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DAIRY COW CALVING INTERVAL: OPTIMUM VERSUS ALLOWABLE LENGTH ; THEORY AND POSSIBLE USE IN HERD HEALTH PROGRAMS

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Au cours des années, la production laitière individuelle des vaches laitières a augmenté alors que les performances de reproduction ont diminué. Les chaleurs des vaches ne sont plus très visibles ou bien les vaches ne sont plus remplies aussi facilement après insémination. Ceci a entraîné une augmentation des incertitudes de vêlages. Sur le terrain, de nombreux vétérinaires conseillers d'élevage affirment que ceci n'est pas un problème car ils pensent préférable d'avoir une production élevée avec un long intervalle de vêlage et que la première insémination peut être reculée.

Dans cette contribution il sera montré que cette opinion est incorrecte d'un point de vue économique. Quand on s'intéresse d'un point de vue économique à l'intervalle de vêlage optimal de chaque vache, il est nécessaire de distinguer les intervalles de vêlages qui sont souhaités d'un côté et possibles d'un autre côté. Economiquement, l'intervalle de vêlage souhaitable, correspond à celui qui, pour une vache de base, produit le meilleur rapport par unité de temps (par exemple par jour, par an). C'est cet intervalle de vêlage que les éleveurs souhaiteraient obtenir. Pour le moment une vache ne peut pas avoir cet intervalle de vêlage optimal, parce qu'on ne peut pas observer ses chaleurs ou parce qu'il n'y a pas succès après la première insémination. La question qui se pose est de savoir qu'elle est la durée optimale de temps pendant laquelle l'éleveur doit continuer d'inséminer la vache avant la reforme ou le remplacement. Ceci représente l'intervalle de vêlage admissible et les choix les moins mauvais entre les deux options suivantes : les pertes dues à l'allongement de l'intervalle de vêlage ou les pertes dues à un avortement prématuré. Dans cette contribution les deux options sont investiguées et quantifiées dans différents élevages en fonction des prix pratiqués. Les outils ont été développés pour calculer l'intervalle de vêlage optimal et l'intervalle de vêlage admissible pour des vaches individuelles dans leurs conditions d'élevage. Ces outils seront utilisés dans des programmes de santé pour évaluer les décisions des éleveurs en matière de reproduction dans le passé (comparaison des intervalles de vêlage attendus avec les intervalles optimaux et admissibles), ainsi que les conseils d'inséminer ou non les vaches vides.

INTRODUCTION

Over the years, milk production of individual dairy cows has increased and reproductive performance has decreased. Cows do not clearly show heat or do not get pregnant after insemination that easily. This resulted in an increase in calving interval. In the field, many (veterinary) advisors state that it is no problem or even to be preferred for high producing cows to have a longer calving interval, and that the first insemination could be postponed.

When discussing optimum calving interval of individual dairy cows from an economic point of view, one should distinguish between the calving interval that is desirable and the one that is allowed. Economically desired is the calving interval that results, on a per cow basis, in the highest net return per time unit (e.g. per day, per year). This is the calving interval farmers should aim at. From the moment a cow cannot realise the optimum calving interval, because of showing no heat or no conception after earlier inseminations, the question arises how long the farmer should continue inseminating the cow before culling and replacement becomes more profitable. This is the calving interval that is allowable from an economic point of view. The allowable calving interval is about the choice between two evils: losses due to lengthened calving interval or losses due to premature disposal. In both cases, there are losses. The allowable length of the calving interval is something completely different from the economic desirable calving interval. In discussions on calving interval these two concepts are often mixed, which leads to confusion. In this paper both concepts will be elaborated for different farm and price circumstances.

DESIRED CALVING INTERVAL

The optimum length of the calving interval and the losses in case of lengthening are dependent on a large number of factors. It is therefore impossible to come up with one figure for the losses which is valid for all farms and under all circumstances. With the computer program TACT-Dairy Animal Management (Jalvingh, 1993) these calculations can be carried out simply and quickly. For the calculation of the optimum calving interval the program calculates for 7 different calving intervals (11 till 17 months) revenues from milk and calves and costs of feed and expresses the gross margin on an annual basis. Calculations take place for different lactations, and seasonality can also be taken into account. The calving interval with the highest gross margin on an annual basis is the optimum calving interval.

