

MORTALITY ANALYSIS AND HERD GROWTH IN INDIAN DROMEDARY BREEDS

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ABSTRACT

Records belonging to 1024 dromedary over a span of about 22 years managed at the centre were analysed to envisage the major threats during different stages of life in different breeds and sexes. Analyses revealed that differential breed mortality had occurred ($\chi^2 = 19.594$, $P < 0.01$). No preferential sex mortality was observed ($\chi^2 = 0.8767$, $P > 0.05$). Chi-square variance test indicated highly significant effect ($\chi^2 = 39.4574$, $P < 0.01$) of age group on mortality. The mortality was maximum in adults above 3 years of age (0.2029) followed by 0-1 year (0.1943) and 1-3 years age group (0.0875). Of the total camels died, 38.4% died in the first year of their life followed by 13.8% in 2nd Year, 5.5, 5.5 and 5.2%, respectively in the 3rd to 5th year. Of the camels that succumb to death in the first year, 49.5% died in the first month of their life followed by 15.3% in the 2nd month, 11.7% in the 3rd month. The major threats during first year of life were identified as pneumonia, heat stroke and enteritis. The mortality due to different systems differed significantly ($\chi^2 = 318.35$, $P < 0.01$). Maximum mortality (41.39%) was due to the involvement of digestive system followed by respiratory system (22.36%). The average annual herd growth was 8.53%. The standard death rate in the four genotypes *viz.* Bikaneri, Jaisalmeri, Kachchhi and Arab-cross was 4.80, 3.01, 3.63 and 10.49%, respectively. Scientifically planned breeding and improved health management would improve the situation and increase productivity.

Key words: Analysis, camel dromedary, herd growth, mortality

Most camel rearing countries are in the era of development and due to depleting grazing resources, the population of the species is going down severely. In India the population of camel has gone down from 1.1 m in 1972 to 0.516 m in 2007 (Livestock Census, 2007). The emphasis to conserve the species by exploiting its production potential to the maximum extent divert the energy of the animals toward production and the incidence of the diseases is likely to increase. Hence, a typical balance should be maintained to harvest maximum production out of the healthy individuals. Mange, gastro intestinal disorders, trypanosomosis and worms puzzle the camel breeders very often. Fracture of long bones, digestive tract disorders and respiratory tract infections are also commonly seen (Agab, 1998). Most diseases of camel can be prevented or losses due to them can be minimised by better management, health care and nutrition (Rolf *et al*, 2001; Kaufmann, 2003; Mochabo *et al*, 2005; Chafe *et al*, 2008,) but most of the reports on the causes of death in dromedary are either based on some survey (Agab, 1998; Mehta *et al*, 2002; Kaufmann, 2003; Mochabo *et al*, 2005; Chafe *et al*, 2008; Raziq *et al*, 2010) or they are some case reports (Bekele, 1999; Al-Swailem *et al*, 2010) or are focused on a particular disease (Ali *et al*, 2005; Gutierrez *et al*,

2005; Tibary *et al*, 1998; Almubrad *et al*, 2010; Bird *et al*, 2008; Munyua *et al*, 2010; Khalafalla *et al*, 2010). In addition, the recent report of zoonotic cases of camel pox infection in India (Bera *et al*, 2011; Duraffour *et al*, 2011) and molecular testing of human patient clinical samples and of tissue from camel revealing DNA signatures consistent with *Yersinia pestis* in an outbreak of gastroenteritis in Afghanistan (Leslie *et al*, 2011) aroused much interest. This study was accordingly planned to envisage the causes of death, pattern of herd growth and preferential breed, sex or age mortality in dromedary so as to suggest suitable measures for the same.

Materials and Methods

Animals and their management

A total of 1024 records of the dromedary herd maintained at the National Research Centre on Camel, Bikaner, India were analysed for a period of 22 years. The causes of death, as ascertained by the veterinary officers and subject matter specialists after postmortem, were grouped into 7 systems *viz.* digestive, respiratory, cardiovascular, peritoneum, urinary, nervous and others. In the 7th group, *i.e.* others, the cases of scorpion bite, snake bite,

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euthanasiation due to fracture of long bones/incurable disease, pica etc. were included.

