

FIELD ASSESSMENT OF BREEDING BULL PERFORMANCE AND MANAGEMENT SYSTEMS IN WEST-CENTRAL AND EAST-CENTRAL BHUTAN

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ABSTRACT: *This study examined the field performance of breeding bulls by comparing reported performance records with verified field data. We interviewed 195 farmers and evaluated 84 breeding bulls. The reported mean (\pm SD) values for the number of services, progeny produced, and natural service success rate were 14.9 ± 19.4 per bull per year, 8.8 ± 14.0 per bull per year, and $48.1 \pm 30.5\%$, respectively. The validated values were significantly higher at 40.6 ± 32.9 per bull per year, 28.3 ± 26.3 per bull per year, and $65.6 \pm 21.5\%$. We found significant differences between reported and validated performance records ($p < 0.001$), indicating major inaccuracies in the current reporting system. The coverage of breeding bulls recorded was 42.9%. Most bulls were supplied through community requests (85.6%) and managed effectively under the existing system. The bulls were generally healthy, with a mean body condition score of 3.05 ± 0.58 ; no significant differences were noted between regions. A strong link was found between existing and preferred bull management systems ($p < 0.001$). The payment of mating allowances positively impacted the health and performance of breeding bulls. Despite the bulls being in good health and well managed, 94.1% had not been screened for infectious diseases after being deployed in the field. Additionally, recommended practices, such as replacing breeding bulls within three years and sterilizing scrub bulls, were not adequately followed. To improve the effectiveness and sustainability of the breeding bull program, this study suggests strengthening performance recording and validation systems. It also recommends maintaining the current community-based procurement and Contract Bull Keeper management approach, ensuring timely payment of mating allowances, conducting annual disease screenings, and enforcing the timely replacement of breeding bulls and sterilization of scrub bulls.*

Keywords: Breeding bull; Management system; Natural service; Performance efficiency.

1. INTRODUCTION

The main cattle breeds reared in Bhutan are Jersey, Brown Swiss (BS), Holstein-Friesian (HF), Siri, Mithun (*Bos frontalis*), and their crossbreeds. Siri cattle, known locally as Nublang (male) and Thrabam (female), make up the largest proportion of the national cattle population, followed by Jersey, Mithun, Brown Swiss, and Holstein-Friesian crosses (DoL, 2020; NSB, 2023). Cattle genetic improvement in Bhutan is driven by two main methods: artificial

insemination (AI) and the distribution of quality breeding bulls. AI services are provided in areas with road access, a minimum population of 120 breedable female cattle within a 5-km radius, and availability of trained AI technicians. In regions where AI services face limitations due to accessibility and infrastructure, quality breeding bulls are distributed to farming communities as an alternative strategy to improve genetic quality and reproductive performance.

Thrabam, a local cattle breed, serves as the base population for crossbreeding with exotic breeds to enhance overall productivity. Among the available breeds, Jersey cattle are most favored by Bhutanese farmers (Choden & Tamang, 2018) due to their relatively small size, better productivity in local conditions, and ease of management compared to other exotic dairy breeds. Farmers can select cattle breeds and breeding services based on their production goals, available resources, and management preferences.

Quality breeding bulls are sourced and supplied through the Contract Heifer and Bull Production Programme (CHBPP), Dairy Farmers' Groups (DFGs), and government nucleus farms at subsidized rates to improve the genetic potential and productivity of cattle in rural areas. All breeding bulls supplied to the field are screened for diseases and breeding soundness, as well as libido and semen evaluation.

Over the years, farmers have preferred AI services over natural breeding due to the burdens of keeping bulls. In 2021, 350 breeding bulls were placed in the field for natural breeding, while 130 Artificial Insemination Outreach Centres (AIOCs) operated nationwide, providing AI services to livestock farmers. The number of calves produced through natural service was significantly higher than that produced through AI. However, verifying the number of calves born from natural service proved challenging. Despite the important role of breeding bulls in improving cattle genetics,

the performance of breeding bulls in the field and their management have not been systematically evaluated. Therefore, this study aims to assess the reproductive performance, health condition, and field use of breeding bulls, as well as the current breeding bull supply and management systems in the two regions of Bhutan. The findings will highlight gaps and create recommendations for better breeding bull management, improve the efficiency of natural service breeding programs, and accelerate the growth of genetically superior crossbred cattle populations.

