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Demographic parameters and disposal pattern in Sahiwal cattle herd

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ABSTRACT

The knowledge of disposal rate, its causes and factors affecting it at various ages are very essential in a given herd for producing replacement stock to maintain proper herd structure. The relevant data for the present study on Sahiwal cows and their calves from 1994 to 2013 (20 years) were collected and recorded at ICAR-National Dairy Research Institute (ICAR-NDRI), Karnal. The analysis of influence of various non-genetic factors on disposal pattern was carried out by Chi-square method using the SPSS software. The age specific disposal of Sahiwal cattle at various age groups i.e. 0–1 month, 1–3 month, 3–6 month, 6–12 month, 12–18 months and 18 month to AFC were 13.79, 4.95, 2.80, 4.53, 1.29 and 3.21%, respectively. The mortality of female from birth to AFC in respective age groups was 13.79, 4.95, 2.00, 2.47, 0.72 and 1.90%, respectively. The incidence of mortality was decreased, while culling increased as the age advanced. Maximum mortality was observed mainly due to pneumonia and enteritis while poor growth and late maturity were the major reasons for culling. It was also observed that about 15.86% of the cows died while they were in the herd and the rest 84.13% were culled from the herd. The expected herd life at first lactation was found to be 2.52 lactations which showed the decreasing trend along the parity. The present study concluded that the first three months of age is more critical period for the survival of calves. Therefore there is need of intensive feeding and healthcare management to minimize involuntary disposal.

Key words: Disposal, Expected herd life, Sahiwal, Survival rate

Poor management practices leads to poor calf survivability as well as heavy culling rates due to lower production or higher reproductive disorders. This, ultimately, results into poor replacement of breeding stock and hence adversely affect the improvement of animals and this constraint can be shot out by both genetic improvement as well as the improvement in management practices. Primary requirement for genetic improvement of the breed is larger herd size (Singh *et al.* 2002) as larger herd facilitates in more intense selection and gives freedom for voluntary culling to the breeder. The disposal (comprising mortality and culling) of animals comes under two categories, i.e. from birth to age at first calving and in adult cows i.e. after age of first calving. The removal of animals from the herd is either voluntary on the basis of low milk production/ below farm standards or involuntary removal for the reasons such as reproductive problems, teat and udder disorders and diseases or poor growth. Mortality patterns in organized dairy herds serve as a useful indicator for assessing the status of herd health and management programs and their efficacy (Prasad *et al.* 2004). So reduction in mortality rate is the first and foremost target of dairy farm management. Several herd-level risk factors for mortality have been identified, such as herd size, herd management, SCC and milk yield (Alvasen *et al.* 2012). Calf mortality in every dairy and breeding farm causes a financial and genetic loss (Islam *et al.* 2006), therefore, successful calf rearing is the key to success of dairy farm enterprise because these young calves will be the future replacement stock of dairy farm. Keeping in view all the above facts, the present study was undertaken to evaluate the effect of non-genetic factors on age specific disposal pattern and demographic analysis in Sahiwal cattle.

MATERIALS AND METHODS

The relevant data for the present study on Sahiwal cows and their calves from 1994 to 2013 (20 years) were collected and recorded from history sheet, stock register, auction and sale registers and health registers maintained at Dairy Cattle Breeding Division, Livestock Research Centre and Animal Health Complex at ICAR-National Dairy Research Institute (ICAR-NDRI), Karnal located in the Trans-Gangetic plains of Indian agro-climatic zone. The geographical location of ICAR-NDRI livestock farm is at an altitude of 250 meter above mean sea level (MSL) in the Indo-Gangetic alluvial plains on 29°42'N latitude and 72°02'E longitude. The climate of the farm is subtropical. The minimum temperature falls to 2°C in winter whereas the maximum temperature goes upto 45°C in summer. The annual rain

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fall is about 760–960 mm; out of which most of the rainfall is received during the July and August months. The relative humidity ranges from 41–85%. Thus, it is obvious that the dairy cattle maintained at ICAR-NDRI farm get exposed to extreme climatic conditions. Loose housing system was followed to maintain the cows in the herd. Calves of both sexes were reared together up to six months of age. The calves were weaned at birth and they were kept on colostrum feeding for first five days and then whole milk is provided up to 30 days. The calves were provided the mixture of skim milk and whole milk up to four months and only skim milk up to six months of age. Concentrate, mineral mixture and roughages were made available to calves from one month of age. They were fed according to body weight as per nutritional standards. After six months of age, male and female calves were reared separately.

