71.79	49	395	5	105.14
Fig	63	22.32	16	64	4	61.44

Table 1 describesthe composition of livestock and agriculture in the rural district of Chemini. The domestic animals owned by the interviewed households were diverse. Besides goats, most households owned bovines (69.57%), sheep (85.51%), and chicken (78.26%). 50.72%of them owned rabbits (50.72%) and 43.48% owned beehives. Turkeys were less frequent (28.99%). In terms of number of heads, the sheep population dominated the other animal species, followed by the chicken (Table 1). Almost all farmers (91.3%) owned fig and olive trees (Table 2).

Table 2
Pearson correlation of different variables studied.

	Farmer age	Goat	Cattle	Sheep	Rabbit	Hen	Turkey	Beehives	Olive
Goat	0.80 ***								
Cattle	-0.58 ***	-0.49 **							
Sheep	0.25 ns	0.53 ***	-0.27 ns						
Rabbit	0.68 ***	0.64 ***	-0.34 ns	0.489 **					
Hen	0.76 ***	0.97 ***	-0.43 *	0.672 ***	0.68 ***				
Turkey	0.12 ns	0.13 ns	0,48 *ns	0,486 *	0,31 ns	0.45 ns			
Beehives	-0.40 *	-0.29 ns	0,48 *	-0.19 ns	-0.38 ns	-0.20 ns	0,42 ns		
Olive	-0.91 ***	-0.92 ***	0,62 ***	0,122 ns	-0.07 ns	-0.895 ***	0.27 ns	0,21 ns	
Fig	-0.95 ***	-0.95 ***	0,63 ***	0,039 ns	-0.21 ns	-0.94 ***	0.24 ns	0,23 ns	0,99 ***

**** : statistically significant (p<0.001); **: statistically significant (p<0.01); *: statistically significant (p<0.05); ns : statistically not significant (p>0.05)*

Regarding Pearson correlation coefficients, gathered in Table 2, highly significant positive correlations ($p<0.001$) were recorded between the breeders' age and the number of goats (0.808), hen (0.764) and rabbits (0.681). In contrast, significant negative correlations ($p<0.05$) were recorded between the breeders' age and the number of fig trees (-0.945), olive trees (-0.91), cattle (-0.58) and beehives (-0.40). The number of goats correlates significantly ($p<0.05$) and negatively with the numbers of cattle (-0.493), olive trees (-0.915) and fig trees (-0.952). It correlated positively with hen (0.966) and rabbits (0.639). The number of cattle correlates positively and significantly ($p<0.001$) with numbers of olive trees (0.615) and fig trees (0.633).

