

Smart Dairy Farming: care for individual cows

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Abstract

Traditionally a dairy farm is managed on the basis of observations of the farmer. He observes the herd a couple of times a day and attention is paid to the individual animal twice or three times a day during milking. The general increase in average farm size leaves the farmers less time for individual animals. Sensor systems and methods for automatic recognition of special care animals are able to assist the farmer in giving the required attention to the herd and individual animals. In the Dutch Smart Dairy farming (SDF) project farmers, breeding industries, feed suppliers, dairy industries, sensor, system and software developers, education and research co-workers cooperate in the development of these supporting systems and methods. The project is focussing on an integrated approach for sensing and information sharing. The following aspects are relevant: sensing, data exchange, data ownership/protection, modelling, financial impact, user interface and education and training. One of the aspects were the research project is focussing on is the use of a Dairy Facility Use Controller (DFUC). Basis for the DFUC is data received from sensors that report the activity and the position of the individual animals continuously. The sensor information can be based on sensors that are attached to the individual animals or based upon sensors that recognize the presence of a cow (e.g. cow id in concentrate box). Another research topic is the development of a Dairy Exchange Module (DEM). The DEM is used for information exchange and therefor stores sensor data (including measuring data), farmer and expert observations. The reports of decision support models are also stored in the DEM.

Keywords: sensors, models, smart, dairy, farming, chain, transparency

Introduction

The dairy sector is facing enormous challenges due to economics of scale, fluctuating milk prices and societal concerns for animal health, animal welfare and environment. From the public society there is a growing need to monitor animal health and welfare (e.g. Welfare Quality® project, Blokhuis,2009). Good animal health and welfare is needed to continue the 'license to produce' coverage. Due to the growing number of cows per farm the farmer has less time available per individual animal. This means that there is a clear need to properly and efficiently monitor and manage critical processes around the cow. Examples are the early and proper detection of cows with health problems and the timely insemination of cows in heat. A continuous attention for the critical processes around the individual cows is important for maintaining a sustainable profitable and socially acceptable dairy supply chain.

Companies within the Dutch dairy sector have launched a project focusing on a broader usage of information available in the dairy chain. In this Smart Dairy Farming (SDF) project the role of dairy farmer is a crucial one. Within SDF it is all about attention to the individual cow and addressing several issues regarding the sustainability of dairy farming. In managing

and controlling complex processes, sensor- and information technology has a role of increasing interest. The parties active in the project expect that dairy farmers financially and practically will profit from the use of supporting technology (ICT, sensors, models) for the operational management of individual cows.

Industrial parties in the SDF project (dairy: Royal Friesland Campina, feed: Agrifirm and breeding: CRV) want to cooperate in the SDF project with innovative farmers, systems innovators, researchers, extension workers, teachers and veterinarians on supply chain management (genetics-feed-farmer-dairy) to create added value for the whole dairy sector.

Structure, partners involved and focus of the SDF project

SDF has work packages on the topics: sensor development, model development, chain transparency and learning network, the developments will focus on the optimization of feeding, fertility and health aspects of animals. The development lines will be the basis for interactions and cooperation between the work packages (Figure 1); motivating farmers, breeding industries, feed suppliers, dairy industries, dairy sensor, system and software developers, educators and researchers to cooperate in the SDF project.

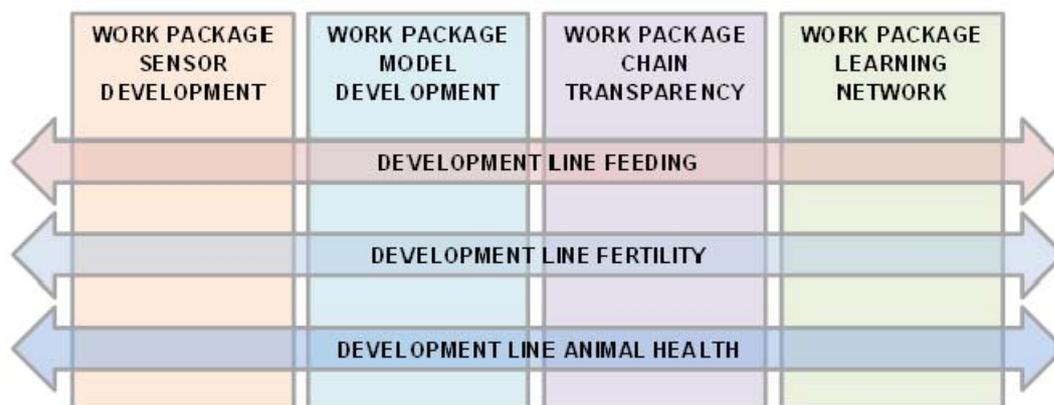


Figure 1. The smart dairy farming project has four work packages and three developing lines for stimulating the cooperation between work packages.

