PRECISION LIVESTOCK FARMING

DATA AND TECHNOLOGY IN FARM ANIMALS

E. (Lenny) van Erp - van der Kooij, MSc PhD

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Dedicated to:
my father, who advised me to go to Wageningen,
and my grandfather Voogt, who sent me articles
on farming from ‘Trouw’.

Acknowledgements:
Judith Roelofs
Ton van Erp
Simon Lague

INHOUDSOPGAVE

1. INTRODUCTION

I'm not a farmer's daughter. Although as a child I loved going to the children's zoo, I had never seen a real farm before I started studying in Wageningen. Somehow I had an innate interest in animals, be it rabbits, horses or pigs. If my sister's guinea pigs fell ill, I took them to the vet. On holiday in Germany, I was convinced that I could ride a horse so I talked myself into going with an outdoor ride. I held on to the horse and learned quickly. Animals, any kind: I wanted to know more about them, learn about it. When I thought about eating meat, I wanted to know how animals were kept. When the dean at my high school told me to go to Utrecht and study veterinary medicine, I had some doubts. But then, my father suggested that there might be a study about animals in Wageningen. "Isn't that where all the farmer's sons go?", he said. Indeed, there was a study for me in Wageningen…... and also a farmer's son. So, I am still grateful to my father for that suggestion.
In Wageningen, my research was about the reproductive cycle of the female elephant, where my interest in animals and data was seeded. I charted the estrous cycle of the female elephant by

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measuring temperature of the fresh manure, determining the conductivity of the vaginal mucus, and using pedometers on the elephants' hind legs. With all this data we could determine their fertile period. However, the pedometers were no match for the elephant cows, within no time they were shaken or scraped off and destroyed, and the data were useless. From this I quickly learned about the importance of robust sensors and the reliability of data.

My later projects also consisted mostly of collecting data on animal behavior and health. Epidemiology and statistics found my interest and besides dealing with animals, I found the most pleasure in dealing with large datasets. Give me a PC, and not a pipette. It is therefore not surprising that ever since, my research at HAS University have been increasingly moving towards technology and data. So many new developments in this area lead to so many interesting projects. I love to work in this innovative field, whether it's on positioning systems, activity meters, LoRa networks or infrared cameras. Every animal species is equally interesting, so I'm happy to work with cows, pigs, chickens and companion animals. Who knows, there might even be another elephant project, sometime.

2. PRECISION FARMING

Precision Agriculture has become big. In arable farming, GPS is being used to drive straight with the tractor and to irrigate, fertilize or spray in the right place. Sensors are being used on an increasing scale to make operations more efficient. Moisture sensors to control irrigation, drones with cameras that use vision techniques to recognize diseases in crops or predict yields. Satellites, weather stations and more provide data and information to optimize business operations.
Besides it being more efficient, this also provides the chance for a more sustainable crop production. Food production using less commodities, less pesticides and less water, because of more precise sowing, spraying and watering (Fresco en Poppe, 2016).

3. PRECISION LIVESTOCK FARMING

Precision agriculture in the livestock industry is also known as precision livestock farming (PLF). As defined by Daniël Berckmans (University of Leuven): 'PLF uses advanced technologies aimed at automatic, real-time monitoring of animal welfare, health, environmental impact and production'. This means that we will use technologies in animal husbandry to continuously monitor animal behavior, animal health, production and environmental impact. The purpose of this monitoring is to detect deviations at an early stage and improve animal health, welfare and efficiency. The expected result is an improvement in the overall production sustainability (Berckmans, 2014).

4. PLF, SUSTAINABILITY AND ANIMAL WELFARE

Precision Livestock Farming fits in a sustainable farming system. Aalt Dijkhuizen (president of the top sector Agri & Food) as well as Louise Fresco (chairman of the board of Wageningen UR) state that Smart Farming is a way to handle resources in a sustainable way and to work towards a sustainable global food production (Fresco and Poppe, 2016).

The promise of Precision Livestock Farming was spelled out during the final conference of the EU-PLF project (EU-PLF, 2016):

'PLF has the potential to:

- make farming more efficient by better use of resources
- guarantee / improve animal welfare

Bron: Fancom

When we can detect diseases with early warning systems and treat animals at an early stage, it costs less medication. Antibiotic reduction is a good result of using this technology. Thus, a pig owner who put up a cough monitor in his pig unit told me that he noticed coughing pigs earlier, and because he could get there early, he could intervene. Treating the whole unit with antibiotics is no longer needed. Systems that alert the farmer to deviations in health and behavior, save on medical costs as well as improve animal welfare. Both enhance sustainability. The better we monitor the animals, the better we can take care of them, and the more sustainable the system (Matthews et al., 2016).

Accurate data on feed and water intake can lead to better health and animal production. Precision feeding is on the rise. In a group, animals can be fed individually, so that the feed composition is better adapted to the individual animal. Thus, high-quality feed can be provided to animals that are growing faster and thus produce more efficiently, while giving low-value feed to the animals that do not have that potential, thus saving expensive commodities.

Location for dairy cows is an example of a PLF technology that can relieve the farmer in the cow shed. By quickly finding the cow that needs attention, the farmer can work more efficiently. This saves him time and annoyance.

Bron: DeLaval

Stress and health could also be measured remotely using a heat camera. When the distribution of blood through the body changes, this can be visualized with a thermographic camera. For example, stress can be made visible because extremities (ears, tail) become colder and the region around the eye becomes warmer.

Inflammation causes an elevated temperature, which can be seen in claw problems or mastitis. The Swedish company Agricam has now introduced a camera that can detect mastitis (the CaDDi). Thermography is potentially very interesting to use in early warning systems, for measuring housing systems and climate, and for measuring stress in all kinds of animal species (Nääs et al., 2014).

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Finally, all kinds of measurements to monitor well-being can be automated using PLF systems. This applies, for example, to the monitoring of lameness and leg problems, but also to the human-animal relationship. For example, the eYeNamic system can measure the activity and distribution of broilers in the farm when someone walks through the stall - an alternative to the human avoidance test now included in the Welfare Quality Protocol (EU-PLF, 2016).