3.2. Multivariate analysis and farm typology

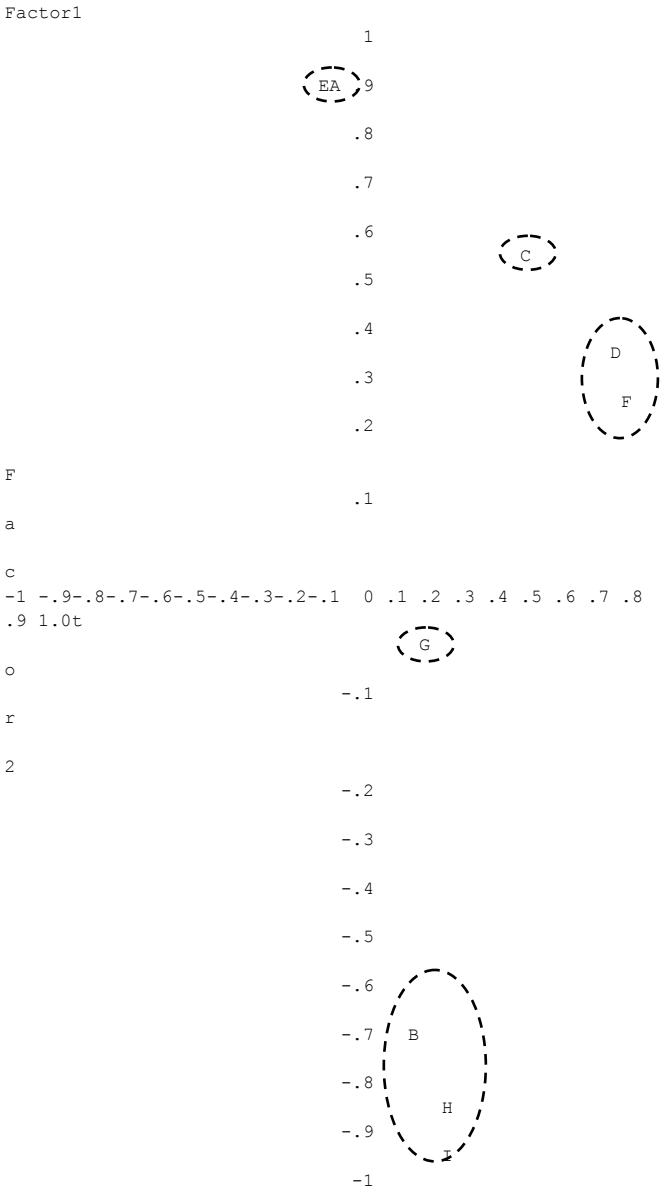
3.2.1. PCA overall description

The first three factorial axes accounted for 76.32% of the total variability. The correlations of the quantitative variables with the three factorial axes are shown in Figures 1 and 2.

- Axis 1 represented 46.45% of total variation. It was positively correlated with the numbers of goats (r = 0.921), hens (r = 0.916) and sheep (r = 0.531). This correlation was negative with the number of fig trees (r = -0.926), olive trees (r = -0.828) and cattle (r = -0.676).

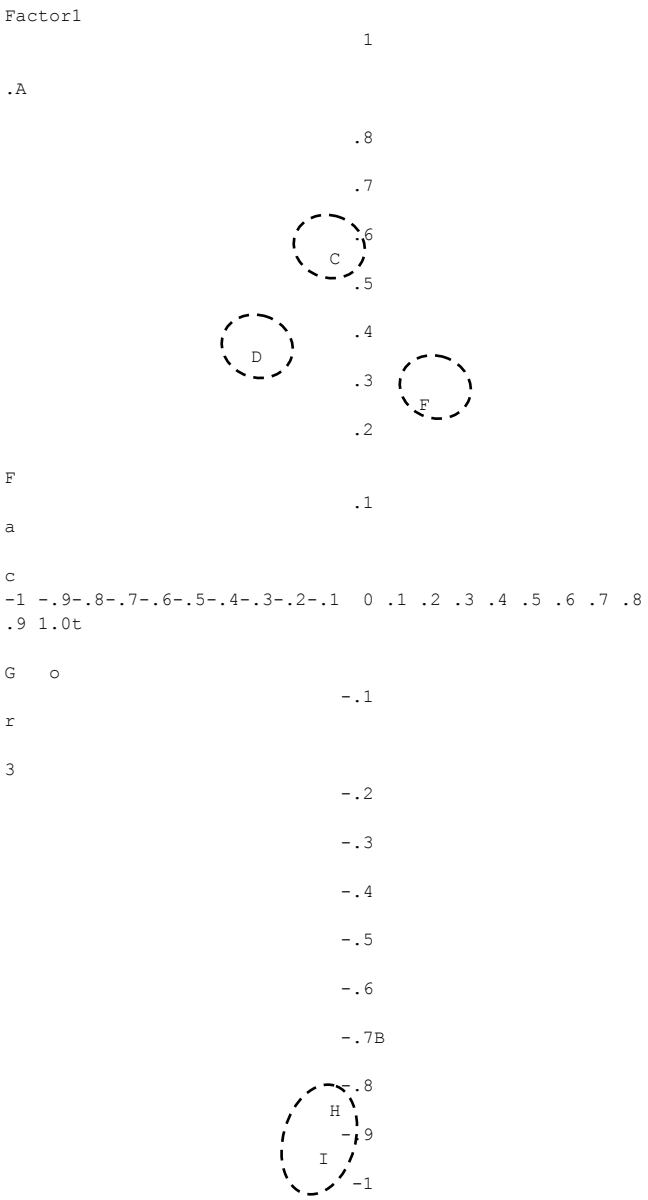
- Axis 2 represented 18.00% of the total variation. It was positively correlated with the numbers of turkeys (r = 0.786), rabbits (r = 0.737) and sheep (r = 0.497).

