A NEW METHOD FOR EFFICIENT HEAT DETECTION IN LARGE-SIZE BUFFALO HERDS
Osman K.T.
Animal Production Research Institute, Agriculture Research Center,
Ministry of Agriculture, Dokki, Giza, Egypt.

ABSTRACT
This study aimed at the adoption of an efficient method of heat detection in buffalo raised in large herds. For that, forty two pluriparous buffalo calvers were used in this study. Calvings were distributed over a nine-months period extending from August, 1998 to May, 1999. The post-partum reproductive traits of the dry-season calvers (n=30) were compared to those of the green-season (n=12). The results of 92 heats, 110 ovulations and 671 peripheral blood samples (analyzed for P4 concentration) were scrutinized.

Heat detection was performed starting from the 2nd week post-partum until the pregnancy was confirmed. Visual observation of estrus was conducted throughout the 24 hours of the day using a T.V-closed circuit unit. Heats were also detected using four types of detector animals i.e., a testosterone-treated buffalo cow, a testosterone-treated buffalo heifer (each was fitted with a chin-ball marking harness), a vasectomized buffalo bull and an intact buffalo bull.

The overall mean of uterine involution period, post-partum ovulation interval, post-partum ovulatory heat interval, number of days-open and calving interval were 36.8±1.2, 39.0±3.6, 49.1±4.8, 75.6±4.5 and 392.2±0.4 days, respectively.

The green-season buffalo calvers had significantly (P<0.05) lower incidence of quiet ovulations, higher conception rate-to the 1st service and longer gestation period as compared to those of the dry-season calvers. The corresponding estimates of these traits were 10.0 vs. 16.4%, 83.3 vs. 60.0% and 323.0±2.2 vs. 314.1±1.8 days, respectively. Nevertheless, the conception rate after the 2nd service and the ultimate calving interval did not show any significant differences due to season of calving.

Heat detection efficiency (HDE) showed significant variations (P<0.05) among the different methods of heat detection used. The calculated estimates of HDE were 97.7% for the androgenized buffalo cow, 91.3% for the androgenized buffalo heifer, 87.1% for the vasectomized buffalo bull, 87.9% for the intact bull and 82.3% for the visual observation method.

It has been shown that well managed buffalo cows raised in large herds are capable of maintaining regular reproductive capacity throughout the year-round. In these herds, the use of an androgenized buffalo cow fitted with a chin-ball marking harness could be suggested as an efficient, sanitary and economic method of heat detection.

INTRODUCTION
It has been well established that accurate heat detection is the essential prerequisite for efficient reproductive management in bovine (Timms, 1985 and Pierson & Ginther, 1988) and buffalo (Drost et al., 1985; Jainudeen, 1986 and Barkawi et al., 1992).

Visual observation of estrus in large-size buffalo herds has traditionally been regarded as a frustrating laborious task. Otherwise, the magnitude of the problem at the level of small holders is low and usually unpronounced. This could be attributed to the fact that the small holder (possessing ≤3 buffalo cows) can easily recognize the characteristic vocalization, frequent urination, restlessness, drop in milk production and loss of appetite.
Osman K.T.

manifested by the estrous animal. The accidental mucous discharge, vulva swelling and redness of the labio-vaginal mucosa are also reliable signs if present and could readily be noticed by the holder who is normally familiar with the individual behaviour of his animals (Aboul-Ela et al., 2000).

In large-size buffalo herds, it is difficult for the herds men to visualize and follow-up the tiny behavioral changes of individuals occurring during estrus (Joosten et al., 1985). More importantly, the inherently high incidence of quiet ovulations (Barkawi, 1981); weak heat symptoms (Aboul-Ela, 1989); secretion of little amounts of estrous-mucous (Drost, 1991) and lack of the female homosexual behavior (Zicarelli, 1991) are the major estrus phenomena in buffalo. Hence, the sole dependence on the naked eyes to detect estrus in these herds is unlogic and usually leads to misleading results. This contradicts the situation in bovine as heat manifestation is obvious and the incidence of female homosexual behavior is high (Drost et al., 1985 and Aboul-Ela et al., 2000).

