

REVIEW ARTICLE

Role, distribution and perspective of camel breeding in the third millennium economies

Bernard Faye^{1,2*}

¹CIRAD-ES, Campus International de Baillarguet, TA C dir/B 34398, Montpellier, France

²FAO Camel Project, P.O. Box 761, AlKharj, Saudi Arabia

Abstract

Although, it is occupying quantitatively a marginal place among the domestic herbivorous (0.4% only of the world domestic herbivorous), the large camelids (dromedary and Bactrian) are present in almost all the arid lands of the old world (except in Southern Africa), being wide spreading over 35 million km². They are overall remarkable valorizers of these spaces by their productive potential and by their role in the agro-ecosystemic balance of the arid lands, especially with the current climatic changes. Elsewhere, they are known for their physiological peculiarities linked to their adaptation ability to harsh conditions of the desert and of its margin. In consequence, they represent a fabulous biological model for the scientists from different disciplines. Their place in the “modern world” has to be re-evaluated by considering these trends and these particularities.

Key words: Camel, Climatic changes, Economy, Sustainability

Introduction

The camel is belonging to camelidae family of mammals among the order of Artiodactyles and to the sub-order of tylopoda (animals with padded feet). Thus, they are different than the ruminantia (especially bovinæ family): in spite the camel is a ruminating animal, it is not a ruminant. The family of camelidae comprised two main types (large and small camelids) distributed into three genus: *Camelus*, *Lama* and *Vicugna* (Figure 1).

The small camelids originate from Andin Mountains of South America include two domestic species (lama and alpaca) and two wild species (guanaco in genus *lama*, and vicuna in genus *vicugna*). The large camelids are represented by two domesticated species, the one-humped camel (dromedary) and the two-humped camel (Bactrian camel), the first living in the hot arid lands from North of Africa and eastern part of Asia, the second in the cold steppes and deserts in Central Asia. For few times, a new large camelids was described. It is a wild species living in very remote areas between

Mongolia and China, called Tartary camel (*C. Bactrianus ferus*) which was distinguished from the domestic double humped camel (Ji et al., 2009).

Thus, the camelidae family is characteristic of animals occupying remote areas, arid lands or high mountains. This is linked to the high adaptation of those species to their ecosystem. This explains the interest of this family for maintaining rural activities in the most inhospitable places of the planet.

The present paper deal with the importance of camelids in the world today, its stakes for human population, its role in social life, and its production potentials for local economy as well as its expected valorization for integration in international economy.

The camel world distribution

It is difficult to exactly determine the number of camels in the world, firstly, because it is mainly an animal of nomadic people and pastoralists who are moving frequently, and secondly, because camels are not usually subjected to obligatory vaccination. So, an exhaustive census for the camels is quite difficult. Officially, the total number of camels in the world was around 25 million heads (FAOstat, 2009). This number is probably underestimated. Particularly, in the Sahelian countries (Mauritania, Mali, Niger, Chad, Sudan, Ethiopia), when the number of camel heads was adjusted after appropriate census, it appeared a quite higher number, increasing the former

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*Corresponding Author

Bernard Faye
CIRAD-ES, Campus International de Baillarguet, TA C dir/B
34398, Montpellier, France

Email: bernard.faye@cirad.fr

estimation of the population. For instance, in Chad, the camel population was readjusted from 800,000 to more than 1.3 million heads after appropriate census by the Ministry of Animal Resources. Thus, by considering both the wild Australian camel population (Gee, 1996) and the different national estimations, the camel world population is probably around 30 million heads. However, as the whole, this population represents less than 1% of the total herbivorous domestic population in the world, far away behind the cattle (more than 2 billions), the sheep and goat (more than one billion each) and

even behind horse (200 millions) and buffalo (150 million heads).

More than 80% of this population lives in Africa with 60% in the Horn of Africa. The most important countries for camel economy with a camel population over 1 million are in the order, Somalia, Sudan, Ethiopia, Niger, Mauritania, Chad, Kenya, Mali and Pakistan (Figure 2). The world camel population is increasing regularly with a yearly growth of 3.4%. Since 1961 (date of the first FAO statistics), the world camel population was more than doubled (Figure 3).

