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ANALYSIS OF INVESTMENT IN AN ESTRUS DETECTION SYSTEM FOR DAIRY FARMS

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Introduction

Activity meters have been studied and are used in practice for the automated detection of estrus in dairy farming. Whereas, information on the economic consequences of using activity meters for automated detection of estrus is lacking. This information is, however, important for farmers to make an informed investment decision and for sensor manufacturers to explain the value of their product to farmers. The current study analyses the economic benefits of a sensor system for the detection of estrus, discusses its financial feasibility and appraises the investment in such a system.

Method

A herd level stochastic dynamic simulation model (adapted from Inchasiri et al. [1]) was used to simulate reproductive performance (including reproductive diseases) of a dairy herd. In short, this model simulates the reproductive status of a cow in weekly time steps and calculates the resulting milk production and number of calves born. The number of cow places is fixed to 130, therefore the model starts with 130 randomly drawn cows (in a Monte Carlo process) and simulates calvings and replacement of these cows in subsequent years. The herd is simulated over a ten year period for 385 herds. Default herd characteristics were a conception rate of 50%, an 8 week dry off period. A Wood lactation curve was adjusted for the cows parity and milk production level (average 8310 kg/cow/305 days). As pregnancy will decrease milk production, the milk production was corrected for each weak in gestation.
Model inputs were derived from real farm data, obtained from Cattle Breeding Company, CRV. The distributions used for milk production and length of the recovery period after a reproductive disease were not available in the farm data, and were based on expertise. For the analysis, visual detection by the farmer is compared to automated detection with a sensor, in this case activity meters. For visual estrus detection, an estrus detection rate of 50% with an specificity of 100% was assumed. Accordingly, for automated estrus detection, an estrus detection rate of 80% with a specificity of 95% was assumed. The detection rate of activity meters was based on available literature. Price used to calculate the cash flow for the investment analysis were based on literature and expertise. The following prices were used, milk price 0.32 €/kg, feed cost 0.16188 €/kVEM, 30.23 €/insemination, calving management152 €/calf, calf sales 100 €/calf, labor cost 18 €/hr and replacement costs based on slaughter values and replacement heifer prices.

Results

Results (Table 1) show that an estrus detection rate of 50% results in an average calving interval of 419 days and an average yearly milk production of 1,032,278 kg. For activity meters, the results show that an estrus detection rate of 80% result in an average calving interval of 403 days, and an average yearly milk production of 1,043,751kg. Furthermore, 1.55 and 1.67 inseminations were needed per calf when visual estrus detection and activity meters were used respectively. In addition, the specificity of 95 results in 25 false alarms per herd per year, in the period that the cow was both open and not in the voluntary waiting period (first twelve weeks postpartum, in which it is assumed that the farmer is voluntarily waiting with insemination of the cow).

Table 1: Average yearly performance of a simulated herd of 130 cows with visual estrus detection by the farmer and sensor based detection by activity meters.

	Milk production (kg)	False inseminations	Number of calves	Inseminations per calf
Visual 0.5 / 1[1]	1,032,278	0	144	1.55
Activity meters 0.8 / 0.95[1]	1,043,751	25	147	1.67

[1] Estrus detection rate / specificity

It was estimated that for a herd of 130 cows the investment for activity meters would be €18,178. The yearly net cash flow is calculated by adding up increased revenues of milk and calves sold, extra costs of increased number of inseminations, calving and feed use, and the reduced costs of culling and labor, caused by the difference in detection sensitivity and specificity. Table 2 shows that the net present value (NPV), benefit-cost ratio (B/C), the internal rate of return (IRR) and discounted payback period (DPBP in years) all indicate that the investment in activity meters is profitable. Returns are lower when a farmer would blindly inseminate cows after each alert of the sensor, than when a farmer would first confirm the alert.

Table 2: Investment appraisal over ten year period, with average cash flows in €/year, Purchase of activity meters, Net Present Value, Benefit-Cost ratio, Internal Rate of Return and Discounted PayBack period (in years). Results are shown for two scenario's blindly inseminate cows upon an estrus alert from the activity meters or visually confirm that the cow is in estrus before insemination.

Scenario		Cash flow	Purchase	NPV	B/C ratio	IRR	DPBP
Blind	Average	2,802	18,178	3,455	1.19	9%	9
	5%	3,060	18,178	5,449	1.30	11%	8
	95%	2,780	18,178	3,285	1.18	9%	9
Confirmation	Average	3,151	18,178	6,155	1.34	11%	7
	5%	3,389	18,178	7,989	1.44	13%	7
	95%	3,082	18,178	5,618	1.31	11%	8

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