It is the author's concept that heat detection in buffalo raised in large herds should be performed using a different methodological approach.

This work aimed at the evaluation of different methods for heat detection in large-size buffalo herds with special attention to the use of an androgenized female buffalo as a heat detector animal. The impact of calving season on the reproductive performance of these herds was also studied.

MATERIAL AND METHODS

This study was conducted at Mehallet Moussa Research Station, Animal Production Research Institute, Ministry of Agriculture, during the period from August, 1998 until May, 1999. The farm is located in the North-Center of Nile Delta, Kafr El-Sheikh Governorate, Egypt.

Buffalo cows and management:

Fourty two clinically normal pluriparous buffalo calvers were used. Calvings covered the period extending from August, 1998 until May, 1999. All buffalo cows had normal calvings. They ranged in their ages between 4-14 years and parities between the 2nd and 9th lactations. By the end of the 1st week post-partum, the dams were separated from their newborns and began to hand-milking (twice daily) until the end of lactation.

The dams had their feeding rations on the basis of thire body weight and level of milk production (APRI, 1997). The dry-feeding implemented herein represented the period from August to December, while the green feeding represented the time interval from January to May.

The dams were kept in a 8X20 meters-open fenced yard with 5 meters height asbestos sheds. They were separated from the yard twice daily to have their drinking water (at 7.00AM and 3.00PM) and then, the concentrate rations (at 8.00AM and 4.00PM) while being hand milked. The total time spent outside the yard did not exceed 3 hours a day. The roughage rations of the season were introduced to the dams in the yard.

Experimental procedures:
Preparation of the androgenized females:

Two sexually mature non-lactating, moderately aggressive and completely sterile female buffalo (a primiparous buffalo cow and a nulliparous
A total of 671 peripheral blood samples were obtained from the jugular vein and analysed for P4 concentration. Blood sampling was started from day 15 PP and then at 5-day intervals until the pregnancy was confirmed. An extra blood sample was collected on the day of heat to assure the occurrence of ovulation. Blood specimens were kept on ice for approx. 30 minutes before they transferred to the lab.
Fig 1: The chin-ball marking harness. Fig 2: The chin-ball marking device being fitted to the head of the female teaser.

Fig 3: The female teaser showing Flehmen posture. Fig 4: An estrous buffalo cow being mounted by the female teaser.

Fig 5: The female teaser showing the chin-resting posture on the back of an estrous buffalo cow. Fig 6: Marking paint being released on the rump area of an estrous buffalo cow.
The specimens were centrifuged at 500x g for 15 minutes, then, the plasma separated and finally stored at -20°C until the time of P₄ determination using the RIA technique. A pre-coated antibody tube kits (Diagnostic Systems Laboratories, Texas, USA) were used. The cross reaction for the antibody was 100% with P₄ and < 0.1 ng/ml with any other steroids. The sensitivity value was 0.12 ng/ml. The intra and inter assay variation coefficients were 8.0 and 13.1%, respectively.

**Clinical examination of the reproductive organs:**

The female reproductive tract and the ovaries were examined at weekly intervals starting from day-15 PP until the time of 1st service (the voluntary waiting period was 40 days post-calving). Rectal examination was temporarily stopped after the 1st service, then, the ovarian activity was assessed by monitoring P₄ levels in the blood plasma. Served females that returned to heat were rectally checked for the uterine tone and the presence of cyclic structures on the ovaries before further breedings were performed. Buffalo cows that did not return to breeding within 45-60 days post-service were palpated for pregnancy diagnosis. The pregnant females were successively excluded from the yard to allow the detector animals to concentrate on the remainder of the female group.