The records collected for the present investigation on disposal of Sahiwal were calf number, date of birth, birth weight, dam and sire number of female calf, date of mortality or culling of female calves and heifers from birth to age at first calving (AFC), reasons of mortality or culling of female calves and heifers for calf records while for adult cows as cows number, its date of birth, sire and dam number, total lactation completed by cow, date and reason of mortality or culling of adult cows at different lactations. The 20 years data were classified into 4 periods i.e. P1, P2, P3 and P4, each comprising of 5 years. The year of birth/ calving was divided into 4 seasons, according to climatic condition of the farm as winter (December-March), summer (April-June), rainy (July-September) and autumn (October -November). The parities were classified in 6 group and birth weights of calves was divided in 4 groups (≤18; 19–21; 22–24 and ≥25 kg). The age of female calves and heifers were divided into six groups as 0–1 month, 1–3 month, 3–6 month, 6–12 month, 12–18 months and 18 month to AFC. Descriptive statistics were computed for analysis of disposal pattern. The percent of animals disposed from the herd due to mortality and culling was calculated by proportion. The analysis of influence of various non-genetic factors on disposal pattern was carried out by Chi-square method (Snedecor and Cochren 1994) using the SPSS software.

The following lactation specific parameters were considered.

Survival rate (P_X): It is the probability of a cow, assuming survival to lactation x, of surviving to lactation x-1 (Schons *et al.* 1985).

$$P_x = L_x / L_{x-1}$$
$$P_x = 1 - Q_x$$

Loss rate (Q_x): It is the probability of a cow, assuming survival to lactation x, of dying or culling before lactation x-1(Schons *et al.*1985).

$$Q_x = d_x / n_x = 1 - P_x$$

where, d_x, number of animals died or culled during lactation x; n_x, number of animals present in the herd at the beginning of lactation x.

Survivorship or Stayability (L_x): It is the probability of a cow at first lactation present in the herd to lactation x and estimated as number present at lactation x divided by the number alive at first lactation. The survivorship at first lactation was taken as unity (L_0=1.0) and hence (Schons *et al.* 1985).

$$L_x = n_x / n_{o.}$$

This can also be estimated as $L_x = P_x L_{x-1}$

where, n, number surviving at lactation x; n_o, number of cows at first lactation.

Expected herd life (E_x): This is the number of additional years that an animal of lactation x is expected to remain in the herd E_x more years and it was estimated as the sum of probability of an animal of a given lactation remaining in the herd (P_x) through each succeeding lactation upto the last lactation. (Ahmed *et al.* 1992).

$$E_x = P_x + P_xP_{x+1} + P_xP_{x+1}P_{x+2} + \ldots\ldots\ldots\ldots P_xP_{x+1}P_{x+n}$$

Lactation specific herd structure: Greer *et al.* (1980) had given the procedure of lactation specific herd structure and they estimated two parameters including the herd structure or age distribution of cows being lost from the herd and being present in the herd belonging to different lactations.

Cows being present in the herd (p_x): It is the probability of cows remaining in the herd that are of each lactation

$$p_x = L_x / \Sigma L_x$$

Disposed from herd (q_x): It is probability of cows being lost from the herd that are of each lactation

