LABOUR USAGE AND ENVIRONMENT

Model-based calving monitor using real time image analysis

The onset of parturition in bovines can be identified by the occurrence of particular behaviour activities such as an increase in the frequency of standing/lying, standing without eating or drinking and occurrence of prostrate lying (sideways with legs stretched). The stockperson uses such behaviours to monitor the progress of parturition and to decide if intervention is necessary to assist the cow.

The objective of this study is to develop a system that makes use of image analysis to identify calving behaviour in an automated way.

In order to identify calving behaviour patterns five pens of nominal dimensions 4.6m X 3.3m were instrumented with cameras and recording equipment in the existing calving facilities at Grange Research Centre. Two cameras were used on each pen (a) an overhead camera which generated a top view of the calving event and (b) a side view camera which generated the normal view of the calving event as seen by the stockperson. Images of cows approaching parturition were subsequently labelled at 10 second intervals (position in pen, lying or standing, type of lying, whether eating or drinking).

The camera images were analysed using a model-based method. After detecting the animal, a 2D model was fitted to its outline. This approach allowed a quantitative description of its body configuration along with its position and orientation with respect to the pen in the image. The model used is a flexible point distribution model where the output consists of 10 points at consistent positions along the outline of the animal (Figure 10).

The image analysis method was used on video images in an automated way by applying it to each subsequent image in the video sequence. The resulting output of the method when applied to a video sequence consisted of the animal's position, orientation and body configuration as a function of time. Using these outputs, calving behaviours such as distance walked, orientation, standing/lying, eating/drinking behaviour can potentially be identified.

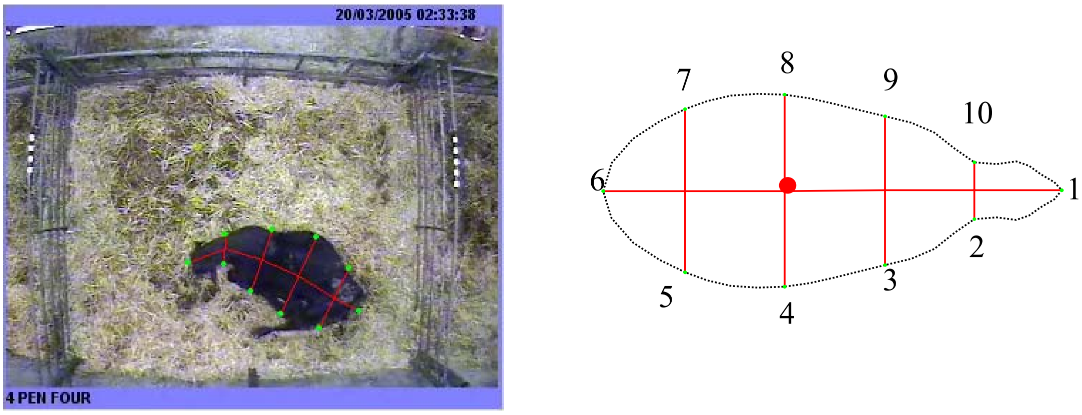

Figure 10. Screenshot of the image analysis output and the 2D model used. The model output consists of 10 points at consistent positions along the outline of the animal.

A changes in standing/lying behaviour is an important indicator of the progress of parturition. An example of the method of analysis to automatically indicate such behaviour patterns is presented for a one hour video sequence of a cow from 02h00-03h00. The cumulative distance walked starting from 02h00 is plotted as a function of time in Figure 11. Standing periods could be differentiated by the steep increase in the cumulative distance walked. While there should be no accumulation of distance walked during lying, the slow increase recorded is due to the limited amount of movement that the cow makes when recumbent.