The successful application of sensor- and management information systems in livestock is depending on three aspects:

1. Characterization of processes and parameters through data recording and sensor measurements: measurements shall give reliable information, having a high correlation with parameter(s) measured, outliers shall be recognized and removed automatically; data recording shall be automated and the process of collecting the information shall not have a negative impact on the animal welfare and the farmer's workload shall not increase.
2. All relevant information available shall be automatically analysed, characterising trends and signalling abnormalities.
3. The abnormalities and changes in trends shall be brought under the attention of the farmer together with an advice on action to be taken.

Sensor development: SDF will use the currently available sensor systems as base and will research the possibility of integrating new techniques. The basis for the developments is individual identification of the animals and the recording of animal related information in databases. Systems for milk recording and concentrate dispensing have already wide application in dairy farming, innovative farmers have started working with automatic heat detection on the basis of animal activity level and heat, mastitis and metabolic disorders are monitored with systems analysing the milk composition. Systems that might become available during the coming years are monitoring general metabolic disorders on the basis pH and temperature (measured with a bolus in the rumen), modules recording body condition on the basis of weight, weight fluctuations and image analysis and systems monitoring and controlling the activities of individual animals during the day.

Model development: The data of the sensor systems shall be transformed into information that the farmer can use in his daily farm management. These software tools recognize patterns being abnormal for a specific animal (André et al., 2011). The models focus on an integrated approach where all available information is considered with intention of improving detection of and oestrus, disease warning and nutrition disorders (Mol de et al., 1999). Challenging aspect of this approach is the access to the different data sources on the farm and from outside the farm. A platform shall be created for exchanging information, regulating ownership and admittance. Not only the farmer benefits from this Dairy Exchange Module (DEM), but also parties in the dairy chain. Standard operation procedures (SOP's) will be developed for guiding the farmer which actions shall be taken when detecting abnormalities.

Chain transparency: The information in the DEM can be the basis of increasing transparency in the dairy chain. From the dairy industry there is increasing interest of sharing information with the consumers of their products. Consumers are interested in having access to the full processing chain of products and consumers want to have the possibility to choose products on the basis of their own convictions. The exchange of information is crucial in offering the requested transparency. By having access to information suppliers can offer products and services focussing on the specific farm-situations. The dairy can have detailed information available before on farm milk collection. The work package 'Chain transparency' will invest on tools for facilitating the exchange of information.

Learning network: The project will create a platform where farmers, feed suppliers, breeders, dairy, education, universities, research, veterinarians and governmental institutions can learn and benefit from each other. The work package 'Learning network' is creating this platform for exchanging views and experiences. This network can also be used for aligning new products and services with requirements and expectations of farmers. This helps in the development of products being applicable in the day to day farming practise, which will have a positive impact on market acceptance of the new products and services.

Dairy Facility Use Controller

Controlling the in barn facility use of cows was studied one decade ago in relation to automatic milking (Halachmi et. al 2000). Through the availability of new sensor technologies and identification methods the possibilities to register the behaviour of individual cows has increased. The investigation into what this information can contribute to

the dairy farm is still in its infancy and translating this information in actions for the dairy farmer is still virtually unexplored.

One of the obvious applications of the Dairy Facility Use Controller (DFUC) is being a tool for guiding the farmer to a specific animal in a group of animals. This tool can be useful when an animal has to be caught and separated for veterinarian treatment or when an animal has to be retrieved for milking in an automatic milking system.

The SDF project is looking for other useful farm management related applications for this DFUC, e.g. reduced activity of a specific animal could relate to claw problems of that animal and a disturbed laying / standing rhythm of several cows could be interpreted as having insufficient suitable cubicles available. The technology can monitor the grazing behaviour of animals, giving information about the duration of their grazing period.

