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REGULAR ARTICLE

Typology of camel farming system in Saudi Arabia

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Abstract

A field survey involving 218 camel farmers from the northern, eastern and central part of Kingdom of Saudi Arabia was implemented in order to collect data on the status of the owner, herd composition and characteristics, feeding practices, moving strategies and disease prevention practices. The method used was Ascending Hierarchical Clustering, a well-adapted technique in case of exploratory approach. After automatic classification analysis of four groups of variables describing the farmer, its herd, some of its practices and the disease prevention practices, a final analysis regarding the clusters of these four items, allowed to identify 4 global types of farming systems with 2 sub-types in each main type. The explaining factors allowed distinguishing camel farms linked to the desert life in opposition to urban people having multi-activity. However, the integration to market could be variable whatever the opposition desert/city. A part of the people living in desert could improve their management and some of the urban owners have camel mainly for social aspect.

Key words: Camel, Farming system, Saudi Arabia, Typology

Introduction

The camel has a great importance in the local, social culture of the societies inhabiting the dry land. Because the camel has developed various adaptive mechanisms for living in the desert, its rearing is regarded like a constant resource for sustenance in the arid lands. Without camel, the rural life in these areas will be abandoned (Abbas et al., 2000). In the Kingdom of Saudi Arabia (KSA) where less than 1% of the lands are suitable for cultivation (Hussain and Al-Saati, 1999), the camel population is estimated to stand at more than 830000 heads (Ministry of Agriculture, 2006) and is considered as a national socio-cultural heritage. The camel population is regularly growing by 5.2%/year (source: FAOstat, 2010) since 1961, date of the first FAO official statistics. The camel population represented more than 50% of the total livestock unit in the country which is one of the highest in the world (source: FAOstat, 2010). Thus, the camel production is still central in the livestock economy of KSA. The life of Saudi Arabians still living in rural areas is effectively closely connected to the camel which was domesticated in the Arabian Peninsula thousands of years ago (Uerpman and Uerpman, 2002). The camel has played and will continue to play an effective and pivotal role in the history and society of KSA.

Nowadays, the camel farming systems are changing due to the urbanization, climatic changes and growth of the economy of KSA (Auty, 2001). Thus, traditional Bedouin way of life is probably changing. To understand how the camel farming systems are adapting and changing, the achievement of farm typology is a current tool used by the researchers and development institutes (Djurfeldt, 1996). A typology is a method to get an image of the diversity of farming systems in a determined zone. In the present study, a typological analysis of the current situation in some regions of KSA was achieved by focusing on structural aspects (herd composition) and functional aspects (moving strategies, feeding practices, diseases prevention practices, links to market). The objective of the present study was to determine the main current farming systems devoted to camel in different regions of KSA in order to underline the farm diversity and the probable changes in camel utilization.

Materials and Methods

To achieve the typology several methods could be used, by segmentation, by expert's knowledge or by automatic classification using a questionnaire

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with closed questions. The segmentation method is based on the hierarchy of identification keys as described by Breiman et al. (1984). The method by expert's knowledge is based on the aggregation of farms around poles defined by experts having a good *a priori* knowledge of the existing systems (Perrot, 1990). The method by automatic classification is based on statistical analysis of typological questionnaire using clustering method (Späth, 1980). The convenient identification keys being not known and in absence of identified experts on camel farming systems, the method based on automatic classification was used in the present study.

Data collection

The data were collected by interviews based on questionnaires with close questions. The interviews were conducted from February 2009 to July 2010. The farmers were chosen randomly by the Ministry of Agriculture from several regions. A number of 218 camel owners were interviewed. They belonged to different tribes coming from 7 regions: Skaka (n=70 farms), Arar (n=20), Tabuk (n=35), Al-Qaseem (n=25), Hail (n=30), Tabarjal (n=25) and Dammam (n=13).

The questionnaire included four page data form and was filled out for each camel farm. The interview took approximately 45 to 95 min per farmer. The questionnaire included 59 questions and was divided into the following five sections:

- Section 1 contained 8 questions regarding information on camel owner identity and its activities (status, place of living, number of herds)
- Section 2 contained 15 questions regarding the descriptions on the herd (number of camel, types and age of the camel, presence of other species…).
- Section 3 contained 20 questions focused on breed description (coat color, size…).
- Section 4 contained 4 questions only regarding informations on feeding and moving strategy (period and areas of moving, production system…)
- Section 5. Included 12 questions regarding informations on diseases (prevention for ticks, internal and external parasites, vaccinations…).

