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Trends in seasonality of birth, weights at birth and sex ratio of Murrah buffalo calves

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Abstract
A twelve years data of buffalo calves born at Buffalo Research Station, Venkataramannagudem was studied to observe the effect of month, season and year on Secondary Sex Ratio, Relative Female Ratio and birth weights. Data from 2011 to 2022 was obtained for the study. September, October and November together accounted for half of the calvings while April, May and June combinedly witnessed less than 5 per cent of total calf crop. Relative Female Ratio was in the range of 0.62 – 1.14 during the months of higher calving rates while the ratio range increased between 0.25 to 2 during the months of low calving rates. Average birth weight of female buffalo calves remained numerically higher for nine years while male calves recorded higher birth weights than female calves during the remaining three years of study period. The numerical differences in the birth weights of males and females remained statistically non-significant. The current study results are of practical value for forecast of calving and milk production for buffalo based dairy farming.

Keywords: birth weight, calving, sex ratio, season and murrah buffalo

1. Introduction
Rural economy and livelihood mainly depend on agriculture, animal husbandry, and the livestock sector. Cattle and buffalo are playing an important role in the livelihood of small, marginal, and medium farmers. At present India produces 187.75 million tons of milk annually and it is significantly contributing to the world's milk production. In India, Buffalo (*Bubalus bubalis*) is the premier livestock which accounts for more than 57 percent of total milk production and plays a salient role in the agrarian economy of many developing nations in Asia by providing milk, meat, and draught power. Although buffaloes contribute only 12 per cent of the global milk production (CABI, 2018) [3], it is the main source of milk in India and contributes a significant share of the total milk production of the Indian dairy industry and its economy. India ranks first in the world buffalo population of 207 million with more than 97 per cent in Asia among which, solely India has 53.07 per cent population (FAO, 2021) [5]. The total buffalo population in India is 109.85 million contributing about 20.5 per cent of the total livestock population which has increased by 1.1 per cent over the previous livestock census (Livestock census, 2019) [10].
Milch animals has increased by 0.2% in India, whereas in Andhra Pradesh, the total population is 6.2 million which has decreased by 3.76% while demand for milk has been increased constantly. More female calving ratio may lead to increased milk production. Managing the conditions, that affect the sex ratio to produce either male or female calves preferentially have economic impact on livestock producers (Seidel, 2003) [20]. Calving to conception interval, nutrition, housing, disease incidence and other managemental practices influences the calving rate in a dairy farm (Lopez *et al*., 2018). Secondary Sex Ratio (SSR) is the sex ratio at birth, which was affected by many factors such as sire age, sire parity, calving year and season, insemination time and maternal factors in dairy cattle (Yilmaz *et al*., 2010). Calf sex is determined at the time of fertilization, but preferential embryonic or fetal mortality can also affect the secondary sex ratio (Glover *et al*., 2019) [7]. So, factors influencing during fertilization and early gestation play a great role in sex determination (Schimidek *et al*., 2013). The perusal of scientific literature revealed that there is scanty/lack of information on the effect of season, month and year on birth weight, sex ratio and Relative Female Ratio (RFR) under semi-intensive system of rearing of Murrah buffaloes. Nevertheless, previously similar type of works was reported in other domestic animal species in different managemental conditions (Mukherjee *et al*., 2000 [15]; Biradar and Suranagi, 2003; Kaygisiz *et al*., 2003 [9];

Singh *et al*., 2004 [21]; Lari, 2006 [1]; Roche *et al*., 2006 [18]; Farahvash *et al*., 2008 [6]; Perumal *et al*., 2014 [16]; Perumal *et al*., 2019) [17]. Therefore, the data was analysed retrospectively to assess the effect of season, month and year on calving pattern and birth weight of Murrah buffalo calves reared under semi-intensive system at Buffalo Research Station of Sri Venkateswara Veterinary University, Andhra Pradesh.

