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Highlights :

- The human-animal relationship is not always degraded by the introduction of PLF
- Farmers have room to maneuver when using a tool or equipment
- Farmers choose to either completely or partially delegate a task to the equipment
- With PLF farmers implement different new practices to familiarize animals
- With PLF farmers fear the loss of observation skills and dependence on the tools

Farmers' representations of the effects of precision livestock farming on human-animal relationships

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Abstract

Precision livestock farming affects the nature and frequency of farmers' daily tasks, specifically in relation to animals. It consequently may modify how farmers consider their animals, the quality of the human-animal relationship and animal welfare. To better understand how new technologies impact human-animal relationships on the farm, a survey was carried out on 25 livestock farms in France. The farms raised dairy cows, gestating sows or broiler chickens using different equipment (sensors associated or not with robots). A qualitative thematic analysis to better identify farmers' views on the different topics, and secondly a statistical analysis to identify if farmer profiles exist and to better understand the diversity of views were conducted. Most of the farmers expressed satisfaction about working with the new technology because their work becomes easier and allows more control over the management of the animals. Using PLF, the farmers describe a profession that has not fundamentally changed but which involves new tasks, new skills and daily schedules. Three farmers' profiles were identified. Profile A farmers consider that one cannot talk about a human-animal relationship on their farm, and do not enjoy either touching or talking to their animals. Profile B farmers associate a good human-animal relationship with the animals' welfare. Profile C is characterized by the central place occupied by animals and associate a good human-animal relationship with an absence of fear on the part of the animals. Farmers motivated by animals (profile C) find in precision livestock farming benefits related to animals, while the others (profiles A and B) find technical benefits detached from the animals. The farmers have room to manoeuvre in how they use the equipment; this can be seen for instance in the degree to which tasks are delegated to the equipment, which can be partial or total. Nevertheless, some farmers expressed concerns regarding the place of the new technologies on the farm, such as the risk of losing their own autonomy or their ability to observe animals and detect problems. Complementary studies could monitor these developments and contribute elements on the role of PLF in the sustainability of livestock farms.

Keywords: human-animal relationship; livestock farmer profession; precision livestock farming; robot; sensor; work.

Introduction

The human-animal relationship, which is defined as the degree of closeness or distance between an animal and a person (Waiblinger et al., 2006), develops over the course of daily interactions on a farm and expresses itself in their mutual behaviour. The relationship always exists, and may take different shapes, be pleasant or not for the animal, or for the livestock person. To study, to describe or to assess human relationship on farm, different aspects can be take into account and different disciplines used.

For the animal, the human-animal relationship is one criterion of animal welfare. In the Welfare Quality© protocols[1], the "Good human-animal relationship" criterion is linked to the "Appropriate behaviour" principle, alongside the criteria "Expression of social behaviour", "Expression of other behaviour" and "Positive emotional state" for all species. The relationship impacts an animal's health and performance. Positive interactions during physical or visual contact (touching, farmer can be seen by the animal, farmer speaking calmly...) help to build a relationship that animals perceive as positive, and instills confidence in the human. Negative interactions (painful treatments, blows, farmer shouting) build a relationship that animals experience as negative, and create fear and mistrust of the human (Zulkifli, 2004; Waiblinger et al., 2006) which expresses itself into a physical distance or closeness. When the relationship is poor, behavioural responses such as physical avoidance, fight or aggression are a result; when it is positive, there is a move toward and search for contact with the human i.e. physical closeness (Boivin et al., 2012 ; de Boyer des Roches et al., 2016). Approaches such as ethology, animal production and health science are used to understand the animal view on the human animal relationships on farm.

