

PERFORMANCE EVALUATION OF BUFFALOES UNDER IRRIGATED CONDITIONS IN RAJASTHAN'S NORTH-WESTERN PLAIN

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ABSTRACT

Performance data on buffaloes under actual smallholder management in Rajasthan's Agro-climatic Zone-1B remain scarce. This study compared growth, productive, and reproductive performance across 120 smallholder farms (60 each in Hanumangarh and Sri Ganganagar) using multi-stage random sampling, structured interviews, and direct body measurements up to 18 months of age. Hanumangarh district and large herds (>10 animals) showed significantly superior growth, productive, and reproductive performance than Sri Ganganagar and smaller herds, including higher body weight, wither height, heart girth, averaged daily gain, lactation length, and milk yield, along with lower age at first oestrus, age at first calving, service period, and calving interval. Stall feeding with wheat straw and non-leguminous green fodder predominated, while artificial insemination adoption (25–53%) increased with herd size. Results indicate that district location and herd size strongly influence buffalo performance under smallholder conditions. Targeted extension services focusing on scientific feeding, breeding, and health management are essential to enhance productivity and farmer livelihoods in the region.

Key words: Buffalo, smallholder management, growth performance, milk yield, reproductive traits, Rajasthan

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INTRODUCTION

Buffalo (*Bubalus bubalis*) contributes more than 57% of India's total milk production and plays a critical role in the livelihood security of small and marginal farmers. In Rajasthan, Agro-climatic Zone-1B (Irrigated North-Western Plain Zone), comprising Hanumangarh and Sri Ganganagar districts, harbours a substantial

buffalo population. Most farmers operate under resource-constrained smallholder systems characterised by traditional feeding, breeding, and health management practices. This often results in suboptimal productivity and increased vulnerability to environmental stressors, especially for breeds like the Murrah buffalo which are susceptible to heat stress (Singh *et al.*, 2025).

International studies have consistently shown the superiority of improved or crossbred buffaloes over native types. Salas *et al.* (2000) reported faster growth and higher milk yield in Murrah × Philippine native crossbreds compared with native Philippine buffaloes. Similarly, Timsina *et al.* (2015) documented significantly higher daily milk yield (5.9 vs. 2.6 L/day), earlier age at first calving, and shorter calving interval in Murrah-cross buffaloes than in local non-descript buffaloes under smallholder conditions in Bhutan. In India, Murrah buffaloes are particularly valued for their superior milk productivity and adaptability across various agro-climatic zones (Makarabbi *et al.*, 2025).

Despite these encouraging findings, comparable field-level data from Rajasthan's Zone-1B are scarce. Most previous research in the state has focused on organised farms or isolated management aspects. The present study was therefore undertaken to provide a comprehensive comparative assessment of growth, productive, and reproductive performance of buffaloes across two districts and different herd sizes under real smallholder management conditions. Accordingly, this investigation fills this

research gap by evaluating the influences of herd size categories, prevailing traditional management practices, and key agro-climatic stressors-particularly elevated temperature-humidity index-on growth rates, lactation milk yields, and reproductive traits such as calving interval in Murrah and local buffaloes under smallholder conditions in Hanumangarh and Sri Ganganagar districts (Choudhary and Sirohi, 2019; Singh *et al.*, 2025).

MATERIALS AND METHODS

Study area

The study was conducted in Agro-climatic Zone-1B (Irrigated North-Western Plain Zone) of Rajasthan, covering Hanumangarh and Sri Ganganagar districts. These districts were selected because they have the highest buffalo populations under the administration of Swami Keshwanand Rajasthan Agricultural University, Bikaner, and represent typical smallholder buffalo farming systems in the zone.

Sampling techniques and data collection

In total, 120 buffalo farming households were purposively sampled from two tehsils in each district (Bhadra and Nohar in Hanumangarh; Suratgarh and Ganganagar in Sri Ganganagar). From each selected tehsil, six villages were randomly chosen and five buffalo farmers were selected from each village. A pre-tested structured interview schedule was administered to collect data on socio-economic profile, existing feeding, breeding, housing, health, milking and calf rearing practices. Growth

measurements (body weight, wither height, body length and heart girth) were recorded at birth, 3, 6, 12 and 18 months of age. Daily milk yield, lactation length, peak yield, fat% and SNF% were also recorded. All data were collected through personal interviews and direct observations at the farmers' households and farms during 2024-25.

Statistical Analysis

Quantitative variables such as growth, productive and reproductive parameters were entered in spreadsheet. Mean, Standard Deviation (SD) and Standard Error (SE) were calculated. Comparisons between districts and herd size groups (small, medium and large) were made and significance was tested using two-sample t-test. Qualitative data acquired through interview were converted into frequency and percentage.