Statistical analysis

The data was classified according to breed, sex and age of the individual with respect to the system involved in causing death. Annual herd strength was utilised for deriving the number of camels available in different breed, sex and age groups. The chi-square goodness of fit test, contingency analysis and test for homogeneity of the binomial samples, analysis of variance, Duncan's multiple range test and arc sine transformation of percent data was carried (Snedecor and Cochran, 1967; SPSS 10.0). The standard death rate (SDR) was calculated using the formula:

$$\text{SDR} = \frac{\text{Number of animal died}}{\text{Number of animals at the end of the period} + \frac{\text{Died animals days}}{365}} \times 100$$

Results

Differential breed and sex mortality

The classified mortality data of 1024 dromedary belonging to 4 genotypes with respect to the system involved is presented in table 1. A total of 148 Bikaneri, 88 Jaisalmeri, 69 Kachchhi and 26 Arab-cross died during the period. The proportion that suffered death in this span was 0.6047 in Arab-cross followed by 0.3594 in Kachchhi, 0.3177 in Jaisalmeri and 0.2891 in Bikaner. The chi-square analysis indicated that differential breed mortality had occurred ($\chi^2 = 19.594$, $P < 0.01$). The chi-square contingency analysis revealed absence of preferential breed-sex mortality ($\chi^2 = 2.4690$, $P > 0.05$) as well as, breed-age group mortality ($\chi^2 = 4.3052$, $P > 0.05$). The males died during the span were 169 as against 162 females. No preferential sex mortality was observed ($\chi^2 = 0.8767$, $P > 0.05$) with the proportion of males (0.3367) succumbing to death was almost equal to that of the females (0.3103).

Differential age group mortality

Chi-square variance test indicated highly significant effect ($\chi^2 = 39.4574$, $P < 0.01$) of age group on mortality (Table 1). The mortality was maximum in adults above 3 years of age (0.2029) followed by 0-1 year (0.1943) and 1-3 years age group (0.0875). Since the stay in different age groups was for unequal period, the data was analysed in detail. It was observed that 38.4% camels died in the first year of their life followed by 13.8% in 2nd year, 5.5, 5.5 and 5.2%, respectively in the 3rd to 5th year (in fact is 3rd, 4th and 5th year, so there are three Figs) and rest in the span of remaining 18 years with a reducing trend (Fig 1). Of the camels that succumb to death in the first year, 49.5% died in the first month of their life followed by 15.3% in the 2nd month, 11.7% in the 3rd and rest in the remaining 9 months with a reducing trend (Fig 2). The major threats during first year of life were identified as pneumonia, heat stroke and enteritis (Fig 3). Further, all 5 deaths due to encephalitis were also observed during this period, precisely during first two months of life.

Differential systemic mortality

The mortality due to different systems differed significantly ($\chi^2 = 318.35$, $P < 0.01$). Maximum mortality (41.39%) was due to the involvement of digestive system. Respiratory system was involved in 22.36% cases. The nervous, cardio-vascular, urinary and peritoneum were involved in 4.53, 3.32, 1.21 and 3.93% cases, respectively. Deaths in 23.26% cases were due to miscellaneous causes. The mortality was also analysed with respect to the disease(s) principally involved in causing death in dromedary (Table 2). Enteritis (22.4%), pneumonia (16.6%), ruminal impaction (11.2%) and heat stroke (9.1%) were the major causes. However, if the data of most vulnerable period i.e. first year is taken away, the tally reveals that deaths due to heat stroke reduced to 1.4% and pneumonia shifted to 3rd position with 9.5% death.

Table 1. Breed, sex and age wise mortality in the Indian dromedary at an organised farm.

Organs Involved	Breed				Sex		Age group		
	Bikaneri	Jaisalmeri	Kachchhi	Arab cross	M	F	0-12 Months	1-3 Years	> 3 Years
Digestive	60	35	30	12	65	72	46	29	62
Respiratory	32	22	15	5	43	31	48	9	17
Cardio-vascular	4	2	4	1	3	8	3	2	6
Nervous	6	4	5	0	10	5	9	2	4
Urinary	3	1	0	0	1	3	1	0	3
Peritoneum	4	3	5	1	4	9	2	1	10
Others	39	21	10	7	43	34	41	13	23

The ruminal impaction emerged as the second most important cause of death in dromedary after one year of age. The enteritis continued to be the most important cause of death throughout the life span. The overall picture revealed that ailments of digestive and respiratory system were the major causes of death in camel.

