Can we consider buffalo a non precocious and hypofertile species?

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ABSTRACT: Several authors recorded that buffalo shows delayed first calving age and a long intercalving period. In this lecture are reported some studies which demonstrate that, if the nutritional requirements throughout growing are ensured and the culling rate is reasonable, the first calving age and the intercalving period are similar to those recorded in dairy cattle. It is worth pointing out that these conclusions come from trials performed in farms, where the out of breeding season mating technique is applied, and, hence, the fertility is affected, because mating is limited to 8 months out of 12.

INTRODUCTION - Several authors recorded that buffalo shows delayed first calving age and a long intercalving period (IP). Although buffalo is irreplaceable in tropical zones, these considerations reduce its productive potentiality. Rakshe (2003) referred that the average age at first calving observed in Surti, Murrha (Delhi) and cross-Breed heifers is 4 years-1 month-15 days, 4 years-4 months-13 days and 4 years-2 months-21 days respectively with the average weights of 409, 435 and 401 Kg respectively. Patro et al. (2003) referred that in Chilika buffaloes in Orissa the average age at first calving varies between 1312 and 1407 days (mean = 1331). In Romania the average age at first calving is between 38 and 42 months (Buffalo population and production in Romania - Internet), while a mean age of 1335.86±128.46 days (3 years, 7 months and 28 days) was recorded in lactating buffaloes in Italy in 1975 (Zicarelli et al., 1977). In a recent study performed in 86 farms that involved 30,753 primiparous buffaloes, which calved between 1975 and 2005, it was observed that the mean age at first calving lowered by 1 month every 5 years (44.7±6.6 and 35.3±6.46 respectively in 1975 and 2005; Figure 1). This results confirm that the delayed age at first calving is not a characteristic of the species, but it depends on the management of the growing animals.

In a previous paper presented in Columbia (Zicarelli, 2006), I reported that the time required by the new-born for doubling its weight at birth in the majority of the domestic
species is indirectly correlated to the protein, fat and ash content of the milk, to the lactose/fat ratio and to the energetic value but directly correlated to the lactose content and the fat/protein ratio of the milk. Buffalo calf represents an exception because, despite a more concentrated milk, for doubling the weight at birth (48 days), it takes more than double the time and the same time required respectively by the kind (22 days) and the bovine calf (48 days). The assumption of 872.7 g of dry matter of buffalo milk corresponds to the content in energy, protein, Ca and P of 1 Kg of dry matter (DM) of bovine milk and to a greater quantity of the colloidal forms of the two minerals. From this confrontation derives that, having buffalo and bovine calf the same growing rate, the ingestion of DM of the first throughout the suckling phase (before weaning) should be lower.

Recent experiences showed that between 130 and 400 Kg of live weight (LW), subjects intake a quantity of DM that increases up to 2.7% of LW until 200 Kg and then decreases progressively to less than 2% of the LW at approximately 400 Kg. The DM intake was reported to be similar, in absolute value, to that of bovine but slightly higher if calculated as percentage of the LW up to 300 kg; on the contrary, starting from 300 Kg the intake in buffalo is higher than in bovine both as absolute value and as a percentage. Despite the higher intake registered between 130 and 300 Kg the growing rate in buffalo, even with diets characterized by 0.85-0.9 MFU/Kg DM, is 600-850 g/day, whereas in beef breeds of cattle fed diets less concentrated is ~1 Kg/day. The lower increase registered in buffalo vs. cattle from weaning to 300 Kg, despite a similar or higher DM intake, might be due to the composition of DM of the utilized diet that is inadequate to support the nutritional requirements during this phase of development. In our opinion, the higher DM intake of buffalo calf during the growing phase depends on the necessity to achieve a body status optimal for that age, that it could not be reached because of the delay related to the lower intake of DM and to the lower growing rate between birth and 200 kg of LW. This explains why a higher energetic density is required in buffalo to obtain performances significantly lower than cattle when “artificial” feeding replaces milk and natural weaning.

In buffalo the lower efficiency in growing rate in the period that should be of compensatory growth is due, in our opinion, to the characteristics of the DM utilized, that is inadequate for replacing the maternal milk and/or the mixed diet (maternal milk and forage) that buffalo assumes during natural weaning. Furthermore, it is worth considering that the achievement of a body status typical of that age requires the compensation of the quantity of body lipids (increase of body lipids storage) that, in subjects with delayed growth, was not accumulated and this implies higher values of the feed conversion index. These observations account for the necessity to utilize diets more concentrated in energy compared to bovine, for anticipating the age at first calving in buffalo (Zicarelli et al., 2005).