5. ROLE OF THE FARMER

Rarely, PLF systems provide direct advice to the farmer. Exceptions are estrus detection systems for dairy cattle, usually based on pedometers or activity meters, that advise when the cow should be inseminated. Most PLF systems warn the farmer in case of deviations from the normal pattern. The farmer then has to decide if something is wrong, and if so, what should be done. That requires craftmanship.

PLF promises a lot for the farmer. The recently published ABN AMRO report on smart farming (Hilkens and Bruinsma, 2016) sums up. Less administrative pressure and greater ease of use of data and data management through high-tech sensors and loggers, smart software and cloud technology. Cost savings through targeted use of feed, fertilizers and plant protection products. Time saving due to greater labor efficiency. A higher sales value of the primary products, and a better guaranteed food quality. Why then has smart farming not yet been broadly embraced by farmers? Apparently, they are not convinced of the technological possibilities. Time is needed

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to get used to the new opportunities, but also to learn to work with these technologies. In this field, the guidance of technology vendors remains behind. When a farmer buys a new system but is insufficiently supervised in the use and application of the technology, the system will have no or few advantages. In addition, there are several disadvantages of current technology. Often it does not respond well to the wishes and requirements of the livestock farmers. There is still a lot to be improved on the ease of use of the systems, as well as connecting different systems on the farm. If any new application is connected to an additional screen that the farmer should look at, then technology makes life much more complicated, and unnecessarily so. On-farm, one must quickly see what is happening in an animal unit, or in an animal. Technology must work intuitively and should not have to be decrypted. Endless lists of alerts also work counterproductive: the farmer will largely ignore them.

It is therefore important for technology to follow the farmer in his daily practice. Technology must provide a solution and make life easier. ‘Listen to the farmer’ was therefore the most important message during the final EU-PLF conference in Brussels in October 2016. Let’s do so.

Bron: Fancom

6. EXAMPLES OF PLF TECHNOLOGIES

6.1 Positioning for dairy cows

Slowly, PLF has become more accepted. First in dairy farming, where activity meters are used for better estrus detection, but also for monitoring cow behavior. Early detection of disease is the next step, with deviations in behavior being used as a predictor of disease. Nowadays the dairy farmer can receive an alert when a certain cow is lying down longer than usual, has a shorter eating time or takes a different number of steps relative to the herd and / or relative to her own average. Deviations from the expectation are the key words. If a cow does something different than we expect based on her normal behavioral pattern (and that of the herd), something might be the matter with her. The farmer's task is to look at her and to determine if something should be done, and if so, what then.

Positioning for dairy farming is now also commercially available, and helps the farmer find the cow in the stable. No unnecessary luxury with the still increasing farm sizes. Different companies provide location for cows in the stable: Gea (CowView) and Nedap are examples. Usually, these systems work with radio beacons, a relatively expensive system with the tags on the collar's communicating with the beacons. Using triangulation, the location of the cow is accurately determined (with an accuracy of approximately 50 cm). In addition to finding the animal, location is potentially very interesting for research into space use, behavioral patterns and new housing systems. Research has shown, for example, that a positioning system can be used to see which cows are most often seen around the mineral blocks; those cows have an increased risk of rumen acidosis (EU-PLF 2016).

It would also be interesting to know what the cow is doing on pasture. Behavioral patterns, activity budgets and deviations therefore can indicate the health status of the cow. Outdoor location systems are now only available for research purposes; For example, neck mounted systems using GPS for positioning of (wild) cows. The price of 1000 to 2000 euros per piece and the large size of the collars make this system not suitable for use in dairy farming. There is another option for outdoor use, which is LoRa. LoRa is a newly developed technology, related to the Internet of Things (IoT). KPN has the mission of connecting 'everything to everything' via LoRa. The goal of KPN is to provide a comprehensive LoRa network for the entire Netherlands to which sensors can be connected by the end of 2016. LoRa stands for Long Range, Low Power and allows small amounts of data to be exchanged between devices and systems with low power consumption. This system allows the location of a thing or animal to be determined, and sensors can also pass other information through the LoRa network, such as temperature or motion. If we use LoRa sensors on cows, the Internet of Things becomes the Internet of Cows. Benefits of LoRa are the low power consumption (i.e. a small battery) and the relatively low cost. Disadvantages are the inaccuracy of the positioning (15-30 meters) and the uncertainty if the system also works well within buildings. For the monitoring of cows on pasture and mapping behavioral patterns outdoors, a LoRa network might provide a good solution. It is also interesting to attach other sensors to the cows, an accelerometer (activity) and a temperature sensor are the most interesting options. Connecterra already brought an application to market. The Dairy Activity Monitor, which uses activity and location to monitor fertility and health of cows. The internet House is setting up LoRa networks, including networks around dairy farms.

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In lactating cows, various parameters can be measured via sensors in the milk. Examples are progesterone sensors for fertility control, LDH or cell count as a measure of (sub) clinical mastitis, urea and BHB to monitor nutrition and energy balance and detect early ketosis. These sensors can be purchased as a single system, where the milk is automatically analyzed per cow and the farmer receives an alert when a cow shows deviations in the values. Finally, boluses are available that can measure activity, pH or temperature in the cow's rumen. This provides information about the correct insemination time, nutritional status or disease status of the cow. Such sensor boluses are commercially available from smaXtec, but also the Faculty of Veterinary Medicine at Utrecht University is developing a sensor bolus for dairy cattle, which exchanges data via LoRa (http://www.uu.nl/nieuws/happy-healthy -cow-close-cow-on-internet).

6.2 Pigs

In the pig farm, PLF is slowly emerging, especially at pen or group level. Automatic weighing systems, such as the eYeScan, monitor the weight at pen level. Cameras with associated software can estimate weight based on image analysis with an accuracy of 3% (Farm, 2012), and in addition to accurate, it is also much more animal (and farmer) friendly than manual weighing. Estimating weight without scales is very inaccurate; Yet there are still many pig farmers who do not weigh. With PLF systems there is a lot to be gained here.