RESULTS AND DISCUSSION

Buffalo management practices

Buffaloes were found predominantly managed in stall feeding system during the day in both Hanumangarh and Sri Ganganagar districts. Small and marginal farmers owning less than 3 acres of cultivable land relied mainly on crop residues (wheat straw) and grazing on communal and fallow land. Green fodder, mainly non-leguminous types such as maize, oats and hybrid napier, was commonly provided to the whole herd. Chaffing of green and dry fodder was widely practised. Concentrates were mostly fed at the time of milking. This strategic feeding of concentrates, often comprising soaked

mixtures, primarily aimed to boost milk production during lactation (Manohar *et al.*, 2014).

Farmers believe that buffaloes are hardy animals, can thrive well in harsher conditions and are less susceptible to diseases compared to exotic cattle. Thus, with less input, farmers experienced that returns from buffaloes are better compared to other dairy animals. This perception, although widespread, often leads to suboptimal management practices, particularly concerning housing and nutritional provisions, which can significantly impact their productivity and welfare (Dodiya *et al.*, 2022; Jatolia *et al.*, 2017).

Buffalo breed types and herd dynamics

Sampled farmers mostly reared local non-descript buffaloes with varying degrees of Murrah influence. Average herd size varied significantly between districts. Small herds (1-4 animals) were predominant in Sri Ganganagar (65%), while Hanumangarh showed a more balanced distribution with higher proportion of medium (5-10 animals) and large herds (>10 animals). Majority of the buffaloes reared in the herds were local type, though larger herds had a greater share of improved/Murrah-influenced animals. This pattern indicates a positive association between larger herd sizes and higher proportions of improved Murrah-influenced buffaloes, attributable to superior economic resources, risk-bearing capacity, and access to breeding technologies among bigger operations (Sharma *et al.*, 2021; Singh *et al.*, 2023).

Reproduction parameters

In the present study, age at first oestrus and age at first calving were lower in Hanumangarh district and large herd groups. Average age at first calving was 39.60 ± 1.2 months (Mean $\pm$ SE) for large herds in Hanumangarh compared to 40.98 ± 1.5 months in small herds of Sri Ganganagar ($p < 0.05$). Calving interval was significantly shorter in large herds (16.00 ± 0.4 months) compared to small herds (17.51 ± 0.6 months) ($p < 0.01$). Service period and dry period were also shorter in Hanumangarh and large herds. These reproductive outcomes indicate that enhanced management practices, superior genetic makeup from greater Murrah influence in larger herds, and improved nutrition and veterinary access contribute to better efficiency, as evidenced by shorter service and dry periods with advanced feeding and farm-scale operations (Sharma *et al.*, 2021; Tanwar *et al.*, 2013). These results indicate better reproductive efficiency in Hanumangarh district and large herds (Table 1).

Production parameters

Buffaloes were milked twice a day in early and mid lactation and once in the later phase. At least two teats were left for the calves to suckle till they attain 5-6 months. Average daily milk yield was significantly higher in large herds and in Hanumangarh district. Lactation length was also longer in large herds. Peak milk yield ranged higher in large herds (15.2–16.5 L/day). The overall lactation milk yield in cooperative member families averaged 1936.09 ± 9.56 liters,

significantly surpassing the 1645.91 ± 13.57 liters recorded in non-member families (Tanwar *et al.*, 2013). These yields reflect better management in larger operations (Table 2).

Growth performance

Growth performance was superior in Hanumangarh district and large herds. Calves in large herds recorded higher body weight, wither height, body length and heart girth at 18 months of age along with better average daily gain and total body weight gain compared to small herds and Sri Ganganagar district ($p < 0.01$). These findings align with observations in other studies where environmental factors such as regional variations and management practices significantly influence growth metrics in livestock (Alkoyak and Öz, 2022).

Income and livelihood source of the buffalo farming communities

Buffaloes (especially from larger herds) contributed a substantial portion of household income through sale of milk and milk products. Large herd owners derived better economic returns due to higher milk production. Buffalo farming has helped to improve livelihoods of farmers despite major challenges faced such as knowledge gaps in scientific management, fodder scarcity and limited veterinary services. The economic viability of buffalo milk production, evidenced by an output-input ratio of 1.56, underscores its potential for generating net returns for farmers (Kamble *et al.*, 2014).

