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Genetic Improvement and the Future Role of the Camel in the Arab World: Problems and Opportunities

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ABSTRACT

This paper discuss the use of genetic means to improve camel productivity such as: selection, systems of mating and genetic evaluation of animals, the use of artificial insemination, embryo transfer, and cloning. Also, obstacles of production evaluation are described. It concludes with the necessity of adoption of these methods, and recommends the use of nucleus systems to speed and enhance the improvement of this animal, to insure its place and role as food provider in the 21st century.

Key words: Selection, Genetic improvement, Camel.

INTRODUCTION

Arid and semi arid zones constitute a large part of the Arab world, which are characterized with low precipitation, prolonged draught, scarce vegetation and hot temperature. Under such circumstances the camel has been demonstrated to be the most suitable habituate and the best user of available feed resources.

The Arab world has more than 12 million camels, which is about 70% of the world camel population (FAO 1989), but the share of camel in meat and milk production is very low. The camel was ignored as a source of food provider and as user of resources and no improvement was directed to increase its productive abilities. The camel will not sustain its role as food provider without changing and improving its performance.

Changing and improving of camel performance is being sought. Let us distinguish between performance and ability to perform using the following relationship:

$$\text{Performance} = \text{Ability} + \text{Opportunity}$$

Ability is determined by heredity, which provides an individual with it's genetic make up and which is determined by action and interaction of heredity units (ability is determined at fertilization so that the new individual is able or not). Opportunity is determined by environment, which determines the extent to which ability can be expressed. This could make animals of similar ability perform differently, and of different ability to perform alike, which creates a problem of choice based on performance (P= G + E)

So we need a relative judgement of genotype and environment. The improvement will always come from choice of the best parents to give the next generation, and not all ability of the parent can be passed or transmitted to the offspring. The parent will transmit only one half of the genes, and not gene combinations.

$$P = GA + GNA + E$$

GA is the effect of genotype that originated from individual genes and which can be transmitted from parent to offspring (additive). GNA is the effect of genotype that originated from a combination of genes, which are not transmitted to the next generation due to segregation (non-additive: such as dominance and Epistasis). Opportunity or environment that influences performance can be divided to temporary (ET) and permanent (EP). There are environmental effects that are specific to the individual and can not be adjusted for the EP, which is the environmental affect that will continue with the animal in his life performance, such as if he lost a part of the udder, or a part of the lung. ET are temporary effects that are many, but which are sometimes positive and sometimes negative and tend to average out if we compare many performances of the same animal. Another type of environment EA: is that which we can account or adjust for such as herd, years, seasons, ages, etc., so:

$$P = GA + GNA + EP + ET + EA + e$$

If we want to know the performance of an individual in the future by keeping more records this will depend on the following ratio: GA + GNA + EP / P or repeatability. Considering comparison of an individual's performance. If we compare animals, we find that they are different in their performance and no two animals will give the same performance under any circumstances except by pure coincidence, so there is variation. “Variation” is the raw material with which the breeder work, stated by Dr. Lush, the father of the modern science of animal breeding. We have to recognize differences between animals and learn why they are different. Through variation only, selection and genetic progress are possible. Variability is most conveniently measured by variance and total variability in records of performance, which can be broken down into genetic and environmental components by some refined statistical techniques.

$$VP = VGA + VGNA + VEP + VEA + VET + Ve$$

So how much of a difference in performance can be transmitted to the offspring or next generation is VGA/VP or the ratio of additive variance to total phenotypic variance, which is called heritability, and which is specific to the trait in a population under a particular environment. This ratio determines the effectiveness of selection, and the breeding value.

The ratio VGA + VGNA + VEP / VP is called repeatability which measures the degree to which differences between individuals are repeated if we keep more records on the same individuals. So this is the model of performance where e is a random element due to sampling nature of inheritance.

These are the model factors that make performance records different and they show that:

- We need adjustments for difference that we can adjust for (EA).
- It is difficult to accurately estimate future individual performance because of temporary effects and they are expected to be large in the case of camel performance.

- A single offspring is not enough to determine breeding value, and performance is not a real indication of breeding value.

Genetic improvement

There are two methods to achieve genetic improvement; selection and systems of mating depend on non-additive genetic variance and the main attribute of these systems is the introduction of new genes and heterosis. Improvement will always come from the choice of the best parents to give the next generation regardless of the method of improvement. If additive genetic variation is the important part of performance variation, then selection is the method of improvement; if the non-additive genetic variation, then systems of mating is the method of improvement.