- Axis 3 represented 12.00% of the total variation. It was correlated with the number of beehives (r = 0.956), indicating the specialization of the interviewed persons in honey production



Goat=A; Cattle=B; Sheep=C; Rabbit=D; Hen=E; Turkey=F; Bee hives=G; Olive=H.

Fig. 1: Projection of variables defining the clusters on the axes (Z1- Z2).



Goat=A; Cattle=B Sheep=C; Rabbit=D; Hen=E; Turkey=F; Bee hives=G; Olive=H

Fig. 2: Projection of variables defining the clusters on the axes (Z2- Z3).

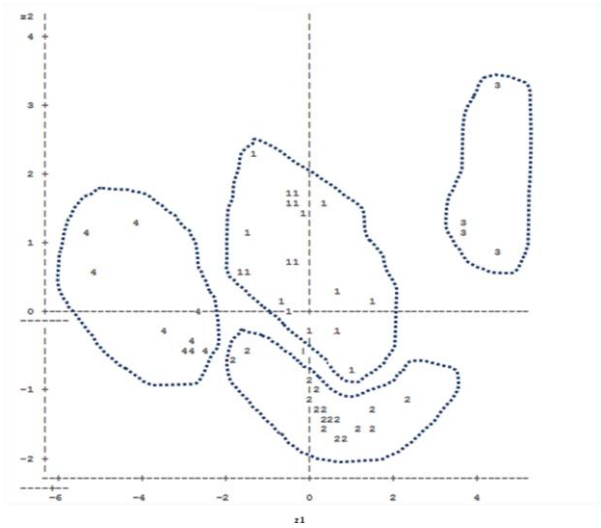


Fig. 3: Distribution of holdings in the principal plane (Z1-Z2).

- *Cluster 1 (n= 29; 23.9% of sample size)*

The median number of goats in this cluster was 6 with a minimum of 4 and a maximum of 12. All farmers of this cluster owned between 6 and 60 sheep (median 13). They also all owned between 22 and 102 olive trees (median 82)and between 11 and 32 fig trees (median 25). The majority of farmers of this cluster also owned rabbits (86.21%) and chicken (79.31%). Around half of them owned cattle (58.62%) turkeys (55.17%), and beehives (41.38%).

- *Cluster 2 (n= 25; 20.1% of sample size)*

The median number of goats in this cluster was 11 with a minimum of 2 and a maximum of 17. All farmers of this cluster owned between 5 and 95 olive trees (median 25)and between 4 and 29 fig trees (median13). The majority of farmers of this cluster also owned chicken (96.00%, maximum 45) and sheep (76.00%, from 1 to 25). Around half of them owned cattle (52.00%, from 1 to 69), and beehives (52.00%, from 2 to 24).

- *Cluster 3 (n=6, 11.7% of sample size)*

This cluster is characterized by the absence of fig and olive tree ownership.The number of goats in this cluster was between 21 and 24. All farmers of this cluster owned between 27 and 79 sheep (median 40). They also all owned between 39 and 66 rabbits (median 47.5), and between 26 and 58 chicken (median 49). Two thirds of farmers of this cluster also owned turkeys (66.67%, from 26 to 52) and beehives (66.67%, each had nine).

- *Cluster 4 (n=9; 6.63% of sample size)*

The median number of goats in this cluster was 35 with a minimum of 29 and a maximum of 48. All farmers of this cluster owned between 96 and 395 olive trees (median 182)and between 31 and 64 fig trees (median 39). They also all owned between 1 and 69 cows (median 45). Around half of them owned sheep (55.56%, from 1 to 9), and a third of them owned rabbits (33.33%, from 2 to 30).

3.2.2.Comparison between clusters

All clusters included both men and women in similar proportions (Fisher's exact test, p=0.07). All four communes[3] were represented in each cluster, except Souk Oufela that was absent from cluster 3. As shown in Table 3, all variables included in the PCA and HC, except beehives number, proved to be significantly different between clusters ($p<0.05$). The age of farmers, which was not included in PCA and HC, also showed a statistically significant difference between clusters (Table 3). Cluster 4 included younger individuals (28 to 48 year old) and cluster 3, the oldest (67 to 68 year years old). Cluster 1 was intermediate in age with individuals 43 to 65 years old, while cluster 2 spread over the wider range of ages (from 28 to 66).

