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Indigenous Kids' Weight Variation with Respect to non Genetic Factors under Pastoral Mode in Tunisian Arid Region

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Abstract: During four years, a weighing program allowed collect about 4900 of data of 722 indigenous kids raised in 9 herds in the Tunisian arid zone under pastoral husbandry mode. A Gompertz model was applied to estimate kids' weights at some standard ages 10, 30, 60, 90, 120, 150 and 180 days. A GLM procedure was applied to decompose the total variance of the kid's traits. A means comparison test (SNK, $\alpha = 0.05$) was applied to identify homogenous class by factor. Results show that the GLM determination coefficient R^2 remains lower than 87% of all studied traits due to the observed data structure. All traits seem to be affected by the significant effects ($p<0.001$ or 0.05) of the factors related to the restrictions and the irregularity of the technical and natural environment of pastoral husbandry. The non-genetic factors impact increases with kids' age and requirements. Growth traits varied with year, herd, month of birth and natural region. The year factor plays an important role upon the kid's weight and it evolution till 6 months age. The sex, birth mode and mother age acts only during first 2 months age. Regarding the birth season effect, regrouping kidding period allows improving herd productivity. So, arid environment affects both quantitatively and qualitatively individual kid's growing behaviour and have to be considered for local goat rational genetic improvement modelling and planning.

Key words: Kids weight, local population, arid environment, non-genetic factors, pastoral breeding, Tunisia

INTRODUCTION

Actually, more than 60% of the national caprine herd estimated to 1 500 000 goats were raised in the Tunisian arid area (Najari, 2003; DGPA, 2005). Since centuries, the pastoral breeding mode allows to valorise the rangelands resources by ambulant small ruminant herds under harsh conditions. In southern Tunisia, kids' meat represents about 75% of the local meat production (Najari, 2003). Kids were not weaned till their separation from ambulant herds in summer when they were slaughtered (Najari *et al*., 2007; Gaddour *et al*., 2007). Regarding the birth season, the age of market class kids varies between 4 and 8 months. Thus, kid's weights during this earlier age represent an important phenotype conditioning the final cash flow of this pastoral production mode (Ouni, 2006; Gaddour *et al*., 2007). With respect to arid difficult conditions characterized by restricted and irregular resources, the kids' meat goat production is affected more by non-genetic factors because of the extensive grazing management. indeed, when establishing breeding programme or estimating genetic parameters, model should account correctly for the environmental effects and interactions (Schinckel and De Lange, 1996; De Lange *et al*., 1998; Schinckel and Craig, 2001). Under arid conditions, rather than the classic effects of non genetic factors upon growth kids, a specific qualitative action of harsh condition was verified (Najari *et al*., 2002). Indeed, severe conditions, do not allow the animals to express their real genetic potential.

As other quantitative phenotypes, kids' weights change by all factors affecting the growth rather than the individual genetic potential differences (Walkden-Brown *et al*., 1994; Schinckel and de Lange, 1996; Alexandre *et al*., 1997a; Bocquier *et al*., 1998; Oltenacu, 1999).

The study aims to estimate the natural and technical non-genetic effects on indigenous kids' weights under

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pastoral conditions in the Tunisian arid region. Also, we purpose understanding kids' growing behaviour of indigenous kids towards arid environment factors by the analysis of a large data set collected within ambulant herds. Rather than the local population characterization, the results may improve the husbandry policy to optimise the herd production and land conservation considering the serious desertification risks in the studied area.

MATERIALS AND METHODS

Study zone: Data were collected from the arid region of Tunisia as ecologically defined by Floret and Pontanier (1982). The climate is arid Mediterranean, very hard and precarious (Ouled Belgacem, 2006). With an annual average of 140 mm, precipitation presents a large spatial and seasonal variation. The arid zone is actually the most important of rangelands of the country and is mainly used for extensive camel and small ruminants grazing (Nasr *et al*., 2000).

Animal material: The indigenous goat population constitutes an animal group adapted to the arid rangelands harsh conditions (Najari *et al*., 2006). The complex adaptation criteria were acquired through a long natural and human selection process under local difficult conditions, especially climate severity and vegetation scarcity (Najari, 2005). The indigenous goat population shows a large variability both in morphology and performances (Najari, 2003). Characteristics of the population include the ability to walk long distances, water deprivation resistance and good kidding ability. Fertility rate is about 87% and prolificacy rate varies between 110 and 130% (Najari *et al*., 2004). Since the fecundation period continues during summer, kidding begins in October and continues till February with a concentration in November and December when 69.2% of kids are born.

