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The Water Buffalo - A Poly-oestrous Animal

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1 Introduction

The fertility of farm animals did not have the same meaning in the past as it has become in the last three decades. The focus of interest was on economic production of the animal and the fields which are directly associated with this. In developing countries however, discussion about farm animal fertility in scientific circles has started, whereby in case of the buffalo, the apparent seasonal nature of calving and the corresponding conception time form the centre of discussion. Similarly in Punjab-Pakistan, where the present study was carried out, seasonal occurence of calving was observed, which leads to the question whether the water buffalo is a poly-oestrous animal with a heat cycle being directed by environmental conditions.

2 General Effects of Enviroment and Nutrition on Fertility

Fertility is the reproductive capacity of an animal. In European high production animals the documented hereditary values for the parameter fertility are nearly equal to zero, which means that the observed fertility is determined only by environmental conditions and the production level (Rieck, 1980). However when the farming conditions are adverse and the management is poor, a clear genetic variance of up to 23% is observed (Hahn, 1967). A normal fertility can be defined as regular production of viable offspring.

Reduced fertility leads to economic losses like:

- Extension of the first-calving age and the intercalving periods,
- Reduction of calving rate,
- Reduction of the genetic development through limitation of selection possibilities (Zeddies, 1976).

The extreme weather conditions in tropical and subtropical countries have a negative effect on many physiological values of the animals. Heat stress elevates the breathing and pulse frequency as well as the body temperature and changes the electrolyte balance. This results in silent heat, reduced milk yield and feed intake.

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Some major problems of buffalo reproduction are silent heat, anoestrus and sterility which leads to major economic losses. The main reasons for weak heat expression, silent heat and sterility are: the tendency to seasonality of the sexual activity, unsuitable or substandard feeding, functional defects of ovaries, decreased function of the glands of sexual hormones and infection of the sexual organs (ZEDDIES, 1976).

Goswami et al. (1965) compared the conception data of 8742 and the calving values of 10690 buffalo cows from different regions of India over five years with the respective climatic conditions i.e. air temperature and relative humidity. They found that climatic factors do influence conception- and consequently calving-periods. The results could be summarised as follows:

- The number of conceptions per buffalo cow increased with decreasing air temperature and vice versa,
- With decreasing humidity and low temperature the number of conceptions increases and vice versa,
- By high ambient temperature associated with high air humidity, a great number of calvings could be observed.

The authors admitted that low air temperatures accompanied with low relative humidity induced conceptions in buffaloes.

Schmidt (1966) administered iodine and the oestrus reaction of Egyptian buffaloes was raised from 42% to 85% relative to the control group. Iodine is needed for the synthesis of thyroxine in the thyroid gland and activates the production of gonadotropin. If the release of thyroxine is reduced due to high temperature, as in summer, the iodine cannot activate the production of gonadotropin. In this way, high environmental temperatures reduce the heat symptoms (SCHMIDT,1966).

In hot months a distinct reduction in function of the suprarenal glands was observed (PARAMESWARAN et al. 1979). Coupled with high humidity, high temperature causes a negative effect on conception rates (GOSWAMI AND NAIR, 1964). Different methods can be applied to reduce the body temperature e. g. spraying the animals with water or bathing and hence the heat detection and conception rates can be increased (GANGWAR, 1982). Apart from improved rearing conditions through cooling in summer, intensive measures for heat detection and -control have to be applied in order to reach an equally good fertility rate in summer as in winter (ROY et al., 1968).

Saxer (1956) concluded from his studies on cattle (*Bos taurus*) that the amount of rainfall during the growing period of feed crops plays an important role for the cow's ability to conceive. The amount of rainfall and the conception level occur in parallel over several years. The feeding of feeds grown in dry periods often leads to considerable fertility disturbances, which is attributed to too low phosphorus intake by the plants which eventually leads to disturbance in the Ca/P ratio of the feed.

3 Reproduction

The rhythms of reproductive functions are inborn and their properties are dependent on the inducing or inhibiting effect of exogenous factors (JÖCKLE, 1966). In case of buffalo cows, the adequate heat detection represents a considerable problem in comparison to cattle: the external heat symptons are often weak, so that it is essential to resort to helping aids like rectal examination, smear preparation of the cervix epithelial layer and marker bulls, in order to recognise the heat period of buffalo cows (ROY et al., 1968). The duration of heat ranges between 12 to 28 hours (Table 1).