**Reproductive traits:**

The true (ovulatory) heats; false (anovulatory) heats and quiet ovulations (QO) were determined on the basis outlined by Barkawi et al. (1998) considering both field observations and P₄ profiles. The different estimates of the uterine involution period (UIP), post-partum ovulation interval (PPOI); post-partum ovulatory heat interval (PPOHI); service period (SP); number of services /conception (NS/C); conception rate (CR); gestation period (GP) and calving interval (CI) were computed for both the green and dry-season calvers. Heat detection efficiency, HDE, (Timms, 1985) as well as heat detection accuracy, HAD, were calculated according to the following equations:

\[
HDE = \frac{21}{\text{Inter-estrous intervals}} \times 100
\]

\[
HDA = \frac{\text{Number of true heats}}{\text{Total observed heats}} \times 100
\]

As “21” = The average length of normal estrus cycle (Drost, 1991 and Beg & Totey, 1999), Inter-estrous intervals = Average interval between estrous events, Number of true heats = Number of ovulatory heats and Total observed heats = Number of true heats + number of false heats. The different estimates of inter-estrous intervals, HDE and HDA were recorded for each method of heat detection and comparisons were made.

**Statistical analysis:**

The statistical analysis was performed using the Linear Model Program of SAS (1995). The model included two fixed factors (methods of heat detection and season of calving). The \( \chi^2 \) test was used to determine the statistical significance between the traits expressed as percentages.

**RESULTS AND DISCUSSION**

Reproductive performance as affected by season of calving:
The impact of calving season on the reproductive traits of buffalo cows is shown in Table 1. It could be seen that the reproductive performance of the green-season calvers is slightly better to that of the dry-season. Nevertheless, the differences between the two seasons were statistically nonsignificant in most traits studied. This may reflect the efficacy of the implemented management throughout the course of the study. However, the diminished seasonal impact on the reproductive performance of well-managed buffalo is not new and well established by many workers (El-Wishy & El-Sawaf, 1971; Barkawi, 1981; Sastry et al., 1981; Gill & Rurki, 1985 and Bayoumi, 2001). The same concept was also emphasized for buffalo bulls kept on a sustained regular management (El-Fouly et al., 1992; Osman, 1996 and Osman et al., 2000).

Table 1: Impact of season of calving on some reproductive traits of buffalo cows raised in large-size herds.

<table>
<thead>
<tr>
<th>Trait</th>
<th>Dry season buffalo calvers (n=30)</th>
<th>Green season buffalo calvers (n=12)</th>
<th>Overall means±SE (n=42)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uterine involution period (d)</td>
<td>37.9±1.4 A</td>
<td>34.0±1.9 A</td>
<td>36.8±1.2</td>
</tr>
<tr>
<td>Post-partum ovulation interval (d)</td>
<td>39.6±4.1 A</td>
<td>37.8±7.8 A</td>
<td>39.0±3.6</td>
</tr>
<tr>
<td>Post-partum ovulatory heat interval (d)</td>
<td>47.5±5.0 A</td>
<td>53.2±10.2 A</td>
<td>49.1±4.6</td>
</tr>
<tr>
<td>Service period length (d)</td>
<td>40.4±4.9 A</td>
<td>34.9±8.7 A</td>
<td>38.8±4.3</td>
</tr>
<tr>
<td>Days open (d)</td>
<td>78.3±5.0 A</td>
<td>68.9±9.6 A</td>
<td>75.6±4.5</td>
</tr>
<tr>
<td>Incidence of Quiet ovulation (based on visual obs)</td>
<td>16.4% B</td>
<td>10.0% A</td>
<td>26.4%</td>
</tr>
<tr>
<td>Number of services/conception</td>
<td>1.4±0.1 A</td>
<td>1.25±0.2 A</td>
<td>1.4±0.1</td>
</tr>
<tr>
<td>First service- Conception rate</td>
<td>60.0% B</td>
<td>83.3% A</td>
<td>66.6%</td>
</tr>
<tr>
<td>Second service-CR</td>
<td>36.7% A</td>
<td>8.3% A</td>
<td>28.6%</td>
</tr>
<tr>
<td>Total CR after the second service</td>
<td>96.7% A</td>
<td>91.6% A</td>
<td>95.2%</td>
</tr>
<tr>
<td>Third service-CR</td>
<td>3.3% A</td>
<td>8.3% A</td>
<td>4.8%</td>
</tr>
<tr>
<td>Gestation period (d)</td>
<td>314.2±1.8 B</td>
<td>323.0±2.2 A</td>
<td>316.8±1.5</td>
</tr>
<tr>
<td>Calving interval (d)</td>
<td>392.7±4.7 A</td>
<td>390.9±8.0 A</td>
<td>392.2±4.0</td>
</tr>
</tbody>
</table>

