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Trend and effect of inbreeding on survivability and performance traits in closed herd of Karan Swiss and Karan Fries cattle

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ABSTRACT

Data on 1021 Karan Swiss females sired by 49 bulls and 1422 Karan Fries females sired by 56 bulls during 1980 to 1992 were used to study the trend of inbreeding over the years and generations and the effect of inbreeding on survivability, growth, reproduction and production traits. The average annual increase in inbred and their inbreeding coefficient were 0.79 and 0.22% in Karan Swiss and 1.10 and 0.37% in Karan Fries herds, respectively. The inbreds, their inbreeding coefficient and inbreeding coefficient of all females were 36.2, 3.5 and 2.0% in Karan Swiss and 21.0, 6.6 and 1.4% in Karan Fries respectively. Fluctuating trends in both herds were observed over the years and generations for number of inbred animals and for their average inbreeding coefficient. The effect of inbreeding was significant on body weight at birth, 3, 6, 12 months age, WFS, WFC, FSP, FCI and MY/FCI in Karan Fries and survivability up to first calving, FDP and EBE in Karan Swiss cattle. Declined performance and survivability of varying magnitude were recorded among inbreds. To control the rate of inbreeding unrelated or distantly related animals or elite bulls from outside may be used.

Key words: Animal production, Growth, Inbreeding, Reproduction, Survivability

Introduction of crossbred cows in many parts of the country has made dairy farming commercially viable (Acharya 1989). In view of above, 2 crossbreeding programmes were started in 1963 and 1971 at National Dairy Research Institute, Karnal to develop crossbreds, which will be suitable for tropical and sub-tropical conditions. Crosses of Brown Swiss with Sahiwal were called Karan Swiss and crosses of Holstein Friesian with Thaparkar were called Karan Fries. These strains were developed by crossbreeding followed by inter-se-mating. The herds of Karan Swiss and Karan Fries followed the closed breeding system and have completed 6 to 7 generations. Close breeding system usually encounters with inbreeding, which reduces the genetic variability and hence, decreased response to selection (Hill 1979). Both herds have shown fluctuating trend of growth, production, reproduction and survivability during last few years. There is a likelihood of increase in level of inbreeding and resulting in ill effects on the survivability and performance of the animals. Incidence and impact of inbreeding have been extensively studied in exotic and zebu cattle (Robertson 1961, Thompson *et al.* 2000, Gurnani *et al.* 1971, Reddy and Nagarcenkar 1989). However, meager information is available on strains/breeds developed through crossbreeding and inter-se-mating. Therefore, a study was undertaken to estimate the trend, magnitude and effect of inbreeding on survivability and performance traits of Karan Swiss and Karan Fries kept closed for outside breeding.

MATERIALS AND METHODS

Data were collected on 1021 Karan Swiss females sired by 49 bulls and 1422 Karan Fries females sired by 56 bulls born during 1980 to 1992. The inbreeding coefficient of each animal was estimated as half the relationship between its parents by the path analysis method (Wright 1922).

To estimate inbreeding coefficient the pedigree of each animal was traced back up to the foundation stock and an arrow diagram was prepared. The purebred animals were considered to be in zero generation. The animals were classified into various generations as one plus average number of parents. The generation number was assigned by rounding the fraction of generation as 0.1–1.0 (1), 1.1–2.0 (2), 2.1–3.0 (3), 3.1–4.0 (4), 4.1–5.0 (5), 5.1–6.0 (6) and 6.1–7.0 (7). The animals were also classified into 4 groups based on their coefficient of inbreeding (Fx) non inbred (Fx 0), lowly inbred (Fx =6%), marginally inbred (Fx >6= 12%) and highly inbred (Fx >12%). The abnormal records resulted from premature birth and incurable diseases were excluded from the analysis

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for performance traits. The effect of inbreeding on performance traits was estimated by regression analysis, while it's influence and on survivability and culling by χ^2-analysis. The traits investigated were body weights at birth, 3, 6 and 12 month, weight at first fertile service (WFS), weight at first calving (WFC), age at first calving (AFC), first lactation yield 305 days (FLY), first lactation length (FLL), first service period (FSP), first dry period (FDP), first calving interval (FCI), milk yield per day of first lactation length (MY/FLL), milk yield per day of first calving interval (MY/FCI), expected breeding value (EBV) and expected breeding efficiency (EBE). Minimum of 2 records were considered for determining EBV and EBE. Breeding efficiency was determined as per Wilcox *et al.* (1957).