Breeding of dairy female calves in buffalo presents some problems that can not be solved by deriving information from researches performed in cattle. The characteristics of buffalo milk and the low DM intake of buffalo calves during the first months of age lead to delayed growth in intensive breeding systems. The subsequent regain of weight can be achieved, according to our recent experiences, only if we give a DM with nutritional characteristics that seem excessive with respect to the growth obtainable.

A further confirmation to this hypothesis arose from the results of a recent trial, during which emerged that the administration of a diet characterized by 0.9 MFU/Kg DM ad libitum ensures a daily body weight gain (DWG) of 797 g from the birth until 400 kg, only if it
is received before 148 days of age. On the contrary, a DWG of 680 g is obtained if the diet is administered after 200 days of age (table 1), similarly to that observed in a previous study (Zicarelli et al., 2005). After 350 kg of LW DM intake becomes steady. This phenomenon explains the lack of a compensatory offsetting DWG, that is usually observed in cattle.

It has been previously reported (Zicarelli and Gasparrini, 2004; Zicarelli, 2004) that the administration of a diet characterized by 0.8 MFU/kg DM and 12.5% crude protein on DM in weaned female buffalo calves for 1, 2 or 3 years allowed that 20%, 42.2% and 65.3% of animals respectively showed an age at first calving lower than three years.

Table 1. Age (days) at which the subjects reached 400 kg of live weight and daily body weight gain (DWG) from birth, in relation to the start of the diet characterized by 0.9 MFU/kg DM.

| Starting (days) of diet administration | 148 | 218 | 302 | 320 | 374 | 596 |
|---------------------------------------|-----|-----|-----|-----|-----|-----|
| Age (days)                            | 458 | 540 | 568 | 618 | 619 | 636 |
| DWG (kg)                              | 0.797<sup>A</sup> | 0.676<sup>B</sup> | 0.643<sup>C</sup> | 0.590<sup>D</sup> | 0.590<sup>D</sup> | 0.574<sup>D</sup> |

Figure 2. Percentages (%) and cumulative percentages (% cumulative) of animals which delivered at different ages.

In the last 5 years the survey was expanded and an age at first calving of 973.62±163.63 days (C.V.=16.82%) was recorded in 953 primiparous buffaloes (Table 2; Figure 2) bred in a farm localized in South Italy (Caserta Province). In this study, 83.11 and 95.17% of animals delivered within 3 or 3.5 years, respectively. Less than 5% of buffaloes delivered between 3.5 and 6 years.
It is worth pointing out that the mean age of 32 months (973.62 days) is affected by the adoption of the out of breeding season mating (OBSM) technique, consisting in the separation of the females from the bulls from the end of August until the middle of the following March. For this reason, the animals that reach puberty after August have to wait for the following March in order to become pregnant. Obviously, this aspect causes a delay of the age at first calving. It is therefore reasonable that, if mating is allowed throughout the year,

| Days | Years | N  | %     | % cumulative |
|------|-------|----|-------|--------------|
| < 730 | < 2   | 17 | 1.78  |              |
| 912.5 | 2-2.5 | 332| 34.84 | 36.62        |
| 1095 | 2.5-3 | 443| 46.48 | 83.11        |
| 1277.5 | 3-3.5 | 115| 12.07 | 95.17        |
| 1460 | 3.5-4 | 34 | 3.57  | 98.74        |
| 1642.5 | 4-4.5 | 6  | 0.63  | 99.37        |
| 1825 | 4.5-5 | 4  | 0.42  | 99.79        |
| 2007.5 | 5-5.5 | 1  | 0.10  | 99.90        |
| 2190 | 5.5-6 | 1  | 0.10  | 100.00       |

953 100

Figure 3. Real and estimated values of milk production (q) in first lactation in function of the age (days) at first calving.
the age at first calving of Italian Mediterranean buffalo cow, fed with a diet characterized by 0.8-0.85 MFU/kg DM, would be similar to that recorded in dairy cattle bred in Italy. However, the age at first calving affects milk production during the first lactation, according to following equation:

\[
\text{Milk quantity during first lactation} = -19.802 + 0.102 \times \text{age at first calving} - 0.0000793 \times \text{age at first calving}^2 + 0.0000000205 \times \text{age at first calving}^3.
\]

From this calculation, it is evident that the anticipation of the age at first calving causes a reduction of 16.3 kg/lactation for each month ahead, compared with an age of 1342 days (44 months). On the contrary, no relationships were found between the age at first calving and milk production in 2nd and 3rd lactation (Figure 4).