Means bearing different superscripts in the same raw differ significantly (P<0.05).

Although, the green-season buffalo calvers has significantly (P<0.05) lower incidence of quiet ovulations (10.0 vs. 16.4%) and higher CR- to the 1st service (83.3 vs. 60.0%), neither the DO, nor the NS/C, nor the total CR after the 2nd service showed any significant differences due to season of calving (Table 1). Ultimately, but most importantly, the CI was almost similar (390.9±8.0 vs. 392.7±4.7 days) for both calving seasons, respectively.

Disregarding the seasonal impact, the reproductive estimates presented here are generally superior to those reported by the vast majority of investigators for buffalo cows raised in large-herds (El-Fouly et al., 1976; Jainudeen, 1986; Barkawi et al., 1992 and 1998). More interestingly, the current reproductive estimates are also superior to those reported for buffalo cows kept at the level of small holders (El-Khaschab et al., 1984; Aboul-Ela, 1992 and El-Wardani et al., 2000). The results of this part clearly manifest the outstanding reproductive capacity of this animal, on one herd, and emphasize
the importance of strict management to uncover this capacity, on the other hand.

As shown in Table 1, the GP of the dry-season calvers (314.2±1.8 days) was significantly (P<0.05) shorter to that of the green-season (323.0±2.2 days). The reason is not clear and needs specific investigation. However, in this study, the majority of the dry-season calvers gave their subsequent births during the following dry (hotter) calving season, the time which could probably be coincided with elevated levels of the stress-corticosteroid hormones, which are in-turn responsible for the enhancement of placental maturation (Otzel et al., 1983), resulting in an earlier termination of pregnancy.

The incidence of quiet ovulations (QO) as determined by the blood- P₄ levels and the confirmation of the 24-hours visual observation of estrus (by the TV-closed circuit) was 26.4%. Although rather high, this incidence is obviously lower to the most corresponding estimates found in the literature (Barkawi et al., 1986; Aboul-Ela et al., 1987 and Khattab et al., 1990).

It could be seen that even under the most optimum management conditions and intensive visual observation of estrus, a considerable incidence of QO (26.4%) has been still encountered. This simply emphasises that the sole dependence on the naked eyes to detect estrus in large-size buffalo herds is unreliable and usually results in plenty of missed ovulations. In such herds, the phenomenal weak estrous manifestation, lowered incidence of estrous vocalization and the rarely encounted/ or entirely lacked homosexual behavior among females (Aboul-Ela, 1988; Barkawi et al., 1992 and El-Wardani, 1995) support our concept. Thus, another methodological approach should be adopted for more efficient heat detection in large-size buffalo herds, the issue which will be discussed later.

**Blood progesterone (P₄) profiles:**

All true (ovulatory) heats detected in this study coincided with blood P₄ level of ≤ 0.5 ng/ml (Table 2). Almost similar P₄-levels (≤0.4 ng/ml) were detected on the day of QO. The overall mean P₄-peak of the mid-ovulation cycle was 3.1±0.2 ng/ml. Non of these levels showed any significant differences due to season of calving. These results agreed with the findings of El-Wardani (1995). Otherwise, they contradicted with those reported by Younis et al. (1996) who found a significant seasonal effect on the P₄-peak during the luteal phase of the cycle. They recorded P₄ peaks during that phase of 3.1 & 3.7 ng/ml for the dry and green-calving seasons, respectively, the values which were nearly similar to the corresponding levels (3.2±0.2 and 2.8±0.4 ng/ml) recorded in the present study (Table 2).