Herd growth and standard death rate

The growth of herd due to natural causes was analysed for the period under study and the pooled information is presented in table 3. The average annual calving rate on herd basis was observed to be 14.98% with non-significant effect of breed ($P>0.05$). The average death rate was 6.45% with significantly higher ($P<0.01$) mortality in Arab-cross animals as compared to the Bikaneri, Jaisalmeri and Kachchhi camels. The average annual herd growth was 8.53% with non-significant variation among the breeds

($P>0.05$) and a maximum of 37.84%. The cumulative growth analysis indicated about 208.10, 206.95 and 191.88% herd growth in about 22 years in Jaisalmeri, Kachchhi and Bikaneri breeds, respectively. The herd growth in Arab-cross camels was observed to be 100.95% during the same period (Fig 4). The standard death rate (SDR) in the 4 genotypes *viz.* Bikaneri, Jaisalmeri, Kachchhi and Arab-cross was 4.80, 3.01, 3.63 and 10.49%, respectively.

Discussion

Differential breed and sex mortality

The mortality analysis revealed preferential breed mortality due to proportionately higher deaths in Arab-cross as compared to the 3 other breeds. This was expected because only 43 Arab-cross animals were available during this period as against the 512, 277 and 192 in Bikaneri, Jaisalmeri

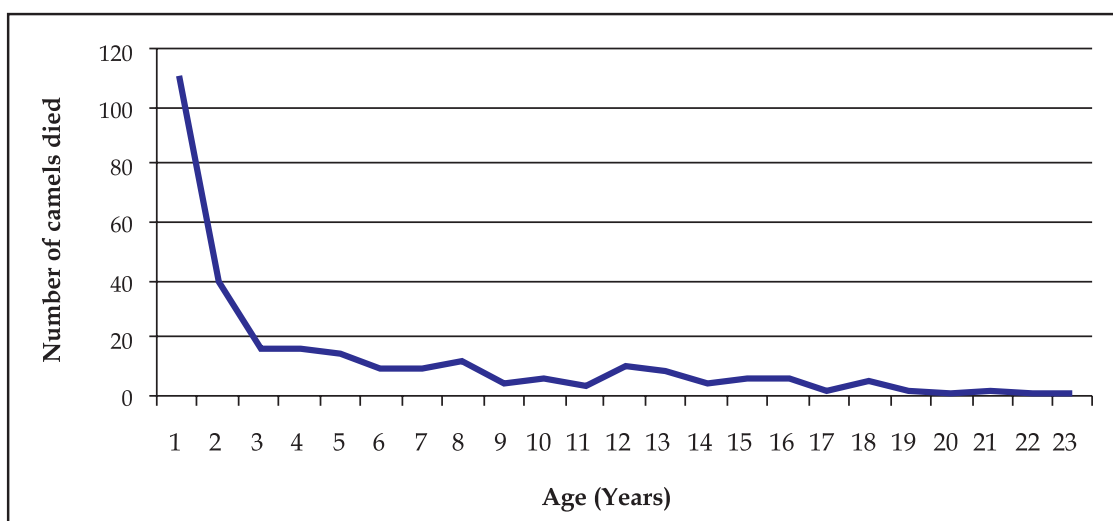