Fancom's camera systems such as eYeNamic can measure activity of the pigs, and when used to chart high and low activity, abnormalities can be detected earlier. The abnormalities occur earlier than the decreasing feed intakes, which the farmer will eventually detect. Two days of production loss can be prevented this way (EU-PLF 2016).

The SoundTalks cough monitor analyzes noise and counts the number of coughs. As a result, lung problems can be detected early (2-12 days before the pig farmer has noticed it) (EU-PLF, 2016).

The developments regarding individual recognition of pigs go fast. Individual recognition of sows is already possible in group housing systems with feed stations. The expectation is that in the near future, also fattening pigs will be recognized individually in the group. After solving a number of technical problems (such as not losing the ear tags from the growing pig ears) this will definitely be possible soon. This can provide a wealth of individual data, which may be interesting in the insemination policy, recognizing returnees (sows that have not conceived or that are no longer pregnant), or for precision feeding, by tailoring the amount of feed or the feed composition to the individual animal. Also, lameness or other abnormalities may be detected earlier - especially in a large group, it is difficult to see and checking on the animals is labor intensive. On average, pig farmers spent less than 5 seconds per finisher pig a day checking animals, we concluded last year in a survey of 12 medium to large meat pig farmers. In the largest company (10,000 meat pigs) this was <1 second per pig. Automatic monitoring may result in quality improvement and saving labor. In pig farming, labor efficiency and personnel management are an important area of concern. If we can better understand the routes and labor processes, we can improve the efficiency of the employees. An example of this is 'Time Keeping' using beacons, an idea that originated during a hack marathon ('FarmHack') at VIC Sterksel in the summer of 2016 (see http://www.wur.nl/en/news /Pigs-Innovation-Centrum-Welkom-hackers.htm). The system works with sensors that can receive and send data, creating an Internet of Things (IoT) in the stable. An app can track what an employee has done during the day in the pig unit, and how much time each action has cost. Analyzing this data possibly compared to other companies can lead to process optimization and increase workforce efficiency (Hilkens and Bruinsma, 2016).

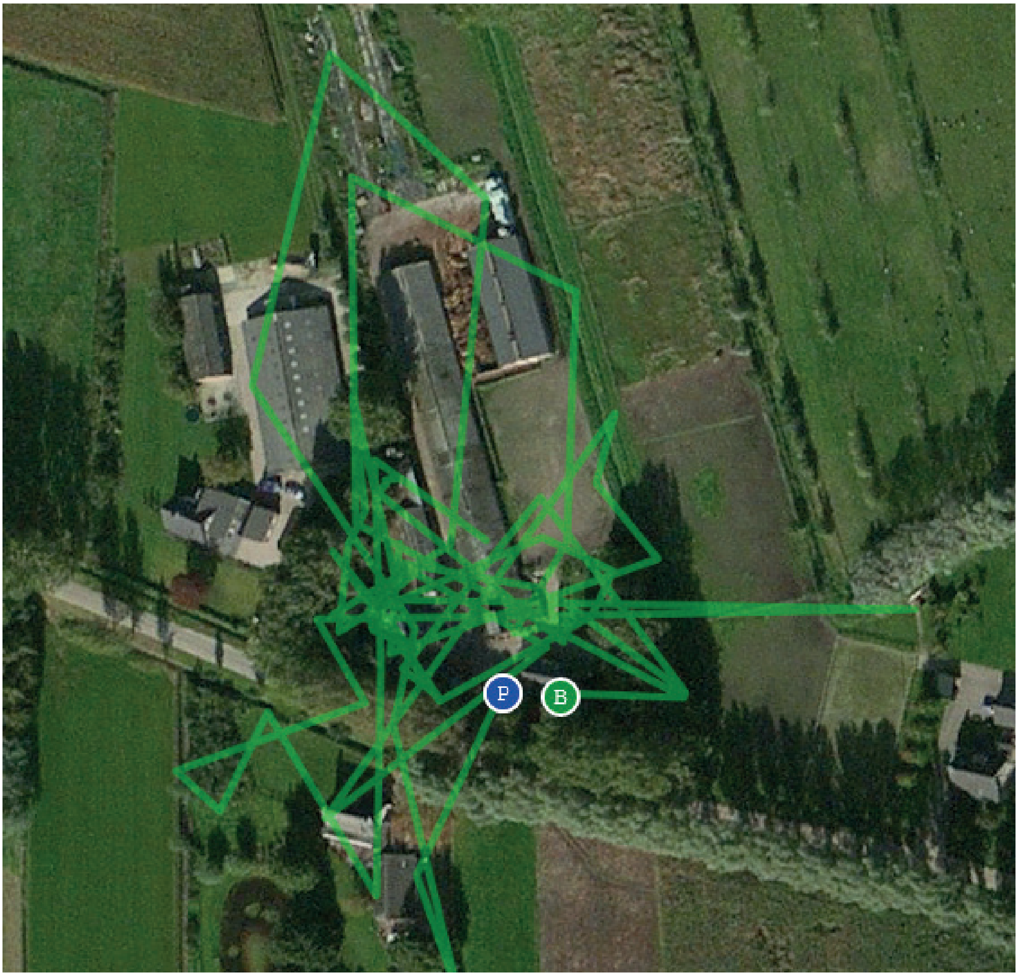

fancom

6.3 Poultry

In the poultry farm, the farmer can monitor the activity and distribution of broilers via the eYeNamic system. Farmers are notified by the system when the parameters differ from the expected pattern. This expected pattern is based on the behavior of recent days. A deviating activity pattern and / or a deviating distribution can be caused by a broken feed line, a clogged waterline, a deviating climate, or problems with the light scheme. Research (EU-PLF, 2016) showed that 95% of the problems with feed and water lines, climate or light were correctly predicted by the system. This saves time, days or sometimes even weeks, in which the farmer can take actions earlier and problems can be solved or even prevented.

Sound analysis has shown that, in less performing rounds, with the chicks growing less fast, they produce a different (higher) sound frequency than during better performing rounds. This difference starts to occur a few days earlier than the point in time when growth starts deviating. Based on sound analysis, an early warning system for poultry could be developed. However, a lot of additional research is needed.