If the production cost of the heifer with different first calving age is detracted from the income obtained by production [net income = (income from milk production – cost up to age at first calving) + (cost of feeding during lactation x 2)], it results that the income is directly correlated with the beginning of production (Figure 5).

Furthermore, anticipating the age at first calving favours an early evaluation of the subjects and, hence, of the bulls used in progeny test, apart from a reduction of the generational interval.

**Age at first calving and intercalving period**

During the same trial exposed above, the age at first calving did not affect the IP. However, a slight positive relationship (R² = 0.078; P < 0.05) was found between the age at first calving and the first IP. In fact, the subjects with an older age at first calving showed a longer IP (Table 3). On the contrary, a direct correlation was found between the 1st and the 2nd IP (R² = 0.123; P<0.01) and between the 1st and the 3rd/4th IP (R² = 0.192; P< 0.05). Therefore, it may be supposed that primiparous buffaloes that show low reproductive efficiency, will likely present similar characteristic either in 2nd (p<0.01) and in 3rd -4th IP. No relationship were found between the 2nd IP and the followings (Table 4).
Table 3. Relationship between age at first calving and 1st, 2nd and 3rd-4th intercalving period (IP).

|                        | Age at first calving | Age at first calving | Age at first calving |
|------------------------|----------------------|----------------------|----------------------|
|                        | 1st IP               | 2nd IP               | 3rd and 4th IP       |
| multiple R             | 0.078                | 0.058                | 0.049                |
| F value                | 4.523                | 1.553                | 0.388                |
| Significance F         | 0.034                | 0.213                | 0.534                |
| Intercept              | 915.353              | 902.052              | 892.156              |
| Variable X 1           | 0.094                | 0.072                | 0.067                |
| n                      | 745                  | 461                  | 164                  |

Table 4. Relationship between the intercalving values.

|                        | 1st IP | 1st IP | 2nd IP |
|------------------------|--------|--------|--------|
|                        | 2nd IP | 3rd and 4th IP | 3rd and 4th IP |
| multiple R             | 0.123  | 0.192  | 0.112  |
| F                      | 7.456  | 6.526  | 2.145  |
| Significance F         | 0.007  | 0.012  | 0.145  |
| Intercept              | 428.405| 371.350| 382.673|
| Variable X 1           | 0.127  | 0.183  | 0.127  |
| € mmn                  | 491    | 171    | 171    |
Intercalving period

In the areas where buffalo population is bred, many scientists affirm that this species shows a long intercalving period (Table 5), which is affected by several factors, such as the year of calving (Khan et al., 1998; Farooq et al., 2001), the season of delivery (Syed al., 1996; Chhikara, et al., 1995; Sule et al., 2001; Pyneet et al., 1992; Singh and Lal, 1992; Farooq et al., 2001), the genotype (Penchev, P., 1998; Rasali, and Yadav, 1993), (Suhail et al., 1998; Sethi, R. K., 1994). An average age at first calving of 384.91 days was reported in Brazil (Oliveira et al., 1994).

If the intercalving period of a population is calculated, it is necessary to consider an adequate long period, in order to avoid that the non pregnant animals, in which it is not possible to evaluate the data, lower the mean value.

In Italy, the out of breeding season mating (OBSM) technique penalizes fertility, because mating is allowed for only 7-8 months (February-September) for each year. Furthermore, these months are the most unfavourable for the reproductive efficiency in buffalo species. When the OBSM technique was not applied, values of 409±64.4 days (Ferrara, 1957; Salerno, 1974), 403.4±447.5 (Maymone and Pilla, 1962), 445.1±110.7 (Proto and Gargano, 1966) and 445±104 days (Zicarelli et al., 1977) have been recorded in Italy. On the contrary, in the last years the IP increased, consequently to OBSM technique application.