Fig 1. Mortality in Indian dromedary

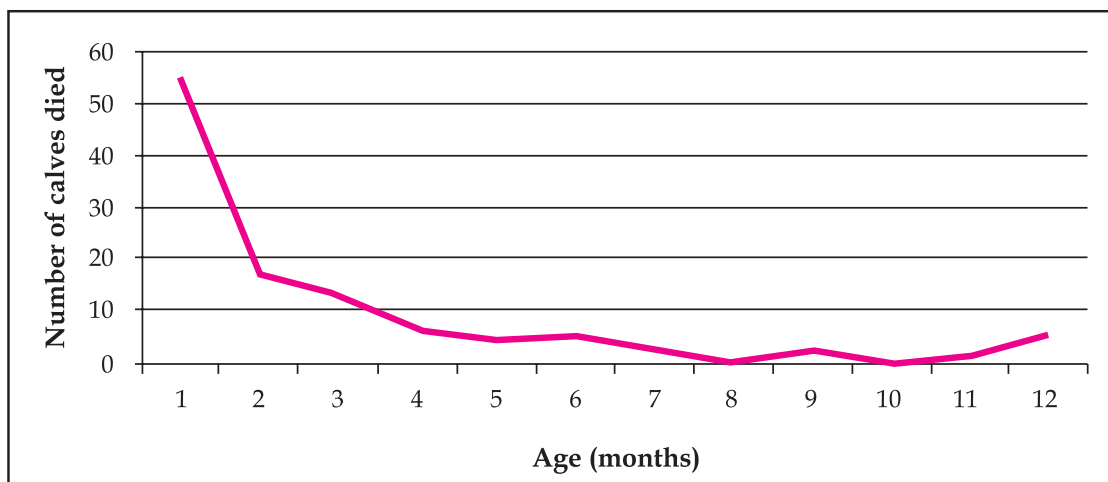


Fig 2. Mortality in dromedary calves.

and Kacchhi breeds, respectively. The inflow of animals in the Arab-cross group was limited because of the availability of limited number of breedable camels and there was no addition due to the purchase of animals from the breeding tract, as was the case in other 3 genotypes. No preferential breed-sex mortality, as well as breed-age group mortality was observed (Table 1).

Differential age group mortality

The chi-square variance test indicated highly significant effect of age group on mortality (Tables

1 and 2). It was observed that 38.4% camels died in the first year of their life, of which 49.5% died in the 1st month of their life followed by 15.3% in the 2nd month, 11.7% in the 3rd and rest in the remaining 9 months with a reducing trend (Fig 1 and 2). The major threats during first year of life were identified as pneumonia, heat stroke and enteritis (Fig 3). Higher calf mortality (48%) in dromedary has also been observed by Agab (1998) and the major causes of mortality were calf diarrhoea, helminth infection, tick paralysis, snake bite and contagious ecthyma in the Sudan. Kaufmann (2003) also reported 25.3, 21.9

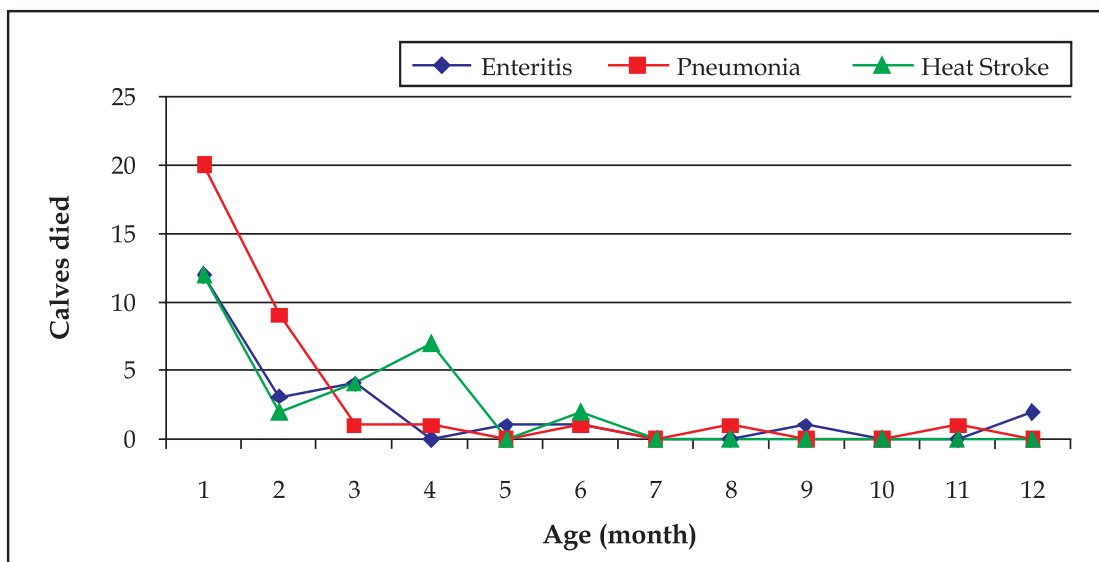


Fig 3. Major threats to young camel calves.