2. MATERIALS AND METHODS

2.1 Area and schedule

The study assessed the performance of breeding bulls stationed in the West-Central (W-C) and East-Central (E-C) regions of Bhutan. The W-C region included Gasa, Punakha, Wangdue Phodrang, Dagana, and Tsirang districts, while the E-C region comprised Bumthang, Trongsa, Zhemgang, and Sarpang districts. Breeding bulls for assessment were selected in consultation with the District Livestock Sector (DLS) using centrally maintained performance records and field location data. The study evaluated at least 30% of the certified breeding bulls in each district, verifying their reported performance data through field visits and farmer interviews.

Further, we selected Gewogs based on the proportional distribution of breeding bulls targeted for assessment and their accessibility. In total, we covered 18 Gewogs in the E-C region and 19 Gewogs in the W-C regions. The geo-coordinates for the bulls' locations were recorded using the mobile App SW Maps and imported the data into QGIS to create maps (Figure 1).



Figure 1: Map showing study areas.

Field visits in the West-Central (W-C) region took place from June 6 to June 20, 2023. In the East-Central (E-C) region, field visits occurred in two phases: Bumthang and Trongsa from November 5 to November 13, 2023, followed by Zhemgang and Sarpang from April 3 to April 17, 2024.

2.2 Sample respondent

A total of 195 households (HH) covering beneficiary farmers of breeding bulls were visited in nine districts covering two regions. Specifically, 84 households (HH) including the contract bull keeper (CBK), private bull keeper (PBK), *Tshogpa* (community elected representative) were visited and collected data on annual services and progeny born of visited breeding bulls.

2.3 Data collection and validation

The National Dairy Development Centre (NDDC) as a central data repository agency at the national level maintains the performance record of breeding bulls such as natural service, progeny born records and

natural service success rate (NSSR) on quarterly basis. In addition, field visits were undertaken to collect additional data, assess and monitor the performance data and health of the breeding bulls.

The health of the visited bulls was assessed using Body Condition Score (BCS) on a scale of 1-5, and collected the health status applying the score for each bull visited. The data on annual services and progeny born of visited bulls were collected from the CBK or PBK to cross-check the data collected with the information maintained at the central repository for assessment of reporting efficiency of the districts. The breeding bulls that were dead at the time of assessment were removed from this analysis, including their breeding and progeny born records.

Among 176 breeding bulls in the study areas covering two regions, a total of 84 bulls (47.7%) were visited during the assessment period (Table 1).

Table 1: Breeding bulls in the region, bulls visited, assessment coverage and households interviewed.

Region	Districts	Total breeding bull (n)	Bulls visited (n)	Bull assessment coverage (%)	HH visited (n)	Avg. cattle/HH		Avg. HH/bull (n)
						M	F	
W-C	Gasa	7	3	42.9	6	2.3±2.1	7.2±4.9	17.7±15.9
	Punakha	14	5	35.7	11	3.6±2.2	7.6±10.9	18.8±17.5
	Wangdue	22	8	36.4	18	3.7±3.3	7.9±4.2	33.6±22.9
	Dagana	9	6	66.7	21	2.1±2.4	5.9±7.7	18.0±13.6
	Tsirang	20	9	45.0	26	1.9±1.5	3.2±1.7	67.8±40.6
	Sub. Total	72	31	43.1	82	2.6±2.4	5.8±6.3	36.6±33.2
E-C	Bumthang	25	14	56.0	19	2.2±2.2	11.4±9.4	21.8±11.9
	Trongsa	31	14	45.2	33	2.4±2.9	7.1±10.8	33.9±31.0
	Zhemgang	38	18	47.4	43	1.7±2.7	4.8±9.1	34.8±17.4
	Sarpang	10	7	70.0	18	2.0±2.4	3.6±2.1	70.4±42.0
	Sub. Total	104	53	51.0	113	2.0±2.6	5.9±8.5	35.4±28.1
Total		176	84	47.7	195	2.3±2.5	5.9±7.6	36.1±29.9