Data collection: About 5000 kids' weights were used in the present study. Data is carried out, during four years, from a periodical weighing plan of 722 indigenous kids raised in eight ambulant herds under arid land conditions in the southern Tunisia. Since the start of the kidding period and till summer beginning, kids were weighed once every two or three weeks. The controlled herds are distributed on different ecological zones of the arid region.

Each kid records included goat mother and kid identification, type of birth, date of birth, sex, herd, natural region and kid's weights measured with the corresponding dates of controls.

Individual growth parameters and weights estimation: Regarding previous studies, (Najari, 2005; Najari *et al*., 2007), it was concluded that the Gompertz function is the convenient model to assess the indigenous kids' growth during the first 6 months age. Hence, this model was used to estimate individual curve parameters and kid's weights at some fixed ages.

According to Schnickel and Craig (2001), the Gompertz function is defined by:

$$\text{Kid weight (kg)} = A*\text{Exp}(-\text{Exp}(-b(t-c))$$

t is the kid age (days); A is the curve asymptote. Parameters b and c adjust both slope and inflexion point. The coordinates of the point of inflection are $t_i=c$ and $W_i=A/e$.

For each kid, the Gompertz growth curve parameters were estimated by an iterative procedure with zero as the starting value for all parameters. The number of the iteration is fixed less than 1000 and the convergence criterion was set at 10^{-8} (Najari *et al*., 2007).

Having the individual growth curve parameters, we estimate for each kid, some weights at fixed ages such as 10 days, 1 month, 2 month, 3 months, 4 months, 5 months and 6 months.

Statistical analysis: The individual estimated weights are analysed as quantitative traits. A General Linear Model analysis was applied to decompose the total variance and to apply the F statistical significance test. Note that for the birth weight, data used is reduced to the kids controlled at the first day age.

The statistical GLM model used with independent variables was as follows:

$$Y_{ijklmnop} = r_i + h_j + s_k + bm_l + mon_m + year_n + agem_o + \text{interactions} + e_{ijklmnop}$$

Where

$Y_{ijklmnop}$ = Is the performance analyzed: kid's weight at 10, 30, 60, 90, 120, 150 and 180 days.

r_i = The geographic zone effect (i=1, 2 or 3, respectively costal, steppe and mountain zone);

h_j = The herd effect (j=1,….8);

s_k = The sex effect (k=1, 2; male or female) ;

bm_l = The mode of birth effect (l=1,2; single or twin);

mon_m = The month of birth effect (m=1,….12);

$year_n$ = The year of birth effect (n=1,…,4);

$agem_o$ = The goat mother age effect (o=1,…,8);

$e_{ijklmnopq}$ = The model residual.

Only interactions of two degree were considered. Except the residual error, all factors and interactions are considered fixe. A SAS GLM procedure was used to resolve the linear equations system (SAS, 1999). The variance decomposition was followed by a Student Newman and Keuls (SNK) test, in order to compare subclasses averages of factors having a significant statistical effect ($p<0.05$ or $p<0.01$) upon the analyzed trait.

RESULTS AND DISCUSSION

Non-genetic factors affecting the indigenous kids' growth : Table 1 presents the results of the GLM analysis of variance for kids weights estimated at fixed ages.

The GLM model coefficient of determination R^2 varied for all traits between 0.65 and 0.89. It seems that an important part of the total variability remains not represented into the model. This can be statistically tolerated when data is collected during large period and under arid irregular environmental conditions (Najari *et al*., 2007). Also the local goat population genetic large variability can induce a data distribution hardly handled by mathematical models (Najari *et al*., 2006). When the performance corresponds to a later age, the R^2 value tends to increase. So, more the kids were older; more the weight variability is explained by unknown environmental factors.

Natural region, herd and year of birth manifest a high significant effect upon all analyzed traits ($p<0.01$). These factors appear having the most important effects through their impacts on the forage availability and the arid climatic stresses; whereas, the other factors effects remain varying with respect to the studied trait and the growth stage.

Among the interactions included in the decomposition model, we note the importance of the effect of those including the factor herd (management mode) with the effect of natural factors such as region, year or month (Table 1).

Regarding kid's sex, birth mode and mother age which were known with a classic impacts upon the early kid growth, it seems that they have only reduced effects under extensive breeding system in an arid land. The influence of such factors is secondary towards the impact of factors conditioning the food availability and herd management under harsh and irregular circumstances. These resultants agree with those presented by Najari (2005).