Selection

Selection is the choice of parents of the next generation measured by selection intensity. The following formula demonstrates forces that produce genetic change and applies to all traits and all species and their components are balanced forces through which we can relate almost all management decisions that influence genetic progress:

$$\text{Genetic progress} = \frac{\text{Accuracy} \times \text{Genetic variation} \times \text{Intensity}}{\text{Generation interval}}$$

Where is accuracy of selection: is the correlation between the estimated breeding value and the true breeding value. Genetic variation: is a measure of variation of breeding values, and tends to be constant for a trait in a given population. Intensity of selection: is the selection differential expressed on phenotypic standard deviation units. Generation interval: is the average age of parents when their offspring are born.

Camel genetic improvement

No methods of improvement have been applied to the camel except a very low selection based on phenotype and a little effect of

unintended migration. There is very little differentiation among breeds and distinction is not based on sound quantitive principles. Despite the huge amount of literature in recent years and after the critique of this literature by (Wilson, 1991), still the performance model of the camel is not yet clear. The estimation of performance in populations targeted for improvement were weak and inconsistent and information available provided no solid base for improvement programs (unrepresentative samples, low number of observation, no consistency in methods of estimation, no indication of variation and indirect estimation)(Field 1979, 1980; Knoess 1982; Schwartz et al., 1983; Moslah 1994, Yagil and Etzon 1980; Zia-ur-rhman 1994 and Ismail and Al-Mutairi 1991,1994). The efforts were not clearly directed to serve goals for improvement.

The recent developments in animal production were established, through the concepts of the quantitative genetics theory of multiple genes, recording of performance, statistical approaches, progeny testing and establishment of artificial insemination. The benefit to the mentioned methods was different and always linked to economic basis, which is weak in the case of camel. A pool of knowledge of genetics is available, which, if linked to improved animal technology, can lead to improved performance in most animals including the camel.

Variation

Literature suggests the existence of considerable phenotypic variation between types of camels (Table 1), but within types or breeds is not clear for all productive and reproductive traits, except for few underlined reports. (Koness 1977, 1982; Khanna et al., 1994; Wardeh et al., 1991; Ismail 1991, 1994; Zia-ur-Rhman 1994; Morton 1984, Aboul-Ela 1991,Chowdary 1986; Beniwal and Chaudary 1983, Hermas an Sharieha 1991 and Wilson 1986) Estimates of heritability of milk yield and growth measures were in the range of other farm animals (Hermas, 1998a).

Generation interval

The generation interval is large in the camel and the age of parents when offspring are born ranges in males from 6 to 27 years and in females 6 to more than 30 years(Hermas 1997;Wilson 1984).

The main components of this large generation interval are low reproductive performance, age at first calving, and very long productive life. This large generation interval will reduce yearly genetic progress.

Selection intensity

Selection intensity is connected to variation in economic traits and a low reproductive rate will strongly reduce the selection intensity. Calf mortality and abortion are high, especially in times of draught. They reach up to 25% in some herds (Hermas *et al.,* 1991) causing a reduction in replacement rate, which reduces selection intensity and increases the generation interval; due to low replacement rate and long herd life. Low intensity can be achieved in females. However in males considerable selection intensity can be attained by artificial insemination.

Accuracy of selection

Accuracy is mainly affected by heritability of the trait selected for. Breeding values evaluation are dealt with indirectly through the records of performance. Accuracy based on pedigree will be low, but combination of individual and progeny performance, with repeated records, will increase the accuracy but will increase the generation interval. For instance, selection for weight after weaning will be more accurate than pre weaning as indicated by heritability estimates (Hermas *et al.,* 1998b).

Herd life

The camel is characterized by a long herd life, up to 30 years, which can be seen as an advantage in the economic sense, but a disadvantage to genetic progress, because we want to replace breeding camels with better and younger ones as quickly as possible. This, coupled with low reproduction, will increase the generation interval. Repeated records will increase the accuracy of selection and genetic evaluation, but generation interval will offset this advantage.

Table 1: Means and variation of productive and reproductive traits.