Statistical analysis

The questionnaire included quantitative and qualitative data. In order to get homogenous data for multivariate analysis, the data preparation involved five steps.

1. Univariate description of the variables (distribution of quantitative variables, number of modalities of qualitative variables). Variables with imbalanced modalities were discarded. The quantitative data were transformed into qualitative variable with modalities according to the distribution of the quantitative values (Snrka and Koeszegi, 2007).

2. Estimation of fecundity rate and mortality rate according to the known number of birth and dead animals within one year, reported to the number of adult females and the total number of animals respectively. For this estimation, we used the method proposed by Lesnoff et al. (2011).

3. Building synthetic variables describing similar topic. For example, herd composition included several questions on the presence or not of different species. After identifying the main combinations of data by cluster analysis, a new variable was created entitled "animals present in the herd" with two modalities: (i) pure camel herd or (ii) camel herd associated to small ruminants and/or cow. Similar approach was achieved for breed composition of the camel herd, camel diet (combination of different foods), camel marketing (selling and/or buying animals), and combination of practice diseases prevention. Finally, from the 59 questions in the previous questionnaire, a total of 31 variables were retained in the final multivariate analysis (Table 1).

4. Multivariate analysis of group of variables: four groups of variables were analyzed, i.e. (i) farmer's data, (ii) herd data, (iii) management practice data (feeding, fattening, moving, marketing) and (iv) disease prevention data. After automatic classification using the method of Ascending Hierarchical Classification (AHC) on Ward distance (Tuffery, 2010), types of farmer, herd, practice and disease prevention practices were identified. The principle of the method of automatic classification (or clustering) was based on the identification of homogeneous groups of individuals (clusters) in the population (here, camel herds). Two camel herds belonging to the same group were somehow close to each other (similar structures or practices). At reverse, two camel herds belonging to different groups are somehow far from each other (they have different structures and/or practices). The classification consists to build a partition of the population into homogenous clusters (having low within variability), different one from other (having high between variability). Each retained cluster, identified by the convenient cutting of a dendrogram (graphic expressing the dissimilarity between clusters or classes) would represent a "type". The convenience of the cutting was estimated when the gain in between-cluster variance is not significant. The retained clustering is expressed by the total between-cluster variance explained by the model. The interpretation of the types was achieved by analyzing the contribution of the different variables to the class. Only variables with significant contribution (assessed

by Chi square test) at $P > 0.05$ were retained for the final interpretation.

5. Final multivariate analysis of a data table including the types of farmers, types of herd, types of practices and types of diseases prevention practices, identified in the previous step. A final typology was proposed and interpreted, notably by calculating some quantitative data (number of camels, buying rate, selling rate, fecundity rate, and mortality rate) in each types and by testing the difference with variance analysis (ANOVA).

For all the statistical analysis used (ANOVA, AHC, chi square test), the software XLstat© was used (Addinsoft, 2007: http://www.xlstat.com).

Table 1. List of variables (acronym and signification) retained in the final multivariate model with their different modalities and the number (n) of each modality.