$$q_x = Q_x L_{x-1}$$

RESULTS AND DISCUSSION

Age specific (months) disposal (%) in Sahiwal cattle from birth to AFC: The age specific disposal of Sahiwal cattle at various age groups i.e. 0–1 month, 1–3 month, 3–6 month, 6–12 month, 12–18 months and 18 month to AFC were 13.79, 4.95, 2.80, 4.53, 1.29 and 3.21%, respectively (Table 1). It revealed that the higher incidence of disposal was in 0–1 month age group (13.79%) while lower in 12–18 month age group (1.29%). It was observed that out of total disposal upto AFC, almost 50% had taken place in 0–1 month age group which was due to higher mortality.The incidence of mortality decreased and incidence of culling increased as the age advanced. There was significant (P ≤0.01) effect of period and season of birth, parity of dam and birth weight of calf on disposal of calves in 0–1 month of age group. Maximum (20.77%) disposal was observed during first period and minimum (8.03%) during third period. Regarding the effect of season of birth, higher disposal was observed in winter (16.25%) and rainy (16.67%) season while lower in autumn (7.78%). Among the parity of dam, maximum disposal was found in fifth parity (23.53%) and minimum in third parity (7.98%). The calves born with lower birth weight showed higher (18.75%) disposal than calves born with higher birth weight. In other age group, there was no significant effect of these non genetic factors on age specific disposal pattern.

Table 1. Age specific (months) disposal pattern in Sahiwalcattle herd from birth to AFC

No available	Parameter	0-1 mo	>1-3 mo	>3-6 mo	>6-12 mo	>12-18 mo	>18 mo-AFC	Birth to AFC
914	Mortality	13.79 (126)	4.95 (39)	2.00 (15)	2.47 (18)	0.72 (5)	1.90 (13)	23.63 (216)
914	Culling	0.00 (0)	0.00 (0)	0.80 (6)	2.06 (15)	0.57 (4)	1.31 (9)	3.72 (34)
914	Disposal	13.79 (126)	4.95 (39)	2.80 (21)	4.53 (33)	1.29 (9)	3.21 (22)	27.35 (250)
				Period wise				
130	P1: 1994-1998	20.77 (27)	8.74 (9)	8.51(8)	4.65 (4)	0.00 (0)	2.44 (2)	38.46 (50)
236	P2: 1999-2003	13.98 (33)	4.93 (10)	1.55 (3)	7.37 (14)	1.70 (3)	1.73 (3)	27.97 (66)
249	P3: 2004-2008	8.03 (20)	3.06 (7)	0.90 (2)	3.64 (8)	0.00 (0)	4.25 (9)	18.47 (46)
299	P4: 2009-2013	15.38 (46)	5.14 (13)	3.33 (8)	3.02 (7)	2.67 (6)	3.65 (8)	29.43 (88)
Chi square (d.f.)	12.92** (3)	4.90 (3)	15.53** (3)	5.17 (3)	-	2.24 (3)	18.64** (3)	
				Season wise				
400	S1: Winter	16.25 (65)	4.78 (16)	1.25 (4)	3.81 (12)	1.32 (4)	2.68 (8)	27.25 (109)
256	S2: Summer	10.16 (26)	6.52 (15)	3.72 (8)	5.80 (12)	1.54 (3)	2.60 (5)	26.95 (69)
168	S3: Rainy	16.67 (28)	3.57 (5)	3.70 (5)	4.62 (6)	0.81 (1)	6.50 (8)	31.55 (53)
90	S4: Autumn	7.78 (7)	3.61 (3)	5.00 (4)	3.95 (3)	1.37 (1)	1.39 (1)	21.11 (19)
Chi square (d.f.)	8.78* (3)	2.11 (3)	5.29 (3)	1.20 (3)	0.32 (3)	5.57 (3)	3.27 (3)	
				Parity wise				
268	Parity 1	12.69 (34)	5.56 (13)	3.17 (7)	6.07 (13)	1.49 (3)	2.02 (4)	27.61 (74)
199	Parity 2	13.57 (27)	4.07 (7)	2.42 (4)	5.59 (9)	1.32 (2)	2.67 (4)	26.63 (53)
163	Parity 3	7.98 (13)	6.00 (9)	2.84 (4)	5.11 (7)	0.77 (1)	3.10 (4)	23.31 (38)
111	Parity 4	18.92 (21)	4.44 (4)	0.00 (0)	1.16 (1)	2.35 (2)	7.23 (6)	30.63 (34)
68	Parity 5	23.53 (16)	5.77 (3)	6.12 (3)	2.17 (1)	0.00 (0)	4.44 (2)	36.76 (25)
105	Parity ≥6	14.29 (15)	3.33 (3)	3.45 (3)	2.38 (2)	1.22 (1)	2.47 (2)	24.76 (26)
Chi square (d.f.)	12.82* (5)	1.44 (5)	4.78 (5)	5.44 (5)	-	5.73 (5)	5.38 (5)	
				Birth weight wise				
208	≤18 kg	18.75 (39)	7.10 (12)	2.48 (4)	5.73 (9)	2.70 (4)	2.08 (3)	34.13 (71)
442	19-21 kg	10.86 (48)	3.55 (14)	2.37 (9)	3.50 (13)	1.12 (4)	4.24 (15)	23.30 (103)
213	22-24 kg	15.96 (34)	5.03 (9)	4.12 (7)	6.13 (10)	0.65 (1)	2.63 (4)	30.52 (65)
51	≥25 kg	9.80 (5)	7.84 (4)	2.63 (1)	2.70 (1)	0.00 (0)	0.00 (0)	21.56 (11)
Chi square (d.f.)		9.11* (3)	4.57 (3)	1.40 (3)	2.68 (3)	-	-	10.39** (3)