2. Material and Methods

2.1 Location of the study

The documented data from 2011 to 2022 for a period of 12 years of 444 calvings in buffaloes at Buffalo Research Station (BRS) of Sri Venkateswara Veterinary University (SVVU), Venkataramannagudem was taken into account for analysis. Buffalo Research Station located at an altitude of 44.7 meter above sea level on 16.8831°N latitude and 81.4513°E longitudes. The institute located at the upland area where the water source is mainly dependent on rainfall and bore well, where temperature raises up to 37 ºC in summer and comes closer to 19 ºC during the winter season. The average rainfall is around 90 mm per annum and the maximum is received during the months of August to October. The buffaloes had free access to green fodder and water while concentrate was given twice a day as per the ICAR recommendations (ICAR, 2013) [8]. The buffaloes used in the present study were apparently healthy and did not have a history of abnormal calving.

2.2 Data recording

The data related to sex of calves, calving year, season and month from the year 2011 to 2022 were collected, grouped and analysed for the study. Calving season was classified as three seasons viz., Summer (March-June), Monsoon (July-October) and Winter (November-February). Secondary sex ratio (SSR) has been calculated as per the procedure followed by Mora *et al*. (2010) [14] which has been described as under. SSR=(A/C) ×100: (B/C)×100; Where, A=the number of male calves, B=the number of female calves and C=the number of total calves (A+B). Relative Female Ratio (RFR) was calculated from number of female and male calves for dairy animals. Numbers of male and female calves become equal to each other when RFR =1. Number of female calves is more than that of male when RFR >1. Number of male calves is more than that of female when RFR <1 (Yilmaz *et al*., 2010).

2.3 Statistical analysis

The collected data was subjected to statistical analysis using a Microsoft Excel-based data analysis tool pack for descriptive statistics. All data were expressed as the mean ± standard error of the mean (SEM). Graphical presentations were made using GraphPad Prism Software version 5.0 (San Diego, CA, USA). In all analyses, significant differences were considered at values of $P<0.05$.

3. Results and Discussion

Out of three seasons summer witnessed only 7.88% of total calf crop followed by winter with 41.89% and monsoon season accounting for more than 50% of calf births (Table 1). The results agree with the general trend of seasonality in buffalo breeding (Misra and Sengupta, 1965). The results are also in alignment with buffalo calf birth patterns reported earlier (Prasad *et al*., 2014) [4]. During all three seasons the SSR remained stable as depicted in Fig. 1. When the calving pattern is further analysed was found that 83.55% of calf births took place between August to January (6 months) while the remaining period accounted for 16.45% of calf births only (Table 2). Monsoon months of September and October and early winter of November i.e., a quarter of the year is witnessed 49.33% of the calf birth. While the summer months witnessed less than 10% of total calvings. The findings of the study agreed with the earlier reports (Kaygisiz *et al*., 2003 [9] in Holstein cattle and Mukherjee *et al*., 2000 [15] in Karan Swiss cows), who reported that no significant differences between calving year and sex. During different months i.e., July to March, the RFR was maintained between 0.62 to 1.14 as the total calf crop was 10 or above (Table 2). During the months of lower calving rates, the RFR varied considerably (0.25-2.00). This indicates that RFR number is stable with highest number of calvings and with lesser calvings the RFR had a tendency of skewing. The results were depicted in Fig. 2, in terms SSR percentage during different months during the period of study. Of the observed 12 years, out of 444 calves crop the least number was observed during the year 2015 i.e., 2.70% against the average of 8.33% and the highest calf crop was observed during 2022 i.e., 13.74% (Table 3). The annual variation is largely because of cullings, introductions and scientific interventions made during that specific year. The RFR remained uniform throughout the period except 2015 when the number of calvings was minimum (n=12) as against the average of 37 (Table 3).