Item (acronym)	Signification	Modalities	n
1-Status	Status of owner	1- Owner	203
		2- supervisor	2
		3- shepherd	13
2-Assoc	associated with other owners	1- Yes	28
		2- No	190
3- Job	main job of the owner	1- Camel farmer	91
		2- Worker in security field (military, police, guard…)	63
		3- Retired owner	38
		4- Worker from Ministry or Educational field	10
		5- Workers from other field	16
4- Live	Place of living	1- In desert	16
		2 - In city	202
5- Nbherd	Number of herd of owner	1-One herd only	196
		2-Two or more herds	22
6- Animherd	Animals present in the herd	1- Camel only	161
		2- Camel, small ruminants and cattle	57
7- Nbcamel	Number of camels in herd	1-Small (less than 40)	89
		2-Medium (40-80)	68
		3-Big (more of 80)	61
8- Selbuy	Number of camel sold &bought since one year	1-Selling/not buying	73
		2-Buying/not selling	23
		3-Not selling/not buying	70
		4-Selling/buying	52
9-Herdcomp	Type of herd composition	1. Female with low fecundity rate	45
		2. Female with high fecundity rate	36
		3. Young herd	72
		4. Female herd with medium fecundity rate	28
		5. Male herd	34
10- Wean	Age of weaning (month)	1-less than 11 months	58
		2- 12 months	149
		3- More than 12 months	11
11-Typbreed	Types of herd composition	1. Herd with half Waddah, 40% Majahim and 10% Shual	26
		2. Herd with 3/4 Waddah and around 15% Homor	49
		3. Sofor mainly	25
		4. 100% Waddah	80
		5. Mainly Majahim and around 15-20% Waddah	38
12-Calvrate	Calving rate	1- Low calving rate less than 30%	30
		2- Medium calving rate 30-75%	98
		3- Large calving rate more than 75%	90
13- Brand	Age of branding young animals	1-At birth	45
		2- 0.3-11 months	53
		3- 12 months	112
		4- more than 12 months'	10
14- Pregmon	Monitoring of pregnant female	1- Yes	186
		2- No	32
15- Colint	Control of the colostrum intake	1- Yes	156
		2- No	62

16- Weantool	Weaning tools	1-Chmel	64
		2-Isolation of mother	79
		3- Khlel	50
		4- Chmel, Isolation of mother and khlel	23
		5- Nothing	2
17- Fatten	Camel fattening	1- Young males	69
		2-Adult males	16
		3-Adult females	11
		4- All kinds of camel	44
		5- Not fattening.	78
18- Fatdur	Duration of fattening	1-0 day (no fattening)	77
		2-15 days→3months	77
		3-4 months→8months	64
19- Fatsale	Place of sale fattened animals	1- Animal market	102
		2- Butcher	8
		3- Market and other	110
20-Typmov	Type of moving	1. Not moving	25
		2. Short moving at every season (less than 10 km)	73
		3. Medium moving every time (>10 to 100 km)	49
		4. High moving humid season, medium at dry season	44
		5. Long moving at every season (> 100 km)	27
21-Typseamv	Type of season moving	1. Moving in winter and summer	40
		2. Not moving in 2009 and moving in 2010	53
		3. Not moving except in winter 2009	35
		4. Not moving or moving short all over the year	90
22-Typdiet	Type of diet	1- Green fodder only	83
		2- Green fodder+hay	56
		3- High quantity green fodder+hay	26
		4- Barley+ green fodder+hay	34
		5- Barley+ green fodder+hay+vitamins+mineral	19
23- Quarant	Quarantine for new introduced animal	1- Yes	63
		2- No	155
24- Typmed	Type of medicine used for parasites	1- Drugs from market	183
		2- Traditional medicine	35
25- Intpar	Treatment against internal parasites	1- Never	55
		2- Occasionally	163
26- Poxvac	Vaccination against camel pox (jedari)	1- Against pox and other	27
		2- Against pox or other	23
		3- Not vaccinate	168
27- Eradpar	Eradication of ticks and mange	1- Against mange and ticks	8
		2- Against mange or ticks	15
		3- Not vaccinate	195
28-MaindisY	Main diseases in the last three years in young camel	1- No disease	12
		2- Mange and other parasites	35
		3- Digestive and respiratory syndrome	19
		4- All disease+ digestive and respiratory syndrom	152
29- Mortrat	Mortality rate	1- Low young mortality rate less than 8%	91
		2- Medium mortality rate 9-49%	102
		3- Large mortality rate more than 50%	25
30- Yngloss	Main causes of young losses	1- Diarrheas	94
		2- Natal mortality	17
		3- Feed deficiency	1
		4- Mixed diseases	50
		5- No declared disease	56
31- MaindisA	Main diseases reported in the last three years in adult camel	1- No disease	21
		2- Mange-Abcesses-ticks-ringworm	37
		3- Digestive and respiratory syndrome	12
		4- Several diseases+digestive and respiratory syndrome	63
		5- All type of diseases+tryps+skin disease	85

