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THE EVALUATION OF REPRODUCTIVE PERFORMANCE IN DAIRY HERDS

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Summary: The routine monitoring of the efficiency of reproductive programs is necessary in large-scale dairy herds in the 21st century. The importance of the economic evaluation of these programs is increasing, as well, since many thousands of euros are spent on reproductive management on a farm. However, different interpretations of reproductive indices cause difficulties among professionals when comparing the parameters of their farms to that of another dairy. Last, but not the least, proper and uniform interpretation of these parameters is a prerequisite in performing correct economic evaluations. Some indices (e.g. calving interval) are classically used for monitoring some aspects of cows' fertility, however they are less adequate to evaluate the reproductive performance of a farm as a whole. Moreover, variations can be observed in the calculation approaches of certain reproductive parameters among herds, and the figures may be further biased due to the exclusion of some group of animals or the use of a hormonal synchronization program. In this study, the authors present the main reproductive indices from a practical point of view and a more comprehensive way of calculating the indices is shown. The advantages and disadvantages of each parameter are also discussed. Special attention is paid to the possible errors which may lead to the miscalculation and misinterpretation of the parameters.

Keywords: dairy, farm economics, fertility, reproduction parameters

1. Managing reproduction in dairy herds

Successful reproductive management is essential for profitable milk production. Since milk is the major source of income on dairy farms, the goal of the farmer is to maximize milk production. Delayed conception – and suboptimal reproductive performance in general - lead to decreased milk yield per time unit (Ózsvári, 2013). Reproductive events should be prudently recorded in order to make certain important parameters quantifiable by the farm manager, the vet or the consultant. The accuracy and the value of these calculations will depend on the quantity and quality of the records. Nowadays farm management softwares offer a great opportunity for recording and analysing information on herd performance, thus, a wider range of more sophisticated fertility measures can be used than in the case of manually written records (Noakes et al., 2001, DairyCo, 2012). Reproductive indices provide the best information of breeding problems, and by monitoring trends, farmers who currently do not have problems with getting their cows pregnant can detect problems as they develop. Guidelines usually show goals for optimal efficiency, but it is highly advised to pay attention to the regional or national values of these indices. These are more realistic, easier to reach and regional differences (e.g. weather conditions) make goals more difficult to reach for some producers (Varner et al., 2012). The most important reproductive indices used in all-year-round calving herds are included in the present work.

2. Indices in quantifying reproductive efficiency

2.1. Calving interval

Calving interval is the interval (in days) between successive calvings calculated retrospectively from the cows' most recent calving date (Noakes et al., 2001). It is a classic parameter of monitoring reproductive performance in dairy herds, but fraught with problems. Firstly, culled cows, pregnant cows which have not yet calved and do-not-breed cows are excluded from the calculation of this parameter. Secondly, first lactation animals, which may account for the 30-40% of the herd are also excluded. Thirdly, since events that were 1.5-2 years ago may be included in this index, calving interval is considered too historical for regular assessment. Fourthly, it is a parameter which is likely skewed upwards, thus, hides extreme and costly within-herd variations (e.g. the average of two cows, one with a 370-day long, the other with a 450-day long calving interval is 410 days, which is considered good). Calving interval covers return to cyclicity and conception (Fetrow et al., 2007, Farin and Slenning, 2001, DairyCo, 2012, ICAR, 2014, Köcski, 2007, Kranjec, 2015). This index can be used well in economic calculations, however, the results should be interpreted prudently.

2.2. Days open (DO)

This index is a good example of the inconsistent use of the reproductive parameters, since different definitions are given in different sources:

- Definition 1: the average interval from calving to conception in a herd (Fetrow et al., 2007, Farin and Slenning, 2001). By adding the average gestation length (280 days) to the DO, we get the predicted calving interval.
- Definition 2: the interval (in days) from calving to the subsequent effective service date of those cows that conceive, and from calving to culling or death for those cows that did not conceive. DO is influenced by management decisions, because the farmer decides when to cull the cows not conceiving. Calving to conception interval is distinguished, since it takes only the conceiving cows into account, culled cows are ignored, thus, DO exceeds CCI. In this respect, CCI is used for calculating predicted calving interval (Noakes et al., 2001, DairyCo, 2012). If 70 cows conceive in a herd of 100 with a CCI of 85 days and the remaining 30 cows are culled 300 days after calving on average, then DO is (70*85+30*300)/100=149.5 days.
- Definition 3: the interval between calving and the last insemination date (ICAR, 2014).
- Definition 4: the average of days open, that is the sum of days open of the cows in the herd divided by the number of cows, calculated as described beneath. The number of days from calving to:
    - conception in pregnant cows,
    - last insemination in cows which had been bred but not confirmed pregnant yet,
    - and the current date for open cows (Varner et al., 2012).