Year of birth effect upon kids' growth: Figure 1 illustrates the evolution of the kids' weights respectively during the four studied years. Means comparison were regrouped in Table 2.

Table 1: Analysis of variance results for kids' individual weights with respect to non genetic factors

		Kid's weight at (days)						
Factor	df	10	30	60	90	120	150	180
Ecological zone (Z)	2	**	**	**	**	**	**	**
Herd (H)	8	**	**	**	**	**	**	**
Sex (S)	1	**	**	**	**	**	**	**
Birth mode (b m)	1	NS	NS	*	**	**	**	**
Birth month (m on)	7	NS	*	NS	NS	NS	NS	NS
Year (Ye)	3	**	**	**	**	**	**	**
Mother age (Age m)	7	NS	**	**	**	*	NS	NS
H*S	8	NS	NS	NS	*	**	NS	NS
H*BM	8	NS	**	**	NS	NS	NS	NS
H*MON	26	**	**	**	**	**	**	NS
H*YE	11	*	**	*	**	**	NS	*
H*AGEM	46	**	**	**	**	**	NS	NS
S*BM	1	NS	NS	NS	NS	NS	NS	NS
S*MON	7	**	**	**	**	**	NS	NS
S*YE	3	NS	NS	NS	NS	NS	NS	NS
S*AGEM	7	NS	NS	NS	NS	NS	NS	NS
BM*MON	5	NS	NS	NS	NS	NS	NS	NS
BM*YE	3	NS	NS	NS	NS	NS	NS	NS
BM*AGEM	7	NS	NS	NS	*	*	NS	*
MON*YE	9	NS	NS	NS	NS	*	NS	NS
MON*AGEM	27	NS	NS	NS	*	**	NS	NS
YE*AGEM	16	NS	NS	NS	NS	NS	NS	NS
Z*H	8	**	**	*	**	**	NS	NS
Z*S	2	NS	NS	NS	NS	NS	NS	NS
Z*BM	2	NS	NS	NS	NS	NS	NS	NS
Z*MON	6	NS	NS	NS	NS	NS	NS	NS
Z*YE	4	NS	NS	NS	NS	NS	NS	NS
Z*AGEM	12	NS	NS	NS	NS	NS	NS	NS
R^2	-	0.69	0.78	0.81	0.83	0.89	0.87	0.87
Observations	-	668	668	668	668	668	668	668

df: degree of freedom ; R^2: Model determination coefficient; NS: Non Significant; *: Significant ($p<0.05$); **: Highly significant ($p<0.01$)

Table 2: Means comparison test (SNK, α=5%) for indigenous kids' weight by years

		Kid's weight at (days)						
Years	N	10	30	60	90	120	150	180
1997/1998	1326	3.77[ba]	5.79[b]	8.98[b]	11.96[b]	14.7[b]	16.51[b]	19.4[b]
1998/1999	1395	3.98[a]	6.18[a]	9.83[a]	13.46[a]	16.97[a]	19.77[a]	22.3[a]
1999/2000	1086	3.07[c]	4.36[d]	6.4[d]	8.37[d]	10.16[d]	11.86[c]	13.7[c]
2000/2001	960	3.67[b]	5.09[c]	7.29[c]	9.34[c]	11.2[c]	12.13[c]	14.3[c]
Means	4767	3.62	5.35	8.12	10.78	13.25	15.06	17.42

a,b,c and d: Homogeneous groups; N: Observations

Table 3. Means comparison test (SNK, α=5%) for indigenous kids' weight by ecological zone

		Kid's weight at (days)						
Natural zone	N	10	30	60	90	120	150	180
Coastal	3069	3.53[b]	5.22[c]	7.82[c]	10.3[b]	12.55[b]	12.76[c]	14.2[c]
Steppe	959	3.81[a]	5.89[a]	9.37[a]	12.82[a]	16.21[a]	18.72[a]	20.1[a]
Mountain	739	3.77[a]	5.49[b]	8.17[b]	10.64[b]	12.8[b]	15.29[b]	15.4[b]
Means	4767	3.7	5.53	8.45	11.25	13.85	15.59	16.56