RESULTS AND DISCUSSION

Trend of inbreeding in Karan Swiss herd

The percentages of low, marginal and high inbred females were 20.9, 8.9 and 6.4 respectively. Inbreeding coefficient of cows ranged upto 37.5. The overall percentage of the inbreds and their inbreeding coefficient was 36.2 and 5.5% respectively. The overall inbreeding coefficient of Karan Swiss females was 2.0%. Proportion of inbreds showed fluctuating trend over the years. Inbreeding coefficient of inbreds varied from 5.2 to 7.3% in 1980 to 1985 then showed declining trend with lowest 3.9% in 1987 and highest 6.3% in 1989 (Table 1). The average annual increase in inbreds and their inbreeding coefficient was 0.8 and 0.2% respectively. Gurnani *et al.* (1971) obtained an increase of 0.28% per year inbreeding coefficient for 27 years in Tharparkar herd. A similar trend was found over the generations. The proportion of inbreds varied from 16.2% in second generation to 49.2% in fourth generation and inbreeding coefficient of inbreds ranged from 4.0% in sixth generation to 6.2% in third generation.

Trend of inbreeding in Karan Fries herd

The incidence and trends over the years and generations in Karan Fries females are presented in Table 1. The low, marginal and high inbreds were 10.5, 4.6 and 5.9% respectively. Inbreeding coefficient of individual cows ranged up to 40.6. The overall inbreeding coefficient of herd was 1.4%, percentage of inbreds was 21.0 and their inbreeding coefficient was 6.6%. The inbreeding coefficient of inbred females varied from 9.7 to 10.5% during 1980 to1983 and thereafter, there was a declining trend with the lowest of 3.8% in 1992. The decline in inbreds from 1982 to 1988 might be due to use of 3 HF crossbred F1 bulls obtained from Military Dairy Farm in 1981. The annual increase in inbreds and their inbreeding coefficient were 1.1 and 0.4% respectively. Khanna *et al.* (1979) reported slightly higher percentage of inbreds and annual increase of inbreeding in closed herds of Hariana and Sahiwal cattle at Hisar. The generation wise analysis further indicated a fluctuating trend i. e., proportion of inbred animals increased from 5.7% in second generation to 34.2% in fifth generation and thereafter showed a slight decline to 29.5% in sixth generation.

The results indicated that the inbreeding coefficient in the entire herds have been, by and large constant, however, inbred animals has been increasing over years and generation and average inbreeding coefficient of inbred females has been decreasing. Three sires in both the herds were extensively used and bulls produced from these sires were also widely used which have played important role to built up inbreeding in both the herds. Slightly higher rate of increase in inbreeding per generation was reported by Reddy and Nagarcenkar (1989).

The percentage of inbreds, their average inbreeding coefficient and annual increase of inbreeding in both herds were either lower or similar to results reported by Miglior *et al.* (1992) and Thompson *et al.* (2000) in exotic cattle and Srinivas and Gurnani (1981), Reddy and Sampath (1989) and Dahlin *et al.* (1995) in zebu cattle.

Effect of inbreeding on survivability and longevity

Lower survivability and higher cullings were recorded among inbreds than the non-inbreds in both the herds (Table 2). However, χ^2-analysis revealed significant ($P<0.05$) effect of inbreeding on survivability in Karan Fries herd only. Maximum losses were recorded at early ages, whereas higher

Table 1. Trend of inbreeding coefficient in Karan Swiss and Karan Fries females over the years