[1] http://www.welfarequalitynetwork.net/en-us/reports/assessment-protocols/

For the livestock farmer, this relationship is a factor determining his or her professional satisfaction, comfort and safety when working with animals as reported through sociological approaches focussing on the social representations of the farmer (Bock et al., 2007; Kling-Eveillard et al., 2015). Dockès and Kling (2006) define four farmer profiles based on their closeness to their animals, which is assessed from the farmer's discourse. This closeness, or distance, is not physical, but relational. This typology brings to light differences between species and between productions regarding the closeness of the farmer to his or her animals. Dairy cow farmers tend to be in the profiles where relational closeness to the animals is the most important, poultry farmers in the profiles most distant from the animals, and sow farmers are distributed among the different profiles. To understand and describe human animal relations from the livestock farmer view, ergonomic approach is used focusing on human work in interaction with the animals, observing the physical closeness or distance chosen or implemented by the farmer to interact with the animals. Other approaches are also developed, for instance psychology. We do not detail all possible approaches.

In this relationship, any improvement benefits both partners, impacting the farmer's daily work and the animal's welfare, and ultimately the livestock farm's economic performance (Lensink et al., 2000 ; Hemsworth and Coleman, 2010). Likewise, any deterioration in the relationship will negatively impact both partners.

As reported by Hostiou et al. (2017) in dairy production, the human-animal relationship is directly modified by any change in livestock farming conditions, particularly the arrival of sensors, automated machines and new technology, which is referred to as precision livestock farming (PLF). The impact on the farmer's work depends on whether the change involves an automated machine capable of replacing the human in the performance of a task, or a sensor which provides data on the parameters of the environment or the animal itself. Equipment combining sensors with automated machines reduce human-animal interactions the most (Hostiou et al., 2017).

With PLF, automated machines take over certain tasks that were previously done by farmers, and consequently directly influence farmers' interactions with their animals and thus the human-animal relationship (Driessen and Heutinck, 2015 ; Schewe and Stuart, 2015). Moreover, the production of new, instant and readily accessible data on biological parameters and animal behaviour can influence how farmers perceive their animals and modify their direct observations of their animals, particularly by reducing their occurrence (Hostiou et al., 2017).

Farm size influences the reasons farmers to equip themselves. When herds are large or growing in size, becoming equipped with sensors and automated machines reflects a desire to increase productivity and save time (Allain et al., 2016; Gargiulo et al., 2018). Cornou and Kristensen (2013) have shown that the combination of new technologies and an increase in the size of a pig farm led to a change in how information is managed. The size of the herd also changes the daily interactions between a farmer and his or her animals (Boivin et al., 2012).

Furthermore, farmers do not all use the tools in the same way. Allain et al. (2016) demonstrated that among dairy farmers equipped with heat sensors, some delegate the task entirely to the equipment and directly contact the inseminator as soon as an alert is sent on a cow, while others begin by first verifying the information, going to see if the cow signaled is actually behaving in a way characteristic of a cow in heat.

Lastly, the development of tasks linked on one side to computers and new technology and, on the other, to equipment and automated machines, can impact how farmers experience and think about their professions, and consequently their job satisfaction or dissatisfaction (Cornou, 2009).

However, the new technology does not necessarily create greater distance between humans and animals. It can enable new relationships to develop, for example, when farmers with milking robots move frequently and calmly through their herd to maintain the machines and rub shoulders with their animals (Lagneaux and Servais, 2014; Wildridge et al., 2020). Furthermore, several authors (Butler et al., 2012; Schewe and Stuart, 2015) have shown a diversity between

farmers with regard to the consequences of PLF on work organization and thus on the farmer's profession.

The present paper aims to present the results of a study conducted in 2016 using a sociological approach on the human-animal relationship on farm. This topic is rarely addressed through qualitative interviews which makes possible a better understanding of human animal relationship from the farmers' views. Most researches focus on the link between farmer practices and animal welfare or animal reactivity to humans. Some assess farmer's attitudes through a closed questionnaire, while our research is based on semi-directive interviews with open-ended questions which enable to collect a variety of viewpoints and thus to understand the different representations of the speakers on a given topic.

We studied the diversity of farmers' representations of their profession and the human-animal relationship in connection with PLF (Kling-Eveillard et al., 2017). Interviews were conducted on farms in three animal sectors (dairy cattle, pigs and poultry). In this study, we chose not to examine the changes that have occurred with the arrival of PLF tools (to do so, we would have had to conduct interviews and observations before and after the equipment was installed). Instead, we chose to explore the farmers' subjective vision and social representations of these impacts based on how they have experienced them. The aim is to understand how they currently were experiencing their work and their relationship with the animals while using these tools, and to listen to what they have to say about the changes that occurred before and after becoming equipped, and about how the arrival of the tools on the farm has taken place.