a,b and c: Homogeneous groups; N: Observations

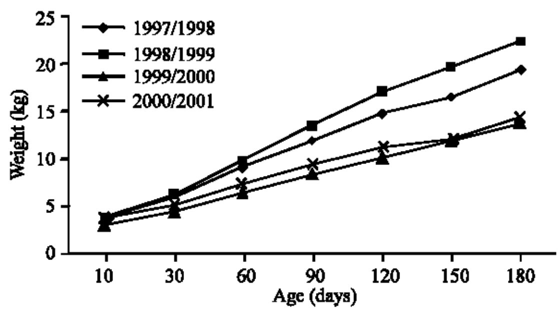

Fig. 1: Kids' weights till 6 months age by year of birth in pastoral mode

The better kids' performances were registered during 1989 and1999 (Table 2). Rather than its harsh conditions, the arid environment is essentially defined by its irregular conditions (Ouled Belgacem, 2006; Ferchichi, 1996). During the survey period, annual rainfall ranged between 37 mm for 2000 and 2001 and 307 mm for 1997 and 1998. Indeed, this variation is expressed by serious fluctuations of the forage available to animals.

Since early age (Fig. 1), the year effect is highly significative ($p<0.01$). This ambiantal effect becomes higher with the kids' age which expresses the nutritive requirements increasing. It seems that reduced requirements can be covered by land grass during this young age. When the animal needs are low, we can expect phenotypic differences expressing various genetic potentialities; whereas, at older age and high needs, the phenotypic differences were essentially attributed to the nutritional availability defined by environmental factors. This qualitative aspect of the year effect upon the kid's growth must be considered to manage genetic improvement plan adapted to the indigenous population and the arid conditions. When the animal's needs are low, it will be possible to express genetic differences between animal's phenotypes; which represents the environment behavior for aged animals under very restrictive circumstances.

The year effect upon the kids' growth was verified by several authors (Walkden-brown *et al.*, 1994; Gipson and Wildeus, 1994; Das *et al.*, 1996; Alexandre *et al.*, 1997a; Bocquier *et al.*, 1998). All authors agree on the year impact witch acts directly on kid's nutritional resources and indirectly by the bias of the mother milk production. The significant effect of the herd* year interaction (Table 1) testifies a different response of herds towards annual conditions. When some herds remain able to stamp the drastic conditions by the transhumance practice or by the herd supplementation; others seem having minor resources to safeguard their herds and remain exploiting the same lands. Thus, the role of the herd and the farmer technical capacity can vary the effect of the year.

Natural zone effects: GLM analysis (Table 1) illustrates a significant effect of the ecological zone ($p<0.01$). Table 3 presents the SNK results for the analyzed kids' weights.
The natural zone affects kid's growth through the resources and the herd management not homogenous in studied ecological zone such as steppe, costal and mountainous zone (Najari *et al.*, 2003; Ouled Belgacem, 2006; Najari *et al.*, 2007). In the coastal zone, the livestock plays a secondary role n the family incomes and the pastoral lands are regressing in favor to oil culture. Whereas, in the second zone, the livestock remains he principal activity and herds graze extensively the vast communal lands and pasture without sensible mobility restrictions. While in mountainous zone, goatherds valorize accidental and vacant lands.

According to Table 3 and since 10 days age, the steppic kids have the highest weights; while the lowest performances were observed in costal herds. This zonal difference remain till 6 months age when the steppic kids' superiority reaches 5.9 kg.

Table 4: Means comparison test (SNK, α=5%) for indigenous kids' weight by herds effect

		Kid's weight at (days)						
Herds	N	10	30	60	90	120	150	180
Herd 1	589	4.32^{a}	6.56^{a}	10.5^{a}	14.87^{a}	19.57^{a}	23.9^{a}	30.7^{a}
Herd 2	442	3.76^{bc}	5.71^{cb}	8.62^{cb}	11.15^{c}	13.29^{c}	17.12^{d}	20.2^{c}
Herd 3	429	3.77^{bc}	5.74^{cb}	8.53^{cb}	11.06^{c}	13.32^{c}	12.46^{e}	13.4^{e}
Herd 4	510	3.5^{6c}	5.44^{c}	8.42^{c}	11.1^{c}	13.34^{c}	13.43^{e}	14.6^{ed}
Herd 5	297	3.84^{bc}	5.71^{cb}	8.71^{cb}	11.51^{c}	13.84^{c}	16.57^{d}	17^{d}
Herd 6	280	3.49^{c}	5.59^{cb}	8.92^{cb}	11.95^{cb}	14.61^{cb}	20.26^{c}	24.9^{b}
Herd 7	239	3.05^{d}	5.21^{c}	8.89^{cb}	11.99^{cb}	14.68^{cb}	21.7^{b}	-
Herd 8	1850	3.42^{c}	4.73^{d}	6.89^{d}	9.08^{d}	11.2^{d}	12.85^{e}	14.8^{ed}
Herd 9	131	4.1^{b}a	6.12^{b}	9.28^{b}	12.54^{b}	15.74^{b}	-	-
Means	4767	3.7	5.64	8.75	11.69	14.39	15.36	15.06