Figures in parentheses are number of observations. *Significant at P≤0.05; **Significant at P≤0.01; df, degree of freedom

The mortality of female calves from birth to AFC in various age group i.e. 0–1 month, 1-3 month, 3–6 month, 6–12 month, 12–18 months and 12–18 months and 18 months to AFC were 13.79, 4.95, 2.00, 2.47, 0.72 and 1.90%, respectively. Gaur *et al.* (2003) and Upadhyay *et al.* (2014b) reported similar findings for Gir and Sahiwal, respectively. Regarding the effect of non-genetic factors, there was significant (P<0.01) effect of period and season of birth, parity of dam and birth weight of calves on mortality in 0–1 month of age. Panmei *et al.* (2016) reported that season had significant effect while period had non-significant effect on age specific mortality in Tharparkar male calves. The present finding showed that there was no culling in 0–1 month and 1–3 months of age group as prior to six month of age no culling was carried out at the farm and it started 6 month onwards. The maximum culling took place in 6–12 months age group which was mainly due to the poor health and debility and afterward it was mainly because of reproductive disorders.It was observed that there was no significant effect of period and season of birth, parity of dam and birth weight of calves on age specific culling pattern in Sahiwal calves and heifers upto age at first calving. The present findings were in general agreement with the findings of Upadhyay *et al.* (2014b) for Sahiwal and Maher (2014) for Tharparkar.

Reasons of disposal in Sahiwal female calves and heifers upto AFC: It was found that the maximum mortality in calves were due to the pneumonia (28%) followed by enteritis and gastro-enteritis (24%), debility and poor health (21%), cardio-vascular problem (6%), toxaemia and septicaemia (5%), Tympany and digestive problem (5%), Pneumo-enteritis (4%), liver disorder (1%), parasitic infections (1%) and miscellaneous (5%). The miscellaneous causes of mortality were joint ill, navel ill, dehydration, anoxia, poisoning, snake bite, encephalitis and hernia. Present findings revealed that higher incidence of mortality was due to pneumonia and similar findings were also reported by Sharma *et al.* (1975) and Maher (2014) for Tharparkar; Reddy (1983) and Upadhyay *et al.* (2014b) for Sahiwal; Singh and Gurnani (2004) for cross-bred,whereas Chaudhary *et al.* (1986) observed higher incidence of enteritis as a cause of mortality in Kankrej calves. Panmei *et al.* (2016) reported that the maximum mortality in Tharparkar calves was due to general debility followed by respiratory problem, enteritis and gastroenteritis.