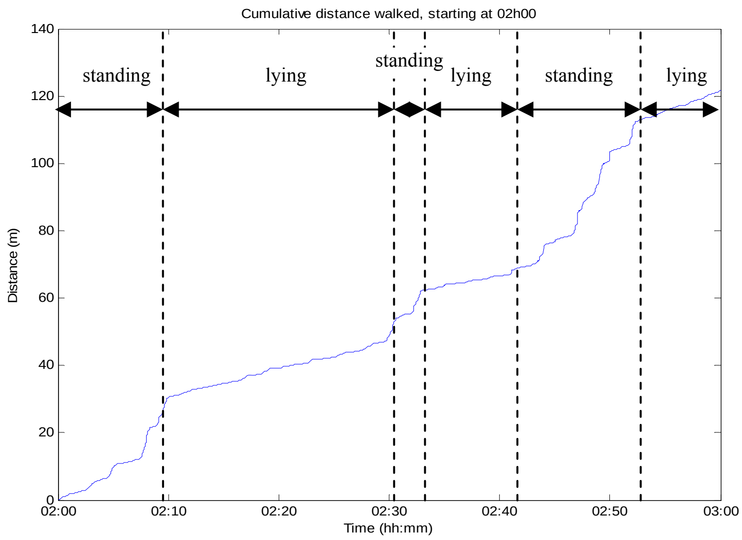

Figure 11: Cow cumulative distance walked in meters from 02h00 to 03h00 as a function of time. A manual reference labelling of standing/lying behaviour is indicated.

A second method to identify the standing/lying times uses changes in body width to length ratio. The classification was performed by applying a threshold on a moving average of the measured body width/length ratio. The outcome was plotted as a function of time in Figure 12. Applying a more accurate threshold and/or combining the data in Figures 11 and 12 can improve the precision in detection of lying or standing events.

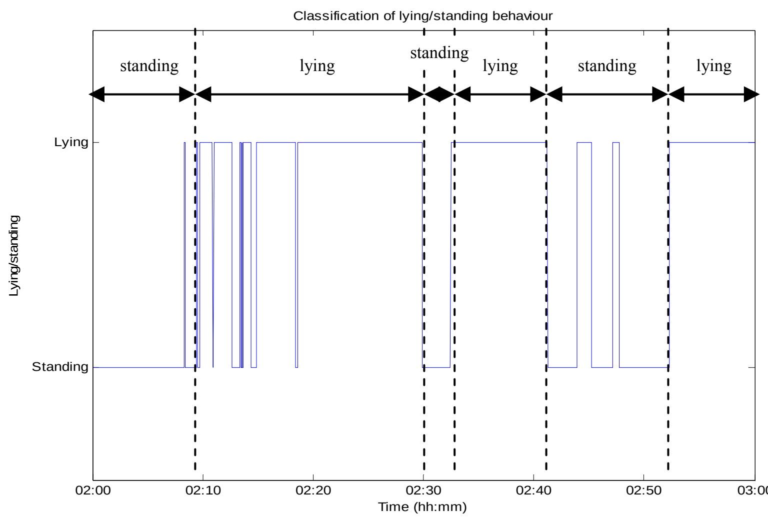

Figure 12. The automatic classification of lying/standing behaviour from 02h00 to 03h00 as a function of time. A manual reference labelling of standing/lying behaviour is indicated.

The potential for using image analysis in the development of an automatic calving monitor has been identified. Research is continuing to refine the model and to establish consistent behaviour patterns which best indicate the stage of parturition and that can be automatically detected.

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Intensity of agricultural contractors usage on suckler beef farms in Ireland

Agricultural contractors have an important support role on suckler beef farms. Data to quantify the usage of agricultural contractors were collected for 115 spring calving suckler farms over a 12 month period. Each month the participating farmers completed a questionnaire documenting the type and duration of contractor usage. A total of 616 suckler beef enterprise contractor related tasks were identified over the 12 month period. The tasks were forage conservation, manure handling, land maintenance, building maintenance, fencing, hedge-cutting, fertiliser spreading and animal husbandry. Results from the study show that contractors were employed for a total of 11,719 hrs. Contractors were used for 5,983 hrs on forage conservation attending 98 farms (197 tasks) with a mean of 2.0 visits per farm and a duration of 30.4 man hours per visit. Details of all the contractor tasks are presented in Table 46. It is of interest that forage conservation and manure handling accounted for 51% and 15% of all contractor time, respectively, in contrast to hedge cutting and fertiliser spreading which accounted for 4% and 1%, respectively. Eighty-five percent of farms employed contractors for forage conservation compared to only 10% of farmers employing contractors for fencing. It is of interest that the hrs/visit for conservation was 30.4 h, for manure handling 10.3 h and for fertiliser spreading at 4.3 h.