The overall mean P₄-level on the day of false heat (FH) were 1.1±0.9 and 0.1±0.1 ng/ml during the dry and green calving seasons, respectively (Table 2). The difference between the two seasons was statistically significant (P<0.05). Two out of the 11 false heats detected (18.1%) coincided with the presence of a CL on one of the two ovaries and P₄ levels of ≥1.0 ng/ml. Both cases were dry-season calvers. It worths to mention that all cases of FH detected in this study (based on the visual observation and P₄ profiles) were not accompanied by firm standing while being mounted by any subject of detector animals. This finding came in a partial agreement with the
results of El-Wardani (1995) who found that about 50% of buffalo cows with false heats were reluctant to stand firmly to the bull during copulation.

The mean $P_4$ peak of early gestation (during the 1st two mo. of pregnancy) was insignificantly higher in the green than in the dry-calving season (5.3±0.7 vs. 4.6±0.3 ng/ml), respectively. These values were almost similar to the corresponding values reported by Batra et al (1979) for Indian buffalo, and rather high than those recorded by Farghaly (1992) for Egyptian buffalo. The lack of seasonal impact on the $P_4$ profiles during the different physiological events studied clearly denotes a regular ovarian function throughout the year-round.

**Incidence of detected heats; quiet ovulations and total ovulations in relation to heat detection method:**

As shown in Table 3, the use of the androgenized buffalo cow has resulted in the highest incidence of captured true heats (93.1%). While this incidence did not vary significantly with those of the androgenized buffalo heifer (92%), the vasectomized buffalo bull (89%) and the fertile buffalo bull (89%), it differed significantly ($P<0.05$) with that of the visual observation method (88%). This trend reflected corresponding percentages of false heats of 3.9; 8.0; 11.0; 11.0 and 12.0% for the different methods of heat detection, respectively. However, the entire cases of true heats recorded in this study (n=81) were uniformly recognized by all methods of heat detection with a 100% efficiency. This percentage was similar to that obtained by El-Wardani and El-Asheeri (2000) employing a four-times heat checks (daily) regimen. It worths to mention that the significantly ($P<0.05$) inferior percentages of true heats (88%) and the concurrent false heats (12%) stuck with the visual observation method in this study have been still superior to the corresponding percentages found in the literature (El-Sheikh and Mohamed, 1976; Borady et al., 1982 and El-Wardani, 1995).

The androgenized buffalo cow had the highest efficiency ($P<0.05$) for detecting QO (82.8% out of the total 29 QO’s recorded). The corresponding efficiency estimates for the androgenized heifer; the vasectomized bull; the fertile bull and the visual observation method were 65.5; 41.4; 44.8 and 0.0%, respectively. It was also shown that the ultimate percentages of the total ovulations detected by the different methods of heat detection were 95.5; 90.9; 84.5; 85.5 and 73.6%, respectively. The counter-part percentages of missed (undetected) ovulations were 4.5; 9.1; 15.5; 14.5 and 26.4%, respectively. These results clearly demonstrate the superiority of the androgenized buffalo cow for detecting QO, the traditional obstacle which afflicted reproductivity of this animal for long decades. It should be mentioned that the recorded incidence of missed ovulation relative to the use of the androgenized buffalo cow (4.5%) is the least figure ever found in the available literature (Barkawi, 1981; Jainudeen et al., 1983; Aboul-Ela et al., 1987; El-Wardani, 1995 and El-Wardani and El-Asheeri, 2000).
Osman K.T.