W-C: West-central; E-C: East-central; Avg.: Average; HH: Households; M: Male; F:Female

2.4 Data computation

The health of bulls visited were assessed through body condition scoring on the scale of 1-5, with score of 1.0 as hide bound, 1.5 as poor health, 2.0 as satisfactory, 2.5 as good, 3.0 as very good, 3.5 as excellent, 4.0 as slightly obese, 4.5 as obese and 5.0 as extremely obese. The education level of farmers was categorized as uneducated, primary education, secondary education and tertiary education. The performances of breeding bulls were computed as Services and Progeny born/bull/year, and the services/bull/year at different levels were compared with recommended performance of 52 services/bull/year (Chenoweth and Larsen 1992). For this assessment, data on all parameters were computed as overall, regional and districts average. The overall average of any parameters in this study is considered as national average, with which the regional and district averages were compared where required for performance

assessment. Further, the national, regional or district averages were compared with the recommended standards under Bhutanese conditions where applicable for analysis and interpretation.

2.5 Data analysis

Data were entered, cleaned, and compiled in Microsoft Excel spreadsheets before being subjected to statistical analysis using IBM SPSS Statistics Version 23. Statistical analyses were performed to evaluate breeding bull performance, health status, and management factors. A one-sample t-test was used to determine whether the reported breeding bull performance differed significantly from the validated performance records and from the corresponding national averages for breeding bull health status and validated annual services. An independent-samples t-test was employed to compare breeding bull performance between the West-Central and East-Central regions.

Associations among categorical variables were assessed using the Chi-square test. Pearson's correlation analysis was conducted to examine relationships among breeding bull health status, validated annual services, and provision of allowances. The effects of breed, health status, and management practices on breeding bull performance were evaluated using analysis of variance (ANOVA). Results are presented as mean \pm standard deviation (SD), and statistical significance was declared at $p < 0.05$.

3. RESULT AND DISCUSSION

3.1 Demographic profile of respondents

The mean age of the respondents was 46.5 ± 13.0 years, with the majority (82.6%) falling within the economically active age group of 21–60 years. Most respondents were male (63.6%) and had no formal education (59.0%). In terms of farm characteristics, the majority owned between 1 to 5 acres of land (65.1%), and maintains fewer than six breeding female cattle (58.5%), and relied on mixed farming systems integrating crop and livestock production for their livelihoods (6.7%). The mean annual household income was Nu. $163,964.1 \pm 216,706.8$, which was lower than the national average annual rural household income of Nu. 276,398.0 reported by the National Statistics Bureau (NSB), (2022).

3.2 Performance and coverage of breeding bulls

Overall, the reported performance of breeding bulls was 14.9 ± 19.4 services per bull per year, 8.8 ± 14.0 progeny born per bull per year, and a natural service success rate (NSSR) of $48.1 \pm 30.5\%$. In contrast, the validated performance records for the same bulls indicated significantly higher

values, with 40.6 ± 32.9 services per bull per year, 28.3 ± 26.3 progeny born per bull per year, and an NSSR of $65.6 \pm 21.5\%$ (Table 2).

The study revealed that the reported numbers of services and progeny born per bull per year were nearly three times lower than the corresponding validated values, with highly significant differences observed between reported and validated performance records ($p < 0.001$). Likewise, the reported natural service success rate (NSSR) was significantly lower than the validated NSSR ($p < 0.001$). These findings indicate substantial discrepancies in the current performance recording and reporting system. Therefore, strengthening the breeding bull performance monitoring system is essential, including wider adoption of the web-based database available at www.ndis.gov.bt and provision of hands-on training for key users, such as Community-Based Breeding Coordinators (CBKs), Private Breeding Coordinators (PBKs), and livestock extension personnel, to improve data accuracy, reporting, and utilization.

