ISSN 1313 - 8820
Volume 1, Number 3
December 2009

AGRICULTURAL SCIENCE AND TECHNOLOGY

2009

An International Journal Published by Faculty of Agriculture,
Trakia University, Stara Zagora, Bulgaria

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AGRICULTURAL SCIENCE AND TECHNOLOGY

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Nutrition and Physiology

The effect of pregnancy on milk yield in Bulgarian Murrah buffalo cows

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(Manuscript received 8 October 2009; accepted for publication 30 October 2009)

Abstract. *A study assigning 694 gestation periods (lactations) of 294 Bulgarian Murrah buffalo cows with recorded milk yield, bred on the farm of Agriscultural Institue – Shumen during the period 1967-2001, was initiated with the objective to estimate the effect of pregnancy – expressed as the specific effect of gestation month – on test-day milk yield. Using linear LS-analyses, it was established that the effect of pregnancy is expressed in significant dramatic reduction in daily milk yield after gestation month five, resulting in 12.9 to 14.4% deterioration per 305-day lactation. It is pronounced only in the high-yielding buffaloes and is analogical to that in high-yielding bovine cows. The effect of the first post conception months is negligible in both cases with short and long days open.*

Keywords: gestation month, milk yield, LS-analysis, buffaloes

Abbreviations: MYD–milk yield deviation, ARM–all-records model, LPM–low-productivity model, HPM–high-productivity model, ECM–early-conception model, DCM–delayed-conception model

Introduction

As a major part of the life of dairy animals, pregnancy is a very important phase of reproduction. In contrast to its relatively constant length, days open is a very variable, management-dependant period, which renders it essential for optimization of the productive life, especially in high-longevity species like the water buffalo. In support to this are the economic effects of the reproductive traits on profitability in buffalo breeding established by Peeva (2000) and S. Khan et al. (2008). On the other hand, shrinking the pre-conception period adversely affects productive performance during the lactation, and there are many studies that have proved it in both bovine (Ali et al., 2000; Roche, 2003; Seyedsharify et al., 2009) and bubaline cows (Boikovski, 1977; Afzal et al., 2007; Khan et al., 2008). However, days open alone cannot be considered an accurate means of assessing the effect of pregnancy on the milk yield at the respective lactation, neglecting the high probability the higher-yielding cows to have greater service period, thereby substantially biasing the results (Lee et al., 1997).

Viewed as sources of variance, it is noteworthy that in distinction to days open which, owing to its very low heritability (Aziz et al., 2001; Thevamanoharan et al., 2002; Khan et al., 2007), is a mostly environmental factor, gestation period should be considered a physiological factor. The mechanism by which pregnancy inhibits milk production is associated with the decrease in the sensitivity to prolactine, the drop in the milk secretion enzymes, and mostly with the prevalence of growth hormones and the decline in insulin leading to partial withdrawal of the glucose from the galactopoesis (Oltenacu et al., 1980). In relation to the dynamics of these metabolic changes, the energy requirements of gestating dairy cows and buffaloes are established to increase constantly, especially from respectively month six and seven onwards (Todorov, 1997; Clark et al., 2001; Peeva et al., 2006).

As for the specific effect of pregnancy and its phases on milk yield there have been detailed studies in dairy cattle (Bormann et al., 2002; Bohmanova et al, 2009; Loker et al., 2009) and goats (Knight and Wilde, 1988; Salama et al., 2005). However, in the buffalo such investigations on global scale are rather scarce, that of Qureshi et al. (2007) with the Nili-Ravi breed being the only official source on the matter we are aware of. In particular, this effect has not been studied on national scale – a scientific knowledge to provide for better control of the buffalo milk produce on the farms and for more efficient selection on the basis of the records from that part of the lactation that is least affected by pregnancy.

The present investigation was initiated with the aim to study the effect of pregnancy – expressed as the specific effect of gestation month – on test-day milk yield in Bulgarian Murrah buffalo cows.