A total number of 6,052 intercalving periods was recorded throughout an interval of 5-10 years in 5 farms, in which a culling rate lower than 10% for year was present. A mean intercalving period of 487±133 days was registered (Table 6). In another elaboration performed by the Provincial Italian Association of Animal Breeders (APA), 2,654 buffaloes, which calved in 1999 were followed until 2001. In this case a mean intercalving period of 456 days was recorded, but 19.1% of the animals were still not pregnant until December 2001. In both studies (Tables 6 and 7; Figures 6 and 7), it was demonstrated that the shortest intercalving periods were recorded in the periods April + May + June (4+5+6) and July + August + September (7+8+9). It is worth pointing out that in all these farms the OBSM technique was adopted, the pasture was not utilized and a constant rationing was given throughout the year. Therefore, the results are not affected by nutrition and are exclusively due to environmental factors.

Sule et al., (2001) reported a delay of estrus in buffaloes that deliver in spring because of high temperatures and a following resumption of ovarian activity during the rain season and in winter. Accordingly to our results, Farooq et al., (2001) recorded a shorter intercalving period (P<0.02) in buffaloes that deliver in spring compared to those that deliver in autumn. Singh and Lal (1992) found a shortest intercalving period during the monsoons season and in summer.

We suppose that buffalo is less sensitive to the high temperatures than bovine. In fact, according to our data, the lowest intercalving periods were recorded in buffaloes that delivered between April and June, and that, consequently, conceived in the warmest months of the year, and in those that delivered between July and September, the period of the year during which the highest temperatures are recorded in Italy. On the contrary, the longest intercalving periods were recorded between October and December, because of the OBSM technique, which retards matings till February, and between January and March, the coldest period of the year. These subjects would conceive in spring, the mildest period of the year, characterized by temperatures between 15 and 22° C. However, conception is usually
delayed until September, except for the 40% of animals (33.14% and 43.37%, respectively in Tables 6 and 7). Therefore, we can conclude that in Italy nutrition and temperature, especially if a swimming-pool is present in the farm, are not able to affect the intercalving period. The main factor, that has to be taken into account in Italy, at the latitude of 42-45, is the light stimulus. Buffaloes, that deliver between January and March, would conceive between March and May, which is a period characterized by increasing day length, and, consequently, delay their conception until August, after two months of decreasing day length. Similarly, buffaloes that deliver in the period April + May + June (4, 5, 6) and July + August + September (7, 8, 9) show the shortest intercalving period, because after 58 days post partum (the useful interval in order to reach an intercalving period of 365 days), decreasing day length begins.

Table 5. Intercalving period recorded in literature.

| Authors                  | Intercalving (days) | Factors: year (1), season (2), genetic type (3) |
|--------------------------|---------------------|------------------------------------------------|
| Khan, R. N. and Akhtar, S. (1998) | 534 ± 21.70         | 1                                               |
| Syed, et al. (1996)       | 513 ± 9             | 2                                               |
| Chhkara et al. (1995)     | 472.93 ± 15.41      | 2                                               |
| Sule, S. R et al. (2001)  | 480.87 ± 10.08      | 2 (*)                                           |
| Farooq, M et al. (2001)   | 528 ± 22            | 1 e 2 (**                                  |
| Singh, A. K. et al. (1996)| 513.84              |                                                  |
| Suhail, S. M et al. (1998)| 467.10              |                                                  |
| Singh, B and Lal, K., (1992) | 580.96 ± 6.69      | 2 (***                                          |
| Penchev, P. (1998)        |                     | 3 (***)                                         |
| Rasali, D. P. and Yadav, E. R. (1993) | 400-526           |                                                  |
| Oliveira, et al. (1994)   | 384.91              |                                                  |
| Sethi, R. K. (1994)       | 466.9               |                                                  |
| Komori, et al. (1994)     | 453.9 ± 66.1        |                                                  |
| Kolachhpati, M. R et al. (1993) | 455,95 ± 10.94     |                                                  |
| Tailor, S.P. and Jain, L. S., (1993) | 500.54           |                                                  |
| Pyne, A. K. et al. (1992) | 492.6 ± 1.92        |                                                  |
| Mourad, M. and Rashwan, S. (2001) | 431               |                                                  |
| Ferrara (1957)            | 409 ± 64.4          |                                                  |
| Salerno (1961)            | 409 ± 46.9          |                                                  |
| Maymone e Pilla (1961)    | 403.4 ± 447.5       |                                                  |
| Proto e Gargano (1966)    | 445.1 ± 110.7       |                                                  |
| Intrieri and de Franciscis (1968) | 419.3 ± 85.4      |                                                  |
| Zicarelli L. et al. (1977) | 445 ± 104           |                                                  |

(*) Buffaloes which deliver in spring retard estrus during the rain season for the high temperatures and during the winter for low temperatures. (**) Buffaloes which deliver in spring show a significantly (P<0.02) shorter intercalving period compared to those which calve in autumn. (***) Buffaloes which deliver in summer and during monsoons period show a shortest intercalving period. (****) Bulgarian buffaloes show a shorter (P<0.01) intercalving period compared to Murrah buffaloes.
Considerations on the intercalving period.