Overall, each breeding bull in the field served an average of 94.7 ± 64.8 breedable female cattle per year. However, based on the validated number of annual services per bull, breeding bulls were estimated to cover only 42.9% of the total breedable female cattle population (Table 2). This finding suggests that a substantial proportion of breedable females were mated by uncertified or scrub bulls, potentially limiting genetic improvement

efforts and reducing the effectiveness of the breeding program.

The reported and validated breeding bull performance indicators, including services per bull per year, progeny born per bull per year, and natural service success rate (NSSR), were compared with the overall averages and are presented in Table 3. The results revealed substantial discrepancies between the reported and validated records, with the validated data consistently showing higher performance values. These findings indicate inaccuracies in the performance reporting system at the district level and highlight the need for improved data recording, verification, and reporting mechanisms.

Table 3 presents the validated breeding bull performance indicators such as services per bull per year, progeny born per bull per year, and natural service success rate (NSSR) in comparison to the overall averages. The results revealed substantial discrepancies between reported and validated records, with validated data consistently indicating higher performance levels. These differences suggest potential inaccuracies in the current performance reporting system at the district level and underscore the need to strengthen data recording, validation, and reporting procedures to ensure improved accuracy and

reliability of breeding bull performance information.

The validated annual number of services per breeding bull was compared with the recommended minimum benchmark of 52 services per bull per year. The overall mean number of services per bull (40.6 ± 33.0) was significantly lower than the recommended benchmark ($p = 0.002$). Similarly, the mean number of services in the East-Central region (32.9 ± 29.4) was significantly lower than the recommended value ($p < 0.001$). In contrast, the mean number of services in the West-Central region (53.7 ± 35.2) did not differ significantly from the recommended benchmark ($p > 0.05$).

The comparison of breeding bulls' performances between the two regions revealed significant differences for performances reported from the districts, whereas no significant difference was noted for the performances validated from field with exceptions in NSSR (Table 3).

The district-level assessment of services per bull per year, compared with the overall mean (40.56 ± 33.0), showed that Tsirang District had significantly higher service rates. In contrast, Gasa, Bumthang, and Trongsa recorded significantly lower service

Table 2: Performance of breeding bulls in the region compared with overall average (Mean±SD).

Category	Parameters	Overall (n=84)	W-C (n=31)	p-value	E-C (n=53)	p-value
Reported from Districts	Services/bull/year	14.9±19.4	21.7±23.5	0.117	10.9±15.4	0.065
	Progeny/bull/year	8.8±14.0	14.7±16.9	0.062	5.4±10.7	0.023
	NSSR (%)	48.1±30.5	61±26.7	0.012	40.2±30.5	0.065
Validated in field	Services/bull/year	40.6±33.0	53.7±35.2	0.047	32.9±29.4	0.063
	Progeny/bull/year	28.3±26.3	40.4±27.7	0.021	21.2±22.8	0.028
	NSSR (%)	65.6±21.5	74.2±9.8	0.000	60.5±24.8	0.144

NSSR: Natural service success rate; W-C: West-central; E-C: East-central

Table 3: Performances of bulls in two regions.

Category	Parameters	Region	N	Mean±SD	p-value
Reported performances	Services/bull/year	W-C	31	21.71±23.50	0.001
		E-C	53	10.92±15.36	
	Progeny/bull/year	W-C	31	14.74±16.93	0.000
		E-C	53	5.39±10.70	
	NSSR (%)	W-C	31	61.01±26.70	0.271
		E-C	53	40.58±30.33	
Validated Performances	Services/bull/year	W-C	31	53.65±35.22	0.126
		E-C	53	32.91±29.43	
	Progeny/bull/year	W-C	31	40.45±27.69	0.083
		E-C	53	21.19±22.82	
	NSSR (%)	W-C	31	74.25±9.80	0.000
		E-C	53	60.54±24.80	

NSSR: natural service success rate; W-C: West-central; E-C: East-central

rates, while no significant differences were observed in Punakha, Wangdue, Dagana, Zhemgang, and Sarpang (Table 5).

