The improvement of camel reproduction performances: just a technical question?

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Abstract

The question of "How to improve camel reproduction" is an age-old dilemma for scientists and veterinarians in the camel sector. In 1990, during the workshop organized in Paris, on the topic "Is it possible to improve the reproductive performance of the camel?", Professor Musa (Sudan) said that "although the field of camel reproduction is no longer the virgin area it used to be ten years ago, there are still a lot of gaps in our knowledge concerning camel reproduction". Among the questions, it was mentioned that infertility was still not well defined in the camel as compared with other farm animals. Knowledge has progressed over the last 25 years but, the improvement in reproductive efficiency of the camel is still limited. The improvement in reproductive efficiency has two main objectives: (i) to contribute to genetic progress, and (ii) to increase the numerical productivity of the camel herd. The main parameters contributing to this productivity are the fertility rate (number of live calves at term/mean number of adult females) of both male and female, the intercalving interval and embryo and calf survival. The main advances over the past 25 years have been due to better management regarding the diagnosis of gestation and fetus monitoring, a better understanding of mechanisms to stimulate male libido, a more rational culling policy for camels with genital abnormalities, better general hygiene of the farm at calving (distribution of colostrum) and at weaning, better health management (vaccination, parasitism prevention) and the introduction of assisted reproductive techniques such as artificial insemination and embryos transfer (AI, ET). On the other hand, advances in the organizational aspects at national level are quite insufficient. For example, no real performance control to identify the best potential genitors, no collection of data regarding reproductive performances except at some big dairy farms and even the strategy for reducing the calving interval has not really been established. In addition, the knowledge and capability of the farmers, veterinarians and technicians at the national level is still insufficient to observe progress in camel reproductive performances and even if these performances were to be improved, there is no national monitoring system to measure this improvement. A demographic model,such as the Leslie Model, could help as a first step in understanding the initial ways for improving camel productivity such as decreasing calf mortality, increasing fertility and decreasing the intercalving interval ? An example is given in the presentation.

Keywords: Camel, reproduction, technical innovations, performances farmers organization

L'amélioration des performances de reproduction chez le chameau: juste une question technique?

Résumé

La question du "comment améliorer la reproduction chez la chamelle" est un vieux dilemme pour les chercheurs et les praticiens vétérinaires dans le secteur camelin. En 1990, au cours de l'atelier organisé à Paris, sur le thème "Est-il possible d'améliorer les performances reproductive chez le chameau ?", le Professeur Musa (Soudan) écrivait "bien que le domaine de la reproduction cameline ne soit plus un terrain vierge depuis une dizaine d'années, il y a encore beaucoup de lacunes dans notre connaissance concernant la reproduction du chameau". Parmi ces questions, il était mentionné que l'infertilité n'était pas encore bien définie chez le chameau, comparé à d'autres espèces de rente. Certes, les connaissances ont beaucoup progressé depuis 25 ans, mais l'amélioration de l'efficacité reproductive du chameau reste encore limitée. L'amélioration de cette efficacité a deux objectifs principaux : (i) contribuer au progrès génétique, et (ii) augmenter la productivité numérique des troupeaux camelins. Les principaux paramètres contribuant à cette productivité sont le taux de fertilité (nombre de chamelons vivants à terme/nombre moyen de femelles adultes) des mâles et des femelles, l'intervalle entre mises bas, et le taux de survie embryonnaire ou néonatal. Les principales avancées depuis 25 ans ont porté sur une meilleure gestion concernant le diagnostic de gestation et le suivi embryonnaire, une meilleure connaissance des mécanismes stimulant la libido, une meilleure politique rationnelle de réforme des chamelles avec anormalités génitales, une meilleure hygiène des fermes à la mise bas (distribution du colostrum) et au sevrage, une meilleure gestion sanitaire (vaccination, prévention parasitaire) et l'introduction des techniques de reproduction assistée telles que l'insémination artificielle et le transfert d'embryons (IA, TE). D'un autre côté, les avancées dans les aspects organisationnels aux niveaux nationaux sont tout-à-fait insuffisantes. Par exemple, il n'y a pas de réel contrôle de performances pour identifier les géniteurs à bon potentiel, aucune collecte des données concernant les performances de reproduction, à l'exception de quelques grandes fermes laitières, et même absence de stratégie de réduction de l'intervalle entre mise-bas. De plus, les connaissances des chameliers, des vétérinaires et des techniciens au niveau national sont encore insuffisantes pour observer un progrès des performances reproductives de la chamelle, et même si ces performances ont été améliorées, il n'existe aucun système de suivi national pour mesurer cette amélioration. Un modèle démographique, tel que le modèle de Leslie, peut contribuer dans une première étape à comprendre les voies initiales pour améliorer la productivité cameline en permettant de faire le choix entre diminuer la mortalité du chamelon ou augmenter la fertilité et diminuer l'intervalle entre mises bas. Un exemple est donné dans la présentation.