Table 1: Length of the heat period in Water Buffaloes

Length of Mating Period	n	Authors
28.47 hr	31	Hafez (1954)
11.92 hr	30	Shalash (1958)
13.42 hr	n. a.	El-Sheik and El-Fouly (1971)
17.65 hr	112	Gill et al. (1973)
24.18 hr	40	Rao et al. (1982)
26.18 hr	230	Patel and Sarma (1982)

n: number of animals studied; n. a.: not available; hr: hour

The gestation period takes an average of 305 days according to Bode (1989). This figure was determined in a field study on 1155 milk buffalo cows. The length of intercalving period (ICP) in water buffaloes depends on the time of year and the prevailing climatic conditions at calving time. Naidu (1983) reported that calvings from August-October were followed by shorter ICP (average 418 days) than calvings from November-April (average ICP 525 days). Through improvement in management like observation of the sexual cycle and accurate heat detection, the ICP could be considerably reduced (NAIDU, 1983).

The length of the service period (time between calving and first heat) also depends on the climatic conditions in the month of calving (VENKAYYA AND ANANTAKRISHNAN, 1966). Studies of Murrah-buffaloes showed, that cows calving in July on average had the shortest service period (120.8 days), whereas those calving in February exhibited the longest service period with 241,2 days on average (BASU, 1962).

4 Conception Rates

The fertility status of milk buffaloes changes from month to month (Table 2). It is expressed in the varying conception- and calving rates over the year.Bhat (1979) investigated the percentage of Murrah-buffaloes in heat per month as well as their monthly conception rates (%) over a year (Table 2). According to his results the smallest number of buffaloes in heat was seen in April and the lowest conception rates were observed in June.The best results were recorded in October/November.

Table 2: Monthly incidence of Heat and Conception Rate in Percentage in Murrah-Buffaloes (BHAT, 1979)

Month	% in heat	conception rate (%)
January	8.8	26.0
February	8.2	26.2
March	7.2	23.6
April	5.9	19.6
May	7.3	25.0
June	7.4	16.2
July	7.0	17.3
August	7.2	18.2
September	8.1	21.2
October	13.3	24.3
November	10.3	28.3
December	9.2	24.9
	Σ 99.9	

Table 3: Yearly distribution of 924 calvings in average size Surti-buffaloes (GOVINDAIAH and RAI, 1986)

Month	Number of Calvings	Calvings (%)
January	73	7.9
February	46	5.0
March	70	7.6
April	39	4.2
May	25	2.7
June	35	3.8
July	51	5.5
August	63	6.8
September	104	11.2
October	148	16.0
November	142	15.4
December	128	13.8
Σ	924	99.9

5 Calving Frequency

Govindaiah and Rai (1986) collected data on the yearly distributions of calvings in Surti-buffaloes (% per month) between 1971 and 1979 (Table 3). They reported lowest values in May and the highest in October.

6 The Present Study

This study is part of a Research Project undertaken by the European Union (EU) within the frame of an Animal Production Project of the German Technical Cooperation (GTZ) in the province of Punjab, north east Pakistan. Punjab is the centre of the Pakistani agriculture. The greater part of the agriculturally tillable land of Pakistan is found in this province, in which the worlds largest irrigation canal system is at disposal. The cultivation of the land lies primarily in the hand of small farmers, who predominantly grow commercial crops like wheat, rice, cotton and sugar cane. Animal husbandry is given comparatively low importance since the marketing structures of the rural areas are poorly developed and hence motivation to intensify the production is low. Among the large ruminants, the milk buffaloes are most commonly reared (more than 90%) with the "Nili-Ravi" being the dominant breed. Considering the prevailing conditions in Punjab these buffaloes are good milk producers. According to results of the project, Nili-Ravi buffaloes produce on average 5.9 litres of milk per cow and day with 7% fat (TER MEULEN AND NOTHELLE, 1993).

The collection of data on conception- and calving rate was performed by veterinarians in the project area over a period of one year. Data was collected from a total of 1.349 buffalo cows. The conception time was determined by rectal examination of ovaries and uterus, as well as by determination of the progesteron content in the blood serum of the cows.