The DFUC can track the rough position of individual cows on the basis of information from the facilities using radio frequency identification in the barn and pasture (e.g. concentrate boxes, selection gates and milking boxes). A more detailed position can be obtained by triangulation of signals of sensors attached to animals communicating with beacons in the stable and or pasture with known positions.

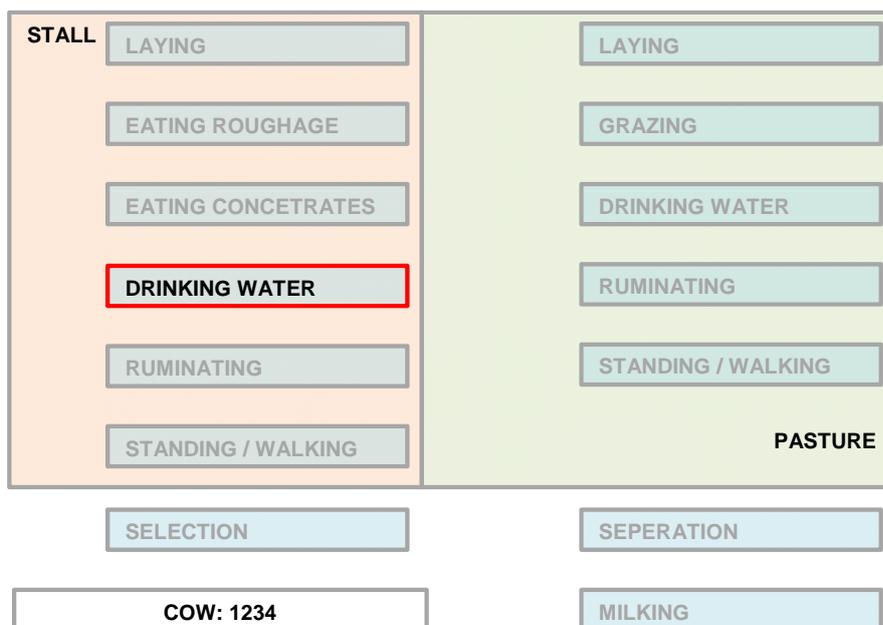


Figure 2. The Dairy Facility Use Controller tool monitors the activities of the individual cow during the day.

Dairy Exchange Module

The DEM is based on the experience the project partner TNO gained from the IJkdijk project (<http://www.ijkdijk.eu/Home>). The IJkdijk focuses on the development, testing and validation of sensor systems in water defence systems. The interfacing of different information systems and the exchange of data and information which is a crucial component in this system is also becoming of more importance for the livestock sector and especially in dairy. In SDF project a first step will be taken in developing a DEM.

The tradition of dairy farmers to purchase equipment and systems from one brand has resulted in a situation that company's tend to work with their own developed interface and to create costume made solutions when having a need of sharing information.

Systems collecting additional dairy farm information (for example, the weighing of animals) can be purchased separately from milking equipment and concentrates dispensers. However, these systems should preferably be used in combination with the conventional equipment (as for example, a weighing platform can be installed in a concentrate station or at the entrance or exit of a milking parlour). It is important that the information collected by the additional systems can be linked to other information. And that information of such systems is integrated in the management system so that the farmer has one user interface. The DEM can be the tool to link all on farm information systems and can be used to link the farm information to information of other farms and external information sources (see figure 3).