Material and methods

Subject of the study were 694 gestation periods (lactations) of 294 Bulgarian Murrah buffalo cows with recorded milk yield bred on the farm of Agricultural Institute – Shumen in the period 1967-2001. The trait milk yield deviation (MYD) was formed to mark the pregnancy-related change (decrease or increase) in test-day milk. It is computed within each X-th lactation month by subtracting each x-th test-day record in gestation (TDR_{xx}) from the relevant test-day average of the non-pregnant records (TDA_x):

$$MYD_{xx} = TDA_x - TDR_{xx} \quad (1)$$

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The LS-analysis, assigning MYD data within 305-day lactation, is expressed by the following equation (all-records model, ARM):

$$Y_{ARM} = \mu + DO_i + P_j + GM_k + LM_l + SC_m + MY_n + AFC_p + PC_q + e_{i,p}, \quad \textbf{(2)}$$

where μ is the mean value of the trait, DO_i, P*j,* GM*k*, LM_l, SC_m, MY_n, AFC_p and PC_q are respectively the fixed effects of days open (*i* = 1…4), parity (*j* = 1…4), gestation month (*k* = 1…9), lactation month (*l* = 2…10), season of calving (*m* = 1…4), 305-day lactation milk yield (*n* = 1…3), age at first calving (*p* = 1…3), period of calving (*q* = 1…8), and $e_{i,p}$ is the residual effect. Along with the all-records model four other sub-models were used.

To establish the effect of pregnancy in dependence on productivity level the data were divided in two separate subsets – with lactation milk yield ? 1600 kg (low-productivity model, LPM) and over 1600 kg (high-productivity model, HPM) – excluding from the complete model the factor 305-day lactation milk yield (MY_n). The second division of data was to develop an early-conception model (ECM) and a late-conception model (DCM), respectively with days open ? 150 and >150, omitting from the complete model the factor days open (DO_i). The data were processed using the software products LSMLMW and MIXMDL (Harvey, 1990) as well as the conventional statistical procedure.

Results and discussion

Variance analysis and gestation month

The ANOVA (Table 1) was fitted at a relatively low standard deviation error (SE= 1.412) and a relatively satisfactory proportion of the overall variance explained by the all-records model (R^2= 0.552).

It shows the highly significant effect of gestation month (F= 7.14, P<0.001), the results of the within-group distribution presented in Table 2. The average value of the pregnancy-related drop in milk yield is 0.953 kg. The LSM-estimates indicate that in the first four months after conception the deviation from the average milk yield records of the open months is negligible – from 0.292 to 0.410 kg in the negative. However, from month five onwards the effect of gestation becomes increasingly more pronounced, the magnitude of reduction growing progressively from 0.611 kg at month five to 1.822 kg at eight (i.e., prior to drying-off). The curve of this effect is illustrated graphically with Figure 1.

Table 1. ANOVA by all-records model (R^2= 0.552)

Factors	df	MS	F	
Gestation month	8	14.24	7.14	***
Days open	3	15.83	7.93	***
Lactation month	8	15.83	7.93	n.s.
Parity	3	4.91	2.46	n.s.
305-d milk yield	2	2288.75	1147.53	***
Age of first calving	2	30.24	15.16	***
Season	3	10.85	5.44	**
Period	7	17.84	8.95	***
Remainder	2928	1.99		

*** – P<0.001, ** – P<0.01, n.s. – Not significant differences

This implies that in the case of the early-autumn breeding season for the buffaloes in Bulgaria attention should be focused on