Similarly, the assessment of NSSR against the overall mean (65.6%) indicated that Punakha, Dagana, and Tsirang achieved significantly higher NSSR values. Trongsa recorded significantly lower NSSR, whereas Gasa, Wangdue, Bumthang, Zhemgang, and Sarpang did not differ significantly from the overall average.

Among the nine districts, only Tsirang exceeded both the recommended minimum of 52 services per bull per year and the overall mean NSSR of 65.6%, while Dagana also performed above the overall averages for both indicators. Overall, most districts including Gasa and Punakha in the West-Central region and Bumthang, Trongsa, and Zhemgang in the East-Central region did not achieve the overall mean of 40.56 services per bull per year, indicating generally low utilization of breeding bulls across the study areas.

Overall, the study found a weak but statistically significant positive correlation

between validated annual services per bull and breeding bull health status ($r = 0.217$; $p = 0.047$) (Table 7). These findings are consistent with the recommendation of the Beef Cattle Research Council (BCRC, 2025), which emphasizes that regular monitoring of breeding bulls is essential for assessing health status and ensuring sustained reproductive performance and longevity.

3.4 Breeding bull supply and management system

The study found that the breeding bulls in field were supplied mostly through community request (85.6%), followed by private procurement (8.2%) and directly placed by the Gewog livestock official (GLO) (6.2%) as per community requirements (Figure).

The study found that breeding bulls in the field were predominantly supplied based on community requests (85.6%), followed by private procurement (8.2%) and direct placement by Gewog Livestock Officers (6.2%), in accordance with demands (Figure 2). With respect to breed composition, farmers showed a clear preference for Jersey-type cattle over other breeds. The

Table 4: Districts level breeding bulls’ performance against overall averages (Mean±SD).

Region	Districts	Bull (n)	Service/bull/year	* <i>p</i> value	NSSR (%)	** <i>p</i> value
West-central (N=31)	Gasa	3	22.3±10.8	0.010	70.0±3.3	0.149
	Punakha	5	34.8±21.5	0.582	72.0±3.4	0.014
	Wangdue	8	58.9±28.8	0.115	64.4±8.8	0.722
	Dagana	6	42.0±19.6	0.864	81.9±4.7	0.000
	Tsirang	9	77.7±45.4	0.040	80.5±8.6	0.001
East-central (N=53)	Bumthang	14	23.6±23.6	0.018	66.8±29.0	0.882
	Trongsa	14	21.4±18.8	0.002	50.9±18.7	0.012
	Zhemgang	18	36.6±28.6	0.566	63.1±24.0	0.667
	Sarpang	7	65.9±38.2	0.141	60.6±28.1	0.658