Culling in female calves' upto AFC was maximum due to poor health and debility (70.58%) followed by reproductive problems (14.70%), lameness and physical deformity (8.82%) and miscellaneous (5.88%). Miscellaneous causes were off bred, transfer and skin

infection. The results indicated that poor growth and late maturity were the principal cause of culling in female calves and heifers. The results obtained were in conformity with the findings of Jadhav *et al.* (1995) for Friesian Sahiwal cross; Singh and Gurnani (2003) for cross-bred and Upadhyay *et al.* (2014b) for Sahiwal.

Lactation specific disposal in adult Sahiwal cows: The average disposals of adult Sahiwal cows due to their mortality and culling in different lactations is presented in Table 2. It was observed that about 15.86 % of the cows died while they were in the herd and the rest 84.13% were culled from the herd. Almost similar findings were also reported by Abbas (2005) and Upadhyay *et al.* (2014b) in Sahiwal and Maher (2014) in Tharparkar cows. Regarding per lactation disposal, it was 28.36% which was 4.50% due to mortality; while 23.86% due to culling. Similar to present finding, Abbas (2005) and Upadhyay *et al.* (2014b) also reported in Sahiwal that on an average 27.82% disposal of cows in different lactations was either due to death or culling from herd while Maher (2014) reported the higher estimate (31.11%) of per lactation disposal in Tharparkar cows.

Table 2. Average incidence of disposal, mortality and culling pattern in adult Sahiwal cows in different lactations

Lactation no	No of cows available	Disposal		Mortality		Culling	
		N	%	N	%	N	%
1	416	65	15.63	14	3.37	51	12.26
2	351	87	24.79	7	1.99	80	22.79
3	268	86	32.09	10	3.73	76	28.36
4	181	64	35.36	15	8.29	49	27.07
5	115	42	36.52	9	7.83	33	28.70
6	73	35	47.95	5	6.85	30	41.10
7	38	20	52.63	4	10.53	16	42.11
8	17	10	58.82	1	5.88	9	52.94
9	7	6	85.71	0	0.00	6	85.71
≥10	1	1	100.00	1	100.00	0	0.00
Overall	1467	416	28.36	66	4.50	350	23.86

N, Number; %, per cent.

The various reasons of mortality in adult cows were categorized as digestive and liver problem, respiratory problem, cardiovascular problem, parasitic problem, debility and poor health, toxaemia and septicaemia and miscellaneous (12.12, 21.21, 12.12, 1.52, 7.58, 31.82 and 13.64%, respectively, of total mortality).The major reason of mortality were toxaemia and septicaemia followed by respiratory problem. Almost similar finding was also reported by Upadhyay *et al.* (2014b) for Sahiwal and Maher (2014) for Tharparkar cows. The various reasons of culling were categorized as low milk production or below farm standard, reproductive problems, udder and teat problem, locomotary and leg problem, debility and poor health and miscellaneous (14.86, 27.71, 42.00, 11.14, 3.14 and 1.14%, respectively, of total culling). The present finding revealed that the major contribution to culling was due to udder and teat problem and reproductive problems, which mostly can be eliminated by adopting the better management practices.

Lactation specific demographic parameters in Sahiwal cattle herd

The findings on lactation specific demographic parameters in Sahiwal cattle are presented in Table 3.

Survival rate (P_X)*:* It was found to be 84.40% in first lactation and after that a decreasing trend along the parity order in survival rate was observed. Abbas (2005) and Upadhyay *et al.* (2014a) also reported similar findings in Sahiwal cows while Maher *et al.*(2015) observed lower estimate of survival rate (70.00%) in Tharparkar cows and no specific trend over the different lactation. Tomar *et al.* (1994), Lathwal *et al.* (1995) and Tomar *et al.* (1996) studied the survival rate for Sahiwal, Red Sindhi and Tharparkar cows, respectively and observed lower estimate which was around 70.0% in first parity and remained nearly constant upto 5–6 lactations after that there was decreasing trend along lactation number.