a,b and c: Homogeneous groups; N: Observations

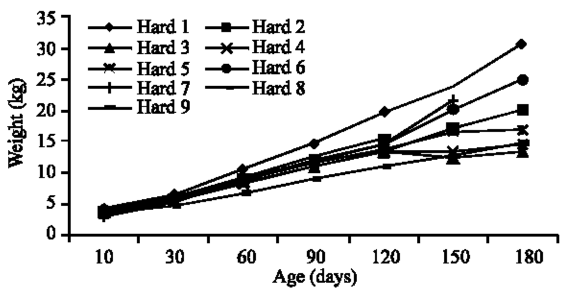

Fig. 2: Kids' weights evolution after birth and till six month age in nine local goat herds

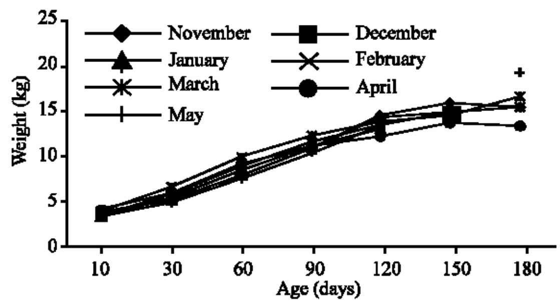

Fig. 3: Kids' weights at 30 days age according to the month of birth

Herds effect upon kid's growth: Results of herds' means comparison are presented in Table 4 and Fig. 2.

Regarding this non genetic technical factor has a particular importance in the pastoral breeding system of the arid region. The management response toward the resources scarcity and irregularity is determining upon the herd production (Santoir, 1993; Niamir, 1996). One of the pastoral management principles is the herd's mobility, practiced since the nomadic period. Transhumance allows to valorize distinct pasture according to their vegetal state and thus, to stamp the arid resources restrictions and irregularities. Due to the herd mobility hardness and costs, only little number of herds remains able to practice duly the transhumance to satisfy the animal's requirements.

Also, in this extensive grazing mode, the herder ability remains the principal factor conditioning the herd cash flow (Najari *et al*., 2004). In fact, the herd management is based on the traditional knowledge to prevent natural stresses and to ensure the best offered conditions to satisfy animal requirements (Niamir, 1996; Najari *et al*., 2003).

Rather than technical management differences, the genetic level varies between herds (Ouni, 2006). Morphologically, some herd specificities were easily revealed on the animals' morphology due long intra-herd consanguine mating. Traditionally, each family selects its own herd on some visible characters to avoid animals' mixture on pastures or during the watering days when many herds are gathered (Najari *et al*., 2006). These simplified selection schemes, can affect productive performances such as kids' growth.

Among the nine herds studied, (Fig. 2) kids of the herd number 1 show the best growing performances since the birth till the age of 6 months.

Differences between herds' performances increase with age to become remarkable after 3 months of age (Fig. 2). Till 10 days of kids' age, the difference between the weight of kids of the best herd and those of the herd 7 is 1.50 kg; while at the age of 180 days, this difference reaches 17.4 kg.

Note that the interaction herd region showed a significant effect upon the majority of analyzed traits; the herd management vary with respect to the natural resources of each region. In fact, herd management and the breeding mode differ according to herd importance and the forage availability.

Month of birth effect: Table 5 presents the means comparison results of the month of birth effect upon kids' weights estimated at some fixed ages. The month of birth affects only the kids' weights at 30 days age.

The kids' weights at 30 days age according to the month of birth is presented in Fig. 3.

Table 5: Means comparison test (SNK, α=5%) for indigenous kids' weight by month of birth effect