Days open is a widely used parameter, which is readily available in most recording systems. It is usually a highly skewed parameter, which may mask the wide distributions in performance. Cow fertility, estrus detection and management decisions affect DO (Fetrow et al., 2007, Farin and Slenning, 2001, Varner et al., 2012, DairyCo 2012). In Hungary, the calving to conception interval (CCI) is mostly considered as days open.

2.3. Voluntary waiting period (VWP)

VWP is the postpartum time during cows are deliberately not bred (Farin and Slenning, 2001, Szelényi et al., 2010). Uterine involution passes off in 42 days, thus, typical length of the VWP is 45-55 days, because it is economically not viable to inseminate the cow before the end of the involution. Extended VWP may be given to the cows to reduce the detrimental effects of negative energy balance and endotoxins in the first weeks of the lactation (Szelényi et al., 2010, Szenci, 1995). However, the stated policy and the actual behaviour may not be the same on the farms, and farmers may start to inseminate their cows before the end of VWP. Actual VWP can be estimated by examining the days in milk (DIM) where first inseminations begin to cluster (e.g. by a scatterplot), anyway, VWP is a parameter which is difficult to track and police effectively.

2.4. DIM at first breeding (days to first service, calving to first service interval)

To assess the DIM at first breeding the number of days from calving to first service must be added together for all cows inseminated and then divided by the number of cows inseminated. This index is influenced by the VWP policy of the farm, the prevalence of delayed return to cyclicity after calving and the failure to detect estrus (Noakes et al., 2001, Farin and Slenning, 2001, Varner et al., 2012).

2.5. Estrus detection

When talking about estrus detection (ED), one has to distinguish between ED intensity and ED accuracy. Estrus detection intensity refers to the proportion of cows seen in estrus. ED accuracy shows the proportion of cows correctly identified being in estrus from those detected in estrus. Improvement of ED has much greater influence on reducing the calving to conception interval than improving pregnancy rate, since the latter parameter can only be improved up to a certain level. It is advised to record observed heats during VWP, as well, because the time of subsequent estrus can be anticipated, thus, estrus detection rate can be improved and acyclical cows can be identified earlier, as well (Fetrow et al., 2007, Noakes et al., 2001).

2.5.1. Estrus detection rate (heat detection rate)

Estrus detection rate (EDR) is a parameter to describe estrus detection intensity. EDR is the proportion of cows identified in heat as a percentage of cows eligible for heat in a defined period. This parameter can be assessed by dividing the average length of the estrus cycle (21 days) by the mean interbreeding interval (IBI) of the herd, and express the result as a percentage. An advantage of the use of EDR is that nonperforming cows are also included in the calculations. A large number of short IBI due to inaccurate estrus detection leads to the overestimation of EDR. This index is inapplicable when hormonal synchronization programs are carried out, because the cows' estrus cycle is manipulated. Distinction can be made between EDR for first service and return to service EDR (Fetrow et al., 2007, DairyCo, 2012, Noakes et al., 2001, Farin and Slenning, 2001).
EDR covers the extent to which heat is expressed, as well as the efficiency of estrus detection. Inadequate nutrition, housing and certain health conditions lead to poor estrus expression. Insufficient observation of cows, poor building layout and staff overload can contribute to low estrus detection rates. When EDR is very high, a large proportion of cows not truly in estrus may be bred, leading to decreased conception rates. When only the cows most profoundly

showing signs of estrus are bred, EDR will be very low, though conception rate may be excellent. Optimal herd performance is reached when neither EDR, nor conception rate is at an extreme. Striving for higher and higher EDR may lead to increasing inaccuracy in estrus detection, therefore it may be counterproductive beyond a certain level (Farin and Slenning, 2001, DairyCo, 2012).

2.5.2. Breeding interval (interbreeding interval, IBI)

Breeding interval expresses the accuracy of heat detection and the selection of cows in heat for service, moreover, disorders occurring postinsemination influence this index, as well. IBI is calculated as follows: (average days open – days to first insemination)/(services per conception – 1). Since average days open is a skewed parameter, IBI is an imperfect measure, as well. Five ranges of IBI are distinguished: 2-17 days, 18-24 days (normal estrus cycle), 25-35 days, 36-48 days (twice the normal cycle) and > 48 days. In well-managed herds the proportion of the 18-24-day long intervals should exceed 45%. If the proportion of 36-48-day long intervals is high and the 18-24-day long is low, it probably refers to poor estrus detection. Increased proportion of 2-17-day long and 25-35-day long intervals show that identification of estrus is inaccurate. Higher percentages of intervals longer than the normal cycle length may reflect increased occurrence of late embryonic or early fetal deaths (Köcski, 2007, Farin and Slenning, 2001, Noakes et al., 2001). Estrus detection accuracy can be improved by performing progesterone tests, as well (if the cow is in heat, progesterone level must be low).