For laying hens, an egg gathering robot has been developed, but has not yet been released commercially. First results showed that besides labor saving, the robot also brought about an improvement in animal welfare; the chickens liked to jump on the robot and go for a ride. The robot was thus enrichment material for the chickens. An interesting idea for further development, especially given the upcoming ban on beak trimming and the need for play material for the chickens.



6.4 Companion animals

For pets and horses, technology is used to collect information about the individual animal. With thermographic cameras, horses can be checked so that, for example, lameness can be detected early. In some stables the owner or caregiver walks along the horses regularly with the thermographic camera and checks the legs. This way, you can detect problems in an early stage. Cats and dogs can be tracked with GPS trackers so that they do not get lost but also to gather information on their territory and walking patterns. In the BBC documentary 'The Secret Life of the Cat' (http://www.documentairenet.nl/review/het-geheime-leven-van-de-kat/) this is clearly portrayed. Tracking equipment for pets is getting cheaper. Last year we bought 3 trackers for $ 200 (excluding import duties) via a somewhat vague Chinese company, this year we bought trackers for 50 euros each via bol.com. Software has been developed that lets you talk to the cat remotely via the tracker (the "cat phone"). This allows you to calm the runaway animal, as mentioned in the brochure.

7. THE DATA CYCLE

When we want to use technology effectively in the farm, we need to address this systematically. This begins with the need to know what we want to know. What information will help the farmer? Gathering data because, by chance, such an interesting sensor has been put on the market, will not help the farmer. For this purpose, research is required in the form of accurate observations of the farmer. What is his sequence of work, how does he use information, what takes a lot of time and what annoys him in his daily activities? This can be supplemented by in-depth interviews, asking for the reasons of the farmer - why does he perform certain actions in a particular order, what does he notice and when does he take action? In my opinion, just asking for the wishes and requirements of farmers is not very effective. We learned from earlier studies that surveys often provide superficial information, and do not reveal what would really help the farmer. Henry Ford said, 'If I had asked people what they wanted, they would have said " a faster horse,"' and Steve Jobs said something similar. "People often do not know what they want until you show them." The secret lies in observing people's behavior, and then coming up with innovative ideas that makes life (and business management) easier.

Next, we need to determine how this information can be collected. What data does the existing systems provide, and what sensors can we use? This includes determining the reliability of the sensors. If the data is not reliable or not accurate enough, it is not usable. For example, a positioning sensor for cows should be accurate up to approximately one meter. The usual 15 meters accuracy for positioning is not meaningful for a cow in a stable – with that inaccuracy we do not know if the cow is in a cubicle or at the feed gate. However, 15 meters could be accurate enough for a cat outside, when it comes to finding the lost animal.

The collected data must be saved. This was a big problem a few years ago. Storage capacity, however, has grown so enormously, that it is now possible to store all the data you can imagine. We do not need to make selections anymore, and can save all data; a big advantage. The other side of the story is that the data threatens to outgrow us when we do not accurately capture where the data comes from and what it means. Also, consideration should be given to how data can be retrieved from the storage system. What characteristics are recorded? Is data ordered by animal number, by company name, by date? If we do not pay attention, it becomes an unimaginable chaos.

Data visualization is a next step in the data cycle. Before we analyze the data, it is often very useful (and sometimes even sufficient) to visually display the data. This can help in many ways, with dashboards, charts and graphs to help understand what's happening. With heatmaps you can see where animals have been, on a dashboard you can see if certain production or health scores are different, and graphs show you the course of parameters such as feed intake, growth or the number of coughs. For most people, images are easier to understand than numbers, so data in this step is already converted into information. There are companies specializing in this, thus providing the farmer with useful visual overviews stemming from his own data. This goes beyond the tables or lists of numbers obtained from most management systems and is an important addition and support in business management.

If we want to get more out of the data, we need to look for relationships or patterns. Through all kinds of analytical methods, we look for relationships between, for example, behavioral patterns and disease, activity and production, or distribution in the farm and behavior. Knowledge of the biology of the animal combined with knowledge of the sector is needed in order to correctly interpret the results. By analyzing data in this way, early warning systems are being developed. An example of this is the pig cough monitor. Using software analyzing sound in the pig unit, the number of coughs in the stable is counted and compared to a reference value. With an increased number of coughs, the farmer receives a warning so that he can check on the animals and possibly treat the sick animals in an early stage. Research into the relationship

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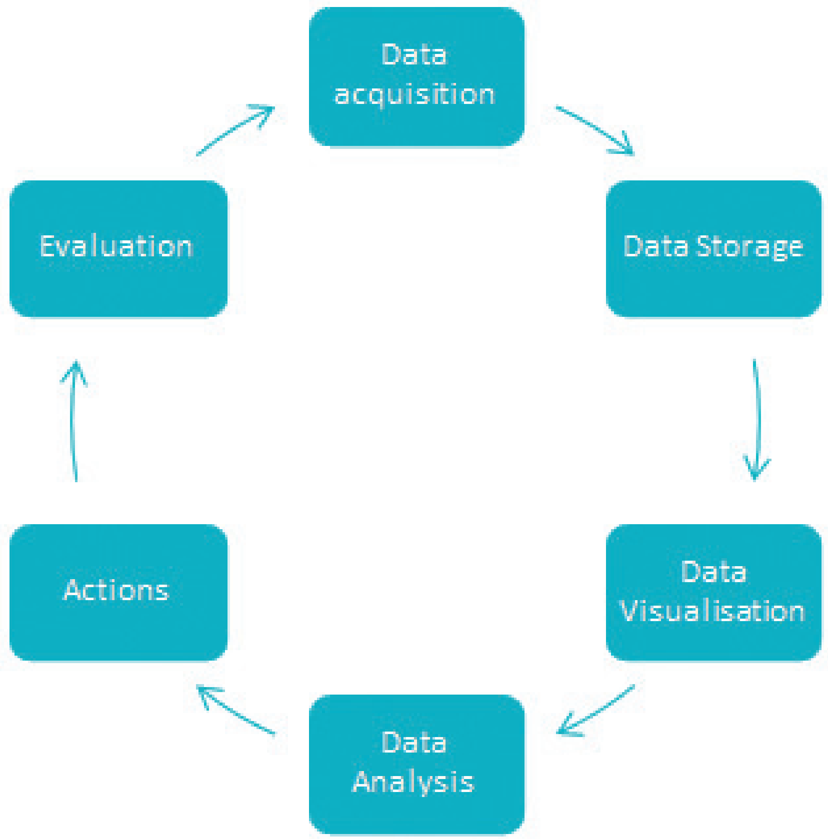
between behavioral patterns and diseases is in full swing. We would like to find out if we can use behavioral data, for example the amount of lying, standing up and walking of cows, to predict whether a cow is getting mastitis or becoming lame. Perhaps it is possible from the behavior data, perhaps we should combine this data with, for example, milk production and feed data. Also for pigs and poultry we are still discovering how data from the farm can be combined into useful management information for the farmer. For example, water intake in pigs appears to have a clear relation to disease, as researchers from VIC Sterksel discovered. A water meter per pig unit could thus yield useful information.