Prospects in Buffalo farming

Despite key challenges such as seasonal fodder shortages, limited knowledge of scientific practices and inadequate veterinary services, it was evident that majority of the respondents were very keen to intensify buffalo farming to sustain their livelihood. Their ability to thrive well and produce under harsh weather conditions with low quality forages and having higher disease resistivity than exotic cattle provided ample scope for farmers to accelerate buffalo production. There is also potential to diversify buffalo products and trap multi-facet benefits associated with buffalo farming. For instance, buffaloes exhibit superior conversion of poor-quality forage due to their less discriminating foraging habits, making them suitable for diverse environmental conditions and promoting sustainable resource utilization (Ayalew and Taye, 2004).

Policy and technical support to accelerate buffalo farming

From the study, it is evident that farmers need regular supply of quality breeding stock, continuous genetic up-gradation through AI services preferably using improved Murrah semen, support in fodder development, mineral supplementation and improved animal sheds. Targeted extension services, farmer training programmes and government intervention in these areas are crucial to enhance buffalo productivity and farmers' income in Agro-climatic Zone-1B of Rajasthan.

CONCLUSION

The present study revealed that buffalo performance under smallholder management in Agro-climatic Zone-1B of Rajasthan is significantly influenced by district and herd size. Buffaloes in Hanumangarh district and large herd groups (>10 animals) exhibited significantly superior growth performance with higher body weight, wither height, body length, heart girth and average daily gain up to 18 months of age compared to Sri Ganganagar and small/medium herds. Productive performance was also markedly better in these groups, recording significantly higher lactation length, total lactation milk yield, peak milk yield, wet average and herd average. Reproductive efficiency was superior as evidenced by lower age at first oestrus, lower age at first calving, shorter service period and shorter calving interval in Hanumangarh and large herds. These findings are consistent with prior studies in Rajasthan indicating that larger farm and herd sizes correlate with superior buffalo performance, including longer lactation lengths, higher milk yields, and better reproductive traits like reduced age at first calving, owing to enhanced management practices such as greater adoption of vaccinations, deworming, and veterinary care (Gupta *et al.*, 2008; Tanwar *et al.*, 2013).

Stall feeding with wheat straw and non-leguminous green fodder was the predominant feeding system across

both districts. However, adoption of scientific practices such as mineral mixture supplementation, silage preparation, consistent artificial insemination and advanced calf rearing practices remained low, particularly in small and medium herds. These management gaps are the major limiting factors for realizing the full productive potential of buffaloes in the region. Furthermore, the impact of nongenetic factors such as calving year and season, along with the age of the animal, has been consistently shown to influence growth performance and production traits in buffaloes (Alkoyak and Öz, 2022; Jakhar *et al.*, 2017).

It is concluded that targeted interventions in balanced nutrition, genetic improvement through timely AI, improved housing and health management are essential to enhance growth, productive

and reproductive performance of buffaloes. Strengthening extension services, fodder development programmes and farmer training will be crucial for sustainable improvement in buffalo productivity and livelihood security of smallholder farmers in Agro-climatic Zone-1B of Rajasthan. Specific, actionable measures for the region include establishment of village-level fodder banks to buffer seasonal shortages, doorstep AI service-delivery models (mobile AI vans or trained village-level AI workers) to raise the currently low insemination coverage, and strengthening of dairy cooperatives to improve farmers' access to breeding inputs, veterinary care and remunerative milk markets. As this field-level dataset from Rajasthan's Zone-1B is one of the first of its kind, it also provides a benchmark for future comparative and longitudinal studies in the region.

Table.1. Reproductive parameters of buffaloes (Mean $\pm$ SE)