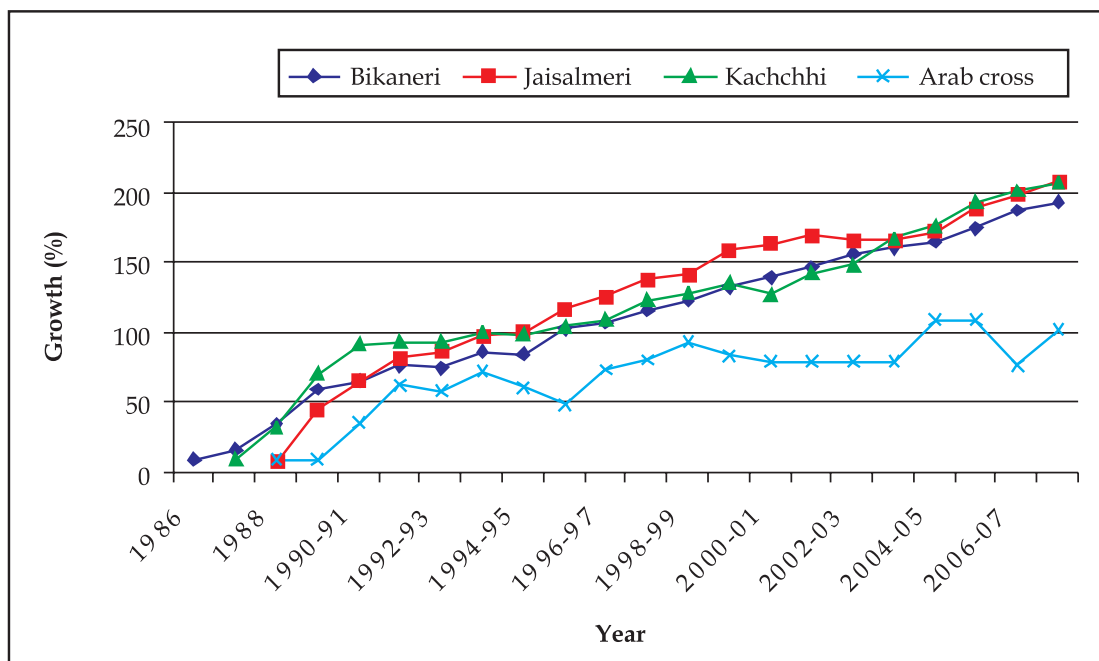


Fig 4. Growth of Indian dromedary herd.

and 27.1% mortality in calves up to one year of age in Rendille, Gabra and Somali population, respectively and diarrhoea, septicemia, emaciation, ticks and pox were the probable causes of death as disclosed by the pastoralists. In Sudan, the morbidity rate of camel calf diarrhoea, a cardinal sign of enteritis, was reported as 83% with 39.9% mortality (Ali *et al*, 2005). The literature, though based mainly on some surveys, doesn't suggest heat stroke and pneumonia as major cause of mortality in dromedary calves as has been observed in the present analysis. The calving at the centre during the period chiefly took place from December to February, but calving up to April was not very uncommon. The weather in

this region remains very cold (up to -2°C) during December and January months and gets very hot (up to 42°C) during March and April months. This abrupt change in climate is envisaged as the main reason behind deaths due to pneumonia and heat stroke. Concentrating calving in December to February months and proper protection from the cold winds during peak winter months would yield us excellent survival rate of dromedary calves. Apart from free access to the colostrum, immune-potentiating chemotherapeutic agents may be of great significance in reducing the calf mortality in dromedary. Further, we noticed that all 5 deaths due to encephalitis were also observed during first 2 months of life (Table

Table 2. Average age at death in camels due to different disease conditions at an organised farm.