Mots-clés: hameau, reproduction, innovations techniques, performances des organisations d'éleveurs

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INTRODUCTION

The question of improving camel reproductive efficiency is an old dilemma for scientists, veterinarians and farmers in the camel sector. In 1990, a workshop was organized in Paris, on the topic "Is it possible to improve the reproductive performance of the camel?" (Saint-Martin, 1993), during which Pr Musa (Sudan) said that "although the field of camel reproduction is no longer the virgin area it used to be ten years ago there are still a lot of gaps in our knowledge concerning camel reproduction". The main gaps were: (i) the fact that infertility was still not well defined in the camel as compared with other farm animals; (ii) the under use of assisted reproductive techniques such as artificial insemination (AI), and embryo-transfer (ET), (iii) knowledge regarding post-partum ovarian activity and/or the interactions with nutrition, management and environment was insufficient, (iv) most of the studies on camel reproduction were carried out at experimental stations and not in the field, (v) data on infectious reproductive diseases and male libido were still scarce, (vi) the mortality rate in young camels, especially in new-borns, was still high.

Although important technical progress has been accomplished since this workshop in techniques such as semen collection, AI and ET in camels, and a deeper understanding of their reproductive physiology achieved, improvement of their reproductive efficiency in the field remains limited by many aspects (Skidmore, 2005; Tibary and Anouassi, 1997). For example, the increase of world camel meat production since 1961, is linked to the increase in slaughtering rate rather than to the individual productivity rate (Faye and Bonnet, 2012): the mean annual camel population growth 1961-2014 is 1.48% whilst the slaughtering rate increased by 2.77%/year (Figure 1).

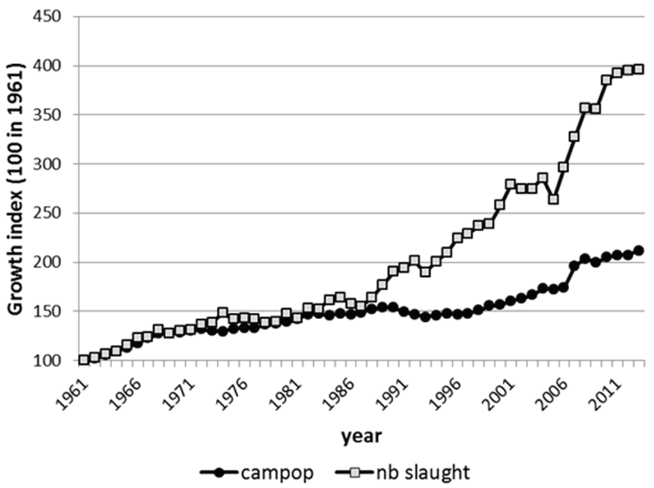

Figure 1: Changes in camel population and slaughtering rate since 1961 (index 100 in 1961) (Source: FAOstat, 2016)

Obviously, the question of the improvement of camel reproductive efficiency, i.e. of camel productivity, is not only a technical question but covers a set of considerations, which are presented in the present paper.

HOW AND WHY TO IMPROVE THERE PRODUCTION PERFORMANCE OF CAMELS?