It was observed that the birth weight remained unaffected by season. Over the 12 years of period under investigation there is a constant trend of increasing birth weight which is an indicative of strengthening of farm management. This trend is observed in birth weight of both male and female calves. Among male and female calves there is a tendency of female calves recording highest birth weights except three years, 2011, 2018 and 2019 when average birth weights of male calves were higher compared to females (Fig. 3). However, the difference between male and female birth weights was found to be statistically insignificant. These results are differed from the findings of Mahmood and his co-workers (2022) in Niliravi buffaloes, who reported that male calves weighed more than female calves and Perumal *et al*. (2019) [17] also reported crossbred male calves weighed higher compared to female calves. The seasonal effect on birth weights shown in table 3. During summer months the male calves weighed more than female calves whereas during monsoon and winter, female calves recorded female calves recorded higher birth weights and the overall average birth weight of female calves was higher than male calves. However, the birth weight differences are non-significant.

Table 1: Season-wise calf births, birth weights and secondary sex ratio (SSR) in Murrah buffalo calves during 2011-2022.

Month	Sex-wise frequency				Total		RFR	SSR	Birth weight (Kg)		
	Male		Female						Male	Female	Average
	n	%	n	%	n	%					
Summer	17	48.57	18	51.43	35	7.88	1.06	1:1.06	31.35± 0.72	29.39± 0.75	30.34± 0.54
Monsoon	112	50.22	111	49.78	223	50.23	0.99	1:0.99	29.59± 0.42	29.90± 0.42	29.74± 0.29
Winter	105	56.45	81	43.55	186	41.89	0.77	1:0.77	28.85± 0.57	30.16± 0.49	29.42± 0.39
	234	52.70	210	47.30	444	100.00	0.90	1:0.90	29.38± 0.33	29.96± 0.30	29.67± 0.31

Table 2: Month-wise calf births, birth weights and secondary sex ratio (SSR) in Murrah buffalo calves during 2011-2022.

Month	Sex-wise frequency				Total calf crop		RFR	SSR	Birth weight (Kg)		
	Male		Female						Male	Female	Average
	n	%	n	%	n	%					
January	29	61.70	18	38.30	47	10.59	0.62	1:0.62	27.66± 1.26	29.44± 0.95	28.34± 0.86
February	9	47.37	10	52.63	19	4.28	1.11	1:1.11	28.33± 1.48	30.40± 1.73	29.42± 1.15
March	7	46.67	8	53.33	15	3.38	1.14	1:1.14	30.29± 1.38	28.38± 1.15	29.27± 0.89
April	4	80.00	1	20.00	5	1.13	0.25	1:0.25	33.00± 0.71	27.00± 0.00	31.8± 1.32
May	3	33.33	6	66.67	9	2.03	2.00	1:2.00	33.67± 0.67	31.33± 1.41	32.11± 1.01
June	3	50.00	3	50.00	6	1.35	1.00	1:1.00	29.33± 0.88	29.00± 0.58	29.17± 0.48
July	9	47.37	10	52.63	19	4.28	1.11	1:1.11	30.56± 1.37	32.80± 1.55	31.74± 1.05
August	26	47.27	29	52.73	55	12.39	1.12	1:1.12	29.69± 0.47	30.48± 0.77	30.11± 0.46
September	40	52.63	36	47.37	76	17.12	0.90	1:0.90	29.25± 0.77	28.58±0.68	28.93± 0.52
October	37	50.68	36	49.32	73	16.44	0.97	1:0.97	29.65± 0.84	29.94± 0.74	29.79± 0.56
November	41	58.57	29	41.43	70	15.77	0.71	1:0.71	29.32± 0.78	31.03± 0.82	30.03± 0.57
December	26	52.00	24	48.00	50	11.26	0.92	1:0.92	29.62± 1.29	29.54± 0.84	29.58± 0.77
	234	52.70	210	47.30	444	100.00	0.90	1:0.90	29.38± 0.33	29.96± 0.30	29.67± 0.31

Table 3: Yearly calving patterns in Murrah buffaloes, birth weights and secondary sex ratio (SSR) during 2011-2022.