The analysis should provide advice to the farmer: what to do with a certain deviation or warning? This is best developed in the estrus detection systems for dairy cows. The activity meters (on the leg, neck or ear) can accurately predict when the cow has to be inseminated. These systems detect 80 to 90% of estrus events, while the farmer himself often does not detect more than 50 to 60% of cows in estrus. Of course, these activity meters work 24/7, and the farmer is only in the farm for a few hours a day (not watching the cows continuously). Additionally, cows are only a



couple of hours in estrus showing specific estrus behavior. Those few hours can also be at night – these events the farmer will certainly miss.

However, as mentioned earlier, no specific advice will be given with most sensors and technologies. If there are deviations from the reference value (which can be a value per animal, looking back at the data of that animal and predicting behavior of that animal, but can also be relative to the group of animals), a warning will be given. It usually does not mention what actions the farmer must perform. Perhaps not all farmers want this, but a general advice or a number of options from which he could choose would in most cases be welcome. In that field, a lot of research is still needed.
An alternative research approach, which is increasingly evolving, is the 'Google method' or in other words searching for relationships or patterns in the data without a specific predetermined hypothesis. For example, Google's computer specialists found a fairly accurate prediction of the summer's disease distribution by looking for correlations between the frequency of certain queries and the occurrence of flu. With mathematical models, they predicted the number of

flu cases in 2007 and 2008 almost real-time: much faster than the CDCs (Mayer-Schönberger and Cukier, 2013). Without knowing exactly what you want to know, you can analyze datasets and look for patterns and relationships. This can reveal interesting insights. Data crunchers are programs that can find connections in large datasets. Large companies like Amazon and Zalando use data crunchers to find out what you want and how they can make more money on the basis of raw data. That is where those unsolicited, personalized offers come from, if you have searched or ordered something on those websites a few times. Now that more and more data is gathered and stored from the livestock industry, and we are gradually growing from 'large data sets' to something that looks like 'Big data', data crunching becomes interesting.

Finally, an evaluation step in the data cycle must be incorporated. Are the actions that were carried out meaningful? Was it beneficial for the animal or the farm? Were the data correct? Perhaps the sensor needs to be adjusted, maybe the proposed actions must be reviewed again, or the reference values should be addressed. Looking back at the results to make the next round better is always useful and, unfortunately, is often forgotten. It is important to use the available information for this purpose.

8. WHO OWNS THE DATA?

In each and every discussion about smart farming, the question is raised: Who owns the data? Is it the animal owner, or the software manufacturer who processes the data and returns it to the farmer?
Third parties gather a lot of data, which makes it seem that other people benefit from data management by the farmer. This applies to government, certifiers and processors, but also to technology companies that manage the data that farmers provide.
Many companies sell technology and software where the farmer receives reports, dashboards and charts, or alerts, but no data. The farmer usually does not have the raw data of his own animals. The question is, of course, whether he wants to have the raw data: what is the value

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of this data to him? Data becomes valuable for him after it is transformed into information. However, it is certain that this data is of great value to the companies that make the software. Especially if data from different companies is combined into larger datasets, this can provide a wealth of information that benefits businesses (now for free). In some cases, a company can even directly earn money from data. When we needed reference data in a project recently, it cost us a lot of money – we had to buy the data from the company that had gathered it. Data is worth money. A new business model might be in place here, so that the owner of the animals can also profit. We could take a look at the iPhone model: giving away data gererating technology for free and pulling revenues from information content. Before money can be made with agricultural data, a number of preconditions must be met. Data ownership must be properly regulated, including the legal frameworks; That is not the case now. The law does not clearly determine who owns the data; Legal conflicts about this are now usually settled (C. Kocks, pers. comm.). When data ownership is clear, collaborations can arise around the data. Then there could be a market for agricultural data (Hilkens and Bruinsma, 2016).

9. ANIMALS AND ETHICS – ARE WE DIGITIZING THE ANIMAL?

Some consumers (and some farmers) fear that technology might lead to the “digitization” of animals. Are animals still seen as animals, or as production factors that we should control with technology? Is the farmer still in the stable, or is he behind his laptop or watching his smartphone? These questions are not easy to answer. Someone does not become a better or worse farmer, due to buying equipment. The success or failure of technology depends very much on how it is used in the farm. Does the farmer learn to work with the technology and apply it in his farm? When the farmer uses the system alerts to prevent disease or treat animals earlier than before, that is a positive development. But when the farmer thinks he does not have to check on his animals anymore, that is less favorable. When behavior and health are monitored automatically in the stable, this can cause the farmer to handle his animals differently. Information from the animals or the farm is received via an app on the phone. This can have a positive effect because the farmer knows more about his animals and can use that extra knowledge, but it can also lead to less personal contact between the farmer and the animals, thus a lesser connection with the animals with potentially negative consequences for well-being. Now the latter seems unlikely to me; The considerations of farmers who purchase precision technology are generally based on a desire to keep an eye on the animals, to detect abnormalities earlier and to intervene earlier if there is something wrong with an animal, unit or stable. As part of the EU-PLF project, 33 visits were made to farms using PLF technology in Europe by researcher Jörg Hartung (EU-PLF, 2016). He reported that most farmers want to understand and interpret the data themselves, and then to take decisions themselves. He also recorded the following statement from one of the farmers: ‘Since I monitor, I understand my animals much better’.
Another question is: Does technology lead to scale enlargement? Scaling up has been happening for many years, starting long before this kind of technology existed. Upscaling does increase the demand for technology. In this, I like to stress that there is a difference between automation and technology. Automation, defined as ‘’replacing handicraft’’ with a “push-button”, is definitely a factor that allows more animals to be provided for with the same labor input. But the technology we are talking about here is aimed primarily at identifying and monitoring animals or groups within a herd or large number of animals. For larger farms, this technology is undoubtedly extra welcome, and also easier to fund, but the technology is not necessarily aimed at enlarging farms.