Year of birth	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	Overall
						Karan Swiss								
Number of females born	100	79	100	89	100	91	95	78	73	63	49	53	51	1021
Per cent inbred	19.0	40.5	32.6	15.8	34.0	51.0	34.4	43.0	30.4	49.2	53.6	35.6	45.9	36.2
Average ΔF (inbreds)	6.0	6.6	6.6	5.2	7.3	6.1	3.9	3.9	4.7	6.3	4.0	4.0	4.4	5.5
Average ΔF (all female)	1.13	2.7	2.8	1.7	2.4	2.8	1.34	0.6	1.4	3.0	2.1	1.45	1.9	2.0
						Karan Fries								
Number of females born	101	121	136	112	136	138	103	92	95	129	87	99	73	1422
Per cent inbred	13.8	15.7	8.1	8.9	21.3	19.6	20.4	27.2	21.1	24.8	31.0	36.3	36.9	21.0
Average ΔF (inbreds)	9.7	9.7	10.5	9.7	7.6	8.6	4.7	6.0	6.3	5.7	5.1	5.1	3.8	6.6
Average ΔF (females)	1.3	1.5	0.8	0.8	1.6	1.7	1.0	1.6	0.9	1.4	2.4	1.9	1.4	1.4

Table 2. Effect of inbreeding on survivability and culling up to first calving

Category	Karan Swiss		Karan Fries	
	Non-inbred	Inbred	Non-inbred	Inbred
Animal exposed	645	347	1062	287
Per cent survived	88.1	82.1	87.8	83.6*
Per cent culled	25.4	28.0	22.12	24.4
Per cent retained	62.7	54.1	65.6	59.2

*Significant (P<0.05).

culling was noticed at later ages. Lower survivability among inbreds could be because these animals might be prone to health disorders, poor growth and have lesser tolerance to cope up with environmental stress. Similarly lower survivability and lower life-span in inbred dairy animals were reported by Belic (1971), Young (1984) and Reddy and Sampath (1989).

Effect of inbreeding on performance traits

Growth traits: Lower mean of body weights at different ages in inbreds indicated discernible effect of inbreeding on growth performance, which was further supported by negative estimates of regression coefficient (Table 3). Regression of body weight at different ages on inbreeding coefficient ranged from –0.053±0.048 (birth weight) to 0.010±0.008 (WFS) in Karan Swiss and –0.133±0.059 (birth weight) to –0.023±0.011 (WFS) in Karan Fries herd. Body weight of inbred animals at different ages upto first calving in Karan Fries herd were significantly lower than the non-inbreds, which could be due to higher individual female's coefficient and higher average inbreeding coefficient in some years. The effect of inbreeding on Karan Fries was pronounced on birth weight, where 1% increase inbreeding resulted in decrease of 133 g birth weight. At later ages, though the effect remained significant but recessed in magnitude. These results were in agreement to the reports of Holtman *et al.* (1970) and Kaygisiz (1997) in exotic cattle and Gurnani *et al.* (1971) and Reddy and Sampath (1989) in zebu cattle. The negative estimates of regression for body weight at birth and 12 months in Karan Swiss also indicated that inbreeding tend to reduce the body weight.

Reproductive traits: The reproductive performance was not by and large adversely affected by inbreeding in these herds (Table 4) that could be due to lower level of inbreeding coefficient. However, depressing effect of inbreeding was observed for FDP, EBE (P<0.05), FSP and FCI and in Karan Swiss. Depressing effects of inbreeding on reproductive traits were also reported by Odedra *et al.* (19974), Khanna *et al.* (1979) and Kaygisiz (1997).

Production traits: In Karan Fries cattle the most affected performance traits were efficiency traits viz., MY/FLL, MY/FCI and EBV. Performance with respect to these traits decreased by 0.21, 0.50 and 6.61 kg for each 1% increase in inbreeding. However, regression analysis showed significant (P<0.05) effect on MY/FCI only (Table 4). In Karan Swiss cows all the production traits showed decline in performance on account of inbreeding, however, effect was non-significant. Similar to Karan Fries cattle, the efficiency traits in Karan Swiss were also most affected by inbreeding viz MY/FLL, MY/FCI and EBV resulted in 0.26, 0.36 and 30.93 kg reduction in their performance, respectively, for each 1% increase in inbreeding. Results were in agreement with the findings of Gurnani *et al.* (1971), Odedra *et al.* (1974), Singh and Nagarcenkar (1997) and Thomson *et al.* (2000).