Month	Sex-wise frequency				Total calf crop		RFR	SSR	Birth weight (Kg)		
	Male		Female						Male	Female	Average
	n	%	n	%	n	%					
2011	13	56.52	10	43.48	23	5.18	0.77	1:0.77	28.69± 0.66	27.80± 0.77	28.3± 0.50
2012	20	47.62	22	52.38	42	9.46	1.10	1:1.10	27.50± 0.91	28.77± 0.69	28.17± 0.56
2013	11	47.83	12	52.17	23	5.18	1.09	1:1.09	26.55± 0.88	28.00± 0.77	27.3± 0.59
2014	8	53.33	7	46.67	15	3.38	0.88	1:0.88	24.63± 0.92	27.71± 1.11	26.07± 0.80
2015	8	66.67	4	33.33	12	2.70	0.50	1:0.50	27.88± 1.54	30.25± 3.07	28.67± 1.41
2016	20	51.28	19	48.72	39	8.78	0.95	1:0.95	26.85± 1.32	31.26± 1.24	29.00± 0.96
2017	22	51.16	21	48.84	43	9.68	0.95	1:0.95	29.82± 1.28	30.05± 0.97	29.93± 0.80
2018	31	55.36	25	44.64	56	12.61	0.81	1:0.81	31.87± 0.86	29.16± 1.14	30.66± 0.71
2019	14	56.00	11	44.00	25	5.63	0.79	1:0.79	31.21± 0.80	29.36± 1.06	30.4± 0.66
2020	28	49.12	29	50.88	57	12.84	1.04	1:1.04	28.64± 1.07	30.24± 0.64	29.46± 0.62
2021	25	52.08	23	47.92	48	10.81	0.92	1:0.92	30.24± 1.05	30.78± 0.75	30.5± 0.65
2022	34	55.74	27	44.26	61	13.74	0.79	1:0.79	31.32± 0.77	32.11± 0.88	31.67± 0.58
	234	52.70	210	47.30	444	100.00	0.90	1:0.90	29.38± 0.33	29.96± 0.30	29.67± 0.31

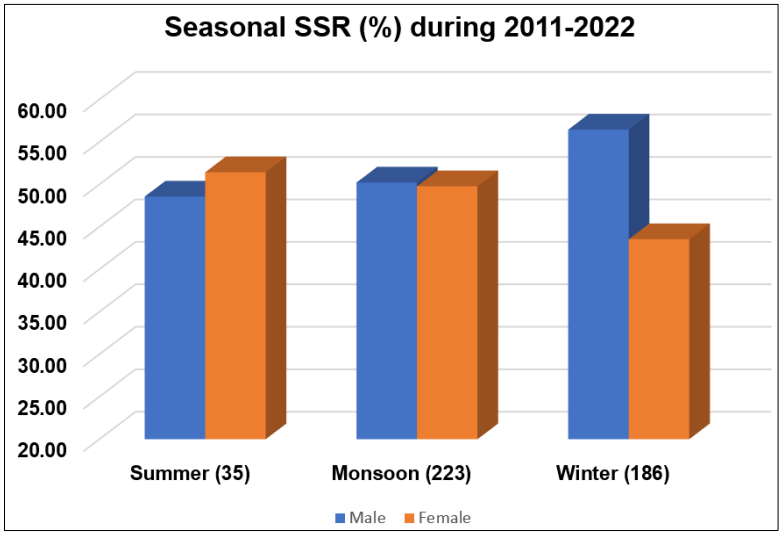

Fig 1: Seasonal secondary-sex ratio (SSR) of Murrah buffalo calves born during the period of 2011-2022.