Trait	Mean±S.E.	SD	Range	Range from Literature
Total milk (kg)	1041±51	348	335-2110	2000-8190
305 milk (kg)	926±36	238	357-1840	1068-5695
Lactation (days)	335±8	61	193-467	210-540
2 YWT (kg)	378±8	16	340-460	340 – 460
MWT (kg)	390±6	17	295-500	
CI (days)	678.6±12	105		429 – 852
DO (days)	234±25	110		234 – 333
AFC (days)	1509±37	143.9		720 – 1856
SP (days)	50±113	112		
NS	1.8±.3	1.32		1.63 – 1.8

2 YWT = Two years weight; MWT = Mature weight; CI = Calving interval; DO = Days open; AFC = Age at first calving; SP = Service period; NS = Number of services.

Reproductive performance

Reproductive performance is dealt with separately because it is the main obstacle to the economics of production and the main hindrance to genetic progress. Low reproduction will affect negatively all forces of genetic progress and it is the main component that inflates the generation interval. Age at first calving 1509 ± 37.2 days, calving interval 678.6 ± 12 days, days open 287 ± 13, and service period 52 ± 12.7, while number of services per conception

1.8 ± 0.1 (Hermas and Sharieha 1991,Wilson 1986,Abuol-Ela 1991). Most of the calving interval is seasonal as indicated from the difference between days open and service period. Season also affects age at first calving for the difference between age at successful service and age at first service. Synchronization of the estrus cycle to breed early in the season, early weaning (Hermas, 1998b) and flushing or supplementary feeding during the breeding season will have positive effects and will reduce generation intervals and improve intensity and accuracy of selection.

Sources of genetic improvement

The contribution of females to genetic improvement will be limited due to low reproductive rate and limited number of offspring (can be increased by super ovulation and embryo transfer); and low replacement rate, which limits selection intensity and accuracy of genetic evaluation. The main contribution of females will be as mothers of top selected sires, if they were accurately genetically evaluated.

Males will have the greatest contribution to genetic progress if they can be accurately evaluated. A very large selection intensity can be applied, even with natural service, because the number of sires needed and the accuracy and intensity of selection will be greatly enhanced if artificial insemination can be applied.

Artificial insemination

The development of AI is a must for genetic improvement even though it is expected to lower the conception rate as compared to natural service. Recent studies indicated a possibility of AI development, especially that ovulation is induced by seminal plasma and not mechanical (Chen and Yuen, 1985; Chen et al., 1990; Xu et al., 1985 and Xing-Xu et al., 1990). However, AI without sound progeny testing and proper genetic evaluation is meaningless.

Selection criteria

A tendency towards selection for dual purpose is probably more suitable for camels than specialization for meat or milk. In any case, a complete investigation of economical traits in camel is needed

including heritabilities, variation, genetic and phenotypic correlation between various economic traits, as well as economic value under system of production. A search for a selection criterion or limited criteria, which is accurately measured, early expressed in life and well be correlated with other traits will certainly contribute positively to any improvement program.

The availability of information will help to set objectives. The first and most important thing to meet the challenge of genetic improvement of the camel is to set realistic objectives and accurate information based on economics and production system analysis. To speed and enhance the process of improvement, a nucleus system of improvement should be adopted for all types of camels on regional basis, managed and directed on a national basis, in addition to development of cooperatives for camel producers.

Traditional methods of improvement which have achieved the most improvement in farm animals to date can be applied in the nucleus and then disseminate the genetic material to other herds in the form of AI, superior males and superior females. Also new technologies should be applied such as super ovulation, embryo transfer, cloning and gene transfer. The contribution of these innovations is not yet a large source of genetic improvement in other animals, and their possible contributions to camel improvement could be very significant.

Recommendations and points for consideration

- Determination of performance for all types of camels and factors that affect performance.
- Reproduction is the main obstacle to production economics of camel and to genetic improvement, so its improvement is essential by the use of estrus synchronization and through early weaning and increasing feed supplementation during the breeding season.
- Establishment of cooperatives for camel producers and encouragement of investment in camel production and the use of modern animal production technologies and practices.
- Introduction of camels to intensive farming, especially for milk and improvement of range conditions.

- Increase cooperation and connection of universities, research centers, extension and cooperatives of camel produces for establishment of nucleus systems of improvement.
- Development of AI and introduction of new technology coupled with traditional methods of improvement through nucleus systems of improvement which should be established on regional and directed on national basis.

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