We relied in this work on the social representation concept, defined by Jodelet (1989) as "a form of socially formulated and shared knowledge intended for a practical purpose". Other works have relied instead on the concept of attitude, such as has been used in the theory of reasoned action. In particular, Hemsworth (2003) uses it in his research on the attitudes of people who work with animals. The concept of social representations is broader than that of attitudes because it considers the social nature of the determinants of both attitudes and levers of

change. Examples are how farmers influence each other, or the influence of parents if they themselves were farmers.

In the first part of the article, we present the methodological choices made in terms of the equipment and livestock farms studied. We then describe the results concerning the farmers' representations of the animal, their profession, and the human-animal relationship, and then on the satisfaction in and new practices stemming from PLF. These thematic results will be complemented by the presentation of the three profiles of farmers that emerged from the statistical analysis.

Material and methods

Sampling criteria

The aim of the sample of farms was to encompass diverse changes in the relationship between farmers and their animals resulting from the use of PLF tools. Farms were selected to cover a diversity of cases, and not to be representative of the French farmer population. We used the following criteria to select farms : i) animal species, ii) herd size, iii) adoption of PLF tools.

The animal species influence the human-animal relationship (Dockès and Kling, 2006). For this, three species were studied : Prim'Holstein dairy cows (DC), gestating sows (GS), and broiler chickens (BR), all in conventional livestock farming systems. The Prim'Holstein being the most represented dairy cattle breed in France and especially in Brittany (around 10 000 Prim'Holsteins in each Breton department), it has become a sampling criterion for the dairy cattle farms to be studied.

The size of the livestock unit was a criteria used to select farms because PLF is often coupled with increased herd sizes. Surveys were therefore conducted for each species in two herd size classes, one above the Breton average and the other below, without including extremes in either class (Table 1).

We used the following criteria to choose the precision farming tools to study: i) tools widely used on farms, and ii) tools differing in terms of the impact they have on animals' living

conditions, farmers' working conditions and human-animal interactions (Table 2). Two main types of equipment were selected according to whether they were composed exclusively of sensors or were associated with automated machines (Table 2). An automated machine combined with one or several sensors was chosen for each of the three sectors: milking robots for dairy cows, individual sow feeding (Electronic Sow Feeding (ESF) or free-access stalls) for gestating sows, barn electronic controllers and automatic weighing devices for broiler chickens. The introduction of milking robots and automated feeding systems led to, or became associated with, a new way of managing animals. For dairy cows, this involved a transition from two milkings per day in a milking parlour to cows having direct access to a robot to be milked whenever the cows wished. For gestating sows, group housing required by European regulations replaced individual pens and access to feed was modified from one or two meals per day at the same time for all sows to open access all day long, one sow at a time. For broilers, electronic controllers have existed for some time. The new feature consists in being able to control barn atmosphere parameters from a distance (for example, remote control using a smartphone) without having to go to the building (for example, to open ventilation hatches). Sensors also were chosen that were not associated with an automated machine, namely heat detectors for dairy cows.

Identification of the farms to be surveyed

The surveys were conducted in Brittany, the leading livestock farming region in France in terms of numbers of farms. The farmers' contact information was provided by field experts. For dairy cows, the person conducting the survey contacted farmers on a private data base of 200 livestock farmers identified by their heat detection or milking robot equipment. For gestating sows and broilers, the snow ball sampling was used: the farmers surveyed themselves provided the names of other farmers (Ghiglione and Matalon, 2008).