		Kid's weight at (days)						
Months	N	10	30	60	90	120	150	180
January	1216	3.49^{a}	5.47^{bc}	8.55^{a}	11.14^{a}	13.16^{a}	-	-
February	660	3.56^{a}	5.8^{bac}	8.99^{a}	11.56^{a}	13.51^{a}	14.92^{a}	15.5^{a}
March	137	4.05^{a}	6.66^{a}	10^{a}	12.38^{a}	13.9^{a}	14.57^{a}	16.7^{a}
April	24	4.18^{a}	6.02^{bac}	9.26^{a}	13.68^{a}	19.73^{a}	13.67^{a}	9.29^{a}
May	23	3.37^{a}	4.98^{c}	7.63^{a}	10.44^{a}	13.46^{a}	-	-
June	54	4.38^{a}	6.44^{ba}	9.95^{a}	13.73^{a}	17.79^{a}	16.51^{a}	19.4^{a}
November	251	3.86^{a}	5.24^{c}	7.84^{a}	10.98^{a}	14.58^{a}	15.99^{a}	23^{a}
December	2402	3.77^{a}	5.27^{c}	7.95^{a}	11.01^{a}	14.29^{a}	14.93^{a}	15.5^{a}
Means	4767	3.83	5.73	8.77	11.86	15.05	5.92	7.23

a,b and c: Homogeneous groups; N: Observations,

Table 6: Means comparison test (SNK, α=5%) for indigenous kids' weight kid's sex effect

		Kid's weight at (days)						
Kid's sex	N	10	30	60	90	120	150	180
Male	2457	3.85^{a}	5.77^{a}	8.87^{a}	11.88^{a}	14.74^{a}	15.35^{a}	16.4^{a}
Female	2310	3.5^{b}	5.25^{b}	8.01^{b}	10.65^{b}	13.06^{b}	14.43^{b}	14.7^{b}
Means	4767	3.67	5.51	8.44	11.26	13.9	14.89	15.55

a and c: Homogeneous groups; N: Observations

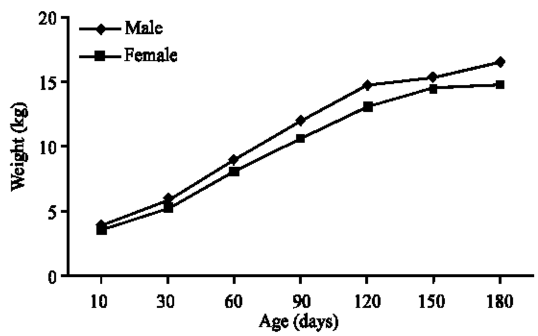

Fig. 4: Kids' growth curve adjusted by Gompertz model and by kids' sex

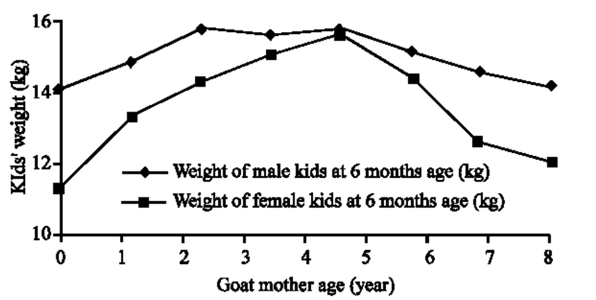

Fig. 5: Effect sex*mother age interaction on the kids' weight (Kg) at 6 months age (Year)

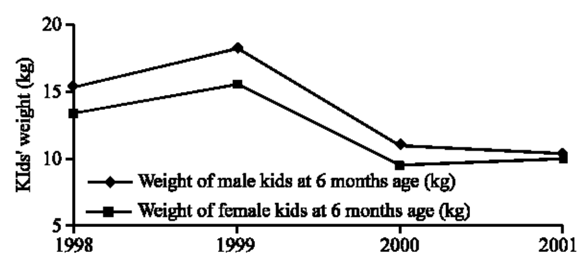

Fig. 6: Effect of sex year interaction on the kids' weight (Kg) at 4 months age

The kids born during the end of the birth season (February, March and April) have the highest weight at this age. The spring season, judged having the better natural conditions (Floret and Pontanier, 1982; Ouled Belgacem, 2006) correspond to the better growth rate. Similar kidding season effects have been signaled by many authors (Ogebe *et al*., 1995).

The kids' sex effects upon growth performances: Kids' weights means and the SNK test results were regrouped in Table 6 and Fig. 4 illustrates the weights evolution till 6 months age by sex.

Since the birth, differences of kids' weights are remarkable for the two sexes. The birth weight, estimated at 2.64 kg and 2.32 kg respectively explain the superiority of earlier male weights (Najari, 2005). This male superiority continues during the growth period and reaches 1.4kg of body weight at 6 months age in favour to males' kids. Similar sex effect is commonly concluded in several studies (Barbato and Vasilatos-Younken, 1991; Barbato, 1991; Banda *et al*., 1993; Bathei and Leroy, 1996; Oltenacu, 1999).