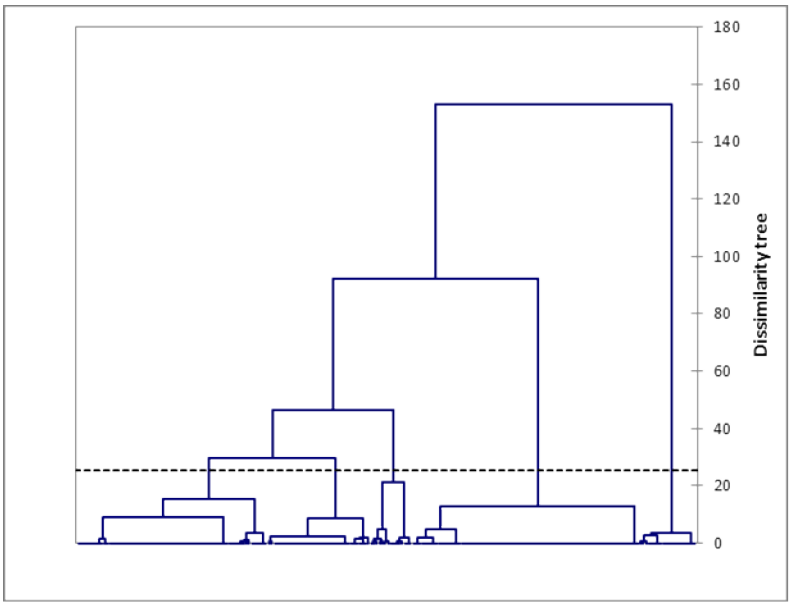

Figure 1. Dendrogram (dissimilarity tree) obtained after cluster analysis of the data table describing the camel farmers, and convenient level of cutting according to the optimal between cluster-variance (----) giving 5 types of farmer.

Results

The whole camel owners' population (n=218) corresponded to a camel population of 14394 camels, representing approximately 8% of the official number of camel in the involved regions of the country (based on FAO statistics). The herd size was 66 ± 89 on average. Among the present sampled camel population, the main breed was Waddah (55.6%) followed by Shual (17.1%), Majaheem (12.4%), Homor (10.5%) and Sofor (4.6%).

The marketing rate was on average 16.8% (sold and buy) with a selling rate (number of sold camel/total number of camels in the herd) of 10.1%, but with a high variability between farmers. The annual mortality rate was on average 16.6 ± 20.9% (all age classes) and birth rate (number of birth reported on number of expected pregnant females) was 96.4 ± 90.6%. For the last 12 months, the fecundity rate (number of birth reported on the total number of adult females) was estimated to 45.2 ± 32.7%. The four groups of variables (farmer, herd, management practices and disease prevention) were analyzed separately. At the end, 4 typologies were obtained.

Types of farmers

After classification of data describing the farmer (variables 1 to 5), 5 types of farmers were identified explaining 74.9% of the total variance between-classes (Figure 1). According to the contribution of the different variables to the clusters, the types of farmers could be summarized as follow: (1) urban camel owner having camel as hobby and working in security field (n=67); (2) pure camel farmer living in desert (n=80); (3) Urban camel farmer having camel as hobby and working in public sector (n=20); (4) retired farmer with one or several herds partly in desert (n=36); (5) shepherd or supervisor from different origin (n=15).

Types of herd

As for farmers, 5 types of herd were identified after classification of data (variables 6 to 12) describing the herds (Figure 2). The retained model into 5 clusters explained 46.2% of the between-cluster variance.

According to the significant variables contributing to the classes, the types of herds could be described as follow: (1) medium camel herd with different breeds, low fertility and commercial use (n=56); (2) camel herd of different size with more similar breeds widely involved in camel market and high turn-over (n=62); (3) small camel herd poorly market integrated (n=40); (4) Majahim small camel herd more or less market integrated (n=20); (5) Waddah small camel herd with good fertility rate (n=40).