Table 46: Agricultural contractor usage on suckler beef farm by task, numbers of visits and time per visit

Task	Total hrs	% of farms	No. of visits	Time (h)/visit
Forage conservation	5983	85	2.0	30.4
Manure handling	1736	57	2.6	10.3
Land maintenance	1613	33	1.5	28.8
Building maintenance	1026	16	1.9	30.2
Fencing	370	10	2.0	16.8
Hedge-cutting	458	30	1.4	10.0
Fertiliser spreading	104	15	1.4	4.3
Animal husbandry	419	19	3.0	6.3

As the size of farms increased the contractor input increased. For small (34 ha), medium (54 ha) and large (121 ha) farms the contractor mean time input for forage conservation was 41.7, 61.2 and 79.7 h respectively (Table 47). Full-time (85) and part-time (30) farmers appeared to have a similar demand for contractors (Table 47). For full (79 ha) and part-time 948 ha) farms the contractor mean time input for forage conservation was 65.8 and 47.9 h, respectively. The corresponding value for manure handling was 26.8 and 25.1 h. As farm size increased the contractor time for conservation increased, however, proportion of farms using contractors was similar across all farm sizes. The dependence on contractor use for manure handling decreased as farm size increased from 74% of small farms to 42% of large farms. In respect of land maintenance a greater proportion of the large farms compared to small farms used contractors for land maintenance.

Table 47: Agricultural contractor usage on small, medium and large farms and for full- and part-time farmers for main tasks by number of visits and time per visit

Task	Total hrs	% of farms	No. of visits	Time (h)/visit
Conservation				
Small farms (38)	1333	84	1.8	23.0
Medium farms (39)	2021	85	2.1	28.9
Large farms (38)	2630	84	2.1	38.1
Full-time (85)	4737	85	2.1	31.2
Part-time (30)	1247	87	1.7	27.7
Manure Handling				
Small farms (38)	550	74	2.1	9.5
Medium farms (39)	579	56	2.9	9.1
Large farms (38)	607	42	2.9	12.9
Full-time (85)	1233	49	2.7	10.1
Part-time (30)	503	67	2.3	10.9
Land Maintenance				
Small farms (38)	141	29	1.2	10.9
Medium farms (39)	564	28	1.5	35.3
Large farms (38)	908	42	1.7	33.6
Full-time (85)	1456	35	1.5	32.4
Part-time (30)	157	27	1.4	14.3

This study shows the considerable dependence of the suckler beef farmer on the agricultural contractor, with conservation accounting for 197 tasks and 51% of contractor time and slurry accounting for 169 tasks and 15% of contractor time. With the predicted increase in the number of part-time farmers operating suckler beef enterprises it is critical that both the farmer and the contractor forward plan so that tasks can be efficiently undertaken.

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Effect of low-rate intermittent aeration on nutrient concentration and homogeneity of beef cattle slurry

The Nitrates Regulations establish that animal slurry must be considered as a valuable source of nutrients which must be taken into account when calculating crop nutrient requirements. It is, therefore, desirable that landspread slurry is homogeneous to ensure that even distribution of nutrients is achieved. During storage, slurry stratifies into different layers. Conventional slurry management includes agitation, whereby stored stratified slurry must be mixed *in situ* prior to landspreading. The effect of low-rate intermittent aeration on beef cattle slurry has been investigated to establish whether there is any difference in a) slurry stratification between conventionally managed slurry and aerated slurry during the slurry storage period, and b) nutrient concentration between conventionally managed agitated slurry and aerated slurry. The hypotheses were that (i) aeration would reduce stratification of beef cattle slurry during storage and (ii) that aeration would have an effect on nutrient concentration of the stored slurry.