p value based on Overall average of 40.56 Ser/bull/yr* and 65.6% NSSR**

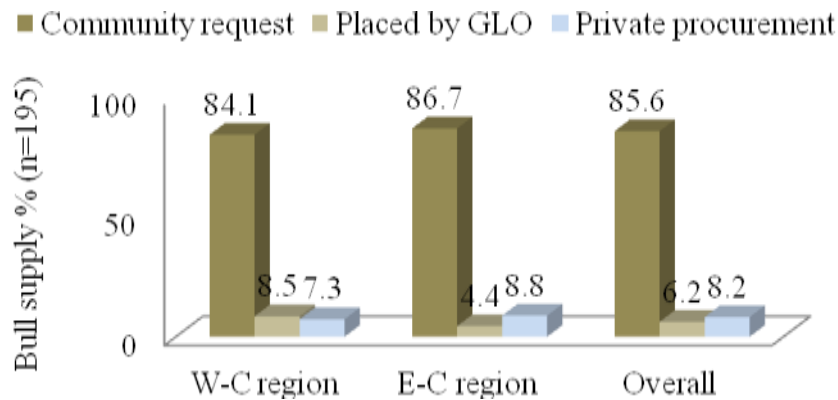


Figure 2: Breeding bull supply mechanism

majority of breeding bulls in the field were Jersey crossbreds (52.4%), sourced mainly from the Contract Heifer Breeding Programme (CHBP) areas across the country. This was followed by Jersey purebred bulls (32.1%), supplied from Jersey nucleus farms at the National Jersey Breeding Centre, Samtse, and the National Cattle Breeding Centre (NCBC), Bumthang. Brown Swiss crossbred bulls were supplied from NCBC, Bumthang and Mithun bulls (11.9%) were obtained from the Regional Mithun Breeding Farms at Aerong and Wangdigang. The availability of breeding bull breeds within communities showed that Jersey crossbreds were most accessible (52.3%), followed by Jersey purebred

(33.3%), Mithun (11.8%), and Brown Swiss crossbreds (2.6%), with a significant association between breed availability and distribution ($\chi^2(9) = 49.953$; $p < 0.001$). This higher access to Jersey genetics provides greater opportunities for improving the genetic potential of indigenous cattle populations in rural areas.

Breeding bulls under the Community-Based Breeding (CBK) system were provided at subsidized rates by the government. In terms of management arrangements, most bulls were managed by CBKs (72.8%), while the remainder were managed through a monthly rotation system among beneficiary households (21.0%). The preferred

management arrangement was community procurement with CBK-based management at the homestead under community by-laws (76.7%). A significant association was observed between the existing and preferred management systems ($\chi^2 (4) = 126.980$; $p < 0.001$). However, a proportion of farmers (10.3%) expressed preference for a Private Breeding Keeper (PBK) system for future sustainability.

Although government-supplied bulls were initially subjected to selection protocols including libido testing, semen evaluation, and disease screening, privately procured bulls were not consistently subjected to these procedures. Furthermore, 94.1% of bulls placed in the field were not routinely screened for infectious diseases (Table 6). This highlights a critical gap in disease surveillance, underscoring the need for mandatory annual health screening of all breeding bulls, including privately sourced animals, in line with World Organization for Animal Health (WOAH) recommendations to reduce the risk of disease transmission through natural service.

As per the study conducted by Banwarth et al (2022), routine semen evaluation, libido testing and disease screening against disease such as Trichomoniasis is important as it negatively affects the productivity of cattle by reducing conception rates, reducing the

number of calves produced, longer calving intervals, and higher culling rates of bulls. The study found that breeding bull replacement practices were in place (64.1%); however, timely replacement within three years of deployment was not consistently followed, as reported by the majority of farmers (52.8%) (Table 6). This was attributed to the lack of readily available replacement bulls and, in some cases, limited follow-up by Gewog Livestock Officers (GLOs). In addition, farmers reported avoiding the use of the same bull on its female offspring, which may help reduce inbreeding within herds and potentially influence observed bull performance. Regarding financial incentives, 40.0% of respondents reported paying a mating allowance (Nu. 150-1,000 per mating), while 30.3% reported paying a progeny-born allowance (Nu. 250–1,200 per calf). These payments, which varied across communities under CBK–community breeding bull management agreements, were intended to incentivize proper care of breeding bulls and improve service performance.

Mating allowance payments were more common in the West-Central region (74.4% of respondents, $n = 82$) than in the East-Central region (15.0%, $n = 113$). In contrast, progeny-born allowance payments were more prevalent in the East-Central region (42.5%, $n = 113$) than in the West-Central region (13.4%, $n = 82$) (Table 6).

Table 5: Breeding bull management system.

Parameters	Category	Overall		W-C region		E-C region	
		Freq.	%	Freq.	%	Freq.	%
Existing management system	CBK (herd)	142	72.8	65	79.3	77	68.1
	CBK (rotation)	41	21.0	14	17.1	27	23.9
	PBK	12	6.2	3	3.7	9	8.0
Preferred management	CBK (at homestead)	150	76.9	71	86.6	79	69.9