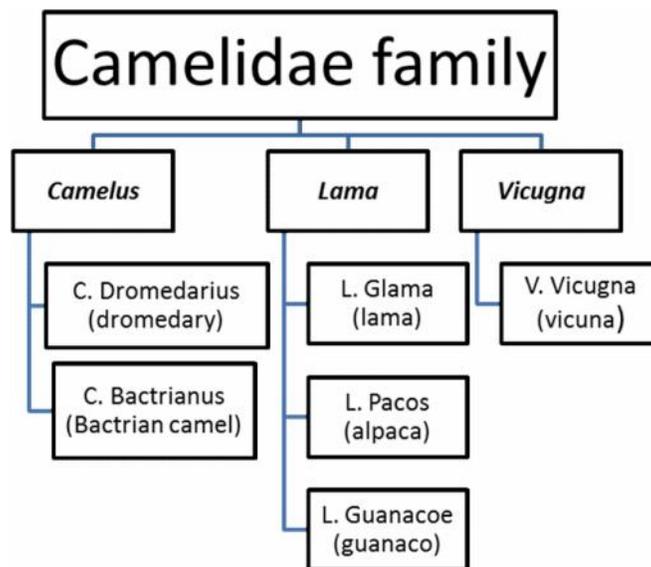


Figure 1. Classification of the Camelidae family.

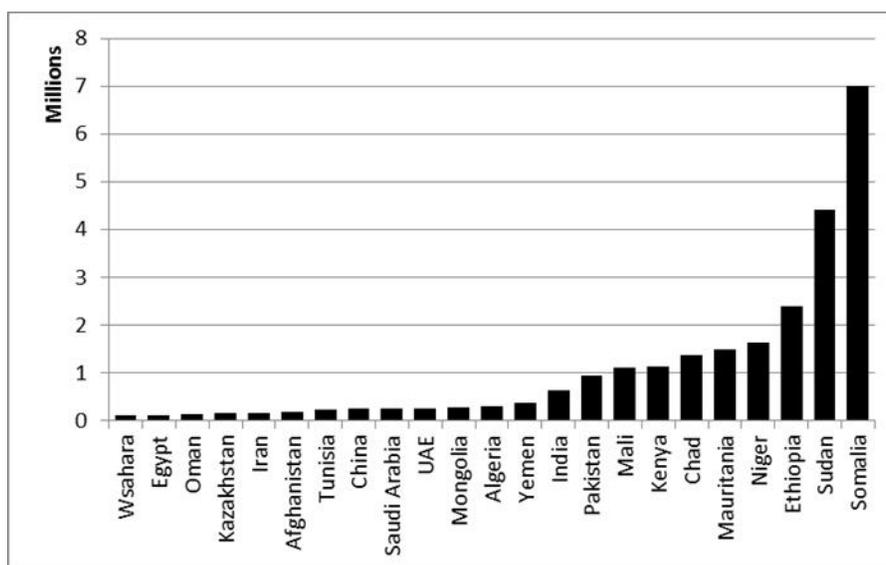


Figure 2. Number of camel in the countries having more than 0.1 million camels.

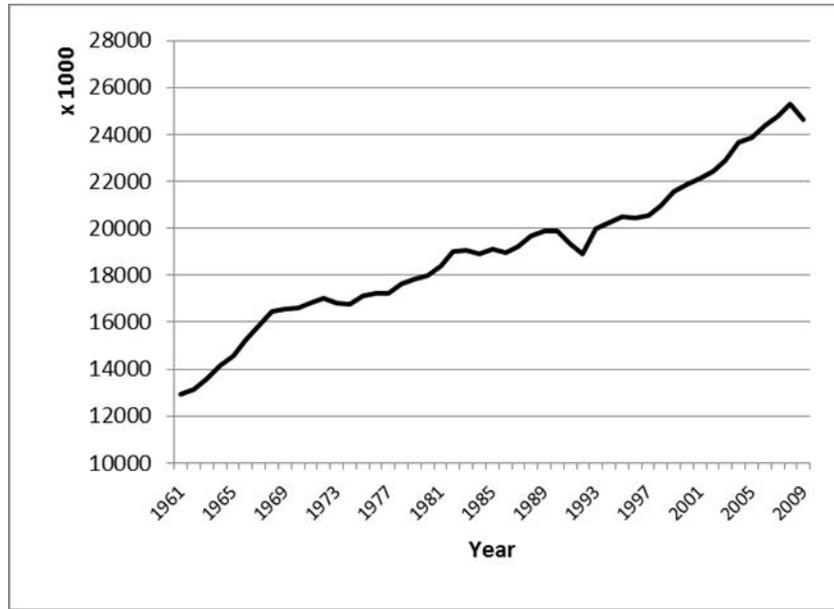


Figure 3. Camel world population growth between 1961 and 2009.