3.3. Morphobiometriccharacteristics and the choice of the live weight prediction model

The results in Table 4 indicate that the mean values of males measurementswere significantly higher, compared to those of females, for all the studies parameters ($p<0.05$). The average goat body weights were 38.99±0.836 kg for males and 31.93±0.474kg for females (Table 4).

[3]*district*

Table 3
Farmer age, animal species, olive and fig owned by cluster (Mean, Kruskal-Wallis test).

	Cluster 1	Farmer number	Cluster 2	Farmer number	Cluster 3	Farmer number	Cluster 4	Farmer number	Cluster Effect
Farmer age	54.24	29	61.16	25	67.33	6	37.11	9	***
Goat	7.17	29	11.08	25	22.33	6	3.44	9	***
Cattle	15.18	17	9.9	13	1.00	1	51.56	9	***
Sheep	16.38	29	9.53	19	48.67	6	6.00	5	***
Rabbit	33.44	25	2.00	1	50.83	6	13.33	3	***
Hen	14.91	23	23.42	24	48.33	6	6.00	1	***
Turkey	26.38	16	-	-	42.00	4	-	-	*
Beehives	9.83	12	14.15	13	9.00	4	24.00	1	ns
Olive	67.10	29	28.64	25	-	-	206.78	9	***
Fig	22.55	29	13.04	25	-	-	47.33	9	***

**** : statistically highly significant (p<0.001), * : statistically significant (p<0.05), ns : statistically not significant (p>0.05)*

Table 4
Least square means (LSM) and their standard error (Se) for each of the 18 body measurments by sex.

Parameters	Lsmeans ± SE		R^2
	Male	Female	
Weight (Kg)	38.99±0.836[a]	31.93±0.474[b]	.369
Body length (cm)	95.12±0.963[a]	92.29±0.547[b]	.074
Chest depth (cm)	33.96±0.571[a]	31.19±0.325[b]	.163
Thoracic perimiter (cm)	76.02±0.946[a]	73.19±0.538[b]	.074
Chest width (cm)	26.30±0.581[a]	23.57±0.334[b]	.155
Ear length (cm)	20.25±0.502[a]	17.48±0.283[b]	.203
Height at back (cm)	69.69±0.981[a]	66.86±0.554[b]	.069
Head length (cm)	20.46±0.582[a]	17.71±0.336[b]	.164
Hair length (cm)	12.24±0.508[a]	9.51±0.292[b]	.197
Height at sacrum (cm)	69.60±0.914[a]	66.78±0.513[b]	.074
Height at withers (cm)	68.23±0.972[a]	65.41±0.554[b]	.063
Hip widh (cm)	17.84±0.539[a]	15.10±0.303[b]	.184
Ischionwidh (cm)	15.60±0.513[a]	12.86±0.291[b]	.195
Neck widh (cm)	38.85±0.803[a]	36.05±0.446[b]	7].092
Pelvis length (cm)	22.37±0.519[a]	19.59±0.293[b]	.191
Side depth (cm)	39.83±0.712[a]	37.05±0.404[b]	.114
Tail length (cm)	20.61±0.642[a]	17.87±0.365[b]	.138
Trunk length (cm)	64.13±1.031[a]	61.35±0.577[b]	.064

a, b: Different letters on a same line indicate statisticaly different values.

Table 5: Stepwise selection of traits by sex

Sex	BarymetricEquation	R^2
Total	Weight (kg) = 0.574 (BL) + 0.509 (EL) –28.56	0.601
Male	Weight (kg) = 0.612 (BL) -19.249	0.302
Female	Weight (kg) = 0.578 (BL) + 0.681 (EL) – 0.422 (PL) - 25.53	0.849

BL: Body length ; EL: Ear length ; PL: Pelvis length

As indicated in Table 5, the variables retained for live weight prediction were body length, ear length and pelvis length. The combinations varied between equations estimated for males, females and total sample.