If the two elaborations are compared it results that the intercalving period recorded in an interval between 5 and 10 years in CE province is lower than that recorded in the four provinces in which buffaloes delivered in 1999 (487 vs. 456; P< 0,001). In fact, in the latter 19.1% of animals were still not pregnant until December 2001. These data demonstrate that, if the intercalving period is calculated for a short period of time, it is shortest, because the non pregnant animals are not considered. On the contrary, its value is longer if the period of observation is long, especially if the culling rate is low.

It is known that buffalo species is a long-lived species and consequently the culling rate is very low. This phenomenon, in our opinion, affects the value of the intercalving period. This aspect can be demonstrated by hypothesizing an increasing culling rate from 20% to 40% and from 10% to 40% respectively in the 4 provinces and in the 5 farms in CE province, eliminating the animals with the longest intercalving periods.

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**Table 6. Intercalving periods recorded in different farms during the chosen periods.**

| Months     | n    | mean | s.d.  | % conceptions within 400 days |
|------------|------|------|-------|-----------------------------|
| 1, 2, 3    | 2229 | 498  | 139   | Aa 28.80                    |
| 4, 5, 6    | 1902 | 472  | 136   | B 39.85                     |
| 7, 8, 9    | 1375 | 486  | 127   | Acb 37.89                   |
| 10, 11, 12 | 550  | 494  | 108   | AC 15.64                    |
| Total      | 6052 | 487  | 133   | 33.14                       |

**Table 7. Intercalving periods recorded in four farms during the considered periods.**

| Months     | CA   | CE   | LT   | SA   | Total | Conception rate within 400 days (%) |
|------------|------|------|------|------|-------|-------------------------------------|
| 1, 2, 3    | 451  | 468  | 428  | 472  | 462   | 37.41                               |
|            | (92) | (275)| (219)| (502)| -1088 |
| 4, 5, 6    | 404  | 437  | 425  | 469  | 446   | 49.59                               |
|            | (41) | (295)| (114)| (278)| -728  |
| 7, 8, 9    | 389  | 464  | 412  | 458  | 449   | 54.91                               |
|            | (32) | (229)| (109)| (251)| -621  |
| 10, 11, 12 | 379  | 485  | 490  | 478  | 481   | 19.35                               |
|            | -3   | -90  | -32  | (92) | -217  |
| Total      | 428  | 458  | 428  | 471  | 456   | 43.37                               |
|            | -168 | -889 | -474 | -1123| -2654 |
| Non pregnant animals (%) | 22.5 | 17.6 | 15.4 | 21.1 | 19.1 |

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Figure 6. Intercalving period (days) in 5 farms, in function of four three months periods.

Figure 7. Intercalving period recorded in several farms in Caserta province (n = 6052).

Figure 8. Intercalving period recorded in four provinces (n = 2654).

Figure 9. Intercalving period in relation to culling rate (%) in 4 provinces (n = 2654).

Figure 10. Intercalving period in relation to culling rate (%) in 5 farms of CE province (n = 6052) subdivided by calving season.
In this case the intercalving period lowers from 443 (culling rate = 20%) to 395 days and from 486 (culling rate = 10%) to 418 days, respectively in the 4 provinces and in the 5 farms in CE province. Both conditions have to be considered optimal in buffalo species, which has a gestational period longer than cattle (382 vs 410 days), although in the latter a culling rate of around 50% is recorded in Italy.

CONCLUSIONS - The affirmation that buffalo species is belated and shows a low reproductive efficiency, can not be acceptable. If nutritional requirements during growing are covered and the culling rate is reasonable, the age at first calving and the intercalving period are similar to those recorded in dairy cattle. Furthermore, it has to be considered that the data of these elaborations were recorded in farms that apply the OBSM technique, which limits the mating to 7-8 months for year.

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