Results indicated that inbreeding has a depressing effect on survivability and performance traits. However, the effect was small in magnitude might be due to not too high average inbreeding coefficient of inbred animals. Inbreeding depression, a consequence of inbreeding was also associated with decrease in performance and fitness. Though, inbreeding also reduced performance and survival through non-additive gene action. Mating between animals with common parent and large uses of few sires were major reasons of built-up of inbreeding. Moreover, individual cow has relatively higher percentage of inbreeding and population as a whole have a low amount of inbreeding. To control the rate of inbreeding, breeding programmes should ensure the use of unrelated or

Table 3. Means and regression coefficients of body weights at different ages on inbreeding coefficient in Karan Swiss and Karan Fries cattle

Trait (s) (kg)	Karan Swiss			Karan Fries		
	Mean			Mean		
	Non-inbred	Inbred	Regression coefficient	Non inbred	Inbred	Regression coefficient
Birth wt	27.8±0.2 (616)	27.2±0.4 (366)	–0.053 ± 0.048	28.4±2 (1094)	27.5±0.3 (291)	–0.133**± 0.059
3 m wt	52.2±0.5 (530)	52.7±0.7 (285)	0.005 ± 0.028	59.3±0.5 (943)	57.5±0.8 (259)	–0.061* ± 0.029
6 m wt	103.8±0.8 (519)	103.6±1.6 (284)	0.005 ± 0.017	113.4±0.8 (914)	111.6±2.0 (231)	–0.059** ± 0.017
12 m wt	178.2±1.4 (486)	175.4±2.3 (260)	–0.009 ± 0.010	182.6±0.9 (835)	178.4±2.2 (220)	–0.045** ± 0.011
WFS	312±3.9 (307)	313±5.1 (164	0.010 ± 0.008	307.4±1.9 (544)	305.1±3.6 (130)	–0.023** ± 0.011
WFC	400±4.9 (298)	403±6.7 (158)	0.003 ± 0.007	402.8±2.7 ((527)	397.8±5.2 (123)	–0.029** ± 0.008

*Significant (P<0.05), **significant (P<0.01). Values in parenthesis are number of observations.

Table 4. Regression of performance traits on inbreeding coefficient in Karan Swiss and Karan Fries cattle

Traits	Karan Swiss			Karan Fries		
	Non-inbred	Inbred	Coefficient	Non inbred	Inbred	Coefficient
AFC (days)	1014±8 (303)	1009±14 (169)	0.005 ± 0.003	954±68 (461)	965±16 (123)	0.005 ±0.003
FLY (kg)	2842±47 (303)	2732±76 (113)	−0.0005 ± 0.0004	3196±35 (461)	2956±81 (102)	−0.0006 ± 0.0005
FLL (days)	326±5 (303)	325±8 (113)	0.0044 ± 0.0052	344±4 (461)	344±13 (102)	0.0036 ± 0.0045
FSP (days)	129±6 (257)	149±11 (73)	0.0008 ± 0.0060	135±4 (387)	135±11 (63)	0.0124* ± 0.0061
FDP (days)	80±3 (257)	105±2 (73)	0.0123* ± 0.0052	71±22 (387)	75±5 (63)	0.0223 ± 0.0133
FCI (days)	412±5 (257)	439±11 (73)	0.0035 ± 0.0047	418±45 (387)	412±10 (63)	0.0134* ± 0.0062
MY/FLL (kg)	9.6±0.1 (303)	9.3±0.2 (113)	−0.264 ± 0.216	10.6±0.1 (461)	9.8±0.25 (102)	−0.2104 ± 0.1580
MY/FCI (kg)	8.0±0.1 (257)	7.4±0.3 (73)	−0.365 ± 0.230	9.0±.01 (387)	8.1±0.26 (63)	−0.5059* ± 0.2523
EBV (kg)	3016±22 (301)	2922±35 (113)	−30.93 ± 16.62	3408±21 (460)	3334±27 (102)	−6.611 ± 19.142
EBE (%)	87±1.5 (257)	80±2.9 (73)	−1.951* ± 0.615	90±1.4 (387)	78±2.6 (63)	−0.173 ± 0.583

*Significant (P<0.05), values in parenthesis are number of observations.

distantly related animals, more zebu cows could be purchased and mated with proven imported semen to produce F1 bulls and herds may be opened for elite bulls from outside.

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