The aim of improving reproductive performance is to increase the numerical productivity of the camel herds. This can be particularly challenging because camel productivity is relatively low due to the late onset of puberty, long gestation period of 13 months, poor survival rate of the young and rather long inter-calving intervals in this species (Nagy *et al*., 2013). Specific objectives should be aimed for when trying to improve reproductive performance such as a further contribution to genetic progress (especially for milk production and growth performance), control of infectious diseases linked to genital contamination and a reduction of the losses due to mastitis and calf mortality. Different methods are used to reach these objectives. They involve improvement of male libido by a better understanding of their breeding behavior (Padalino *et al*., 2015), increasing fertility of camel semen (El-Bahrawy *et al*., 2015), and better culling management of infertile or subfertile bulls and females. It involves also a better knowledge of the risks linked to genital infections (Al-Afaleq *et al*., 2012; Benaissa *et al.,* 2014) and a decrease in the early embryo-mortality and abortion rates which are currently high in camel (Tibary et *al*., 2006; Narnaware *et al*., 2016). Finally, the increase of numerical productivity of camel herds is depending to the fecundity performances of the camels and of the survival rate of the young.

TECHNICAL IMPROVEMENT IN CAMEL REPRODUCTION

Scientists regard that biotechnology of reproduction (AI, ET), which was very successfully used in cattle, is an essential step towards improving the reproductive performance of camels. However, even though AI and ET techniques have been developed and applied now for many years in this species, several technical constraints still occur (Skidmore *et al*., 2013) which have to be overcome if success rates are going to match those achieved in cattle. The difficulties are linked to the characteristics of the camel semen, which is very viscous and therefore difficult to handle. In addition there are no reliable methods for the deep freezing of camel semen which further limits the use of AI in this species (Monaco *et al*., 2016). Moreover, the use of these biotechnologies has not been applied out of research stations and at best is limited to a number of big intensive camel dairy farms (Nagy *et al*., 2013).

Other technical improvements are also possible such as the management of natural mating, diagnosis of pregnancy with portable ultrasound machine, stimulation of male libido by better housing management, culling camels with genital abnormalities or with repeated infertility, better management of farm hygiene especially around parturition and weaning, control of colostrum distribution and good health management through vaccination campaigns and programs for prevention of diseases.

All these technical achievements, however, are not sufficient for a significant improvement in the numerical productivity at a national level. Indeed, there is an obvious lack of global systems aiming to organize performance control. Only such a national system would lead to the identification of the "best potential genitors" that in turn would lead to animals producing better quality semen and embryos. There is a distinct lack of data regarding reproductive performance, milk production and growth performances of the young camels in the field. Therefore, there is a need for a policy for a national performance control system which should include: (i) registration of data on camel production eg. growth and milk production, (ii) identification of the best genitors for the establishment of a camel nucleus with higher genetic potential, (iii) creation of semen and embryo collection centers and of systems for distribution of improved embryos.

The improvement in reproductive efficiency is linked to the specialization of the camel farms. The objective, in terms of reproduction, would be different according to the type of camel farm: (i) for intensive dairy farm, it is not reasonable to decrease intercalving interval below 2 years due to the impact of pregnancy on milk production as it has been demonstrated by Nagy *et al*., (2015): the milk production was on average 4856 ± 567 kg in non-pregnant camel after 280 days post-partum vs 2705 ± 198 kg in pregnant animals after 280 days post-partum. On the other hand, on farms aiming to produce young camels for meat purposes, the intercalving interval could be reduced by up to 15-16 months in order to increase the numerical productivity (Faye *et al*., 2002).

Technical innovations in reproduction also require an important investment in improving the capabilities of veterinarians, technicians and farmers on the farm. This should include: (i) training of livestock technical officers or technicians in local veterinary services on camel diseases linked to reproduction (diagnosis and treatment), (ii) training and support to animal health operators who are camel farmers that carry out some basic treatments and distribute certain drugs (OIE recommendation), (iii) the organization of regular meetings with camel farmers for information on general hygiene, good farming practices and reproduction management. Unfortunately, in the camel sector, training of farmers through special training sessions run by local authorities is difficult to set up and are generally not in demand (Faye, 2003).

THE USE OF DEMOGRAPHIC MODEL

Herd demography is an important element to assess the numerical productivity. The estimation of demographic rates is necessary to assess impacts of management or veterinary interventions on herd production or to assess the livestock population dynamics under different scenarios. As it has been underlined above, this productivity is mainly due to calf survival and adults' fecundity rate. However, in a herd, it could be difficult to address all parameters simultaneously, and the question for the herd manager could be, "shall we give priority to the improvement of fertility rate or to calf survival?" To reply to such question, the use of a demographic model would be useful.

