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Research Article

RISK FACTORS IMPACTING KID SURVIVAL OF BLACK BENGAL GOATS RAISED IN FIELD CONDITION OF WEST BENGAL, INDIA

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ABSTRACT: Kid mortality due to various factors leads to substantial economic losses for goat farmers. This study assessed the survival rates of Black Bengal goat kids from birth to 12 months, analyzing data from 11,996 kids raised across different agro-climatic clusters in West Bengal, India, over the period 2010-2021. Birth weight, cluster, year and season of birth, type of birth, sex, and parity of kidding were considered as key variables. At birth, the survival rate was recorded at 99.86%, with 90.96% of kids surviving through the critical period of up to 3 months. The overall survival rate by 12 months was 85.55%. The significant factors influencing survival up to 3 months, identified through maximum-likelihood analysis of variance, included birth weight, cluster, season of birth, sex, and type of birth. Among the clusters, the Jalpaiguri cluster exhibited the highest survival rate up to 3 months (98.70%), followed by Jhargram (95.82%), Sundarban (93.47%), Murshidabad (87.03%), and Nadia (86.95%). These variations were linked to differences in agro-climatic conditions, availability of grazing pastures, and environmental factors. Kids born during summer showed a higher survival rate (92.14%) compared to those born in other seasons. Furthermore, kids with a birth weight exceeding 1.5 kg exhibited the highest survival rate (86.28%) up to 12 months. The findings highlight the potential to improve goat productivity by adopting enhanced management practices and prioritizing the selection of larger kids at birth.

Keywords: Kid survival; Survival rate; Black Bengal goats.

INTRODUCTION

India boasts the largest reservoir of livestock genetic diversity globally, with 34 registered goat breeds [10]. Among these, the Black Bengal Goat, a native of West Bengal, is a dwarf breed renowned for its adaptability, high fertility, prolificacy, excellent meat quality, and superior skin texture [2]. This breed thrives in hot and humid conditions and is known for producing twins or triplets. In goat husbandry, kid survival is a critical health trait and a key determinant of productivity. High survivability among kids significantly contributes to the economic success of goat farming. However, early mortality reduces the number of animals available for future breeding and marketable purposes.

After birth, kids encounter several physiological, behavioural, and immunological challenges [6]. Survival depends on various factors, including birth weight, age, sex, litter size, parity, environmental conditions, and management practices. It is closely linked to reproductive and health traits such as fertility and mothering ability [9]. A positive genetic correlation between survival and live weight has been reported [12]. Consequently, high mortality rates among kids lead to reproductive inefficiencies within the flock, translating into financial losses for farmers.

Addressing these challenges necessitates identifying risk factors, improving kid survival, and incorporating survival traits into breeding programs. Despite their significance, limited efforts have been directed toward understanding the genetic parameters and risk factors influencing goat survival [13]. Studies have consistently shown that pre-weaning mortality rates are higher than

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those of adult goats, with up to 37% of total mortality occurring during the weaning phase [14, 15, 17]. Key factors such as birth weight, doe weight at kidding, sex, season, type of birth, and year of birth significantly impact kid survival [16].

Gaining insights into the survival potential of Black Bengal kids up to 12 months can help mitigate mortality rates. The findings of this kind of research can guide the development of targeted breeding policies for West Bengal and India. Encouraging farmers to rear pure Black Bengal goats will also support the conservation of this valuable breed in its native region.

MATERIALS AND METHODS

Study population and its management

The animals were maintained at different agro-climatic zones (Table 1) by farmers at different clusters of the All India Coordinated Research Project (AICRP) on Goat Improvement, Black Bengal Field Unit, Kolkata, India.

Goat housing was typically located near farmers' residences, with various housing patterns. These included separate Kutcha houses for goats, separate Pucca houses, and shared housing where goats lived alongside humans as part of their family. Feeding practices across the five clusters primarily involved two methods: grazing and browsing on grasses, shrubs, and tree leaves within the village, supplemented with minimal homemade concentrates. Many farmers practiced tethering instead of free grazing, although a portion allowed both, *i.e.* grazing in the morning and tethering in the afternoon.

A few farmers provided balanced concentrate mixtures, single ingredients like broken wheat, or combinations such as broken wheat, broken rice, and oil cakes. Mineral supplementation, often mixed with rice gruel, was occasionally practiced.