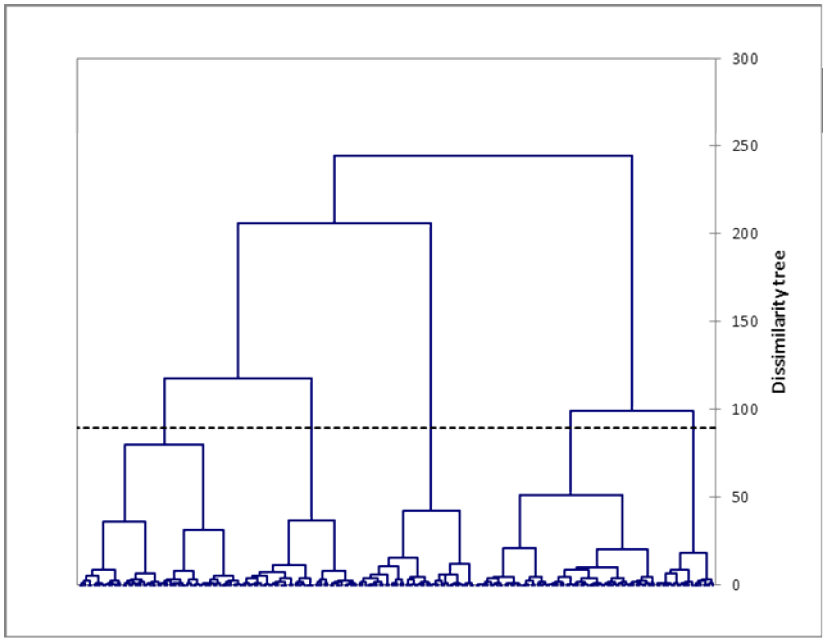

Figure 2. Dendrogram (dissimilarity tree) obtained after cluster analysis of the data table describing the camel herd, and convenient level of cutting according to the optimal between cluster-variance (----) giving five types of camel herd.

Types of management practices

With similar method involving data describing the farmer's practices (variables 13 to 22), 4 types of practices were identified explaining 40.7% of the total between-classes variance (Figure 3). The classes were interpreted according to the 8 significant variables as follow: (1) Farmer moving, no fattening animals and distributing green fodder without supplement (n=58); (2) Farmer moving, practicing late fattening and well integrated to market (n=42); (3) Farmer moving, practicing early fattening but well integrated to market (n=87); (4) No moving camel, no fattening, but branding young animals, distribution of barley and selling animal to market (n=31).

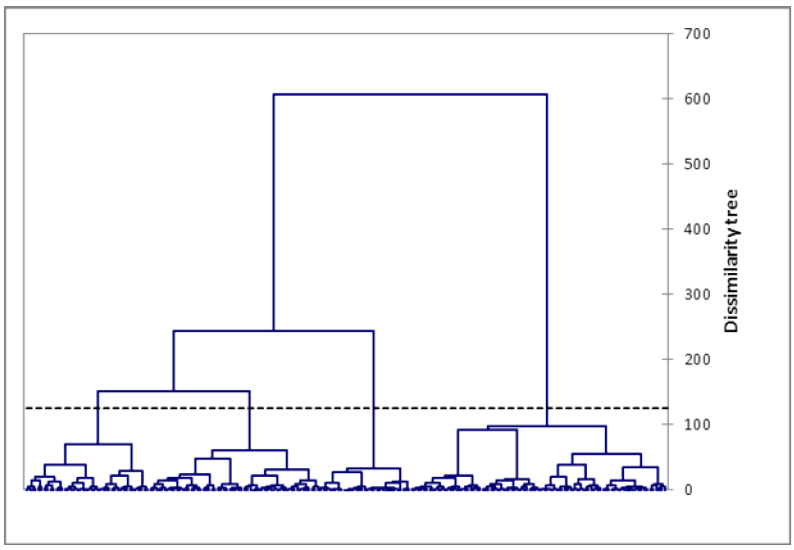

Figure 3. Dendrogram (dissimilarity tree) obtained after cluster analysis of the data table describing the management practices, and convenient level of cutting according to the optimal between cluster-variance (----) giving four types of practice.