A beef cattle shed divided into twelve slatted floor pens underlain by six underfloor slurry tanks was selected for the experiment. Each slurry tank was overlain by two cattle pens. A low-rate intermittent aeration system (Milbury Systems Ltd.) was installed in three of the six slatted tanks. Fourteen animals were housed in each pen and fed the same diet (grass silage *ad libitum* plus 3 kg concentrates). The experiment commenced on 22 December 2005 lasted for

99 days. On the advice of the aeration system manufacturer, water was added to each of the six tanks early in the animal housing period (day 47). The cattle were removed and slurry samples taken at various depths and distances from the feed face within each tank. The samples were analysed for dry matter concentration (DM), pH and electroconductivity (EC) as it was considered that these parameters were good indicators of slurry homogeneity. Aerated slurry was then pumped to a reception tank and slurry samples collected from the pump outlet at varying times during the pumping period. Test pumping of conventionally managed slurry was carried out and it was concluded that agitation was required. Water was added to two of the non-aerated tanks during agitation to aid the mixing (14% and 31% of slurry volume, respectively). The agitated diluted slurry was pumped to a reception tank and slurry samples collected as for aerated slurry. The slurry samples from each treatment were composited and analysed for EC, pH and DM. Differences between treatments were tested by a two-sample paired t-test. Samples of pumped agitated slurry and pumped aerated slurry were collected and their nutrient composition analysed.

Table 48: Means and standard deviations of both slurry treatments sampled from slatted tanks

Treatment		pH	EC µS/cm	DM g/kg
Conventionally	mean	7.67	33.11	106.31
managed slurry	s.d.	0.34	4.90	28.78
Aerated slurry	mean	7.72	35.22	90.32
	s.d.	0.18	2.04	9.57

In Table 48 standard deviation values of pH for both treatments show small dispersion about the mean. However, standard deviations of EC and DM values are greater for conventionally managed slurry than for aerated slurry which indicates that slurry samples taken from conventionally managed tanks were more variable than those sampled from the aerated slurry tanks. It is reasonable to suggest that beef cattle slurry which has undergone low-rate intermittent aeration is in a more homogeneous state than conventionally managed slurry. During the pumping phase, it was possible to pump the aerated slurry directly to the reception tank without requiring agitation or further water addition, whereas, both agitation and water addition were required for the conventionally managed slurry. Average DM values for all samples taken during the pumping phase for both treatments are presented in Table 49.

Table 49: Average DM (g/kg) for both treatments from all samples obtained during pumping phase

Treatment	Conventionally managed mixed slurry	Aerated slurry
Mean	89.0	93.1
s.d.	8.59	6.05

Treatment effect on chemical composition of beef cattle slurry pumped from underfloor slatted tanks is presented in Table 50. Samples taken from each tank were composited prior to analysis (one nutrient composition analysis per tank).

Table 50: Effect of treatment on slurry nutrient composition of bulked samples of slurry collected during pumping

Chemical composition	Pumped conventionally managed slurry	Pumped aerated slurry		
	mean	mean	Probability	s.e.m.
Total soluble P g/kg DM	0.94	0.97	0.75	0.067
Total P g/kg DM	8.22	7.77	0.42	0.353
Nitrogen g/kg DM	46.3	49.1	0.10	0.95
NH_3 g/kg DM	27.9	29.9	0.31	1.24
K g/kg DM	59.9	64.5	0.24	2.35
pH	7.6	7.5	0.21	0.06
EC µS/cm	32.4	35.0	0.12	0.94
DM g/kg	87.2	89.2	0.77	4.5

This experiment indicates that low-rate intermittent slurry aeration reduces stratification of beef cattle slurry during storage. Furthermore, low-rate intermittent aeration does not appear to have an effect on nutrient concentration of stored beef cattle slurry.

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