The sample was composed of 25 farms distributed between the three species (8 GS, 10 DC and 7 BR) and equipment presented in Table 1. The farms in the sample were slightly larger than the average French or Breton farm in terms of utilised agricultural area (115 ha for GS, 147 ha for

DC, and 52 ha for BR), and herd size (263 gestating sows, 106 dairy cows, 2840 m^2 in broiler chickens farms) (Table 1). 21 farms combine different agricultural activities (livestock, crops), 4 farms (1 GS, 1 DC, 2 BR) are specialized. The average age of farmers was 45 years old. The farmers were slightly younger than the average French or Breton farmer. 8 farmers are between 30 and 40 years old and 10 farmers are between 50 and 60 years old. Pig farmers are on average younger (42 years old) than cow farmers (45 years old), and than chicken farmers (50 years old). The youngest farmer is a pig farmer, who is 23 years old, and a large majority of the chicken farmers interviewed are currently preparing for retirement. Of the 25 people surveyed, 7 were women and 18 men.

Survey method

We have given priority to semi-structured interviews, often used in sociology to study social representations of speakers like farmers. The interviews were recorded (Ghiglione and Matalon, 2008). The following topics were addressed: the profession of a livestock farmer; the introduction of PLF tools; the management of PLF; the human-animal relationship; PLF and the evolution of the profession (Table 3).

Once the qualitative interview was completed, a closed questionnaire was given to the farmers in which they could note the extent to which they agreed (6 levels possible, from "strongly disagree" to "strongly agree") to items involving their representations of animals, their profession, PLF, and what they appreciate about their profession. They were also asked to describe their relationships with their animals at the time of the interview and prior to introducing PLF using an ungraduated axis between "very poor relationship" to "very good relationship".

Analysis method

We carried out two types of analysis to get two kind of results : firstly a qualitative thematic analysis to better identify farmers' views on the different topics, and secondly a statistical analysis to identify if farmer profiles exist and to better understand the diversity of views. In our analysis a profile regroups farmers who have common characteristics compared to the other

profiles. Doing so, we did not lose qualitative information, and both kind of results are complementary.

Thematic analysis

The notes taken during the interview were completed with the listening of the recording. A monograph for each farm was done for each interview gathering the interviewee comments, or the discourse, on the main topics addressed during the interview. The contents of the interviews and the answers to the closed questionnaires were analysed using an analysis grid crossing the different topics and the different interviews. The grid served as a support for an analysis of the thematic content concerning the representations of the profession, the animal and the human-animal relationship, and the satisfaction found in and the new practices used in PLF. The results of this qualitative analysis constitute the three first parts of the results presented below.

Statistical analysis

The statistical analysis had to answer to two questions :

1) Does it exist farmer profiles describing the diversity of attitudes and representations of the animals and of human-animal relationships among the interviewed farmers ?

To answer this question, the representations of the profession, of the animal and of the human-animal relationships were chosen to be the active variables to build the profiles.

2) Do these profiles show different views of precision livestock on the farm and of its impacts ?

To answer this question, the variables regarding the use of PLF were supplementary variables which add information on the profiles built from the active variables.

The thematic analysis of representations of the profession, the animal and the human-animal relationship then enabled the construction of a summary grid regrouping the most discriminating variables (Table 4).

A statistical analysis combining a multiple correspondence analysis (MCA) and an ascending hierarchical clustering (AHC) were carried out to identify the livestock farmer profiles. The 17 active variables selected concerned the representations of the profession, the animal and the

human-animal relationship (Table 4). All these variables are qualitative. The AHC method cannot be used with qualitative variables, a step before using the MCA method is needed. This method is frequently used to analyze survey answers (Saporta, 2011). The principle of the AHC method is to gather similar individuals in separate cluster, similar in sense that they have the same values for active variables. The method starts with each farmer in a separate cluster, then the farmers are grouped according to the values of their active variables. At the end, each farmer is assigned to one cluster. This ascending hierarchical building is represented in a dendrogram (figure 1). The best split of this dendrogram is selected by a statistical rule and create a given number of clusters. With MCA and AHC methods, three clusters were identified and are described as livestock farmer profiles. The 8 supplementary variables concerning representations and practices involved in PLF gave additional information regarding these profiles (Table 4). A chi-square test was used to compare the percentage of each modality of the variables in each cluster with its percentage in the population. Due to a low number of interviews, the level of significance was set at 10% for all the analysis. These analysis were made with R software version 3.6.0 and the FactoMineR package (Le et al., 2008).