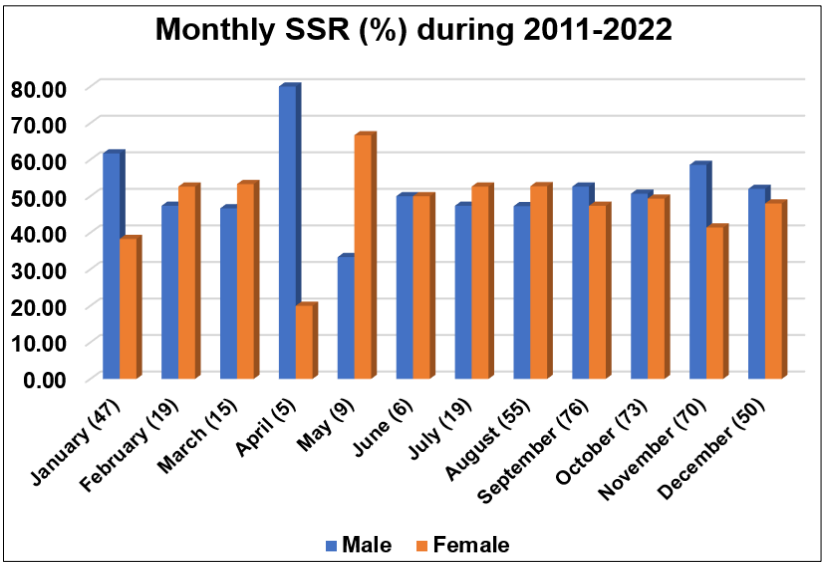

Fig 2: Monthly secondary-sex ratio (SSR) of Murrah buffalo calves born during the period of 2011-2022 (Number of calves born in a particular month is mentioned in the parenthesis followed by that month).

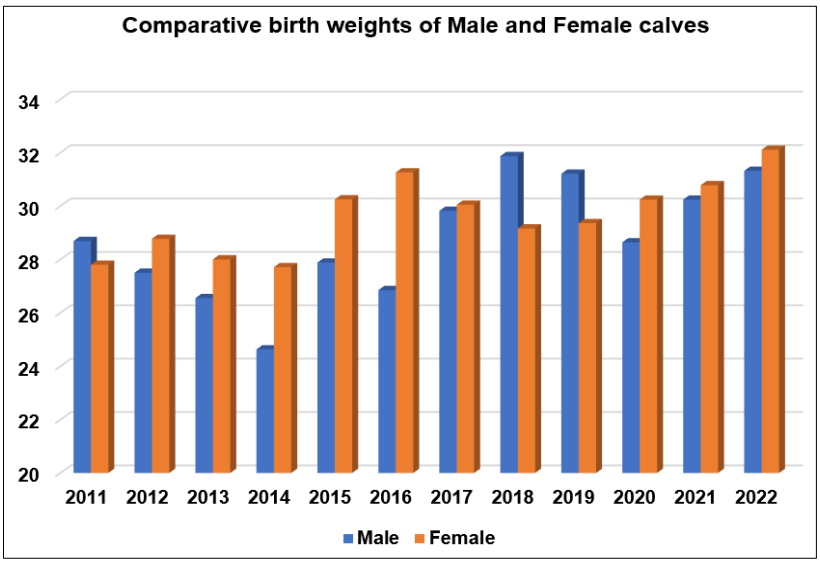

Fig 3: Comparative birth weights of male and female Murrah buffalo calves born during the period of 2011-2022.

4. Conclusion

Distribution of calvings during different months of year play crucial role in seasonal milk production. Understanding the seasonal impact on birthweights would help the breeders to prepare for taking additional care in case poor birth weights. Studying the existing calving trend would help breeders to alter the calving pattern involving better management practices and assisted reproductive technologies to produce milk as per the market demand. The present study confirmed that male and female calves will be born in equal proportion. Hence, calf rearing/ calf disposal plans can be made in advance.

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6. Conflict of Interest

The authors declare that there is no conflict of interest.

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