In a herd or in a country, animal demography is based on similar parameters (Lesnoff *et al*., 2011): the initial composition by sex (female and male) and age, animal inputs (birth, purchase for a herd or import for a country, eventually gift or heritage) and animal outputs (mortality, culling selling or export at country level). For each sex, different age classes could be determined but the usual classification considers three classes: juveniles, sub-adults and adults but the actual ages for each class depend on the species and farming management traits (Lesnoff, 2008). With this classification, only adult females are assumed to be reproductive. The distribution of males and females in the juvenile group at birth depends on the sex ratio and the number of animals passing from one age class to another depends on mortality rate, birth rate, culling rate, offtake/intake rate and at country level import/export volume (Figure 2).

The model used is deterministic. It is based on one application under Excel table developed for assessing the potential growth and potential income of a camel (Alzuraiq *et al*., 2015) and is based on the Leslie model described by Lesnoff *et al*., (2013).

The parameters of the models are determined by the user (for example mortality or pregnancy rates) based on the available data in the camel sector. The time-interval used in herd-level computation was the year leading to the lack of representation of potential seasonal variation although it is an important feature in camel reproduction. However, the reproduction cycle in the camel is roughly two years (one-year gestation, one-year lactation, two-years of calving interval), so the year-interval could be considered as convenient. Due to the long lifespan of camels, the age classes were divided into 0-1, 1-2, 2-3, 3-4 years (sub-adults) and adults. For projections over several years the variability of the environment is not considered with these present models so the impact of resources (feeding, water), diseases or economic constraints (market's prices) are not included. The model is based on the decomposition of the demographic events as schematically represented in the Figure 2. Since the birth of twins is rare in camelid species, the prolificacy rate is considered as equal to the calving rate.

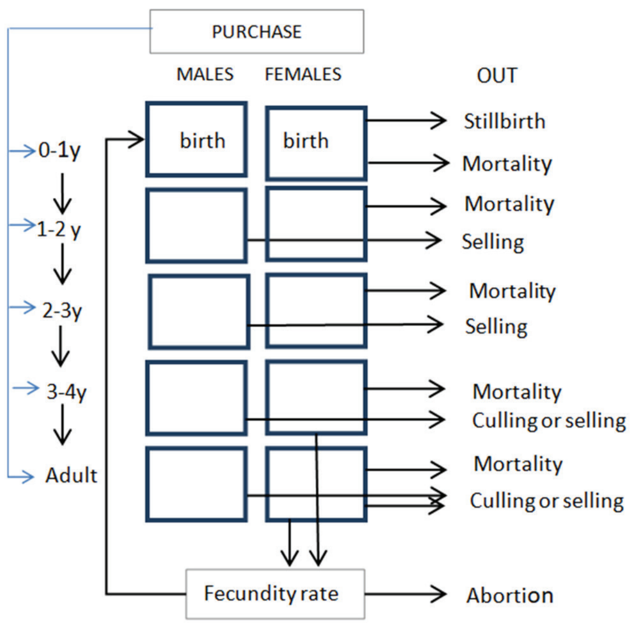

Figure 2: Decomposition of the demographic events in a camel farm for assessing the numerical productivity

The ranges of the different parameters retained in the model are the following: calving rate (number of calving/number of pregnant females): 80-90 %; Abortion rate (1-calving rate); sex ratio (number of females/number of males): 80-120; mortality rate 0-1 y: 5-30 %; mortality rate 1-2 y: 0-15%; mortality rate 2-3 y: 0-10 %; mortality rate 3-4 y: 0-5%; mortality rate adult: 0-5 %; pregnancy rate (number of pregnant/number of mated females within a year): 70-95%; culling rate for males according to age class: 5-60% and for female 5-15%; Mean lactation length: 300 to 400 days. The application also includes some economic parameters such as annual milk productivity growth (1 to 10%), the mean individual daily milk production (5 to 10l), milk price (10-15 Dirhams-Dhs- in Morocco), price of culled animals (15 000-25 000 Dhs), annual inflation (2.5-3% in Morocco), % of milk sold (50 to 100% depending on its use for processing). The farm application was built on an Excel table and the demographic projection was done for a period of 10 years.