2.6. First service conception rate (also referred to as first service pregnancy rate or fertility)

This parameter is considered one of the best predictors of overall reproductive program success. First service conception rate is defined as the number of first services resulting in a pregnancy as a percentage of the total number of first services given over a certain time period. If 40 cows of 90 hold in-calf to the first service, then first service conception rate is (40/90)*100=44.4%. This index covers cow fertility, bull fertility and management influences (such as heat detection accuracy, AI timing and technique), as well. One must be aware that larger DIM to first service may result in better first service conception rate (Farin and Slenning, 2001, DairyCo, 2012, Köcski, 2007).

2.7. Services per conception

Two approaches exist in assessing services per conception: to use the number of pregnant cows or the total number of cows inseminated as the denominator. Services per conception (pregnant cows) has to be calculated as follows: the total number of inseminations must be given for each pregnant cow, then these values have to be summed up, and then divided by the number of pregnant cows. In this approach non-pregnant cows are not included in the calculations. Services per conception (all cows) is a better index for evaluating conception in the herd, because it includes all inseminations, whether the cow finally became pregnant or not. If the "all cows" parameter is much higher than the "pregnant cows" one, then there must be several problem breeders in the herd. The inverse of services per conception (all cows) parameter is the conception rate (Farin and Slenning, 2001, Varner et al., 2012).

2.8. Pregnancy rate (PR)

The definition of pregnancy rate varies among different sources. It is more widely used as the proportion of open cows that become pregnant during a specified period of time (usually 21 days), expressed as a percentage of eligible cows (Fetrow et al, 2007). Another definition is that PR is the number of services given to a defined group of cows or heifers, over a specified period of time, which result in a diagnosed pregnancy expressed as a percentage of the total number of all services and should include culled cows (Noakes et al., 2001). PR is usually calculated as the product of estrus detection rate and conception rate, however, this method is fraught with errors, since the inclusion of different groups of cows and the way of calculation of each parameter included may vary. It is much better to calculate PR directly from actual pregnancy diagnosis results. PR is a very useful index, which is up-to-date and not biased, since all eligible cows are included in the calculation. Trends can be observed by using PR as a monitoring parameter. PR has a significant effect on the number of inseminations required and the number of calves born. However, PR has little value in pinpointing the origin of any fertility problem. Another disadvantage is that the length of time from insemination to pregnancy examination affects the interpretation (early pregnancy diagnosis may lead to higher pregnancy rates and higher abortion rates, since a significant proportion of embryos observed on day 28 may not survive until day 42, for example). Thus, the method of pregnancy diagnosis should be specified (Farin and Slenning, 2001, DairyCo, 2012, Noakes et al., 2001, Fetrow et al., 2007).

2.9. Non-return rate (NRR)

The calculation of NRR relies on the basic assumption that an animal not subsequently recorded as re-served is pregnant. NRR is the percentage of females inseminated for the first time and not recorded as having returned for another service within a specified number of days. Although this index overestimates PR, it can be useful for comparing the performance of artificial insemination (AI) personnel and the fertility of different bulls. Therefore, this index is used particularly in AI centres (DairyCo, 2012, Noakes et al., 2001, ICAR, 2014).

2.10. Productivity

Productivity is the sum of the number of pregnant cows and the number of cows that calved in the last 3 months, divided by the number of cows, expressed as a percentage. It is considered good above 70% (Pál, 2012).

3. Economics of reproduction

Reduced milk production is the major source of financial loss when conception is delayed, because the cow spends more time at the end of lactation (when daily milk production is lower). In addition to this, inefficient reproduction leads to less calves born, higher semen and labour cost, higher veterinary cost and slower genetic progress, as well. Recent results of Hungarian surveys show that reproductive problems cause 130-270 EUR loss per cow annually and the cost of excess days open is 1.6-3 EUR per day (Fodor, 2011, Ózsvári, 2013).

4. The importance of reproductive indices in dairy herd management

Deriving the reproductive indices and comparing them to established standards, to the performance of other dairies or to the preceding performance of the same dairy is of utmost importance in the assessment of the efficiency of the reproductive management. However, results are comparable only if the definitions of reproductive parameters are used uniformly, which is lacking nowadays among Hungarian dairy farmers and veterinarians. Efforts should be made regarding uniform use of the indices. The milk quota system has been abolished in the EU recently, which puts dairy farms into a radically different economic context: milk prices will probably decrease in Hungary. The reproductive indices should be used properly and with high confidence to enhance efficient allocation of farm resources among the different fields of cow health management, therefore promoting competitiveness.

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