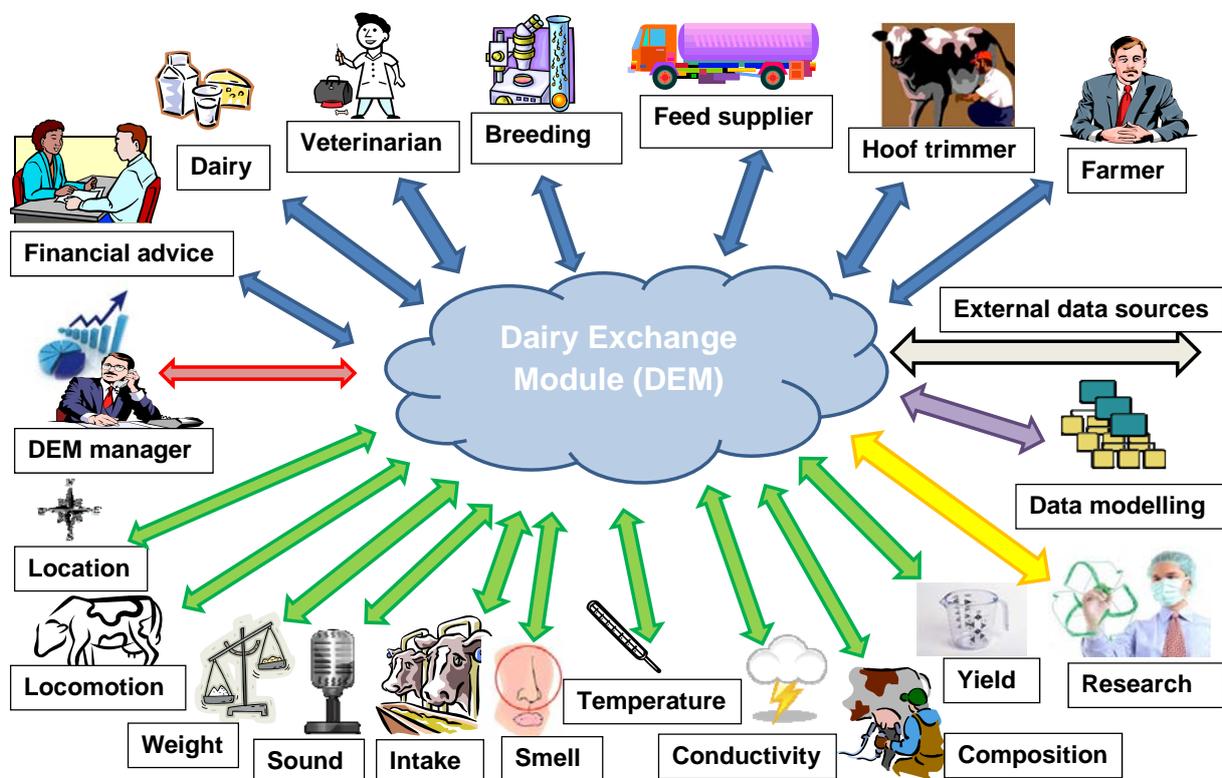


Figure 3: The Dairy Exchange Module is used for exchanging information between processes, farms and external parties with the required authorisation.

Standards that have been developed for the on farm exchange of information do not cover all needs in relation to the exchange of information, but can be used as a starting point:

- ISO 11787 'Machinery for agriculture and forestry - Data interchange between management computer and process computers - Data interchange syntax'. This standard specifies an Agricultural Data Interchange Syntax (ADIS) to exchange data electronically between on-farm process computers of stationary and mobile agricultural equipment or machinery, and management computers. It implies that the syntax is not intended for real-time data exchange.
- Another relevant ISO standard for information exchange is ISO 11788 'Electronic data interchange between information systems in agriculture - Agricultural data element

dictionary - Part 1: General description' and '- Part 2: Dairy farming'. In this standard a protocol is defined for the exchange of some elements (e.g. milk yield information).

The DEM offers the possibility of comparing situations and financial results of different farms (the information of the farms shall be made anonymous). A detailed description of every farm shall be recorded in the DEM allowing a useful comparison of different farming conditions. Together with advisers farmers can use the results of the comparisons (bench marks) in their choices on future acquisitions, innovations and investments.

An important aspect that has to be solved in the DEM is the ownership and the protection of data and information. In many cases the farmer is the owner of the information and he shall have possibilities to share information with parties of his own choice. For comparison individual farm information shall be available in an anonymous form allowing the use of every independent farm as a data source for sophisticated comparisons.

Concluding remarks

In the Netherlands business, knowledge institutions and government have signed contracts for innovation; budget is made available for research and development of innovative products and services in the top sectors of the economy. Agro & Food is one of the Dutch top sectors and the SDF project is one of the first initiatives in line with this Public-Private Partnerships.

The SDF project is an initiative where dairy industries, the dairy supply chain, research, farmers and dairy equipment manufacturers cooperate. The focus of the industrial partners is concentrate on the development of new products and services to be offered to the farmers (introduction of new hardware and software services), while for the research organisations focus on the introduction of alternative ways of working is the most important aspects. Both manufacturers and research are trying to achieve a more efficient farm management resulting in high quality products, healthy animals and a sustainable farming practise (e.g. increased average animal age) and source of income for the farmer.

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