Inter-estrous intervals:

The impact of heat-detection method on the inter-estrous intervals (estrous cycle length) is shown in Table 4. The use of the androgenized buffalo cow has resulted in the lowest mean estrous cycle length (21.5±1.1 days). Conversely, the highest mean interval (25.5±1.3 days) was recorded for the visual observation method (P<0.05). Nevertheless, variations in this trait among the different experimental types of detector-animals were statistically nonsignificant. Regardless of heat-detection method used, the current inter-estrous intervals were in general accord with the means reported by Beg and Totey (1999) for Indian buffalo and Khalil (2001) for Egyptian buffalo. The differences among the various studies could, in large part, be attributed to the efficiency of heat-detection regimen adopted (Barkawi et al., 1998; El-Wardani and El-Asheeri, 2000 and Khalil, 2001).

Heat-detection efficiency (HDE):

The use of the androgenized buffalo cow resulted in the highest HDE (97.7%), otherwise, this estimate reached its lowest level (82.3%; P<0.05) when the visual observation method was used (Table 4). However, the differences among the androgenized buffalo cow, the vasectomized buffalo bull and the intact buffalo bull lacked statistical significance.

In their study, Barkawi et al. (1998) using the equation of Timms (1985) found that HDE was 86.1% when buffalo cows were checked for heat 4 times a day, and this efficiency declined dramatically to 39.9% as the number of heat-checks decreased to 2 times a day.

Heat detection accuracy (HDA):

The estimates of HDA had almost the same trend imposed by the HDE (Table 4). The significant superiority (P<0.05) of HDA for the androgenized females over the visual observation method comes in complete accord with the aforementioned results of this study. Moreover, it confirms our previous concept that the visual observation of estrus should not be the method of choice for heat detection in large-size buffalo herds.

It has been concluded that in large-size buffalo herds, the use of an androgenized buffalo cow fitted with a chin-ball marking harness could be suggested as an efficient, sanitary and economic method of heat detection.

REFFERENCE


Osman K.T.


طريقة جديدة لاكتشاف الشياع بكفاءة فى قطعان الجاموس الكبيرة

خالد توفيق عثمان

المعهد بحوث الإنتاج الحيواني - مركز البحوث الزراعية – وزارة الزراعة – القاهرة

أجريت هذه الدراسة بمحطة بحوث الحيوانات بمحلية مثبوطة في معهد بحوث الإنتاج الحيواني بعد ازدياد نسب الشياع في عدد الجماعات الحيوانية، وتم اختيار الجماعة التالية في فصل الشتاء.

عانى كلاً من الامام ورائدة من الشياع وانتشرت في عدد الجماعات الحيوانية، وتم اختيار الجماعة التالية في فصل الشتاء.

استخدمت الطريقة المذكورة في طريقة القائمة والجهازات المخصصة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطرق المختلفة للكشف عن الشياع، وتم استخدام عدد من الطر
Table 2: Blood-P₄ concentration (ng/ml) in relation with some physiological events and with season of calving in large-size buffalo herds.

<table>
<thead>
<tr>
<th>Trait</th>
<th>Dry season buffalo calvers (n=30)</th>
<th>Green season buffalo calvers (n=12)</th>
<th>Overall mean±SE (n=42)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean±SE</td>
<td>Range</td>
<td>Mean±SE</td>
</tr>
<tr>
<td>On the day of true heat</td>
<td>0.1±0.02A (83) ND-0.5</td>
<td>0.1±0.04 (18) ND-0.5</td>
<td>0.11±0.02 (81) ND-0.5</td>
</tr>
<tr>
<td>On the day of false heat</td>
<td>1.1±0.9A (9) ND-8.0</td>
<td>0.1±0.10B (2) ND-0.2</td>
<td>0.9±0.70 (11) ND-8.0</td>
</tr>
<tr>
<td>On the day of quiet ovulation</td>
<td>0.1±0.03A (18) ND-0.4</td>
<td>0.1±0.03A (11) ND-0.4</td>
<td>0.1±0.02 (29) ND-0.4</td>
</tr>
<tr>
<td>On the day of ovulation</td>
<td>0.1±0.01A (81) ND-0.5</td>
<td>0.12±0.02A (29) ND-0.5</td>
<td>0.1±0.01 (110) ND-0.5</td>
</tr>
<tr>
<td>Peak of mid-ovulation cycle</td>
<td>3.2±0.20A (53) 1.0-9.0</td>
<td>2.6±0.40A (17) 1.0-6.2</td>
<td>3.1±0.20 (70) 1.0-9.0</td>
</tr>
<tr>
<td>Peak of the 1st 2mo. Pregnancy</td>
<td>4.6±0.3A (30) 1.8-9.5</td>
<td>5.3±0.70A (12) 2.1-9.0</td>
<td>4.8±0.3 (42) 1.8-9.5</td>
</tr>
</tbody>
</table>