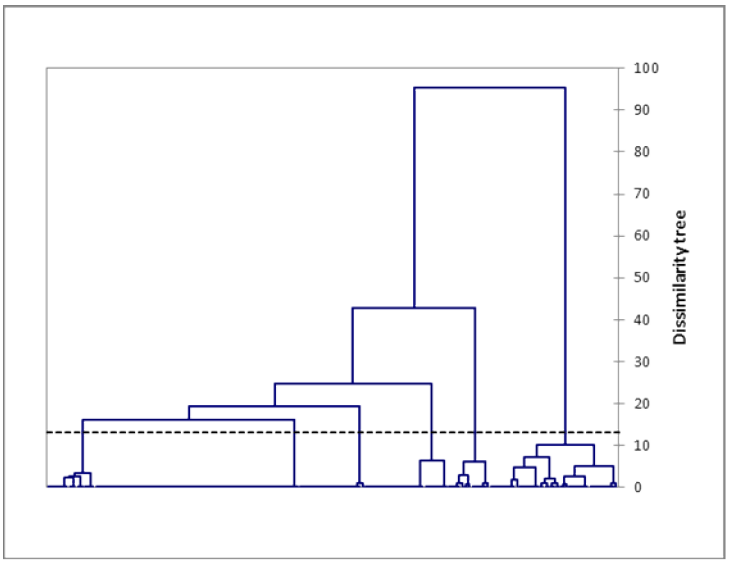

Figure 4. Dendrogram (dissimilarity tree) obtained after cluster analysis of the data table describing the disease prevention practices, and convenient level of cutting according to the optimal between cluster-variance (----) giving six types of prevention practice.

Types of prevention practices

After classification of data describing the practice of disease prevention (variables 23 to 31), 6 types of practices were identified explaining 75.1% of the total between-classes variance (Figure 4). Only 6 variables contributed significantly to the classes and could be interpreted as follow: (1) Low health management (n=78); (2) High health management (n=49); (3) Traditional health treatment (n=16); (4) No health management (n=32); (5) Parasite management mainly (n=25); (6) Traditional prevention against parasite (n=18). The use of traditional medicine or ethnoveterinary medicine (mainly by using desert plant) rather than medicine from the market was more common for treating camel parasites as mange or ringworm.

Camel farm types

In the last step, a global classification of the camel farms described by their 4 different clusters identified in the previous steps was achieved, and gave a balanced dendrogram including four main classes divided each into two sub-types explaining 70.2% of the total between-classes variance. Those types could be interpreted as follows (Figure 5):

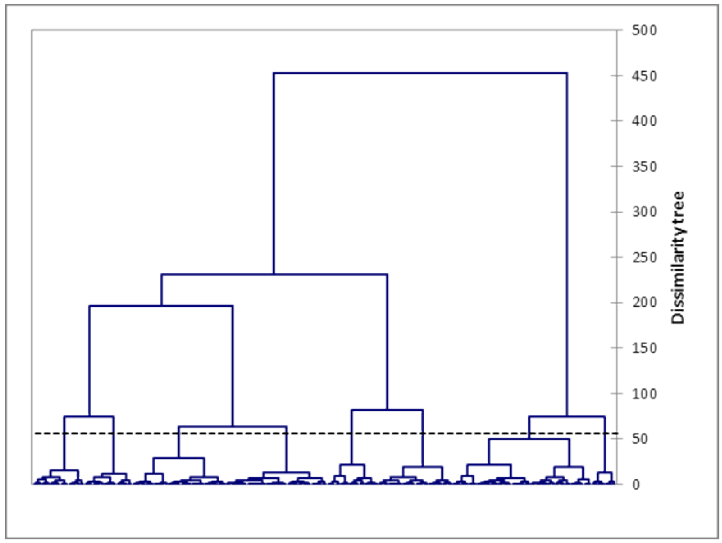

Figure 5. Dendrogram (dissimilarity tree) obtained after from final cluster analysis of the data table where the camel owners are described by their types of farmer, herd, practice and disease prevention, and convenient level of cutting according to the optimal between cluster-variance (----) giving eight types of camel farms.

The first type contained pure camel farmers living more or less exclusively by their camel rearing. They are divided into 2 sub-types:

- Type 1a (16.1% of the camel farms): Pure camel farmers having big herd, living in desert and regularly moving, using green fodder sometimes added with mineral and vitamin, no fattening practice (2/3 of the cases) or late fattening (1/3 of the cases), more or less integrated to market, with low health management. They can be regarded as pure camel farmers having big herd with traditional way of life more or less integrated to market.
- Type 1b (17.4%): Moving pure camel farmers with homogeneous herd (only one breed), high turn-over to camel market, practicing early fattening for camel market, but low (55% of the cases) or high (45%) health management. They could be defined as pure camel farmer with higher integration to market and modernized management.

The second type was retired people still keeping camel for different purposes. They can be divided into 2 sub-types again:

- Type 2a (8.3% of the sample): retired people or shepherd with low reproductive performances, variable health management, given supplementation in diet with barley, weak integration to market. They could be defined as retired people keeping camel for hobby.
- Type 2b (23.9% of the sample): retired people with low or traditional health management but with very high market integration, adding mineral and vitamin in the diet. They are clearly retired people having camel for market activity.