Calculations in this paper have been carried out for a farm with an average production of 7500 kg of milk, milk price of 0.75 Dfl per kg and price of new-born calves of 350 Dfl. The farm produces its own roughage and purchases concentrates for 0.35 Dfl per kg. Calculations are carried out for a situation with a milk quota which is

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produced with as few cows as possible. Shortening the calving interval results in a higher production per cow per time unit, which means that fewer cows are needed to produce the farm's quota. Therefore, the value of an extra kg of milk is determined by the variable costs that could be saved and is dependent on the opportunity costs for the fixed costs; what alternatives does the farmer have for use of the fixed production factors that become available (labour, capital, buildings). In the calculations it has been assumed that the farmer has a good alternative (e.g. rearing heifers for export) and the value of an extra kg of milk is assumed to be 0.30 Dfl.
Table I gives the results for the basic situation and some alternatives. Presented is the marginal loss per day lengthening of the calving interval, which represents the additional losses compared to the preceding interval. The optimum calving interval for an average cow (weighed according to the age structure of the herd) is 11 months. The losses of an extra day calving interval increase when the calving interval increases. Lengthening the calving interval from 11 to 12 months costs 1.03 Dfl per day, where as a lengthening from 16 to 17 months costs 2.94 Dfl per day. The losses are higher for older cows than for younger animals. For first lactation cows the optimum calving interval is even 12 months, due to the flatter lactation curve of these animals. These figures can be used to calculate for a herd the average loss per cow, given the distribution over calving intervals.
In Alternative 1 the calf revenues are reduced by 100 Dfl, which does not have much impact on the losses due to the sub-optimum calving interval. Better persistence of milk production (Alternative 2) results in a large reduction of the losses. The difference between 11 and 12 months becomes very small. When the value of an extra kg of milk is reduced till 0.15 Dfl per kg (Alternative 3), which means that only variable costs can be saved and no alternative is available for (empty) fixed production factors, the losses are reduced. When all alternatives are combined (Alternative 4) the losses are much lower than in the basic situation. The losses per day are never greater than 1 Dutch guilder, but the optimum length remains 11 months. When additionally milk production is raised till 9000 kg (Alternative 5) the level of losses does not change much compared to Alternative 4, but the optimum length shifts slightly from 11 to 12 months.

Table I
Optimum length of calving interval (losses are zero) and marginal losses per extra day calving interval (in Dfl) for an average cow for different situations (Dfl).

	Calving interval (months)						
	11	12	13	14	15	16	17
Basic	0.00	1.03	2.16	2.54	2.82	2.87	2.94
1: Calves -100 Dfl	0.00	0.75	1.93	2.34	2.65	2.72	2.81
2: Persistency +10%	0.00	0.15	0.94	1.16	1.40	1.72	1.82
3: Net value extra kg milk 0.15 Dfl	0.00	0.82	1.37	1.55	1.70	1.71	1.74
4: 1 + 2 + 3	0.00	0.10	0.51	0.63	0.75	0.95	0.99
5: 4, 9000 kg milk	0.08	0.00	0.58	0.71	0.85	1.03	1.13

From these results it can be concluded that the optimum length of the calving interval is not strongly influenced by modifications in the farm and price conditions. The losses of lengthening the calving interval are much more influenced and will vary from farm to farm.

ALLOWABLE CALVING INTERVAL

The calving interval farmers should aim at is still around one year, but no farmer will be able to realise this calving interval for all the cows in the herd. Not all cows will come in oestrus again in time, oestres may be missed and also conception rate is not equal to 100%. Houben (1995) developed a dynamic programming model that determines for individual cows the optimum decision when the optimum calving interval cannot be reached anymore. The program optimises the choice between inseminating a cow again and accepting the longer calving interval or stop inseminating and replacing the cow later on in the lactation and accept the losses due to premature disposal. Allowable calving interval varies from 11 to 17 months. The risk that a high-producing animal may have a low future production and the risk that an animal may by replaced by a low-producing animal can both be taken into account. Calculations with the dynamic programming model can be carried out under different farm and price conditions. Expected net returns can be maximised per kg of milk (quota situation) or per cow. Furthermore, opportunity costs for labour and housing can be included or set to zero.
Table II contains some outcomes of calculations when maximising the net returns per kg of milk for situations with and without opportunity costs for labour and housing. The allowable calving interval increases with production level and decreases with age. The level of opportunity costs for housing and labour has a considerable effect on the allowable calving interval. When opportunity costs are set to zero, cows with a low production have a longer allowable calving interval, and will consequently stay longer in the herd. In case a farmer consequently applies the advised allowable calving intervals belonging to opportunity costs set to zero, the average calving interval of the herd is increased by 13 days. When opportunity costs are set to zero, in many cases inseminations resulting in an 11-month calving interval should be postponed. When maximising the net returns per cow, the level of opportunity costs for labour and housing showed hardly any effect on the length of the allowable calving interval. The allowable calving intervals equal the intervals calculated for the situation with maximisation per kg of milk including opportunity costs.
For more than a decade farmers in the Netherlands have been faced with milk quotas. Many farmers do not have alternatives available for production factors that become available, and hence have no opportunity costs. This means that farmers should be more tolerant towards low producing cows. When they already have done this over the past years, this may partly explain the increase in calving interval that has been observed in the Netherlands. The dynamic programming model can generate for each individual farm the allowable calving intervals for the cows that are present in the herd. Next to allowable calving intervals, the model calculates at time steps of 1 month whether a cow should be replaced in the current month or not.