7 Results and Discussion

Figure 1 shows conception rate and calving frequency in percentage per month. A total of 1.155 buffalo cows was examined to obtain these data. From the time of the poorest conception rates (May/June) to the "breeding season" in September-December the fertility improves consistently. This development corresponds with the steadily improving nutritional and climatic conditions under which the animals are kept.

Thibault and Levasseur (1974) are of the opinion that the seasonal nature of sexual activity appears in nearly all mammals. However, due to the degree of breeding and prevailing environmental conditions, this seasonal nature is usually masked. These authors give the months of June for the minimum- and November for maximum fertility. This finding tallies to some extent with the result of the present study. According to Thibault and Levasseur (1974) the photoperiod is responsible for the seasonality with special reference to length of daylight, since this parameter - different from temperature and feeding - turns out to be axactly the same every year at the same time of the year. Nothelle (1992) argued that the exclusive dependence of fertility on light periods can not be confirmed in this study where also the correlation between fertility and feeding was investigated. Though amount and quality of feed is determined by the time of year, it is not only determined by hours of daylight, but also by other climatic factors such as

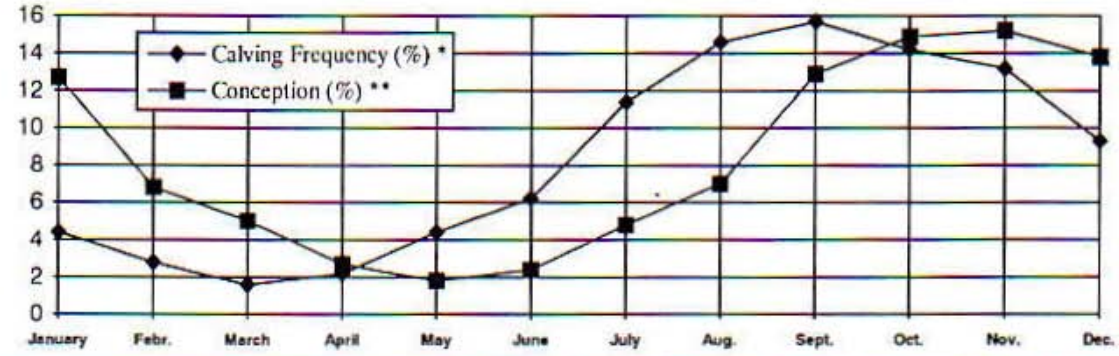
humidity and temperature.

Thibault and Levasseur (1974) considered temperature only as a factor which influences the seasonal nature of fertility when it exceeds the range of the organism's thermoregulatory ability to maintain the body's temperature stable. But also here the feeding has to be considered. Poor feed quality leads to unnecessary elevation of the endogenous heat production of the animal: the point is reached faster where the surrounding temperature exceeds the thermoregulatory ability of the animal in comparison to a feeding which is optimally adjusted to the climatic conditions and the requirement of the animal. The feeding, which is expressed in the instantaneous physiological condition, plays a key role on the degree to which the climatic influence on the single animal is expressed (SADLEIR, 1969).

In India Arora (1987) compared the oestrous behaviour expressed by two groups of buffaloes fed on different diets. He concluded that the group fed on the standard ration for a whole year had a considerably more balanced heat frequency than the group offered a deficient feed. The latter group not only exhibited a low number of animals in heat per month but also displayed changing frequencies of animals in heat per month, with an absolute minimum in the months of June and July. In the group fed on standard diet only two main levels could be identified: from March through to June the frequencies proved at 80% lower than for the rest of the months with values around 100%. Thus, through balanced feeding, the monthly strongly varying number of buffaloes in heat was levelled and the seasonal impact was counterbalanced.

Not to be neglected is the specific influence of the nutrition on the fecundity of buffalo bulls. Low protein and energy supply reduce sperm volume, motility and concentration as well as libido (MAKSIMANKTO, 1973; SAMPATH and KUMAR, 1975) which all affect the conception rate negatively. The prolificacy of the buffalo cows should therefore not be regarded alone. Also our investigation shows, that a close relationship exists between feeding and fertility.