However the growth rate was not similar for all the countries. We can distinguish 5 types of trends:

- Countries with high recent growth (Algeria, Chad, Mali, Mauritania, Oman, Qatar, Syria, UAE, Yemen, Ethiopia, Eritrea)
- Countries with regular growth (Bahrain, Burkina Faso, Djibouti, Egypt, Iran, Kenya, Niger, Nigeria, Pakistan, KSA, Somalia, Sudan, Tunisia, Western Sahara)
- Countries with stable population (Lebanon, Libya and Senegal)

- Countries with declining population (Afghanistan, China, India, Israel, Jordan, Mongolia, ex-Soviet-Union republics from Central Asia)
- Countries with high rate of decline (Iraq, Morocco, Turkey)

The dromedary is obviously linked to the arid countries and on sociological aspects mainly (but not exclusively) to Muslim countries (Figure 4).

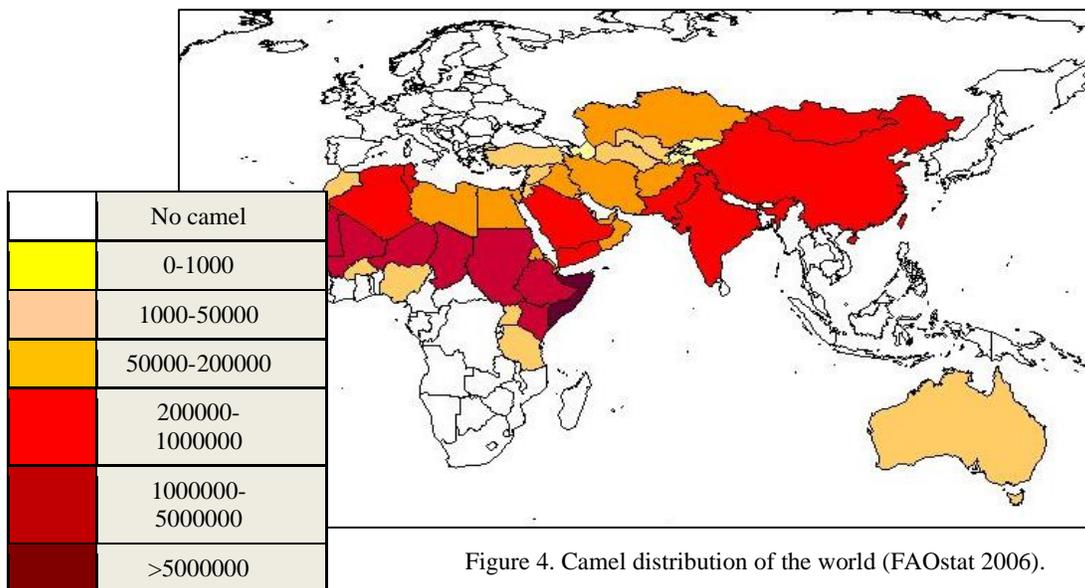


Figure 4. Camel distribution of the world (FAOstat 2006).

In countries of desert nature (e.g. Mauritania, Saudi Arabia, Gulf countries), the camel farming systems are found all over the country, but only a small space is devoted to camel rearing in sub-arid countries. For instance in India, only the north-western area (Rajasthan, Gujarat states) is favorable for camel farming. In Ethiopia, only the lowlands (below 1500 m altitude) are regularly occupied by camels. Similar patterns are observed for Bactrian camel. For instance in China and Kazakhstan, the Bactrian camel is present only in the arid part of the country (Gobi desert in China and Moyoum-Koum desert in Kazakhstan).