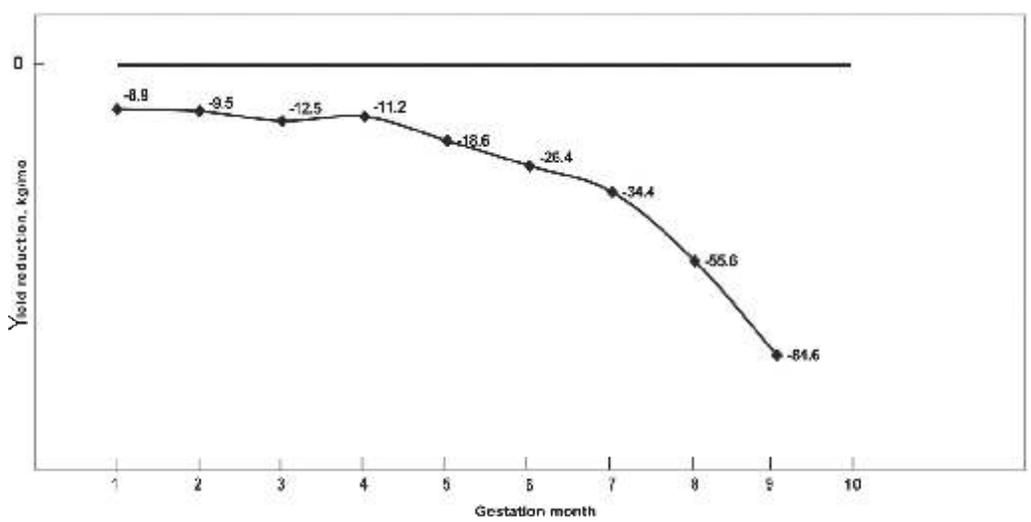

Figure 1. Milk reduction due to pregnancy

Table 2. LSM-estimates and standard errors (SE) of the effect of gestation month on test-day milk yield reduction by all-records model, low-productivity model (n= 1212, R2= 0.127), high-productivity model (n= 1753, R2= 0.242), early-conception model (n= 876, R2= 0.611), delayed-conception model (n= 469, R2= 0.587)

Gestation month	All-records model		LPM (F= 0.916^{ns})	HPM (F= 4.45***)	ECM (F= 0.87^{ns})	DCM (F= 0.69^{ns})
	n	LSM ± SE				
First	574	-0.292 ± 0.065	-0.135 ± 0.106	-0.046 ± 0.094	-0.203 ± 0.093	-0.571 ± 0.109
Second	537	-0.313 ± 0.079	0.059 ± 0.125	-0.168 ± 0.116	-0.130 ± 0.118	-0.483 ± 0.132
Third	499	-0.410 ± 0.103	0.107 ± 0.161	-0.256 ± 0.151	-0.087 ± 0.150	-0.725 ± 0.158
Fourth	454	-0.367 ± 0.130	0.242 ± 0.202	-0.221 ± 0.189	-0.433 ± 0.230	-0.489 ± 0.199
Fifth	389	-0.611 ± 0.161	0.039 ± 0.252	-0.477 ± 0.234		-0.801 ± 0.344
Sixth	275	-0.864 ± 0.195	0.023 ± 0.304	-0.782 ± 0.282		
Seventh	158	-1.127 ± 0.237	0.016 ± 0.377	-1.112 ± 0.337		
Eighth	71	-1.822 ± 0.291	0.090 ± 0.494	-1.889 ± 0.402		
Ninth	8	-2.774 ± 0.563	-0.701 ± 1.027	-2.272 ± 0.747		
Overall LSM	2965	-0.953 ± 0.152	-0.029 ± 0.250	-0.803 ± 0.216	-0.214 ± 0.099	-0.614 ± 0.114

the feeding and management from the second half of the winter onwards.

The results of the present study with the Bulgarian Murrah differ from those reported by Qureshi et al. (2007) for the Nili-Ravi breed in the conditions of Pakistan, establishing that after an initial increase the milk yield decreases constantly and most noticeably from third to sixth month of gestation.

Gestation month and productivity

Table 2 suggests that there is difference in the pregnancy-dependant reduction of milk yield between the low- and high-productivity models. In the case of low milk yield the influence of gestation month is minor and insignificant (P>0.05), the deviations from the yield of the open months (assumed as minuend) being small, most of them in the positive. These low values of the LSM-estimates

Table 3. LS-estimates of the effect of lactation month on test-day yield reduction and $\bar{x}$ values for the open months

Lactation month	All-records model		Open months test-day yield, kg
	n	LSM ± SE	
First	—	—	8.58
Second	64	-0.674 ± 0.313	8.71
Third	189	-0.780 ± 0.265	8.36
Fourth	277	-0.969 ± 0.233	7.67
Fifth	345	-0.987 ± 0.199	6.99
Sixth	429	-0.998 ± 0.169	6.31
Seventh	469	-0.885 ± 0.141	5.47
Eighth	475	-1.056 ± 0.119	5.01
Ninth	410	-0.951 ± 0.101	4.39
Tenth	307	-1.279 ± 0.094	4.24
Overall LSM	2965	-0.953 ± 0.152	

Table 4. LS-means of the effect of parity on test-day milk reduction and $\bar{x}$ values for lactation milk yield and days in milk