Parameters	Category	Overall		W-C region		E-C region	
		Freq.	%	Freq.	%	Freq.	%
system	CBK (rotation)	25	12.8	6	7.3	19	16.8
	PBK	20	10.3	5	6.1	15	13.3
Disease screening practices	No	185	94.1	75	91.5	110	97.3
	Yes	10	5.1	7	8.5	3	2.7
Breeding bull replacement practice	No	70	35.9	20	26.8	48	42.5
	Yes	125	64.1	60	73.2	65	57.5
Breeding bull stationed in same locality	<1 year	24	12.3	6	7.3	18	15.9
	1-3 years	68	34.9	33	40.2	35	31.0
	>3 years	103	52.8	43	52.5	60	53.1
Mating allowance payment	No	117	60.0	21	25.6	96	85.0
	Yes	78	40.0	61	74.4	17	15.0
Progeny born allowance payment	No	136	69.7	71	86.6	65	57.5
	Yes	59	30.3	11	13.4	48	42.5

CBK: Community bull keepers; PBP: Private bull keeper; Freq: Frequency; W-C: West-central; E-C: East-central

Overall, mating allowance payments showed a significant positive correlation with breeding bull health ($r = 0.273$; $p = 0.012$) and validated annual services ($r = 0.467$; $p < 0.001$) (Table 7). In addition, a significant positive correlation was observed between bull health and validated annual service performance ($r = 0.217$; $p = 0.047$). These findings suggest that incentive-based payment systems, particularly mating allowances, are associated with improved breeding bull health and performance. Therefore, incorporating structured mating allowance payments into formal breeding bull management by-laws may strengthen enforcement and enhance overall bull performance in the field.

Although most breeding bulls were reported to be in good health, farmers identified several management challenges within the community. The key constraints included poor coordination among beneficiaries (26.7%), shortage of feed and fodder (23.1%), inappropriate placement of breeding bulls (14.4%), and the aggressive

behavior of some bulls (10.8%). These findings are consistent with reports from Uganda on community-based bull breeding programs, where similar challenges related to governance such as weak collective action and management costs, including feeding, housing, and watering of bulls, were identified and reported (Sekibaala et al., 2024).

3.5 Health of breeding bulls

The study indicated that the overall health status of breeding bulls in the field was satisfactory, with a mean body condition score (BCS) of 3.05 ± 0.58 (Table 8). Bulls in the West-Central (W-C) region exhibited marginally higher BCS (3.08 ± 0.48) compared to the East-Central (E-C) region (3.03 ± 0.64), although the difference was minimal, suggesting broadly similar feeding and management practices across the two regions. These findings align with Palmer (2016), who emphasized that mature breeding bulls should be provided with a balanced ration to meet their nutritional requirements, particularly in preparation for the short but energetically demanding breeding season.

Table 6: Correlations between health of bulls, performances and mating allowance.

Parameters		BCS (n=84)	Validated annual service (n=84)	Mating allowance (n=195)
BCS (n=84)	Pearson Correlation	1	0.217*	0.273*
	Sig. (2-tailed)		0.047	0.012
Validated annual service (n=84)	Pearson Correlation	0.217*	1	0.467**
	Sig. (2-tailed)	0.047		0.000
Mating allowance (n=195)	Pearson Correlation	0.273*	0.467**	1
	Sig. (2-tailed)	0.012	0.000	

* Correlation is significant at the 0.05 level (2-tailed); ** Correlation is significant at the 0.01 level (2-tailed)

Table 7: Health status of breeding bulls in field.

Health status (BCS)	Overall (n=84)		W-C region (n=31)		E-C region (n=53)	
	Frequency	%	Frequency	%	Frequency	%
Very poor (1.5)	2	2.4	0	0	2	3.8
Poor (2.0)	6	7.1	1	3.2	5	9.4
Good (2.5)	12	14.3	6	19.4	6	11.3
Very good (3.0)	37	44.0	14	45.2	23	43.4
Excellent (3.5)	16	19.0	7	22.6	9	17.0
Obese (4.0)	11	13.1	3	9.7	8	15.1

BCS: Body condition score; W-C: West-central; E-C: East-central.