Disease(s)	Mortality (%)	Age at Death (days)		
		Average	Minimum	Maximum
Enteritis, Gastroenteritis	22.4	1442	2	7459
Hepatitis, Cirrhosis of liver	3.6	1906	27	5263
Intestinal obstruction	1.2	1897	45	4400
Ruminal impaction	11.2	2791	63	7987
Tympany	2.1	2248	1114	4241
Colitis	0.9	887	471	1472
Pneumonia	16.6	472	1	4498
Injury, Abscess, Oedema of lungs	4.2	4004	154	6970
Tracheal Injury, Choking	0.6	5212	5212	5212
Asphyxia	0.6	321	2	640
Tuberculosis	0.3	2246	2246	2246
Pericarditis	1.5	2990	444	7525
Anaemia	0.3	1272	1272	1272
Severe haemorrhage, Blood loss	1.2	3031	2202	4042
Congestive heart failure, Anomaly of heart	0.3	348	348	348
Nephritis	0.9	4449	3607	6045
Haematuria	0.3	NA	NA	NA
Peritonitis	3.9	3370	438	5661
Meningitis, Encephalitis	1.5	28	19	43
Rabies	1.8	1528	400	4056
Tetanus	0.3	12	12	12
Anaphylactic Shock	0.9	1129	123	1744
Debility, Worm infestation, Pica	0.9	4091	3607	4574
Snake bite, Poisoning	1.8	1120	326	2806
Acute generalised infection	0.3	2728	2728	2728
Heat stroke, Dehydration	9.1	256	10	5231
Poly-arthritis, Lameness	0.3	71	71	71
Fracture	0.6	198	4	391
PM Not Possible	3.0	1036	0	3258
Euthanasiation	7.3	2269	13	8270

2), suggesting the vulnerability of the camel calved during early months of life to this nervous disorder. However, Al-Swailem *et al* (2010) reported a case of cerebral listeriosis in a 6 year old she camel of Saudi Arabia.

Differential systemic mortality

The mortality due to various systemic diseases differed significantly (Table 1). Maximum mortality (41.39%) was due to the involvement of digestive system, which included enteritis, haemorrhagic enteritis, gastro-enteritis, hepatitis, cirrhosis of liver, intestinal obstruction, ruminal impaction, tympany, colitis and associated symptoms (Table 2). Involvement of digestive system as one among the major cause of mortality has also been reported by Agab (1998), Mehta *et al* (2002), Mochabo *et al* (2005) and Chafe *et al* (2008). Deaths due to involvement of respiratory system were 22.36% and the ailments were pneumonia, suppurative pneumonia, broncho-pneumonia, oedema of lungs, lung abscess, tracheal choking, asphyxia and suspected cases of tuberculosis. Similar findings for the involvement of respiratory system in causing mortality in camels have been reported by Baba *et al* (1994), Agab (1998), Mehta *et al* (2002), Chafe *et al* (2008) and Raziq *et al* (2010). Bekele (1999) reported a new epidemics of respiratory disease "Sonbobe" in the Somalia region of Ethiopia causing 29.6% morbidity and 6.4% mortality. The nervous, cardio-vascular, urinary and peritoneum were involved in 4.53, 3.32, 1.21 and 3.93% cases, respectively. Deaths in 23.26% cases were due to miscellaneous causes which include pica, worm infestation, general debility, snake bite, poisoning, acute generalised infection, anaphylactic shock, heat stroke, dehydration, poly-arthritis, lameness, fracture and other incurable conditions. The cases resulting in death due to debility and worm infestation were expected to cover the deaths caused due to much studied trypanosomosis caused by *Trypanosoma evansi*. The observations reveal that the trypanosomosis was of very minor importance in causing mortality in the arid climate. However, the annual incidence and mortality rate of trypanosomosis in Lapur division of Turkana district of Kenya were estimated at 15% and 9.9% in adult camels and 5.2% in young camels, respectively (Mochabo *et al*, 2005). These estimated figures are quite high and can be accounted for poor management and prophylaxis. Mochabo *et al* (2005) also reported the camel diseases identified by the pastoralists, the estimated annual incidence of trypanosomosis, mange, tick infestation, haemorrhagic

septicemia and non-specific diarrhoea was 11.4, 10.8, 7.9, 7.7 and 7.6%, respectively in the Kenyan camels covered in the study. Chafe *et al* (2008) also reported common diseases of camel of northwestern Nigeria as mentioned by the herd owners in order of higher to lower incidence as skin diseases, blood disorders, gastrointestinal disorders, respiratory disorders and others. The average mortality in the Nigerian camels studied was reported to be 6.4%. Mange, tick infestation and associated skin affections have been reported as the major cause of worry to the camel owners by Agab (1998), Mehta *et al* (2002), Mochabo *et al* (2005), and Raziq *et al* (2010). However, the contribution of the skin affections in mortality was also considered minor and was included in the "others" category.

Herd growth and standard death rate

The growth of herd is another important parameter to assess the reproductive efficiency of the animals, breeding, health and nutritional management of the herd. The average annual calving

Table 3. Growth of Indian dromedary herd at an organised farm.