Each profile is described in relation to the other two and to the survey population, highlighting the characteristics which are more common in the given profile than in the others. All farmers in a profile do not necessarily have all of these characteristics but they are broadly similar.

Results

We have chosen to first present the farmers' representations of the animals, their profession, and the human-animal relationship, and then to complement these with their representations of PLF on their livestock farms produced by an analysis of the thematic contents of the semi-structured interviews. In this part, as we have no quantitative objectives given our small sample size, we do not always indicate the number of farmers who expressed one view or another, and we highlight the diversity of the social representations identified. After these thematic results, we describe the three transversal profiles of farmers, applicable across the animal species (dairy cow, gestating sows and broiler chickens), produced by the statistical analysis.

Representations of the animal, the profession and the human-animal relationship

The satisfaction farmers say they find in their work and their definition of what makes a good farmer reflect how they view the place of the animal. What the farmers appreciate in livestock farming activities can be grouped around three features. Some emphasize the animal, the contact, and the work with animals. Others mention instead technical features, such as technical aspects of animal management, animal genetics, technical monitoring of production or technology at the service of farmers. Lastly, some note the characteristics of their profession, such as being independent, being their own boss, having a real profession, and pleasant working conditions. Diversity with regard to the place of the animal is also found in the farmers' definition of what makes a good farmer. Some farmers define a good farmer as one who takes good care of his or her animals. However, this can mean two different things: taking good care can mean being attentive to the animals' needs so that they are well, or it can mean ensuring that the animals are productive. Other notions are mentioned: a good farmer has strong technical skills, achieves good technical or economic results, or combines animal, technical and economic expertise.

With regard to the representation of the profession, some of the farmers interviewed demonstrated satisfaction with - or were even passionate about - their work, while others dwelled on the difficulties involved, and reflected a loss of motivation.

The farmers were questioned about what they thought the human-animal relationship encompassed. It was difficult for most of them to answer this question, both because they were unfamiliar with the term, and because the question involved a very personal dimension that is not usually discussed in livestock farming. Four farmers thus considered that they did not have a relationship with their animals on the farm (3 BR and 1 GS), this view meaning that they feel a relational distance with the animals. It was easier for the farmers to speak about their view of a good human-animal relationship. Most frequently, they mentioned the animal's welfare, and some (mainly dairy and pig farmers) spoke of the animal's absence of fear in relation to people, or even a mutual sense of confidence between the farmer and the animals. Good production

levels are mostly considered as a reflection of a satisfying human-animal relationship. For the majority, a good human-animal relationship renders it possible to work more easily with the animals, regardless of the species. At the same time, they also mention farmer well-being, and good livestock farming conditions with equipment.

Satisfaction under PLF

For many farmers, setting up precision farming tools on their farms was an expression of their desire to work differently: to improve working conditions with robots (work comfort, reduced drudgery, free themselves from the constraint of milking, ...) or to improve their techniques and performance with sensors (better identify cows in heat, better adapt feed rations to animals' needs, ...). In addition to these motives, some farmers were encouraged to invest in new technologies by economic and regulatory incentives. The shift to group housing for sows required by European regulations accompanied the automation of feed distribution. On broiler farms, farmers receive a bonus if they provide an accurate estimation of the weight of the broilers in a batch. This has encouraged the installation of automatic weighing devices, as they can provide data on a greater number of chickens than if they are weighed manually.

Nearly all of the farmers surveyed expressed satisfaction about working with the new technology. They highlight that work is easier and the equipment allows them more control over the management of the animals, particularly with the provision of data. They furthermore consider that PLF will prove to be indispensable for farms in the future. Mastering new technologies appears to be a new job skill in a profession which has become more technical. The modern image given to the profession deeply pleased many of the farmers surveyed, who felt less left behind in relation to other professions. Four farmers (sow or dairy with milking robot) describe a profession which is in closer contact with animals, and state feeling "more like a farmer" in livestock farming conditions where they and their animals are less restricted in their activities. According to the farmers interviewed, the improved working conditions and connectivity of the farming profession renders it more attractive to younger generations. Several

farmers, however, expressed some reservations about the tools, which cannot do everything, and noted the importance of also trusting a farmer's eye and gut feelings. Four farmers appeared unenthusiastic about new technologies and either consider that they look for other satisfactions in their profession such as spending time in contact with their animals or do not like to use this kind of tools (computers, etc.), even in their private life.