3.6 Breeding practices and service preference

Farmers in rural areas demonstrated a higher preference for natural service (57.4%) compared to artificial insemination (48.7%). This preference may be attributed to the remoteness of village herds and the relatively higher conception rates associated with natural service. Regionally, the use of natural service was 52.4% in the West-Central (W-C) region and 61.1% in the East-Central (E-C) region, with no significant difference between the two regions. A similar trend has been reported by Chethan et al. (2024) in a study on breeding practices in Karnataka, where 59.72% of farmers

relied exclusively on natural service, while only 21.67% used artificial insemination.

Overall, 86.7% of respondents (93.3% in the W-C region and 79.6% in the E-C region) reported that certified breeding bulls actively provide services in the field. However, they also indicated that uncertified (scrub) bulls are widely present in the community and compete with certified breeding bulls. In this regard, 91.3% of farmers (91.5% in W-C and 91.2% in E-C) confirmed the abundance of such uncertified bulls.

Despite their prevalence, 73.3% of respondents (74.4% in W-C and 72.6% in E-C) acknowledged that they had used scrub bulls for mating their cows or heifers at some point, citing reasons such as avoiding inbreeding (35.9%), uncontrolled/free grazing conditions (31.8%), backcrossing practices (4.1%), and occasional unavailability of certified breeding bulls (28.2%), particularly when community breeding bull keepers graze bulls along with their herds. Encouragingly, 83.6% of farmers (74.4% in W-C and 90.3% in E-C) reported receiving awareness and guidance from Gewog livestock officials on managing scrub bulls through measures such as castration or culling. Statistical analysis further revealed that the education level of respondents had no significant association with breeding service preference ($\chi^2(3) = 3.56$, $p = 0.313$) or with the practice of mating cows/heifers with scrub bulls ($\chi^2(3) = 2.75$, $p = 0.517$).

Overall, the study suggests that farmers are generally aware of the negative consequences associated with inbreeding. To optimize the utilization and genetic impact of certified breeding bulls in the field, their timely replacement at approximately three-year intervals is recommended, with Gewog Livestock Officers (GLOs) playing a proactive role in implementation and monitoring. The study confirmed the continued presence of scrub bulls within the community. To enhance the genetic potential and productivity of herds, these uncertified bulls should be routinely sterilized or culled prior to reaching breeding age, following a structured schedule comparable to established vaccination programmes. In addition, uncontrolled free grazing should be discouraged, as it increases the likelihood of unintended mating with scrub bulls, thereby contributing to genetic dilution of the herd.

4. CONCLUSION

The study revealed that the performance of breeding bulls, in terms of validated services, progeny born per bull per year, and non-return service rate (NSSR), was approximately three times higher than previously reported estimates. Despite this, scrub bulls continue to dominate breeding activities in rural areas, underscoring the need for their mandatory culling or sterilization before reaching breeding age, implemented at regular and systematic intervals. In addition, uncontrolled free grazing should be discouraged, as it facilitates indiscriminate mating with scrub bulls.

To ensure the optimal utilization of certified breeding bulls, timely replacement at approximately three-year intervals is recommended, with Gewog Livestock Officers (GLOs) playing a proactive role in coordination and implementation. The current system of breeding bull supply, which is largely based on community requests and managed by community-based bull keepers (CBKs) at their homesteads, was found to be appropriate and should therefore be continued and strengthened.

However, the study identified a critical gap in animal health management, as most breeding bulls in the field were not routinely screened for infectious diseases. It is therefore recommended that annual disease screening, as per WOHA guidelines, be made mandatory. Furthermore, all potential breeding bulls from various sources should undergo systematic selection procedures, including libido assessment, semen evaluation, and biannual disease screening, to ensure their suitability prior to deployment in communities or private use. The study also found that mating allowances had a positive influence on both the health and performance of breeding bulls, suggesting that the continuation of this

incentive would contribute to improved management outcomes.

Finally, the breeding bull performance reporting system should be strengthened through the development and implementation of a web-based database, supported by hands-on training for key users, including CBKs, private bull keepers (PBKs), and livestock field staff.

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