4. Discussion

4.1. Herd structure

Most of the surveyed farmers had mixed herds, comprising several animal species. Herds consisting of both sheep and goats are common in Chemini region and account for about 85% of the interviewed farmers. This sheep-goat production system in small farms is sedentary and agro-pastoral. It is very common in Algeria, as described by Madani*et al.*[10]and Bencherif[11]. According to these authors, a typical herd composed of sheep and goats is entrusted to a shepherd, who is a member of the family, which is then responsible for pasturing his herd and buying grain to feed the animals. In mountainous region, goat meat is highly appreciated and its consumption is mainly in the summer time, following the animal's reproductive cycle. In addition, raw milk, curd and sour milk are produced for home-consumption, despite the low individual milk yield of goats.

The goats-to-sheep ratio in this study was 0.54, which is significantly in favor of sheep. Farmers thus opt for breeding sheep rather than goat, not only for production motives but also due to the ease to keep larger herds of sheep compared to goats thanks to their herd behavior. Less easily monitored on pastures, goats are more prone to cause nuisance in orchards and cultivated fields, and thus conflicts. Similarly, Wilson [12] reported and discussed a goats-to-sheep ratio in Senegal and Mauritania of 1:2 and 1:3, respectively.

The very difficult farming conditions and the weak technical supervision of goat herds in the studied region explain the low total productivity of the Kabyle goat (milk and individual weight gain). Nevertheless, prolificacy of the Kabyle goat breed being renowned in the region, this quality should be assessed under improved conditions and its potential for further development of goat breeding should be fully assessed. Commercially-oriented production might develops as a new local economic opportunity, aiming at production of meat, milk and leather. Due to the agro-pastoral involved, production of manure would be also a valuable contribution of goat breeding.

4.2. Farm typology

The composite agro-pastoral systems in which goats are found in Kabylie are part of a strategy of diversification and complementarity between productions. The species-mix moreover results from opportunities met by the farmers. In order to contribute to a further development of goat production, its insertion in these composite production systems has to be understood. Therefore, this paper proposes a typology based on the composition of the agro-pastoral portfolio of farmers in the considered district.

The most striking characteristics of the described clusters are as follows. Cluster 1 and cluster 2 are quite similar, except for the total lack of turkeys and relative lack of rabbits in cluster 2. Accounting together for 78% of the total sample, they may be considered as the dominant type of farm in the region, cluster 1 is showing a slightly better endowment and more diversification.

The main feature of cluster 3 is that it is composed of older individuals, owning the largest numbers of animals (except cattle) among the four clusters but no fig or olive trees. The relative specialization of these farmers in small livestock could be explained by their old age. This is in accordance with the overall positive correlations between the farmers' ages and the number of small ruminants, chickens and turkeys.

In contrast, cluster 4 is composed of younger individuals owning the most fig and olive trees and the most cattle. This latter cluster typically results from a national agricultural policy, which encourages the breeding of dairy cattle through subsidies. The need to own at least one hectare per cow to receive these subsidies explains the high number of olive and fig trees in this group. Indeed, these trees are traditionally grown in Kabylie and are present on virtually all agricultural fields in the region of the study. The high number of beehives in one household of this cluster is also related to the public subsidies to young farmers.

4.3. Morpho-biometry study of the Kabyle goat

As described by Espérandieu and Chaker [13], the Kabyle goat is small with long hair. Its ears are drooping, its convex profile has a slightly pronounced nasal split and its coat colour ranges from dark brown to black. However, the crossbreeding with exotic breeds (mainly with Saanen goat), controlled or uncontrolled, increased the frequency of white coat [6].

The greater body size in males is consistent with the marked sexual dimorphism widely documented in goats [14]. The measurements that have been selected for the prediction of live weight, namely body length, ear length and pelvis length, are easy to take and did not require much labor to restrain the goat. Unlike the interesting coefficients of determination obtained for predictive models in total and female samples, the coefficient for males was very low (0.30). This could be due to the low number of males studied.

5. Conclusion

From the present results, the Kabyle goat appears as a well-characterized breed, exploited in diversified agro-pastoral production systems. In the prospect of capitalizing on this valuable genetic resource, the population nevertheless lacks a management structure that would pursue collectively defined selection goals. Such a structure would need a strong involvement of breeders and is by nature concomitant to the setting-up of a strategy for the development of a value chain for goat products. This survey indicates that the involvement of younger breeders, that would be useful in such a perspective, is at present diverted from investment in goat production due to public subsidies stimulating cattle production and larger land holdings.

Acknowledgment

The farmers of the region of Chemini are fully thanked for their availability during the survey.

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