Bron: Fancom


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10. ANIMALS, DATA AND HAS UNIVERSITY

HAS University provides the link between science and practice. In our applied research projects we test and validate sensors, develop new applications in cooperation with companies and farmers, and translate data into information for the farmer. We can combine technology and data with our biological knowledge of animal health and animal behavior, thus helping technological companies in the livestock industry. We also know the sector, which enables us to map the wishes and requirements of the livestock farmers for companies.

10.1 Cooperation with companies

We have been working with many different companies for a long time. A summary of all the projects we have conducted in recent years in cooperation with the business community, which took place in the field of data and technology, goes too far. The outcome of some projects was also confidential. Nevertheless, I would like to mention a number of showcase projects.
For Fancom we have conducted several projects in the field of Precision Livestock Farming, or iFarming as they call it. Measuring and analyzing sound in chicken farms was an interesting exploration of what it means when broilers produce more or less noise and which patterns are found in the sound. We have tried to develop a well-being monitor for meat pigs from farm data, which shows via dashboards whether a particular pig unit is performing well. Students have been working on designing the farm of the future for fattening pigs (using technology in the farm), and we have made several inventories of the wishes and requirements of farmers in the field of technology.

For Nedap we have done validation tests with the Smarttag Neck and Smarttag Leg activity meters. In order to analyze cow behavior, many hours of live observation and video analysis have been carried out, and in addition a large amount of milk samples have been analyzed to validate the estrus detection. Results of the behavioral analysis were presented at Precision Dairy Farming 2016 in Leeuwarden.
For NoldusIT we conducted a study where we analyzed the sound of dairy cows and compared that with video images. This resulted in a publication in Computers and Electronics in Agriculture.
For Wageningen Livestock Research we tested a virtual fencing system. Cows learned to stay within the virtual fence by hearing a sound cue when approaching the border. Results were also presented on the Precision Dairy Farming conference 2016, and trials have been continued at Dairy Campus.
For MS Schippers we worked on a validation test of the MS Optima Box. Data from companies with and without the use of this concept, with cows automatically receiving a feed supplement, were compared. We generated large data sets and a lot of interesting analyzing work. This project was a collaboration with Van Hall Leeuwarden and CAH Vilentum Dronten, and was conducted within the CoE AgroDier. A nice example of a cooperation between government, business and green colleges.

10.2 Practical training farms

What is better teaching than students coming into a farm regularly to hear lectures, to see the theory in practice at the farm and to carry out real life projects? HAS University of Applied Science signed a cooperation agreement with Hoeve Boveneind, the dairy farm of the De Bruijn family, last year, and recently a second cooperation was formalized with Pels Melkvee, the dairy farm of the Pels family. HAS University of Applied Sciences has invested in technology at these farms, and at Hoeve Boveneind there are teaching facilities in the form of a fully equipped classroom for 20 students. At Hoeve Boveneind cows have activity meters on the neck and leg and there is a Nedap cow positioning system. At Pels Melkvee, a DeLaval Body Condition Score camera is installed and the cows have activity meters on the neck. We have agreed with the suppliers and farmers that we can use the data of these cows for education and research, and that is what we do. We are studying the relationship between claw scores and cow behavior on Hoeve Boveneind, and are working on mapping the cows' walking patterns in relation to