The camel was introduced in other countries, either for leisure as in circus or zoological garden, or for rearing in multipurpose activities such as: touristic attraction, walking in remote places, beaches, and sometimes for milk production. Some camel farms in Western Europe (Faye et al., 1995) or in North America were established, but its significance remains quite marginal. Even the dromedary introduction to South-African desert (Kalahari) was poorly developed. The main success of camel introduction out of its original home countries was in Australia but the major part of the herd is now feral (Faye et al., 2002). With a wild camel estimated population approximately 1 million heads, the camel in Australia is regarded mainly as a big environmental problem in the Central desert area of the country rather than a

potential source of meat (Saalfeld and Edward, 2010).

Camel biodiversity

The selection pressure on camel was low. Except for keeping animal with specific purpose (packing, riding, milking), few selection programmes by choosing the best animals according to the performances of their descendants were implemented, except for racing animals. However, at the world level, a high variability is observed although a high confusion is reported. Indeed, several breed names could be given for the same type of animals. Some denominations could make reference to the coat color only or different breeds could be described on the base of the tribe name of the owner. In a relative old publication, (Blanc and Ennesser, 1989), 48 dromedary breeds were described in the world and classified into 8 sub-groups according to their phenotypes, but this classification was based only on the general conformation of the animals. Finally, if the camel biodiversity is attested by many authors, it is not properly described up to now at the world level. The results based on molecular genetic attested the high confusion in the camel biodiversity description. Thus, the different phenotypes described in Kenya appeared without genetic differences (Jianlin et al., 2000). In Saudi Arabia, 9 camel phenotypes are described (Figure 5), but after analysis by molecular genetics, only 3 sub-types were identified (Faye et al., 2011).

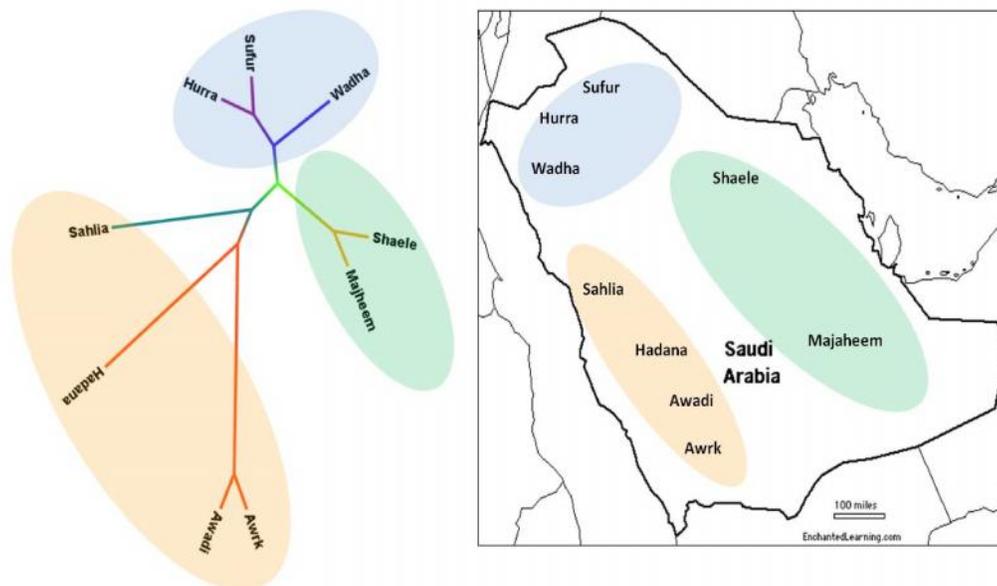


Figure 5. Left: Phylogenetic tree of camel populations in the Kingdom of Saudi Arabia using microsatellite markers. Right: Location of the three camel population groups in Saudi Arabia.