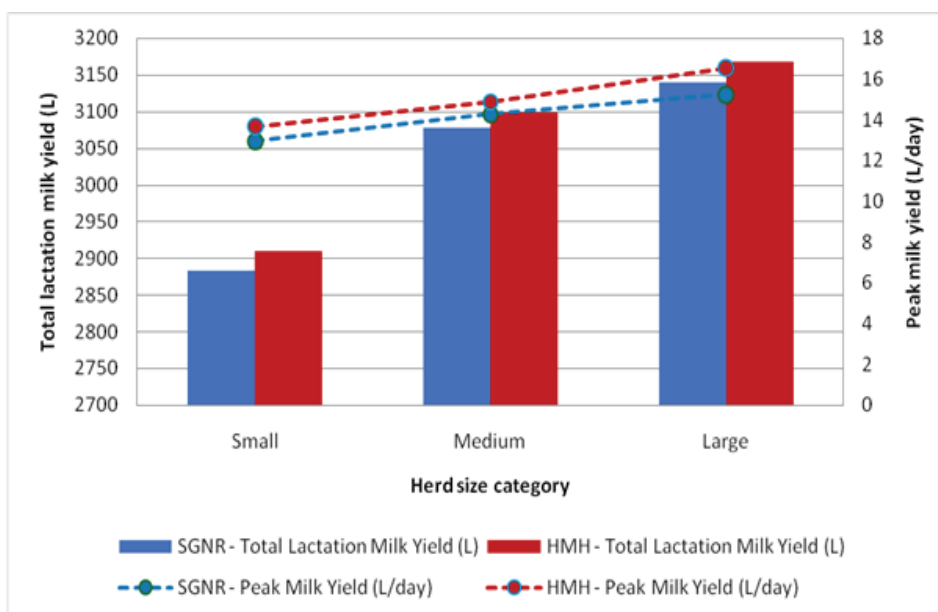
Reproductive parameters	Small Herd (n=65)	Medium Herd (n=37)	Large Herd (n=18)	HMH (Overall) (n=60)	SGNR (Overall) (n=60)
Age at first oestrus (months)	29.18 $\pm$ 0.8	29.27 $\pm$ 0.7	26.79 $\pm$ 0.9	28.12 $\pm$ 0.6	28.71 $\pm$ 0.7
Age at first calving (months)	41.48 $\pm$ 1.1	41.46 $\pm$ 1.0	40.08 $\pm$ 0.9	40.80 $\pm$ 0.8	40.88 $\pm$ 1.0
Calving interval (months)	17.01 $\pm$ 0.5	16.49 $\pm$ 0.4	16.30 $\pm$ 0.3	16.50 $\pm$ 0.4	16.54 $\pm$ 0.5
Service period (days)	137.58 $\pm$ 2.1	136.55 $\pm$ 1.8	136.22 $\pm$ 1.5	136.78 $\pm$ 1.6	136.78 $\pm$ 1.9

Note: n denotes the number of respondent farm households sampled in each herd-size category (Sri Ganganagar, n = 60; Hanumangarh, n = 60); trait values are the unweighted mean of the two district-level means.

Table.2. Average daily milk yield and productive performance of buffaloes (Mean $\pm$ SE)

Reproductive parameters	Small Herd (n=65)	Medium Herd (n=37)	Large Herd (n=18)	HMH (Overall) (n=60)	SGNR (Overall) (n=60)	p-value
Average daily milk yield (L/day)	5.02	5.44	6.08	5.82	5.20	<0.001
Lactation length (days)	280.0	286.9	293.0	288.2	285.1	<0.05
Peak milk yield (L/day)	13.30	14.57	15.88	15.02	14.14	<0.001

Note: n denotes the number of respondent farm households in each herd-size category, as above. Values are the unweighted mean of the two district-level means (Sri Ganganagar and Hanumangarh).

**Fig.1. Total lactation milk yield and peak milk yield of buffaloes by district and herd size**

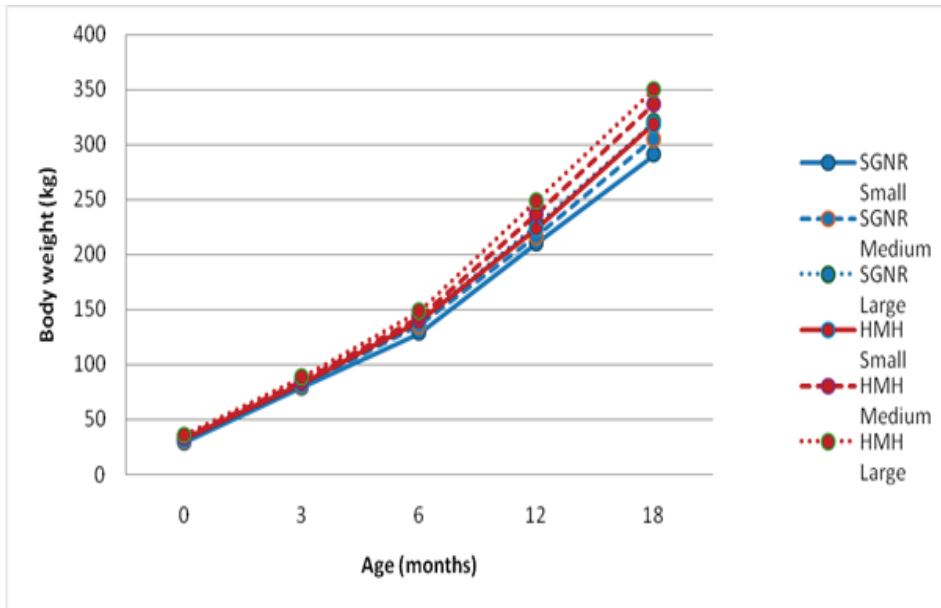


Fig. 2. Growth trend (body weight) of buffaloes from birth to 18 months, by district and herd size (source: field survey data).

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