The third type included pure camel farmer or multi-active people with small herd but good integration to market, and health management focused on parasite prevention. The 2 sub-types could be described as follows:

- Type 3a (12.8%): Pure camel farmer living in desert with small or medium camel herd composed of one breed only, low reproductive performance but commercial use with more or less good health management. They are moving herds. They can be defined as small pure camel farmer well integrated to market but with low management
- Type 3b (4.1%): Multi-active farmers (security work) with small camel herd (mainly Waddah), good reproductive performance but only parasite prevention, management with traditional drugs, moving or not moving herd, well integrated to market: They are Multi-active farmer with small herd using camel for market but with traditional management.

The fourth type was mainly multi-active owners practicing camel rearing as hobby but looking for proper management. They could be divided into

- Type 4a (8.7%): Camel farmer living in city, multi-active or sometimes retired, herd having one breed only with good reproductive performance, but rather low market integration and low health management in spite of a good calf mortality control. They are multi-active retired farmer using camel for hobby with low commercial objective and health management.
- Type 4b (8.7%): Multi-active owner (mainly from security field), herd having one breed only with high reproductive performance but with moving animals and better commercial objective than 4a. They could be defined as multi-active owner looking for proper commercial management.

In order to interpret the identified types, some quantitative variables were estimated: number of camels per herd, buying rate, selling rate, fecundity rate, and young mortality rate (Table 2). The number of camels was significantly higher in type 1a while the marketing rate was significantly higher in type 2b. No significant difference was observed for annual fecundity rate (from 30.4 to 53.0%) and mortality rate (from 10.5 to 20.6%) in spite of a high observed variability.

Table 2. Some characteristics of the 8 camel farming types identified in KSA.

	1a	1b	2a	2b	3a	3b	4a	4b
Number of camels	100.2[a]	66.0[b]	71.8[b]	56.1[b]	66.3[b]	72.8[b]	59.8[b]	63.3[b]
Buying rate (%)	4.0[b]	22.6[a,b]	4.0[b]	68.9[a]	6.7[b]	2.5[b]	1.1[b]	3.0[b]
Sold rate (%)	6.5[b]	22.8[a,b]	7.2[b]	54.3[a]	7.7[b]	6.2[b]	14.4[a,b]	16.5[a,b]
Fecundity rate (%)	41.0[a]	45.4[a]	30.4[a]	37.1[a]	43.5[a]	47.2[a]	42.1[a]	53.0[a]
Mortality rate (%)	18.2[a]	15.0[a]	23.1[a]	13.9[a]	17.2[a]	25.6[a]	10.4[a]	13.6[a]

a,b Different letter in one row is significant at $P < 0.05$

Discussion

The typology of camel farming is a common tool to understand the organization and/or the strategies of the camel owners. It is generally helpful for the people in charge of the rural development, because the recommendations could change according to the type of farmers and of their activities. Camel farming typologies were already achieved in Morocco (Michel et al., 1997), in Niger (Chaibou and Faye, 2005), in Mauritania (Correra et al., 2009) and in India (Laval et al., 1998; Benard et al., 2008). A description regarding dairy camel systems was also available in Sudan (Eisa and Mustafa, 2011).

In Saudi Arabia, livestock farming systems were described according to the ecosystem where livestock is reared and according to the link with agriculture (Boum, 2003). Some references on the herding strategies and health performances in Saudi camel farms were available but limited to restricted area (Abbas et al., 2000). Few data published in scientific papers were available for specific description of camel farming system, notably according to the husbandry practices (Gaili et al., 2000).

Traditionally, livestock systems in Saudi Arabia like in most of the arid countries are divided into nomad (or transhumant) systems and settled systems (Jasra and Mirza, 2005). But this distribution did not underline the differences between the farmers' strategies and practices. At the national level, a recent report (Mahmoudi, 2010) had identified 6 types of camel farms including commercial farm, racing farm, camel farm for leisure ("week-end farm"), camel farm for renting, traditional farm, and camel for prestige. This typology was based on a simplified questionnaire including essentially data on farmer and herd composition, but little information on practices. In the survey published by Abbas et al. (2000), four types were described in Qassim region as commercial dairies, prestige herders, pastoralist and agropastoralist herders and periurban feedlots, but this typology was based on *a priori* classification.