Our results on conception and calving frequency obtained in the area of investigation expressed in percent per month clearly demonstrated a tendency to seasonality with low values in March and May and peaks in September and November. The simultaneous observations of the feeding practices in the project area (NOTHELLE, 1992) however show, that also here periods of deficiency change with periods of more balanced feeding, though it never reached an optimal level. A certain seasonality in sexual activity as described by Thibault and Levasseur (1974), is probably also given among buffaloes, though oestrous is observed throughout the year. The water buffalo is a poly-oestrous animal with a sexual cycle regularly recurring throughout the year. Only in specific months the sexual activity is lower. This sexual behaviour of the buffaloes in the area studied is gradually inhibited by poor husbandry, poor management and by unbalanced feeding and unfavourable climatic conditions which further impede an optimal nutrient supply.



*4.4	2.8	1.6	2.2	4.4	6.2	11.4	14.6	15.7	14.2	13.2	9.3
**12.7	6.8	5.0	2.7	1.8	2.4	4.8	7.0	12.9	14.9	15.2	13.8

Figure 1: Conception- and Calving-frequency per Month in Percent (n=1155 animals)

8 Abstract

The conception rate and calving percentage of Nili-Ravi milk buffaloes were investigated over an one year period in the Punjab region of Pakistan. The results show prominent fluctuations over the year with absolute minima in March (calving-percentage 1.6%) and May (conception-rate 1.8%) and maxima in September (calving-percentage 15.7%) and in November (conception-rate 15.2%). These low and high points correspond with unfavourable respective favourable climatic conditions, also the common feeding situation (NOTHELLE, 1992) is better in autumn than in spring. Thibault and Levasseur (1974) believe that there is an inborn seasonal nature of sexual activity for nearly all mammals.This principle surely also applies to the milk buffaloes although it is confirmed in this study that the buffalo cow is a poly-oestrous animal with a regular sexual cycle all the year round. Through controlled breeding, nutrition and good management, it is possible to compensate for the fluctuations of conception rate and calving percentage over the entire year.

Der Wasserbüffel - ein polyöstrisches Tier

Zusammenfassung

Die Konzeptions- und Kalbehäufigkeit von Nili-Ravi-Milchbüffeln des Punjabs (Pakistan) wurde in der vorliegenden Veröffentlichung untersucht. Es zeigen sich starke Schwankungen über das Jahr mit Tiefpunkten im März (Kalbehäufigkeit: 1,6%) bzw. im Mai (Konzeptionshäufigkeit: 1,8%) und Höhepunkte im September (Kalbehäufigkeit: 15,7%) bzw. im November (Konzeptionshäufigkeit: 15,2%). Diese Gegebenheiten fallen zusammen mit ungünstigen bzw. günstigen Bedingungen in Bezug auf Fütterung (NOTHELLE, 1992) und Klima, die im Herbst besser sind als im Frühjahr. Es gibt nach Thibault und Levasseur (1974) eine angeborene Saisonalität der sexuellen Aktivität für fast alle Säugetiere, die auch für den Milchbüffel zutrifft. Die Büffelkuh ist ein

polyöstrisches Tier, dessen Zyklus regelmäßig wiederkehrt. Über Zucht, Fütterung und Management kann man die Schwankungen in Bezug auf Konzeptions- und Kalbehäufigkeit annähernd über das ganze Jahr ausgleichen.

9 Acknowledgement

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9 References

1 Arora, S.P.: Nutritional deficiencies in relation to fertility in buffaloes. Proc. Int. Symp. Milk Buff. Reprod., Islamabad, Pakistan, Vol II, (1987) 506.

2 Basu, S.: Seasonal variation of fertility in Murrah buffaloes. Indian Vet. 39 (1962) 433.

3 Bhat, P.N.: Genetic parameters of milk production and scope of increasing milk production in buffaloes vis-a-vis cattle. Proc. Seminar Buffalo Reprod. and A.I., FAO/SIDA, Govt. of India, Karnal, (1979) 129.

4 Bode, V.: Ernährungs- und managementbedingte Einflüsse auf das Fruchtbarkeitsgeschehen bei Nili-Ravi-Büffeln im Punjab / Pakistan. Vet Med. Diss., Berlin (1989).

5 El-Sheik, A.S., El-Fouly, M.A.: Estrus, estrus cycle and time of ovulation in a herd of buffalo heifers. Alex. J. Agric. Res. 19 1. A.B.A. 40 (1971) 687

6 Gangwar, P.C.: Effect of spray cooling and wallowing on potassium concentration of erythrocytes in buffaloes during summer. J. Agric. Sci. Camb. 99 (1982) 373.