The camel, a multipurpose animal

The camel is a multipurpose animal. It can be used for milk, meat, wool, transport, race, tourism, agricultural work, and beauty contest. No other domestic animal is able to provide as many variable services to human. Meat and skin productions are the only purposes which require the camel to be slaughtered. Consequently, meat production is linked to proper herd management in terms of selection of animal to be slaughtered such as young males which are not kept for reproduction or other activities and culled female or males and to market organization at local and regional level. Milk production is the principal purpose for camel rearing in many countries especially for dromedaries (the dairy yield of Bactrian is lower). The camel milk self-consumption is common as the camel is mainly reared in remote areas. The quality of camel wool is widely variable. It is better in countries having cold winter and the Bactrian wool is more appreciated. In Mongolia, some breeds were selected for the wool production, giving fiber as cashmere. The camel is used for riding but also for racing. The camel race is an important cultural event in the Arabian Peninsula and becomes popular also in Africa. Historically, the ability of camel to be ride was used by the army and still now, camel military companies are implemented in Sub-Sahara countries. However, the camel power is used peacefully for transport (packing or pulling animals). The use of camel in caravans through the desert belongs to popular image, but is still operational in some areas. Pulling camel is common in India for transportation of all kind of industrial or agricultural goods. The camel is also an auxiliary of agricultural activities for ploughing, water extraction, seeding, harrowing, etc... The tourism attraction is on development, not only for riding on beach, dunes or around the pyramids in Egypt, but also for festival, fantasia and other spectacles like the dancing camel at Pushkar fear (India). In Saudi Arabia, an important event occurs for evaluating the beauty of the camel with high value awards for the winners.

From tradition to modernity

Traditional camel farming systems are extensive, based on the use of natural resources and on the herd mobility. The biological particularities of camel conduct to a very slow reproductive cycle: long gestation (13 months), late precocity for reproduction (rarely before 3 years), long inter-calving interval (generally 2 years). Moreover, the survival rate of the young being low (the young

mortality could reach 20% and even more), the numerical productivity is weak, even if the longevity of the camel could compensate it. Yet, the traditional camel farming systems show a very high variability, showing the possibility for important productivity progress. This potential could be used to intensify the camel productivity through intensified systems. Some examples are available in the field of milk and meat production showing the ability to develop “modernized” farming system for camel.

• Dairy potential

The milk is one of the main production of camel with a high interest for local population in arid lands for at least 3 reasons: (i) the main part of the production is self-consumed and thus, contributes to the food security of arid lands, (ii) there is a growing interest for camel milk from the urbanized population in those areas and then an increasing market opportunity, (iii) there is a trend to the development of dairy camel intensive system which could be profitable for settled producers (Faye et al., 2002). However, as the camel milk is still not widely integrated into national market (except in some countries like Mauritania, Kenya, Emirates or Saudi Arabia) the official statistics could be debatable. According to available FAO statistics, the camel milk production increased by 2.45% yearly, i.e. more than the camel population. Passing from 629,148 tons in 1961 to 1,635,807 tons in 2008, the camel milk production was multiplied by 2.6. At the world level, the camel milk represents 0.23% of the consumed milk but this proportion is probably underestimated: On the base of 16% of lactating animals producing on average 1500 l/lactation, the milk production by camels could be estimated to 6 million tons.

The increase in dairy production by camels was due to 2 facts: (i) the slight increase of the proportion of lactating animals in camel herds passing from 14.7 to 19.2% between 1961 and 2008, (ii) the camel population growth. However, the increase in camel milk production is not due to the improvement of the dairy productivity. Compared to cattle and buffalo, the investigation of research and development was not sufficient to increase the dairy yield in camel (figure 6) in spite of its high potential. It is probably the main point regarding milk production in camel: an important potential for increasing dairy yield in camel is existing, but this potential is not widely supported by research program (Faye, 2004).

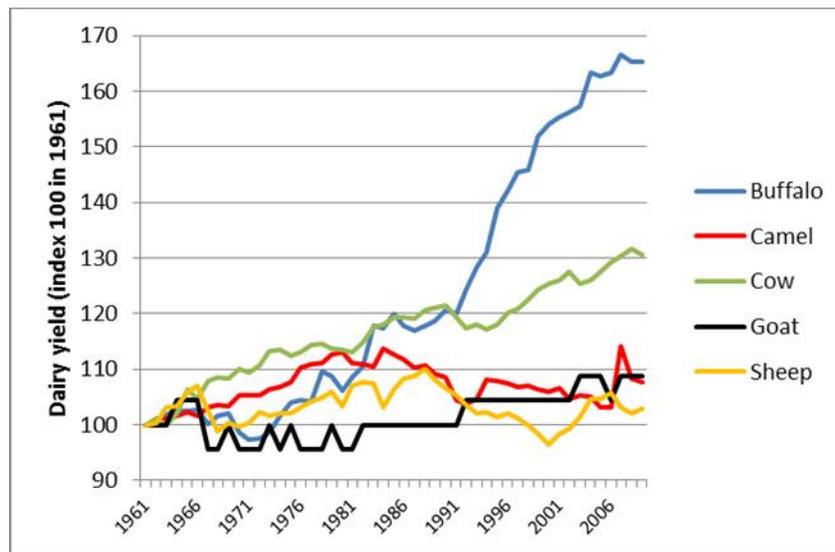


Figure 6. Change in dairy yield /animal from 1961 to 2009.