The Fig. 5 and 6 illustrates the effect of the sex age of goat mothers interaction on kids weights at 6 months age and the effect of sex year. Normally, the best performances of kids are recorded when their mothers are aged between 3 and 6 years. Also, the male kids have superior weights to those of females. However, the Fig. 5 shows different aspect; the effect of the sex seems to disappear when the goat mother is 5 years old. For the male kids the effect of the favourable mother ages was quasi suppressed because the severe conditions don't permit them to express correctly their genetic potentialities. The same aspect is illustrated by the Fig. 6, representing interaction of sex year on weights of kids to, the difference between the two sex performances varies from one year to other. During the dry years such as 2000 and 2001, the male kids could not have recorded superior performances to those of females compared to good years. Thus, the identification of the some fixed factors and levels of the mixed model of genitors' evaluation is conditioned by environmental action on genotypes expression.

The kidding mode effects upon kids' growth: Kids' weights means and the SNK test results were regrouped in Table 7 illustrate the weights evolution by kid's mode. The effect of this factor is considered classic in the bibliography (Lyatuu *et al*., 1992; Okello, 1993; Gromela *et al*., 1998; Gaddour *et al*., 2006). The single kids have normally better conditions to realize heaviest weights. Alexandre *et al*. (1997c) indicate that the difference between simple and double could represent until 15% of weight at birth. The simple births have some best conditions to achieve some heavier weights (Alexandre *et al*., 1997b; Oltenacu, 1999). In our case (Fig. 7), this difference isn't clearly showed till 3 months age which concord normally ith the spring favourable season. It seems that the restricted indigenous goat milk production (Najari *et al*., 2000) avoid the expression of the single kids superiority. In fact, at earlier age, the kid's nutrition is essentially based on the mother milk which appears insufficient to express differences between single and multiple kids growing behaviour. Single kids have to wait the grazing age to converge to a heaviest asymptotic weight. To express genetic superiority, animals need favourable conditions.

The mother age effect upon kids' growth: Kids' weights means and the SNK test results were regrouped in Table 8 illustrate the weights evolution by mother age.

The mother age effect upon the kids' growth is illustrated in Fig. 8. The mother age represents essentially the lactation range with which varies the milk potentialities. In fact, goat lactation evolves to a maximum reached at the 3rd or 4th lactation (Ba diao *et al*., 1994). The relation between kids' growth and the mother age was demonstrated in several studies (Pinkerton, 1995). In our case, the lowest kids' performances were registered for the kids of goats having the first lactation, followed by the category of the goat two years aged and the oldest

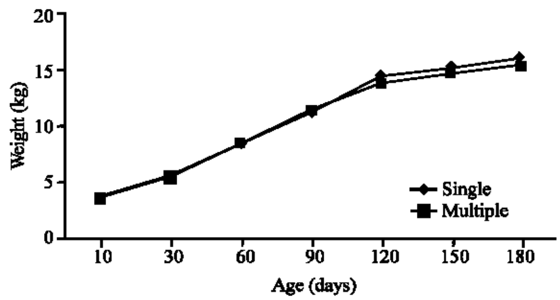

Fig. 7: Kids' growth curve adjusted by Gompertz model and by kids' birth mode

Table 7: Means comparison test (SNK, α = 5%) for indigenous kids' weight by kidding mode

		Kid's weight at (days)						
Kidding mode	N	10	30	60	90	120	150	180
Single	2962	3.75[a]	5.58[a]	8.49[a]	11.22[a]	14.39[a]	15.13[a]	15.9[a]
Multiple	1805	3.57[b]	5.4[a]	8.4[a]	11.42[a]	13.68[b]	14.75[b]	15.3[b]
Means	4767	3.66	5.49	8.54	11.32	6.84	7.37	15.60

a and b: Homogeneous groups; N: Observations

Table 8: Means comparison test (SNK, α=5%) for indigenous kids' weight by mother age effet