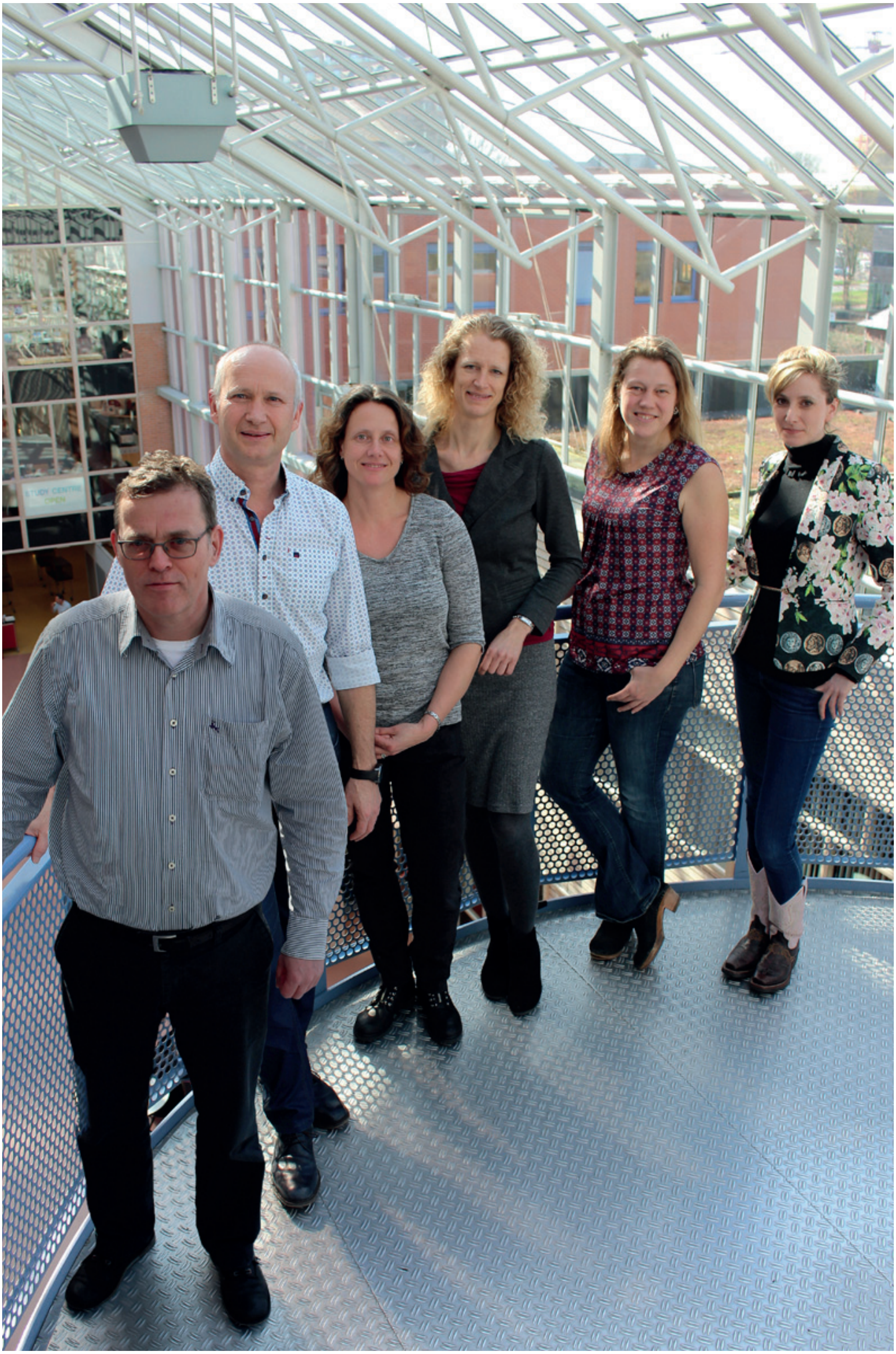
“ We are studying the relationship between claw scores and cow behavior on Hoeve Boveneind, and are working on mapping the cows' walking patterns in relation to lameness.

lameness. Students and teachers from different courses work together, for example from Animal Husbandry (housing, health, reproduction and practical advice for the farmers), from Applied Biology (statistical analysis, animal behavior) and from Geo Media and Design (analyzing and visualizing data). The positioning system generates a lot of data (every 5 seconds the x and y coordinates of 105 cows), so much that it almost looks like Big Data. We therefore want to experiment with new analyzing methods, such as data crunchers and programs that search for patterns and correlations within large data sets.

At Pels Melkvee, the technology has just been installed and we will first build up experience with the systems. In the near future, we want to combine the data from the BCS camera and from the activity measurements of the cows, to trace patterns and combine this information with other management data. On these farms we also gain insight in the way farmers use (new) technology, and how farms change after installing new systems.

10.3 Course module Smart Farming

In September 2016, the HAS University started a new course module 'Smart Farming'. The idea for this module has emerged from the HAS's Precision Agriculture Working Group (WGP). The WGP is a group of lecturers from different courses, who meet regularly and inspire each other in the field of precision agriculture. Teachers from the fields of Horticulture, Animal Husbandry, Applied Biology, Geo Media and Design and Rural Development take part in this workgroup and together we are engaged in teaching the students of the module Smart Farming. Students from different courses participate in the module; In addition to the above-mentioned courses, students also come from the field of Agribusiness, Environmental studies and Food Technology. Students from outside the university can also participate. The focus of the course is on data and the application of sensors and technology in agro-food. Students learn the structure of the data cycle and how we can work with sensors in livestock and crops. Field trips to companies, but also to the Ajax ARENA in Amsterdam (soil sensors) and the robot lab of both the Technical University Eindhoven and AVANS Applied University in Breda are part of the program and inspire students with technology and data from outside their area of expertise. Within the module, projects are being carried out for external clients, in crop science and in livestock. For example projects have been carried out for Agrisyst on data in the pig farm, and for NoldusIT on grazing behavior of cows. All projects again have a focus on data application, data visualization and data analysis. Having students from different backgrounds work together in multidisciplinary projects not only leads to better results but is also a lot of fun. A valuable combination.



PLF expert group: Michel Smits, Peter Jacobs, Judith Roelofs, Lenny van Erp, Irene Pleizier, Manon de Kort

10.4 Expert group

There is a lot of knowledge and experience present within the HAS University. I am very pleased to be able to work with the following experts:

Judith Roelofs, she knows all about fertility, especially in cattle and pigs. Her motto is: “Working with students, exploring how all sensor data from our practical learning farms can be transformed into actions for a farmer ... How much more fun can it be?”

Irene Pleizier, she loves data and knows everything about data visualization and data analysis. Her point of view is: “Today we can receive data in many ways, but knowing how to interpret it, leads to true knowledge.”

Manon de Kort, specialist in training and companion animals. Her goal is: ‘To get more insight into the lives of our (companion) animals, to make our living together even more enjoyable’.

Michel Smits, he has extensive experience in the field of engineering and research in farm animals. He defines the following challenges: “Designing farms and stables that are more animal-orientated; translating (Big) data from PLF sensors into operational information and actions; interesting assignments for HAS students, appealing themes and cooperating with companies.”