Parity	All-records model		305-d yield, kg	Days in milk
	n	LSM ± SE		
First	754	-0.833 ± 0.159	1683.8	291.8
Second	701	-1.048 ± 0.158	1832.6	281.6
Third	477	-0.974 ± 0.164	1794.8	280.8
Fourth plus	1033	-0.958 ± 0.157	1842.7	278.5
Overall LSM	2965	-0.953 ± 0.152		

are to be duly attributed to the low productivity in this subset of records. In the model assigning high-production lactations (HPM), however, the established effect of pregnancy is highly significant (F= 4.45, P<0.001) with overall mean and slope-down curve resembling those from the all-records model. Here the pregnancy-related reduction during the initial four months is even slighter, but analogically increases substantially afterwards – from 0.782 kg at the sixth month to 1.889 kg before the dry-off period. These results indicate that the curve of the effect of pregnancy on milk yield in the high-yielding buffaloes rather resembles that in high-yielding bovine cows (Bormann et al., 2002; Bohmanova et al, 2009; Loker et al., 2009) than that in the low-yielding buffaloes. According to Knight (2001), high productivity is associated with dramatic decrease in milk output in the third gestation trimester in order to compensate the decreased food intake due to the oestrogens drop, to foster the development of the conceptus, and to create accretion of body reserves in preparation for the hazardous transition period (around parturition) and especially for the period of adipose mobilization during early lactation; a rationale that is contrary to the assumption that buffaloes would rather worsen their productivity than resort to their body reserves during peak lactation and part gestation, which applies more to buffaloes in general or to poorly performing ones.

Lactation month

Table 3 represents the test-day milk yield reduction in relation to lactation month. The deviation in milk due to pregnancy ranges unsubstantially, non-linearly and insignificantly from -0.626 kg at the second month to -1.279 kg at the end of the 305-day lactation.

However, given the normal decline in milk productivity with the advance of lactation, it is to be considered the percentage of this reduction out of the test-day yield of the open months, to show that it is much more markedly expressed – from nearly 8% in month two to 30% in month ten.

Parity

The data show that the smallest yield reduction belongs to the primiparous buffaloes, which is not statistically proved (Table 4). In terms of economics and management, these monthly differences in test-day milk come up to an accumulated total drop of 218 kg per first lactation (on the basis of 292 days in milk and excluded first month, i.e. 262 d), which is 13.0% out of the average of 1684 kg. The LSM-estimates for the later lactations are near the overall mean (-0.953)

and to each other; for the gestation days in milk the respective reduction is 264 kg at second lactation, 244 kg at third, and 238 kg at fourth-plus, or a relative deterioration by 12.9 to 14.4%.

Gestation month and days open

Table 2 also shows the effect of pregnancy relatively to days open. It is evident that in both models, fitted to comparatively good reliability of the forecasting observations (R^2= 0.611 and R^2= 0.587), this effect is ill-expressed and insignificant. The values of yield reduction in the case of conception during the first half of the lactation are approximate to those for the first gestation months from the all-records model, while after delayed conception they are little greater – from 0.483 to 0.801 kg. It should be borne in mind that in all cases the milk yield in the first half of the lactation is to a little or no extent affected by pregnancy, which renders this productive period more beneficial from a selection standpoint.

Though not statistically proved, improving reproductive efficiency (reducing days open), on one hand, is not expected to create additional negative effect of pregnancy on milk yield (in distinction to the findings of Qureshi et al., 2007) but, on the other, it will reduce the lactation part that is less dependant on pregnancy. Delayed conception would, contrariwise, sizably minimize the negative impact of gestation on lactation milk, but penalize reproduction rate. In other words, these results are in correspondence with the observation that delaying conception is, on one hand, favourable to the milk yield at the concurrent lactation but, on the other, detrimental to profitability of buffalo breeding (Peeva, 2000; Afzal et al., 2007; S. Khan et al., 2008), unlike cattle where some authors recently recommend it for the benefit of the prolonged lactations (Knight, 2001; Arbel et al., 2001; De Vries, 2006).

In comparative terms, the matches with the study of Qureshi et al. (2007), the only one in the buffalo known to us, are not many – particularly the general trend of milk yield deterioration due to pregnancy. This implies different influence of gestation period in relation to breed of origin, management, reproductive ability, and, as it was found herein, to productive performance.

Conclusions

In the Bulgarian Murrah breed the effect of pregnancy on productivity in the initial post conception months is negligible, regardless of the days open, while after fifth gestation month it is expressed in significant drastic decrease in daily milk, in the high-yielding buffaloes only.

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AGRICULTURAL SCIENCE AND TECHNOLOGY

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December 2009

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www.alfamarket.biz