	Kid's weight at (days)						
Mother age	10	30	60	90	120	150	180
1 year	3.14[a]	4.71[b]	7.18[c]	9.6[c]	11.99[c]	10.64[d]	12.9[c]
2 year	3.67b[a]	5.43[a]	8.22[ba]	10.88[ba]	13.4[ba]	13.56[c]	13.9[bc]
3 year	3.81[a]	5.63[a]	8.54[a]	11.45[a]	14.27[a]	15.79[ba]	17.2[a]
4 year	3.66[ba]	5.7[a]	8.92[a]	11.84[a]	14.31[a]	16.3[a]	16.1[ba]
5 year	3.67[ba]	5.63[a]	8.76[a]	11.71[a]	14.41[a]	15.27[bac]	16.2[ba]
6 year	3.8[a]	5.62[a]	8.68[a]	11.76[a]	14.69[a]	15.79[ba]	16.1[ba]
7 year	3.59[ba]	5.2[ba]	7.78[bc]	10.27[bc]	12.67[b]c	13.43[c]	15.2[bac]
8 year	3.79[a]	5.11[ba]	7.33[c]	9.59[c]	11.77[c]	13.83[bc]	15[bac]
Means	3.64	5.37	8.17	10.88	13.43	14.32	15.32

a,b,c and d: Homogeneous groups

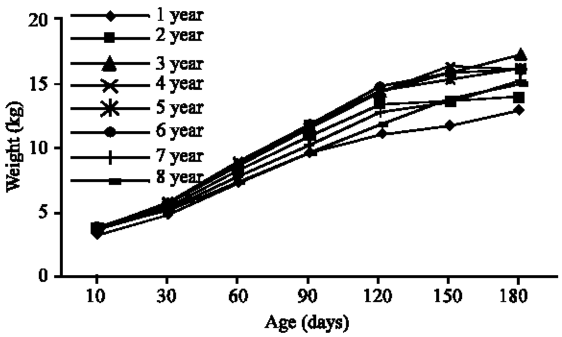

Fig. 8: Kids' growth curve adjusted by Gompertz model and by mother age

goats. Goats aged between 3 and 7 years seem to allow the better kids growth; it seems that the forage scarcity avoid to distinguish differences into this group.

The variance analysis shows a significant effect of some interaction intervening the mother age (Table 1). The effect expression of other factors, such as herd, sex, birth mode seems to be conditioned by the mother age which can stamp the impacts of favorable or non favorable conditions.

CONCLUSION

The indigenous kid's weights during the first 6 months age seem to be seriously affected by technical and natural production factors. Especially, the natural factors conditioning the resources availability, such as year of birth, synthesize the impacts of scarce, sparse and irregular forage upon the kids growing behavior. When the nutritional resources are seriously reduced, the meat production evolution does not manifest individual genetic potentialities; all animals have heavy weights even though the genetic capacity allows higher production. The technical aspects represented by the herd factor, can stamp the impacts of the natural restrictions, although by herder knowledge, the herd mobility and the use of the food supplementation by local by products and barley. The notable regression of the common pastoral area and the number of qualified traditional farmers, will accentuate the effect, of natural conditions upon animals performances.

Rather than the classic quantitative impacts of non genetic factors, an important qualitative affect can be illustrated under arid drastic conditions. Indeed, we can divide the growing process into two categories regarding the environmental effects. The first category corresponds to young age when kids have low requirements or the period when the natural conditions were relatively favorable. Into this category, the phenotypic differences can been considered due to individual capacity for growing. Whereas, the second category regroups older kids and/or difficult periods when the animal strive to survey and their performances express essentially the environmental conditions. When the conditions become drastic and the animals' requirements become high, kids can't express their real genetic potential for growing. Also, the effects of sex, birth mode and mother age, manifest dependently to the technical and natural factors. Under harsh conditions, male and female, single or multiple births realize comparable performances especially during young age. This can affect the performance modeling under difficult conditions. In fact, the majority of the genetic evaluation models need to apprehend the factors to be corrected. Indeed, the nature of the arid factors effects can avoid the correct definition of the fixed factors. These aspects can induce a bias or increase the prediction error using the classic phenotype modeling for selection plans. The favorable period for kids' growing seems to be the spring and the weight evolution standby during summer. Hence, the kids born at November and December seem to have a longer period of growth with respect to the kids born after winner, which have to converge rapidly to low asymptotic weights under the summer restrictions and stress. Thus, it's recommended to reduce, trough herd management, the number of births after winter season; these last kids do not improve meat production and however, they complicate the herd management and mobility and reduce the reproductive performance of lactating goats.

So, non genetic factors study, allows improving herd management and productivity even though under arid conditions and pastoral ambulant husbandry. However, to schedule genetic improvement of local population, some interactions and corrective indexes need to handle more appropriate numeric methodologies and statistical package. So, some quantitative genetic hypotheses seem to be not verified to adapt improvement plans considering indigenous population productive behavior and arid conditions specificities.

To conclude, it appears that indigenous kids growing behavior has to be more studied to allow better pastoral herds management, to improve local population genetic potentialities and also to avoid excessive rangelands use to stamp the degradation process.

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