In the present study, the identification of the farming systems were focused on four items: (i) the farmer status, (ii) the herd composition, (iii) the main practices which are the classical parameters used to describe livestock system (Lhoste et al., 1993) defined as the interaction between the farmer, the herd and the farming conditions. This approach was applied both in cattle production (Lhoste, 1984) and camel production (Saini et al., 2006). Prevention practices (iv) were added in order to take in consideration the importance of this item in camel management.

Of course, some items were lacking for an exhaustive understanding of the owner's strategies as education level, age pyramid of the camel herd, reasons for culling, disease prevalence, individual reproductive performances, etc. However, a questionnaire is a compromise with the acceptable time for the interview, and some data could be reliable by monitoring only (longitudinal study). A typological questionnaire is applied in a cross-sectional survey with limiting time of interview in order to give the priority to the number of interviewed owners.

In Saudi Arabia, the place of camel in the social life is very central because it is a heritage of the Bedouin culture. This explains the importance of camel rearing without economical purpose and the fact that many people having another activities or being retired wanted to have camels. Among the eight types described in the present study, there was also a clear distinction between farmers living in desert with moving animals and those living in cities, having other professional activities but keeping camel around the city or in desert. The role of camel in that sense was fundamentally a matter of social satisfaction rather than economical target. However, this distinction is not always strict as the present typology showed. Even urban owners having multi-activities could be highly integrated into market, could search proper management of disease and production performance. For example, the type 2b gathering mainly retired people, has on average a significant higher selling rate and buying rate (54.3 and 68.9% respectively) compared to the other types. However, owners keeping their animal mainly for hobby (type 2a) had a lower fecundity performance (around 30%) and a high mortality rate (more than 20%).

It is obvious that camel farming systems in the Kingdom are changing progressively, the traditional way of life in desert having to face to urbanization and improvement of the incomes. The tendency to be settled around the town and the highest integration to milk and meat market is increasing as in other camel country (Faye et al., 2002). Since the sixties, urban population in Saudi Arabia changed from 20 to 87% whereas in the same time the camel population increased according to FAO statistics (http://www.faostat.org) from 80 thousand to 260 thousand heads (which is widely lower than the probable population estimated to more than 800 thousand by

the Ministry of Agriculture, 2006) i.e. an annual growth of 5.2%. For the same period (from 1961 and 2008) the official growth of camel milk and meat production was 6.4 and 6.6% respectively indicating an increase of the productivity. This increasing productivity was possible with the intensification of the production (Gaili et al., 2000; Al-Mutairi et al., 2010) as it is observed in periurban farming system (improving of the diet, better health management) described in other part of the world (Faye et al., 2003). Furthermore, economical survey would be necessary for a better understanding of the economic importance of camel, not only at national level, but also in the incomes for the camel owners (Al-Khamis and Young, 2006).

The camel farm types in Saudi Arabia are characterized by a wide variability of the total number of camels in the herd. The herd size varied from 1 to more than 800 heads. The camel herd size was higher in farms where owner was living in desert (the mean camel herd size was more than 100 camels in type 1a *vs* between 56 and 72 in all other types). On average, the camel farms had fewer camels in number within the herd but probably with a higher productivity. The settlement, especially around the town was facilitating the access to health and other services, to inputs and to higher quality food.

Conclusion

The present typology gave overview of the current situation of camel farming system in some part of KSA (Northern, eastern and Central regions). Without previous similar studies, it is difficult to assess the trajectories of these production systems and to know how the different types of camel farms are still changing. However, the country has known very strong changes since the last decades (improvement of the life level, very high urbanization growth). The national authorities have to pay attention to the current changes in camel farming. The requirements of the camel farmers (in high quality food, health protection, camel product processing, and improvement of the camel product marketing…) are increasing. The services to the farmers have to be adapted to these trends. In our sample, more than the half of the farmers appeared to be multi-active or retired. Further surveys have to be envisaged in order to make a clear diagnosis of the change in the farming system and to deepen also the knowledge on the camel market sector in the country. Even if the camel industry is probably not dominant in the national economy, the investment of many people living in urban areas shows the still high interest of Saudi population to the camel farming. It appears clearly that camel farming is compatible with the modern way of life.

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