Peter Jacobs, he knows all about the intensive poultry farming and pig farming sector. His conviction is: ‘With smart farming we can monitor the animal better, and therefore predict what will happen. Every new development gives new possibilities. “

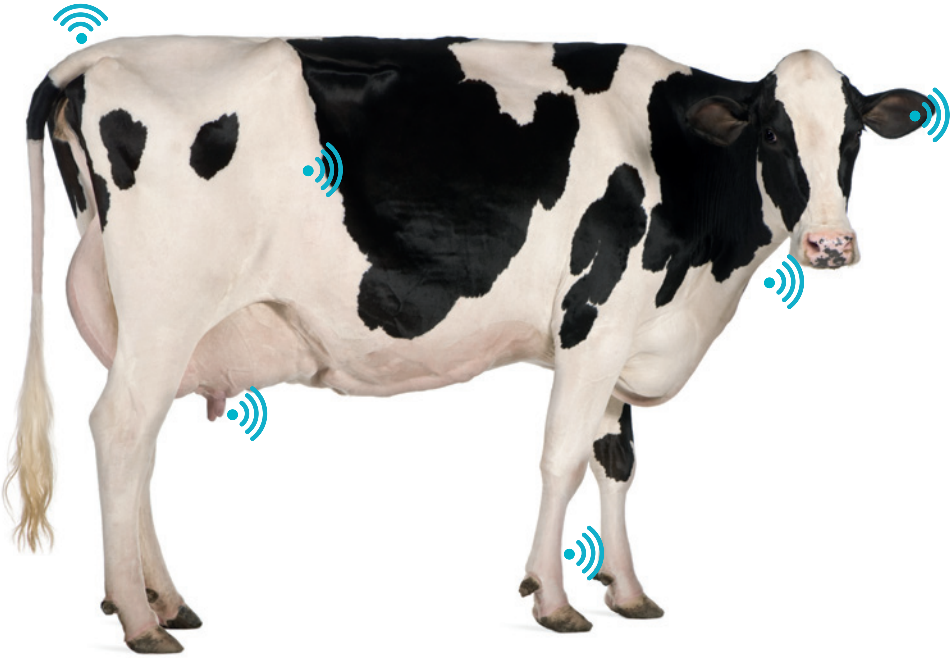
With that knowledge and experience in the expert group, I am convinced that we will achieve much. Within the PLF expert group we will jointly work on applied projects in the field of PLF for dairy cattle, pigs, poultry and pet animals. My ideal is to have a test yard for each sector, where we can conduct research in cooperation with students and companies. For the farm animals, I would prefer a physical place, such as a research farm or a practical learning farm where we can teach and carry out applied research projects. Hoeve Boveneind and Pels Melkvee are perfect examples for such a model. For companion animals, the test yard would consist of a coherent number of studies at different locations and homes of owners. Lecturers, students and companies together can achieve much in such a setting.

11. ANIMALS, DATA AND DAREDEVILS

To make precision livestock farming a success, guts is needed. This applies on multiple levels. First of all, companies need to develop and market new technologies. This requires investments. Companies must undertake to make investments, even though it does not yet deliver net results for the company. We see that some companies do this, but others don't. It is worrying when a company impedes developments and inhibits investments in new technologies. 'Focus on the core business' is in that case the argument, and financially, the smart farming technologies do not (yet) make enough profit. The technology has to become cheaper, then it will be sold to more farmers, which stimulates the development and the next release of the technologies. When the early adapters are followed by a larger group of entrepreneurs, the next wave of innovation is stimulated. Guts is needed.

Research institutes, universities and colleges, together with industry, must dare to invest time and energy, and study new technologies to ensure that we turn data into useful information for the farms. Data collection is not that difficult, data storage is also getting better and easier, even when it is large amounts of data, but translating data into management information is still difficult. In addition to this, developing technology for animals requires a lot of knowledge about the biology of the animals. Which behavioral patterns, what sound or which activity levels are normal, and what does a deviation mean in terms of animal health and welfare? The animal environment is often a disruptive factor, which complicates interpretation of the data. For example, we know from research all about the sounds of individual chickens: they react to danger with an alarm call, make a specific sound when stressed or call their chicks with the warbling sound. But how do we interpret the sound of 10,000 chickens in a stable? Should we then measure frequency or intensity of the sound, what are the normal patterns, and what do the deviations mean? When we develop technology that fails in this area, this means, for example, that too many warning messages are given by the system, that are then systematically ignored by the farmer. And even if the deviations really mean something in the biological sense, then the farmer must still have an idea of the consequences: what should the farmer do, when that warning message appears?

In addition, farmers must dare to invest in these new technologies, which do not always give direct value for money. Buying a new technology for your farm does not immediately improve your business performance. Precision livestock technology systems are tools. In order to improve your farm, the farmer must learn to use these new tools. The farmer needs to get to know the technology, but also has to learn how to make use of the data the technology provides. In the case of pedometers for dairy cows, software is also delivered with the technology, which means that you will get an advice on when to inseminate certain cows that the system has defined as being in heat (fertile, ready to be inseminated). This means that the farmer can directly follow the



> “ To make precision livestock farming a success, guts is needed.

advice given by the system: e.g. cow number 51 must be inseminated within 6 hours. But in most cases the advice is not so concrete, and it mainly provides information about abnormalities in animal behavior, sound or activity. Maybe a dairy cow lies down longer than usual, fattening pigs cough more often than average, or broilers are unexpectedly more active than otherwise – the farmer gets a warning message but must decide what to do. These early warning systems can certainly contribute to a more efficient operation, but this costs money, time and energy of the farmer. Only a farmer with guts dares to get started. It is positive to see that farmers who were daring, and bought new technology, often get used to it very quickly and no longer want to go without. A good example is our practical learning farm, where we have installed a positioning system in addition to activity meters on the leg and neck of the cows. At first, the farmer did not think he was going to use the positioning system. But sometime after installation, we decided to take a few cows out of the system for a project. Immediately the farmer called: where were his cows? It turned out that he had quickly started to use the positioning system, and already could not do without it.

Students in livestock related courses often find technology and data scary, more so than students in crop related courses. We have to get the idea, that technology as well as data is understood only by clever boys (!), out of the minds of our students. Technology is also for girls, and working with data is also for people without an exceptional aptitude for mathematics. Data and technology are tools to better chart animal behavior and to better understand signals from animals. This allows us to monitor and improve the health and well-being of animals. For this, students with guts are required.

I will finish this lecture with a call. To companies, to dare to invest in new technologies. To research institutions, to cooperate with companies and to develop software to translate data into useful information for the farmer. To farmers, to invest in new technologies and to learn to work with those. And finally, to our and other students to join us in all the interesting research projects in this field.

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