In spite of this slow change in dairy productivity at world level, some significant trends are observed:

(i) The camel milk market integration is developing. For most of the pastoralists, camel milk cannot be sold because it is a gift. This cultural behavior was the main obstacle for implementing camel milk market (Abdeirahmane, 1997). However, with the urbanization of population formerly living in pastoral areas, the camel milk demand increased, encouraging the implementation of periurban camel farming systems integrated to local market (Faye et al., 2003).

(ii) Traditionally consumed under fresh or fermented form, the processing of camel milk into cheese was difficult. However, several technological researches were achieved for performing cheese making (Boudjenah-Haroun et al., 2011) and other dairy products (ice cream, yoghurt). Nowadays, camel cheese production is available in few countries.

(iii) The use of milking machine is developing in big size farms (Emirates, Saudi Arabia, Central Asia) and the camel shows a convenient adaptation to automatic equipment without significant effect on udder health.

(iv) The development of the camel milk market is linked to the implementation of dairy plants able to process camel milk like the factory Tiviski in Mauritania (Mohammed, 2003).

(v) The intensification of the reproductive cycle of camel is based on the resort of

biotechnology of reproduction and new farming practices like artificial insemination, embryo transfer, early weaning or artificial milking of the young (Tibary and Anouassi, 1997).

(vi) The implementation of genetic selection program for racing performance (Emirates) or for milk production improvement which was developed in Central Asia (Tasov and Alybaev, 2004).

• Meat production and market

The available statistics on camel meat production in the world are limited to the number of slaughtered animals, the mean carcass weight upon which meat production is estimated. However, there is no available statistics on the type of camels slaughtered or meat processing. A significant number of camels are slaughtered out of official channels and they are unaccounted for suggesting that camel meat production is probably underestimated.

The percentage of slaughtered camels has regularly increased since the year 1960 ranging from 5 to 7%. This increase could be explained by a better organization of the camel meat commodity channels and a decrease of the unofficial slaughtering although unofficial slaughtering in camels is less important than for small ruminants or even for cattle. Indeed, the heavy weight of the camel does not usually encourage killing one animal for few guests contrary to goat or sheep. The slaughtering rate is obviously higher in male than in female camels. Only local statistics are available for camel meat production. For example

in slaughterhouse of Laâyoune (South-Morocco/Western Sahara), the observation of the age pyramid of slaughtered animals for 5 months monitoring (Faye, unpublished results) have shown that 44% of the slaughtered males were less than one-year old vs. 14% of the females. The culled adult females represented 28% of the slaughtered females vs. 7.7% only for adult culled males (Figure 7). From 1961 to 2009, the camel meat production increased at a rate of 2.8% from 123,000 to 356,000 tons. The more important camel

meat producers are Sudan, Egypt, Saudi Arabia (KSA) and Somalia, but some of these countries are mainly exporting (Sudan, Somalia) while others are rather importing (KSA, Egypt). In spite of the low contribution of camel to the world meat production, it is noticeable that the growth is higher than for cattle, sheep and horse meat. Using the index 100 in 1961, the index of meat production in 2011 was 448 for goat, 309 for buffalo, 285 for camel, 223 for cattle, 165 for sheep and 136 only for horse (Figure 8).