Newborn kids were fed colostrum immediately after birth. Their navel cords were cut, and tincture iodine was applied for disinfection. The neonatal kids and their mothers were then moved to a separate pen, where they remained for 3 to 4 days to ensure adequate colostrum intake and proper care.

Collection of data

Data for the study were collected from 2010 to 2021, encompassing information on 11,996 kids. Detailed records like identification numbers, cluster, year, type of birth, sex of kids, parity of the doe, season of birth, and survival data at three-month intervals up to 12 months were collected and the datasets were carefully reviewed to exclude any erroneous or unsuitable entries. The type of birth was categorized into five groups: single, twin, triplet, quadruplet, and pentaplet. Parity was classified into eight levels, with any parity beyond the eighth grouped as eighth parity.

The season of birth was divided into three categories based on environmental conditions: summer (March-June), rainy (July-October), and winter (November-February). The dataset included 3,114 single-born, 6,538 twin-born, 2,018 triplet-born, 305 quadruplet-born, and 21 pen tablet-born kids. There were 6,556 males and 5,440 females. Birth season distribution showed 4,171 kids born in summer, 3,063 in the rainy season, and 4,762 in winter. The mean birth weights were 1.315 ± 0.031 kg for males and 1.293 ± 0.032 kg for females.

Data analysis

The R statistical environment [11] was employed to estimate the maximum-likelihood analysis of variance for survival rates up to 3 months. Survival was coded as a binary marker, with "1" representing the occurrence of the event and "0" indicating its absence. The explanatory variables included in the analysis were birth weight, cluster, year, season of birth, sex of the kid, type of birth, and parity. A linear time effect was incorporated to model the time-dependent influence of these variables. Birth weight was further categorized into three groups: <1 kg, 1-1.5 kg, and >1.5 kg. To explore associations between environmental factors and survival rates, cross-tabulations were conducted using IBM SPSS Statistics version 23.0 [8].

The following model was used for the analysis of the dataset:

$$Yijklmno = N + W_i + C_j + Y_k + S_l + T_m + M_n + P_o + e_{ijklmno}$$

Where $Y_{ijklmno}$ is the individual survival rate, N is overall mean, W_i is the effect of ith birth weight of the kid, C_j is the effect of the jth cluster (j = 1, 2, 3, 4 & 5), Y_k is the effect of kth year of birth (k = 2010-2021), S_l is the effect of lth season of birth (l = 1, 2, 3), T_m is the effect of mth type of birth of kid (m = 1, 2, 3, 4, 5), M_n the effect of nth sex of kid (n = 1, 2), Po the effect of oth parity (o = 1, 2, 3, 4, 5, 6, 7, 8) and $e_{ijklmno}$ is the residual error.

RESULTS AND DISCUSSION

Table 2 presents the maximum-likelihood analysis of variance for survival rates up to 3 months in Black

Table 1. Details of study area.

Agro-climatic zone	Cluster	Latitude and latitude	Average rainfall (mm)	Average temperature (°C)	Relative humidity (%)
Gangetic Alluvial	Nadia	22º53″ - 24º11″ N 88º09″ - 88º48″ E	67-233	15.6-35	65-58
Coastal Saline	Sundarban	21°27′ - 22°30′ N 89°02′ - 90°00′ E	82-195	16-34	68-82
Vindhya Alluvial	Murshidabad	23º43' - 24º52' N 87º49' - 88º44' E	18-489	13-41	46-72
Undulating Red and Lateritic	Jhargram	21°-52' - 22°-48' N 86°-34' - 87°-20' E	30-275	17-39	46-73
Tarai	Jalpaiguri	26° 32' 25.6452" N 88° 43' 9.8076" E	11-632	16-35	56-78

Source: World weather online. www.worldweatheronline.com.

Table 2. Maximum-likelihood analysis of variance of survival rate upto 3 months in Black Bengal goat.

Source of variation	d.f.	Chi-square
Intercept	1	2.75^{ns}
Birth weight	2	17.63^{*}
Cluster	4	53.91^{**}
Year of birth	10	31.52^{ns}
Season of birth	2	29.47^{*}
Sex of kid	1	6.28^{*}
Type of birth	4	16.11^{*}
Parity	7	15.34^{ns}
Likelihood ratio	273	332.29

*indicates p<0.05, **indicates p<0.01, ns indicates non-significant (p>0.05).