Means bearing different superscripts in the same row differ significantly (P<0.05).

Table 3: Impact of heat-detection method on the different percentages of true heats, false heats, quiet ovulations and total ovulations detected.

<table>
<thead>
<tr>
<th>Trait</th>
<th>Androgenized buffalo-cow</th>
<th>Androgenized buffalo-heifer</th>
<th>Vasectomized buffalo bull</th>
<th>Fertile buffalo bull</th>
<th>Visual observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent true heats recorded</td>
<td>93.1%A (81/87) 92.0%A (81/88)</td>
<td>93.0% AB (81/81)</td>
<td>93.0% AB (81/81)</td>
<td>93.0% AB (81/81)</td>
<td>88.0% (81/92)</td>
</tr>
<tr>
<td>Percent false heats recorded</td>
<td>6.9%A (6/87) 8.0%A (7/88)</td>
<td>11.0% AB (10/91)</td>
<td>11.0% AB (10/91)</td>
<td>12.0% AB (10/91)</td>
<td>12.0% (11/92)</td>
</tr>
<tr>
<td>Percent true heats detected</td>
<td>100% (81/81)</td>
<td>100% (81/81)</td>
<td>100% (81/81)</td>
<td>100% (81/81)</td>
<td>100% (81/81)</td>
</tr>
<tr>
<td>Percent missed (undetected) ovulations</td>
<td>4.5%A (5/110) 9.1%AB (10/110)</td>
<td>15.5% B (17/110)</td>
<td>14.5% B (16/110)</td>
<td>26.4% C (29/110)</td>
<td>3.6% (0/29)</td>
</tr>
<tr>
<td>Percent total ovulations detected</td>
<td>95.5%A (105/110) 90.9%AB (100/110)</td>
<td>84.5% B (93/110)</td>
<td>85.5% B (94/110)</td>
<td>73.6% C (81/110)</td>
<td></td>
</tr>
</tbody>
</table>

- Figures in parenthesis represent the number of observations.
- Means bearing different superscripts in the same row differ significantly (P<0.05).

Table 4: Impact of heat-detection method on the inter-estrus intervals (days), efficiency and accuracy of heat detection (%) in large-size buffalo herds.

<table>
<thead>
<tr>
<th>Trait</th>
<th>Androgenized Buffalo-cow</th>
<th>Androgenized buffalo-heifer</th>
<th>Vasectomized buffalo bull</th>
<th>Fertile buffalo bull</th>
<th>Visual observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervals between estrus events (days)</td>
<td>21.5±1.1m (55)</td>
<td>23.0±1.6m (53)</td>
<td>24±1.8m (50)</td>
<td>23.9±1.5m (51)</td>
<td>25.5±1.3m (46)</td>
</tr>
<tr>
<td>Heat-detection efficiency (HDE)</td>
<td>97.7% A</td>
<td>91.3% AB</td>
<td>87.1% B</td>
<td>87.9% AB</td>
<td>82.3% C</td>
</tr>
<tr>
<td>Heat-detection accuracy (HDA)</td>
<td>93.1% A</td>
<td>92.0% A</td>
<td>89.0% AB</td>
<td>89.0% AB</td>
<td>88.0% B</td>
</tr>
</tbody>
</table>

- Figures in parenthesis indicate the number of intervals between estrus events.
- Means bearing different superscripts in the same row differ significantly (P<0.05).