New practices under PLF

Using PLF, the farmers describe a profession that has not fundamentally changed but which involves new tasks and daily schedules. They say they spend more time in front of the computer each day. In terms of time spent with their animals, some say that they now spend more time, while others say that they spend less. For many, "observing" animals includes both direct observations, for example by moving among a herd of cows in a shed, and looking at digital data about the animals on their computer. Furthermore, when questioned about what they thought of as a "good animal", some spoke of the "invisible animal" which does not trigger alerts because it poses no problems.

The morning routine illustrates the diversity of practices among farmers. Only five farmers (three dairy farmers and two pig farmers) say they start their day by first looking at the animals, while all of the others begin by looking at the computer and the daily alerts before going to see the animals. Of the five who start their day by going to see the animals, four are women. Three female pig farmers prefer to first go see their animals to get a feel of the atmosphere and identify the sows which will need attention. They explain that their associate starts his day by consulting the computer.

A range of practices also was identified with regard to delegating a task or a decision to the tool. For the three species, delegation to equipment was not always complete, and some farmers verify the data provided by the sensors. For example, broiler chicken farmers weigh several birds manually in addition to using the automatic weighing device. Dairy cow farmers prefer to visually verify that a cow designated by a detector as being in heat is showing the associated signs before calling the inseminator. Regarding the detection of heat, the four farmers whose

sows are equipped with electronic chips to record the visits of boars said that they check for the behavioral signs of heat when a sow is signaled by the computer. The other pig farmers delegate all responsibility to the equipment.

In certain situations, three farmers equipped with milking robots continue to manually carry out certain tasks, for example leading a heifer to the robot and attaching the teats in order to accustom the animal to the machine.

The equipment can induce new kinds of contacts with the animals when first set up or when new animals arrive. On dairy cow and gestating sow farms, the arrival of new animals appears to be a key period when opportunities exist for the famer to establish contact and implement habituation strategies (apple juice to tame gilts in quarantine for example).

Three profiles of farmers and their relation with PLF

Three farmer profiles emerge from the statistical analysis of variables involving the representation of the profession, the animal and the human-animal relationship (Figure 1).

Profile A is characterized by a negative image of the profession, which is experienced as not very rewarding. Eighty per cent of individuals answered “rather disagree” to the item “The profession is rewarding”, whereas 16% of the population answered that. The difference is significant because the p-value of this difference is less than 10% (80% vs 16%; <10%). The farmers consider that there is no human-animal relationship on their farm (80% vs 16%; <10%), and they do not enjoy either touching (60% vs 12%; <10%) or talking to their animals (60% vs 16%; <10%). They consult their computers first thing in the morning before going to see their animals (profile A 100% vs 76%). These five farmers are all men, working with all three species (2 GS, 2 DC, 1 BR).

Profile B is characterized by a rather positive image of the profession, which they consider rewarding (0% answered “rather disagree” to the item “The profession is rewarding”; <10%). Independence, a diversity of tasks and technical features are the characteristics which satisfy these farmers most. For them, a good human-animal relationship is associated with the animals’ welfare (76,9% vs 44%; <10%). They consult their computers first thing in the morning before

going to see their animals (profile B 76,9% vs 76%; ns). These 13 farmers (10 men and 3 women) are divided between the three species (3 GS, 4 DC, 6 BR), notably including nearly all of the broiler chicken farmers of the sample (6 out of 7).

Profile C is characterized by the central place occupied by animals. The animals are the main source of job satisfaction for these farmers (100% vs 48%; <10%). They associate a good human-animal relationship with the animals' absence of fear (100% vs 40%; <10%), revealing through this response their feelings for the animal. They enjoy touching (85,7% vs 28%; <10%) and observing the animals (71,4% vs 36%; <10%) and say that animals have a memory (71,4% vs 28%; <10%) more often than the farmers from the other two profiles. They implement strategies to familiarize the animals with humans and the equipment to facilitate their work (85,7% vs 40%; <10%). Among these seven farmers, there are three men and four women, and they are raising gestating sows and dairy cows (3 GS, 4 DC).