7 Gill, R.S.; Gangwar, P C; Kooner, J.: Studies on oestrus behaviour in buffaloes. Indian J. Anim Sci. 43 (1973) 472.

8 Goswami, S.B., Nair, A P.: Effect of some climatological factors on reproduction of buffaloes. Indian J. Vet. Sci. 34 (1964) 127.

9 Goswami, S.B., Luktuke, Nair, A.P.: Effect of artificial cool air temperature on reproductive behaviour and some physiological norms of the Indian water buffalo. Indian Vet. J. 42 (1965) 410.

10 Govindaiah, M.G., Rai, A V.: Effect of month of calving on lactation parameters in Surti buffaloes. Indian J. Dairy Sci. 39 (1986) 227

11 Hafez, E.S.E.: Oestrus and some related phenomena in the buffalo. J. Agric. Sci. Camb. 44 (1954) 165.

12 Hahn, J.: Untersuchungen zur Fruchtbarkeit des Rindes. Schaper Verlag Hannover (1967).

13 Jöckle, W.: The circadian rhythm in female reproduction, in: Lamming/Amoroso „Proceedings of Reproduction in the Female Mammal", London (1966).

14 Maksimankto, V.F.: Effect of level of protein feeding on semen production of Yaroshavl bulls. A.B.A. 41 (1973) 120.

15 Naidu, K.N.: Effect of season of calving on the subsequent reproductive behaviour in buffaloes. Indian Vet. J. 60 (1983) 34.

16 Nothelle, G.: Einfluß der Fütterung auf das Fruchtbarkeitsgeschehen beim weiblichen Nili-Ravi-Büffel in der Provinz Punjab, Pakistan, Diss. FB Agrarwissenschaften, Göttingen (1992).

17 Parameswaran, M.; Desai; Janakiraman: Biochemical profile of the adrenal in buffalo in relation to reproductive performance. Indian J. Anim. Sci. 13 (1979) 63.

18 Patel, J.M.; Sarma P A.: Note on oestrus behaviour during winter in buffaloes. Indian J. Anim. Sci. 52 (1982) 437.

19 Rao, V.P.; Reddy; Gopalakrishna: Note on oestrus, oestrus cycle and time of ovulation in Murrah buffaloes. Indian J. Anim. Sci. 52 (1982) 354.

20 Rieck, G.W.: Konstitution - Adaptationsleistung, Krankheitsresistenz, Krankheitsdisposition. In: Comberg „Tierzüchtungslehre",Stuttgart, 3. Auflage (1980).

21 Roy, A., Raizada., B C., Tewari., R.B.L., Pandey., M D., Sengupta, B.P . Effect of management on the fertility of buffalo cows bred during summer. India J. Vet. Sci. 38 (1968) 554.

22 Sadleir, E.: The ecology of reproduction, London (1969).

23 Sampath, S.R.; Kumar, M.N.A.: Semen quality in relation to the nutrition of bulls. India J. Dairy Sci. 28 (1975) 940.

24 Saxer, M.: Erhebungen über fütterungsbedingte Fruchtbarkeitsstörungen bei Rindern auf zwei Jurabetrieben, Diss. Bern (1956).

25 Schmidt, K.: Ovariell bedingte Infertilität des ägyptischen Wasserbüffels. Zuchthygiene 1 (1966) 125 und 145.

26 Shalash, M.R.: Physiology of reproduction in the buffalo cow. Int. J. Fertil. 3 (1958) 425.

27 ter Meulen, U., Nothelle, G.: The nutritional feed supply of the Nili-Ravi-Buffalo in the irrigated area of the Punjab/Pakistan and possibilities for improvement. Poc. Soc. Nutr., 1 (1993) 68

28 Thibault, C.H.; Levasseur M.C.: Reproduction Life Cycle in: HAFEZ «Reproduction in farm animals». Philadelphia (1974).

29 Venkayya, D.; Anantakrishnan C.P.: Effect of season of calving on the length of service period in Murrah buffaloes. Indian J. Dairy Sci. 19 (1966) 1.

30 Zeddies, J.: Der wirtschaftliche Wert der Fruchtbarkeit. 6. Hülsenberger Gespräche (1976).