Year	Birth (%)	Death (%)	Growth of Herd (%)	Cumulative Growth of Herd (%)
1986	9.0	1.5	7.5	7.5
1987	11.6	5.2	6.4	13.9
1988	23.2	4.8	18.4	32.3
1989-90	30.9	3.7	27.2	59.5
1990-91	15.5	3.4	12.2	71.6
1991-92	16.0	4.8	11.2	82.8
1992-93	7.1	7.4	-0.2	82.6
1993-94	15.0	4.6	10.5	93.1
1994-95	8.0	9.1	-0.8	92.2
1995-96	17.3	4.3	13.0	105.3
1996-97	9.4	2.9	6.6	111.8
1997-98	15.1	4.1	11.0	122.8
1998-99	11.9	6.0	5.9	128.6
1999-00	18.6	8.2	10.4	139.1
2000-01	9.6	6.6	3.0	142.1
2001-02	13.6	6.0	7.6	149.7
2002-03	8.5	4.8	3.7	153.4
2003-04	13.0	7.9	5.1	158.5
2004-05	11.1	5.0	6.1	164.6
2005-06	17.2	3.9	13.2	177.8
2006-07	16.7	6.5	10.2	188.0
2007-08	15.2	7.9	7.2	195.3

rate on herd basis was observed to be 14.98% (Table 3, Fig 4), which can be considered as good because camel being seasonal breeder with gestation length of 384.12 ± 0.98 days and calving interval of 676.71 ± 10.60 days calves only once in 2 years. Further, one has to wait for 2020.02 ± 59.88 days to get first calf out of it (Mehta and Sahani, 2009). The average death rate was 6.45% with significantly higher mortality in Arab-cross animals as compared to the Bikaneri, Jaisalmeri and Kachchhi camels. The cumulative growth analysis indicated that in the span of 22 years about twice the original number of Bikaneri, Jaisalmeri and Kachchhi were added in the herd by a balance between annual birth and death rate. However, the herd growth in Arab-cross camels was observed to be 100.95% during the same period. Higher percent death and lower herd growth in Arab-cross was mainly due to availability of fewer animals i.e. 43 against 512, 277 and 192, respectively in Bikaneri, Jaisalmeri and Kachchhi breeds. The standard death rate (SDR) is useful when performance of animals belonging to different herds is to be compared. In order to get this figure for the dromedary breeds the standard procedure was adopted. The SDR in the 4 genotypes *viz.* Bikaneri, Jaisalmeri, Kachchhi and Arab-cross was 4.80, 3.01, 3.63 and 10.49%, respectively. Higher standard death rate in Arab-cross was expected due to the reasons already discussed.

Initiating pre-seasonal breeding in the month of September by sonographic monitoring of mature follicles in the ovary and early initiation of routine breeding would concentrate calving in the months of October to February and is likely to reduce early calf mortality. However, it has been observed that due to global warming, the onset of winter season in the region is often delayed and hence delay in onset of rutting symptoms in most male camels is noticed. Nevertheless, some males are always available for pre-seasonal breeding and in rest the day-light can be regulated to optimise the reproductive behaviour of the dromedary males (Marai *et al*, 2009). Protecting the calves from cold winds during severity of winter season and providing proper shelter during early summer months would further facilitate in reducing calf mortality in dromedary. Apart from improvement in management practices, use of immune potentiating agents in early months of life and supplementary feeding would be of great use in reducing the mortality, especially in the young animals. Since, the cases of acute illness were less in adult camels, individual attention and better care by the veterinarians may further improve the survival rate in dromedary. Further, better treatment regime

for enteritis and ruminal impaction would increase life expectancy in dromedary. Fractures are very common and fracture of long bones is very critical in camels because such animals get non-natural deaths. Cost effective management of long bone fractures will be of great use not only in reducing the mortality but also in saving the life of some of the priced animals. Despite of seasonality of reproductive behaviour and longer gestation length in dromedary, the growth of herd can be improved by reducing the calving interval through post-parturient breeding. Further, substantial reduction in age at puberty in females can be achieved by better nutritional management of heifers. Nevertheless, regular breeding of females and reduction in calf mortality through improved veterinary practices remains undebatably important in improving the herd growth in dromedary.

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