ASSESSMENT OF THE FARM MANAGEMENT ON NUMERICAL PRODUCTIVITY

The farm model helps to assess the impact of improving management (ie. a decrease in mortality rate, an increase in pregnancy rate, better culling or offtake management, an increase in milk productivity), on the numerical productivity and the farm income.

For example, with 90% pregnancy rate, 10% abortion, 50% offtake rate for young males and 10% culling for adult females and sex ratio 100, the herd growth over 10 years was 3.9 % if mortality rate in 0-1y age class is 20% and 5% in following age classes (Figure 3).

With mortality rate of 10% for 0-1 year and an increase in annual fecundity rate of 5% (from 0.4 to 0.45) an improvement in annual herd growth of +1.27% was achieved which increased annual growth from 4.18 to 5.45% (Table 1). At the same time annual milk incomes (in Moroccan dirhams -Dhs) increased by + 12165 Dhs (+10.5%). A mortality rate of 20% and improvement of fecundity rate by 5% lead to a similar improvement in herd growth (+1.18%) and of milk incomes (+12781 Dhs, i.e. +11.2%).

The decrease in mortality rate of young camels (0-1 year) increased the numerical productivity by 0.45% when the fecundity rate was 0.45 and by 0.36% when the fecundity rate was 0.40. The improvement of annual milk income was only +991 (+0.7%) and +1065 Dhs (+0.9%) respectively (Table 1).

The impact of pregnancy rate appears to be more important than the mortality rate for the milk income. The benefit over 10 years is multiplied by 10 with 90% pregnancy rate vs by 7 with 80% pregnancy rate, whilst the decrease in mortality rate during 0-1 year from 20 to 10% did not significantly change the expected milk incomes.

Such applications are useful for decision-making and to manage camel farms (for example by foreseeing the expected incomes) but other applications are also available depending on the objectives of the decision makers (Lesnoff, 2013). The consequence of improving the reproductive performance, especially by acting on the fecundity rate, could be quantified and the use of a demographic model could help in making the right decision in terms of cost-benefit analysis.

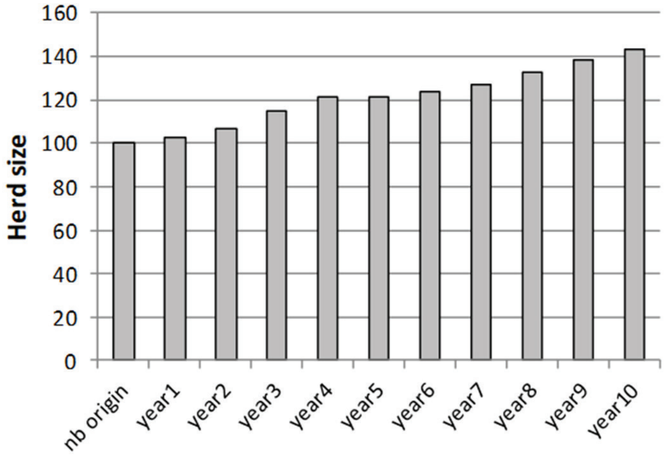

Figure 3: Changes in camel herd size for the next 10 years in the case of a 90% pregnancy rate, 10% abortion, 50% offtake in male and 10% culling in adults, sex-ratio 100, and mortality rate 0-1 year 20%. The original herd size was 100 heads with 36 adult females

CONCLUSION

The improvement of camel reproductive performance is influenced by three main drivers: (i) technical set up of modern biotechnological protocols based on a deeper understanding of camel reproduction, (ii) improvement of camel farming management, and (iii) clear national strategies for implementing the development of improving camel stock (ie. performances control system, identification of the animals, identification of the best reproducers).

The challenge of the improvement of reproduction performance could be raised only if these three drivers are taken into account.

Table 1: Changes in numerical productivity and milk incomes according to the improvement of management (increasing of fecundity and/or survival rate 0-1 year)

	Herd growth	Incomes	Herd growth	Incomes
	Mortality 0-1 y 10%		Mortality 0-1 y 20%	
Increase fecundity by 5%	+1.27%	+12 165 Dhs	+1.18%	+12 781 Dhs
	Annual fecundity rate 0.45		Annual fecundity rate 0.40	
Increase survival rate by 10%	+0.45%	+991 Dhs	+0.36%	+1 065 Dhs

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