Bengal goats, while Table 3 summarizes the cumulative survival rates up to 12 months based on various factors, like birth weight groups, clusters, year of birth, season of birth, type of birth, sex, and parity.

The effect of birth weight was found to be significant (p<0.05) on survival rates up to 3 months, with the highest survival observed in the >1.5 kg group, followed by the <1 kg and 1-1.5 kg groups. This finding aligns with previous studies [3, 16] which indicated that lighter kids had a reduced survival probability, whereas heavier kids had a higher chance of survival. However, in our dataset, the effect of birth weight could not be fully separated from the effect of litter size. Considering the significant relationship between birth weight and early survival, adopting improved management practices to enhance birth weight would be advantageous. Enhancing management for rearing triplets, quadruplets, and pentaplets throughout lactation would ensure that each kid receives adequate milk. Supplementation during the final trimester, especially for animals in poor body condition, may help increase birth weight.

The highest survival rate up to 3 months was observed in twins (92.40%), followed by single-born and other types of birth. The survival rate of pentaplet born kids (76%) was notably low at 3 months, with this trend continuing up to 12 months. These findings are consistent with earlier observations [7] which suggested that lower birth weights, a larger surface area for heat loss, smaller body fat reserves and competitions for colostrum and milk in multiple births contribute to poorer survival. This indicates that while increasing litter size as a breeding goal may lead to more kids being born; it could also reduce their chances of survival.

Additionally, does that produced heavier kids also had survival rates for their offspring, suggesting the potential for genetic improvement through selection in maternal lines. These results further support the previous findings [1] which noted that Awassi lambs from twin or triplet litters faced higher risks of hypothermia, starvation, gastrointestinal infections, and respiratory issues, leading to higher mortality rates.

As revealed in this investigation, the effect of cluster played a highly significant (p<0.01) role in the survival of kids. Up to 3 months, the Nadia and Murshidabad clusters showed the lowest survival rates (86.95% and 87.03%) while the Jalpaiguri cluster had highest (98.70%) survival rates. As time progressed, the trend was changed up to 12 months' data and the performance of the Murshidabad cluster was lowest (64.80%). Jalpaiguri cluster, being situated at the foothill region of the Himalayas, attained the highest survival

Table 3. Factor wise cumulative survival of Black Bengal kids.

Factors	Sub-class	No. of kids born	Survival (%)				
			At birth	Upto 3 month	Upto 6 month	Upto 9 month	Upto 12 month
Cluster	Nadia	4837	99.94	86.95	85.32	84.66	84.43
	Sundarban	3798	99.66	93.47	91.31	89.94	89.26
	Jhargram	886	99.89	95.82	93.79	93.00	92.44
	Murshidabad	1318	100.00	87.03	78.60	68.66	64.80
	Jalpaiguri	1157	100.00	98.70	98.10	98.10	96.37
Year	2010	998	100.00	83.67	81.36	79.16	78.46
	2011	906	99.78	87.53	83.77	82.01	81.13
	2012	744	100.00	86.96	83.87	82.80	81.32
	2013	820	100.00	86.83	83.90	82.32	82.20
	2014	838	100.00	87.35	85.92	84.84	84.84
	2015	841	99.52	92.87	90.96	88.70	88.23
	2016	1043	99.81	90.99	87.34	83.70	82.26
	2017	1129	99.65	92.47	89.11	85.39	82.91
	2018	919	99.89	94.78	91.95	90.53	88.68
	2019	1235	99.68	94.41	91.58	89.96	88.50
	2020	1031	100.00	92.63	91.46	89.72	89.33
	2021	1492	100.00	94.44	93.36	93.10	93.10
Season	Summer	4171	99.90	92.14	89.14	86.67	85.66
	Rainy	3063	99.90	89.81	87.53	85.93	85.18
	Winter	4762	99.79	90.30	88.16	86.69	85.68
Type of Birth	Single	3114	99.84	89.08	86.26	84.04	83.01
	Twin	6538	99.86	92.40	89.94	88.13	87.08
	Triplet	2018	99.85	88.80	86.92	85.23	84.74
	Quadruplet	305	100.00	88.85	85.57	85.25	84.59
	Pentaplet	21	100.00	76.19	76.19	76.19	76.19
Sex	Male	6556	99.80	91.29	88.99	87.29	86.46
	Female	5440	99.93	90.24	87.56	85.51	84.45
Parity	1	1787	99.66	90.26	87.80	85.23	83.72
	2	2188	99.91	91.13	89.17	87.57	86.61
	3	2026	99.85	90.97	88.75	86.77	85.88
	4	1694	99.94	91.03	88.02	85.95	84.95
	5	1467	99.80	91.21	88.07	85.82	85.21
	6	1055	100.00	88.15	85.21	83.89	83.32
	7	681	100.00	91.34	88.40	87.22	86.05
	8	1098	99.82	92.17	90.62	89.62	88.98
Birth weight	<1 kg	908	100.00	90.09	88.22	86.89	86.23
	1-1.5 kg	9944	99.84	90.81	88.26	86.36	85.40
	>1.5 kg	1144	99.91	91.43	89.07	87.24	86.28