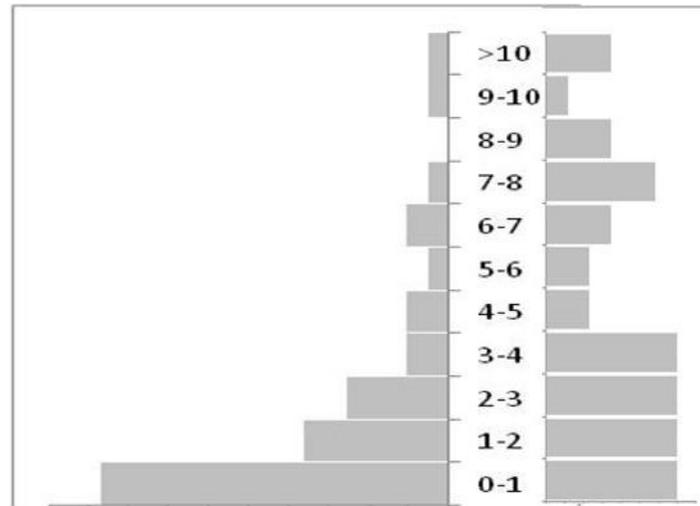


Figure 7. Age pyramid of the slaughtered camels at the Laâyoune abattoir (Morocco).

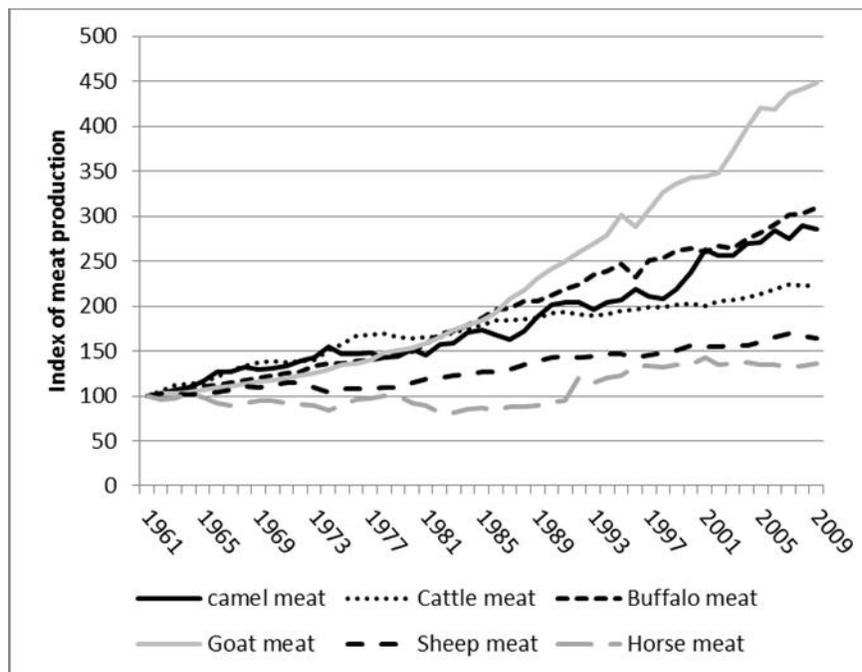


Figure 8. Growth of the red meat production in the world since 1961 (index 100).

The contribution of camel meat to the world meat production is rather marginal due to the less significant place of camel among the herbivorous. Compared to all meat producing types (except fish), the camel meat represents 0.13% of the total meat produced in the world and 0.45% of red meat from herbivorous. However, contrary to milk which is only integrated into local market, the camel meat is involved in international market, especially in the Horn of Africa (Alary and Faye, 2011).

Regarding the camel meat sector, the improvement of the market is based on the following items:

(i) The implementation of camel feed-lots for encouraging the delivery of very well fattened animals on the market is increasing.

(ii) Specialized butchereries for camel meat marketing are implementing in North Africa (Tunisia, Morocco) in order to satisfy the urban demand.

(iii) The official slaughtering is increasing in most of the countries and proposals for carcass classification, meat quality evaluation, convenient cutting, and better veterinary control are more and more frequent.

(iv) New camel meat products are available on the urban market like “camelburger”, sausages and corned camel in canned box (Farah and Fisher, 2004; Kadim et al., 2013)

(v) The nutritive value and the physico-chemical composition is in favor of commercial added value of camel meat, especially because its low cholesterol content (Faye et al., 2013)

• **Other purposes**

In spite of the rapid urbanization in the “camel countries, the interest of camel for cultural events is increasing. The camel race is still very popular in gulf countries especially. This activity pushed many innovative research on genetic, biotechnology, physiology and contribute to a better understanding of the camel biology.