Survivorship/Stayability (L_x)*:* It was observed that, by taking the Stayability as unity in first lactation, the survivorship was 0.84, 0.64 and 0.43 at second, third and fourth lactation, respectively. It also revealed a decreasing trend in survivorship as lactation number increased

Table 3. Lactation specific demographic parameters for lactating Sahiwal cow herd

Lactation no	No of cows available	Disposal	Loss rate (Q_x)	Survival rate (P_x)	Stayability (L_x)	Present in herd (p_x)	Disposed from herd (q_x)	Expected herd life (E_x)
1	416	65	0.156	0.844	1.000	0.284	0.156	2.521
2	351	87	0.248	0.752	0.844	0.239	0.209	1.988
3	268	86	0.321	0.679	0.644	0.183	0.207	1.643
4	181	64	0.354	0.646	0.435	0.123	0.154	1.419
5	115	42	0.365	0.635	0.276	0.078	0.101	1.195
6	73	35	0.479	0.521	0.175	0.050	0.084	0.883
7	38	20	0.526	0.474	0.091	0.026	0.048	0.697
8	17	10	0.588	0.412	0.041	0.012	0.024	0.471
9	7	6	0.857	0.143	0.017	0.005	0.014	0.143
≥10	1	1	1.000	0.000	0.002	0.001	0.002	0.000

(Table 3). Similarly, Mukherjee (1993) for crossbred cows; Tomar *et al*. (1994) and Upadhyay *et al*. (2014a) for Sahiwal; Lathwal *et al.* (1995) for Red Sindhi; Tomar *et al.* (1996) and Maher *et al.* (2015) for Tharparkar and Arun (1999) for Hariana also considered the survivorship as unity in first lactation and observed the decreasing trend along parity order.

Expected herd life (E_X): The expected herd life at first lactation was found to be 2.52 lactations and showed a decreasing trend along the parity as 1.64 at third lactation, 0.88 at sixth lactation and 0.14 at ninth lactation. Similarly, Upadhyay *et al.* (2014a) for Sahiwal and Maher *et al.*(2015) for Tharparkar cows reported the expected herd life during first lactation as 2.59 and 2.24 lactations, respectively with a decreasing trend along with increasing lactations. Tomar *et al.* (1994) for Sahiwal; Lathwal *et al.* (1995) for Red Sindhi; Tomar *et al.* (1996) for Tharparkar and Arun (1999) for Hariana cows also reported the expected herd life during first lactation to be 2.72, 2.38, 2.82 and 3.52 lactations, respectively with a decreasing trend along with parity.

Age distribution of cows left the herd (q_x): Probability of cows being disposed from the herd due to their mortality and culling was 0.15 at first lactation and 0.20 at second and third lactations. The results revealed that more than half of the first lactation cows disposed from the herd before they completed fourth lactation. There was a decreasing trend of disposal as lactation increased. Similar finding was also reported by Abbas (2005) and Upadhyay *et al.* (2014a) in Sahiwal. Kumar *et al.* (2013) in Frieswal cows reported cows being lost from herd due to death and culling were 0.23, 0.21 and 0.20 in the first, second and third lactations, respectively and more than half of the females of first lactation left the herd before they completed third lactation.

Age distribution of cows present in the herd (p_x)*:* It was observed that about more than one-fourth (28.4 %) of total herd comprised the first lactation, whereas in second lactation, it was 23.9% and 18.3% in third lactation and decreased as lactation number progressed. The result showed that about 80% animals of the herd belonged to first four lactation which indicated that herd was mostly comprised of younger females. Similarly, Lathwal *et al.* (1995) in Red Sindhi; Tomar *et al.* (1996) in Tharparkar cows; Abbas (2005) and Upadhyay *et al.* (2014a) in Sahiwal and Singh *et al*. (2006) in Holstein Friesian herd also reported that about 80% of the herd comprised mostly of younger cows.

The present study concluded that the major cause of disposal in female calves and heifer was mortality while in adult cows it was mostly due to culling. In calves, the first month of age is more critical period as maximum mortality was found in this age group. As the neonatal stage of life is more critical period for the survival of calves, therefore, there is need of intensive feeding and healthcare management to minimize involuntary disposal. There is need of further improvement in udder and reproductive herd health management of adult cows for augmenting productivity of dairy animals.

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