Table II

Allowable calving interval (months)[1] for different combinations of lactation number, production level and opportunity costs for labour and housing.

Lactation number	Relative production level (%)[2] 74-78 w/[3]	74-78 w/o	86-90 w/	86-90 w/o	98-102 w/	98-102 w/o	110-114 w/	110-114 w/o	122-126 w/	122-126 w/o
1	-	14	12	17	16	17	17	17*	17	17*
2	-	13	14	17	17	17*	17	17*	17	17*
3	-	12 *[4]	13	15	17	17*	17	17*	17	17*
4	-	-	13	15	16	17*	17	17*	17	17*
5	-	-	12	14	15	16*	17	17*	17	17*
6	-	-	12	12 *	15	15*	17	17*	17	17*
7	-	-	-	-	14	14*	16	16*	17	17*
8	-	-	-	-	13	12*	15	15*	17	16*
9	-	-	-	-	-	-	14	13*	16	15*
10	-	-	-	-	-	-	13	-	15	13*

1) Allowable calving interval ranges from 11 to 17 months, or none is allowed (-)
2) Relative to cows of same age and month of lactation.
3) With (w/) and without (w/o) opportunity costs for labour and housing.
4) Calving interval 11 months should be avoided (*)

MODIFY CALVING INTERVAL

Jalvingh (1993) developed a dynamic probabilistic simulation model that simulates herd dynamics (TACT-Dairy Animal Management). Cows vary in age, calving interval, season of calving and production level. The model can be used to compare the current situation of the herd with situations in which certain input parameters on reproduction and replacement have changed, for instance a reduced interval calving-first insemination or improved heat detection. The consequences for herd dynamics, including calving interval, are generated and additionally technical and economic results of the herd are calculated. In Table III results are presented for a situation in which a basic situation is compared with alternatives in which the interval calving-first insemination is reduced and/or conception rate is increased. Furthermore, the model can be combined with linear programming to determine the economic consequences of optimising calving pattern, in combination with improving reproductive performance (Jalvingh et al., 1994).

Table III

Major input and results for basic situation and alternatives in which reproductive management has improved. Results of alternatives are presented as deviation from the basic situation.

	Basic situation	Alternative 1	Alternative 2	Alternative 3
Input				
Interval calving-1st insemination (days)	90	-14		-14
Conception rate (%)	40		+20	+20
Results				
Calving interval (days)	399	-11	-16	-28
% Calving interval ≥ 14 months	33.2	-6.8	-13.6	-19.7
Culling rate (%)	34.2	-1.2	-5.7	-6.5
Milk production per cow (kg)	6840	+76	+162	+247
Average number of cows	61.4	-0.7	-1.4	-2.1
Gross margin (Dfl per cow)	3644	+54	+135	+192
Gross margin (Dfl per kg of milk)	53.27	+0.20	+0.70	+0.85
Gross margin (Dfl per herd)	223727	+865	+2963	+3590

FUTURE OUTLOOK

The tools described in this paper have been developed to calculate the optimum calving interval and the allowable calving interval for individual cow and farm conditions. These tools can be used in herd health programs to evaluate farmers' reproductive decision making in the past (compare expected calving interval with optimum and allowable interval) and to advise on whether or not to inseminate open cows. In this it will be important to use the optimisation criterion that fits best with the individual farm (per cow or per kg of milk; with or without opportunity costs for labour and housing). Furthermore, the economic impact of using allowable calving intervals as guide for inseminating open cows can be calculated, next to the economic impact of improving reproductive performance through changes in management (e.g. heat detection). In the Netherlands activities are underway to get these tools available for individual farms by implementing them in herd health programs.

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