Farmer profiles in relation to the profession and the animal also differ with regard to PLF. Profiles A and B farmers distinguish themselves from profile C farmers in their responses concerning PLF. In profile C farmers feel that they know their animals better since installing the equipment (milking robots for cows and automated feeders for sows housed in groups ; 100% vs 56%; <10%). They also say that the human-animal relationship is better (85,7% vs 52%; <10%). In contrast, in profiles A and B farmers say less often that they know their animals better (profile B 30,8% vs 56%; <10% and profile A 60%; ns) and that the relationship is better (profile B 30,8% vs 52%; <10% and profile A 60%; ns). They tend to most often claim to appreciate working in a modern profession (profile A 80% vs 60%; ns and profile B 61,5%; ns).

Discussion

This exploratory study was conducted on a limited number of farmers per species and per equipment, but permitted farmers who were different from each other to be interviewed. This enabled the identification of three farmer profiles, determined by the farmers' proximity to their animals or their interest in management. In PLF, farmers motivated by animals find benefits

related to animals (profile C), while those who are less motivated by their profession or animals find foremost technical benefits disconnected from the animals (profiles A and B). The profiles appear to be fairly generic due to their similarity with those identified in a previous study (Dockès and Kling, 2006) on closeness with animals. They illustrate the diversity which exists between farmers, and show that farmers have some flexibility in how they use equipment related to new technology.

The study showed that the farmers entertain a fairly positive image of PLF. They consider that their work has become easier with sensors and automated machines, and that they have greater control over the management of their animals. They describe a situation in which there are fewer constraints on both themselves and the animals. The farmers have some leeway in how they use the equipment; this can be seen particularly in the degree to which tasks are delegated to the equipment, which can be partial or total (Allain et al., 2016). The improvements in the farmers' working conditions or in their experience at work are likely to positively influence their practices with the animals, moving towards a better human-animal relationship and improved animal welfare through the virtuous circle described by Boivin et al. (2012). In the same way, Hansen and Osteras (2019) have shown that high farmer occupational well-being and low level of stress are linked to a better animal welfare. As showed by some authors, the main motivation for farmers to invest in PLF is not economic but rather to improve their working conditions and their quality of life (Vik et al., 2019). Introduction of PLF in farms modifies farmers' working conditions in terms of work duration, work flexibility and mental workload (Hostiou et al., 2017; Schewe and Stuart, 2005; Tse et al., 2018; Vik et al., 2019).

Most farmers are positive and say that PLF, sometimes associated with new farming conditions, has not degraded but has rather contributed to an improved relationship, as brought out by Wildridge et al. (2020). These enhanced relationships appear through the implementation of new practices to familiarize animals with the new systems as well as to familiarize them with people. Getting the animals accustomed to the equipment facilitates its use over their entire life

cycles. Familiarizing them with humans makes later human interventions easier. The shift from individual stalls to open buildings has provided an additional opportunity to work with animals differently.

Some of the farmers surveyed mention that the human-animal relationship had deteriorated, such as has been cited in certain studies (Boivin et al., 2012; Cornou, 2009). The data provided by the new technologies indeed help to modify the way a farmer sees the animals, providing an individualized vision of the animals that is no longer at the herd scale. However, data management consumes time at the expense of other tasks. It also can prove difficult for the farmer to sort through the mass of data available. This change in the nature of the profession can lead to the acquisition of new skills, but it also can cause the loss of "traditional" skills and, for some farmers, result in a loss of interest in the profession and in the relationship with the animals (Cornou, 2009). This loss of certain skills raises questions regarding the long-term impacts of PLF (Driessen and Heutinck, 2015; Marinoudi et al., 2019). In this study, the technologies were installed on farms that previously had functioned without them for years. The farmers therefore analyse the contribution of this new information in the light of their previously developed knowledge and skills. What hindsight will be afforded to farmers and workers who directly start out on farms with PLF equipment? It could be interesting to survey the farmers who have practiced PLF for many years, or young farmers who are setting themselves up on farms that already are equipped with PLF tools. In order to better consider farmer discontent with PLF, studies could also be conducted with farmers who have stopped using the equipment or who have chosen not to equip themselves.