The camel face to climatic changes

That point is particularly important to understand the present trend on the expansion of camel farming system in Africa and Asia. All the authors in the scientific literature stress on the ability of camel to survive in the desert ecosystems, and underline the physiological particularities testifying its adaptation to arid conditions (Bengoumi and Faye, 2002). The camel is belonging to the domestic species characterized by hyper-adaptation to a given milieu leading to a low plasticity (as for yak, reindeer or lama), but

essential for keeping rural activities in remote areas. The indirect effects of the climatic changes on animal were described by some authors underlining the impact on feed resources (including water) and on diseases (Sirohi and Michaelowa, 2007). In Sahelian countries, the climatic changes observed from meteorological reporting since one century, are characterized sometimes by severe droughts more marked than in the past, and sometimes (especially in the recent time), by very abundant rainfall on shorter time. These changes have some effects on camel stock and breeding, both on their geographical distribution, their health status and on their social use by the farmers. Four main aspects could be observed in Sub-Sahara Africa: (i) a tendency to the camel population increase in settled livestock farming systems, (ii) a tendency to the use of camel as auxiliary of agriculture, (iv) a more close market integration of the camel commodity channel, (iv) an increased role of camel in the security of farming systems traditionally focused on cattle breeding (Faye et al., 2012).

Of course, the proper dynamic characteristic of the pastoral societies and the global economy have also an impact on the observed evolutions as well on progressive market integration, as on the emergence of new pathologies. But, the indirect effects induced by the pressure of the climatic changes on the space occupation and, consequently, on the relationship between social and economic use, resources management, interaction with the environment and epizootiological risks cannot be ignored.

The trends in camel sciences

According to the number of publications focused on camelids each year, we can consider that the interest of the international scientific community still exists. The trend is to a slight increasing of the scientific production since 30 years. However, the camel studies are still quantitatively marginal compared to other ruminant species. This marginality is linked first to the low camel stock compared to cattle for example, and to the limited geographical distribution of this species. Second, for funding agencies and main decision makers, camel is rarely considered as a productive animal, but rather as an animal from the past, just interesting to walk in the desert with the tourists (Faye and Brey, 2005). So, the scientific interest of camel appears to be low for many research institutes in the North and even in the southern countries. For example, in sub-Saharan African

countries, development projects and research interest increased first for political reasons after different periods of rebellion of nomads traditionally camel keepers (Mali, Niger, Chad, Morocco...). But in the same time, as it has been shown above, camel farming is engaging into intensification process for dairy and meat production. Elsewhere, the camel appeared as a very interesting biological model for scientists in different field. The international scientific community must be aware to these trends, and the camel scientists, especially in the southern countries, contribute to the promotion of new scientific approaches. A short analysis of these new trends in camel sciences is presented below. However, the camel scientists have to stay modest. From 1779 up to 2010, no more than 10000 official publications are available in camel sciences field, which is more or less the total number of references for cattle into three years. Nevertheless, the present trends could be observed and are encouraging for the camel scientists:

- The camel interests the scientists as biological model: adaptation to extremes conditions, bio-actives molecules in milk as Lactoferrin or lysozymes (Konuspayeva et al., 2006), exceptional particularities of the immunoglobulins (Hamers-Casterman et al., 1993) and medicinal properties of camel milk (Konuspayeva et al., 2004).

- The camel has shown its high productive potential in arid conditions (milk, meat, wool, energy), but the progress was slow in the last decades. However, recent researches have supported new considerations regarding the productivity of camel (Faye, 2004; Kadim et al., 2008).

- The camel is an element of the arid ecosystems and the global change could conduct to change in farming systems, to the appearance of emerging diseases, and could underline the adaptation of camel face to climatic changes. All these aspects are more and more taken in account by the camel sciences.

Conclusion

The camel is a marginal animal at the world level with still now a false image of a past animal. Yet, the main aspects to be underlined on camel today are the followings:

- The camel is able to produce milk, meat, wool in very harsh conditions with a high added value for the producers and interesting dietetic and nutritive properties for the consumers,

- The camel is no more the only ship of desert but also a productive animal able to be involved in intensification process and in consequence, in modern farming systems,

- The camel rearing is expanding in the world especially in Africa and the camel population is still growing

- The camel has its place for the future, notably with the climatic changes

- The organization of the camel scientists' community through the International Society of Camelid Research and Development -ISOCARD (www.isocard.org) is an important step for supporting the acknowledgement of the camel sciences.

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