rates (96.37%) up to 12 months and the trend continued through all the time intervals. Comfortable temperature and humidity along with the highest amount of rainfall were helpful to provide favourable conditions for survival and growth with adequate availability of grazing fodder in the pasture lands. In contrast, the Murshidabad cluster experienced low rainfall, with extreme temperatures and humidity throughout the year, which favoured ectoparasite infestation in kids. The grazing time was also less to cope with the heat stress in the summer seasons. All these factors accounted for a total of 22.5% cumulative mortality exclusively between 3 months and 12 months. Thus, it is evident that genotype-environment interactions significantly influenced the varying survival rates across the different clusters.

Year of birth did not impose any significant ($p<0.05$) influence on the survival rate of kids. The survival rate

up to 3 months was lowest in the year 2010 and highest in the year 2018 (range 83.67-94.78%). Considerable influence of the year on kid survival in Iranian Kermani sheep was reported earlier [5]. During the initial years, the farmers were not aware enough of scientific rearing techniques and did not have much logistic support due to a paucity of funds. But gradually, with the facilities of training, health cum awareness camps, and field support by project personnel, the farmers were able to adopt scientific rearing practices which ultimately attributed to better survival rates in subsequent years.

Season was also a significant ($p<0.05$) source of variation in survival rate. Up to 3 months, the highest survival rate of 92.14% was found in summer, while kids born in the rainy season had the lowest survival rate of 89.81%. Despite having better availability to feed during the rainy season and access to enough vegetation to produce milk for young offspring compared to other times of the year, the incidences of illness and parasite infestation were considerably higher. The results are contrary to another study [18] where it has been found that the survival of Dorper x Menz crossbred lambs at various ages was not significantly influenced by the lambing season, dam genotype, or blood level. However, it was noticed that compared to other seasons [4], the winter had a considerably high mortality estimate (57.7% vs. 42.3%). In winter season, newborns are susceptible to cold and a sudden drop in temperature can lead to hypothermia and increased mortality. It is suggested that better feeding methods, routine deworming and enhanced housing management are crucial for maximizing kid survival rates throughout the year.

The survival was impacted by the kid's sex in a statistically significant ($p<0.05$) way. A better rate of survival was noticed in male kids (86.46%) than females (84.45%) up to 12 months. However, reports have indicated no significant difference in the survival rates between male and female lambs in Iranian Kermani sheep [5]. It may be necessary to conduct further research in this field.

Parity did not have significant ($p>0.05$) influence on kid survival for up to 3 months. From the dataset, it is observed that the kids born in the first parity had lower survival than that of subsequent parities. As parity increases, the chance of survival also increases. The rates of triplets and twinning decreased with subsequent parities, resulting in kids having more milk from the dams, which enhances their ability to withstand harsh environments, parasite infestations, and disease.

CONCLUSION

Based on our study, it may be concluded that farmers can improve their management practices for raising their goats by being aware of the risk factors that affect kid survival. It is found that both environmental and animal-related issues have a significant impact on the viability of kids. The findings suggest that environmental manipulation offers a larger chance for boosting survival than selection. The viability, productivity, welfare, and financial success of goat farming will improve with optimal birth weight, proper housing, stress reduction, availability of grazing pasture, routine deworming, immunization and awareness of adequate colostrum feeding in early days. Further investigations are required to understand the complex impact of nutrient levels, parasites, and grazing management practices across different agro-climatic clusters on kid survival.

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