In this study, we focused on two types of equipment which are quite different: sensors alone, such as heat detectors, and sensors combined with automated equipment (milking robots, sow feeding systems). The sensors provide farmers data on their animals, and our results confirm that this changes how farmers view their animals and raises questions about the role of observation in their work. When the sensors are combined with automated machines, it is the daily tasks that may be changed, and in particular occasions for interaction between humans and

animals. In addition to PLF, sometimes human-animal relationships are affected by changes in production and rearing conditions, such as the introduction of keeping gestating sows in groups. In this case, the impacts thus result from this combination of new farming conditions and new equipment. The changes can vary greatly in nature and scope depending on the different situations.

Also of interest would be complementary studies on several parameters that could influence changes in farmer work in relation to animals and equipment like sensors and robots. These parameters can have an influence on both the work and the relationship with animals, and on interest in new technologies. Our study focussed on farmer representations considered as the farm manager. However the human-animal relationship is the result of interactions between animals and several people, as shown by de Boyer des Roches (2016). Studies should therefore better take into account how the farm workforce composition (including family and non-family workers) organises work with animals in farms that have adopted PFL. Moreover, our study showed that in our sample, there are proportionally more women in profile C, focused on the animals. The role of women changes with the introduction of PLF with an increasing involvement in animal husbandry and the use of new technologies (Eastwood et al., 2012 ; Hay and Pearce, 2014). Finally, PLF seems to be more adopted in larger farms (Gargiulo et al., 2018), which also has consequences on the human-animal relationship.

A comprehensive approach to the human-animal relationship should be multidisciplinary (Boivin et al., 2012). It should involve complementing the sociological approach exploring farmer representations presented in this article with an ergonomic approach to farmers' activities and practices, observing farmers at work. Furthermore, it should take into account what animals "say" about the relationship and how this is reflected: these approaches are zootechnical (animal welfare and performance) and ethological (animals' responsiveness to people). Such an approach was not possible within this study but is planned for a new project (Courboulay et al, 2020).

Conclusion

Our study confirms that the human-animal relationship, and thus animal welfare, can be impacted by the introduction of PLF on a farm, just as it can be affected by any other changes in livestock farming conditions. As the farmers have described, the human-animal relationship is not always impacted in the same way, and it is notably not always degraded by PLF. The situations and farming conditions associated with PLF are diverse (for example, grouping or not grouping animals), as is the equipment (sensors, automated machines) and the farmer profiles. The profiles illustrate the diversity of the farmers' experiences and choices, and confirm that they have room to maneuver when using a tool or equipment. Farmers thus can choose to either completely or only partially delegate a task or decision to the equipment. Others differentiate themselves by implementing (or not implementing) relational practices to maintain a sense of closeness with their animals; some start their day by observing their animals while others consult their computers.

In describing these profiles, three themes are linked: how farmers view their profession, how they define the human-animal relationship, and how they perceive the impacts of PLF. This convergence reinforces the idea of a link between animal welfare and farmer wellbeing, as expressed in the One Welfare concept. What enables farmers to better enjoy their profession and their work, with fewer constraints, contributes to a certain extent to a better human-animal relationship and to the welfare of the animals.

While the majority of the farmers interviewed demonstrated broad satisfaction with PLF as implemented on their farms, some reservations and questions were raised. They concern in particular dependence on the tools and the sustainability of animal observation skills over time with the development of new habits formed by the way the equipment functions. Some farmers were furthermore reticent about PLF. Complementary studies could monitor these developments and contribute elements on the role of PLF in the sustainability of livestock farms.

Lastly, the effects of the development of PLF on the general public's image of livestock farming was not addressed in this research but also merit being examined in detail as society's image of livestock farming is a decisive factor in the evolution of livestock farms and their sustainability.

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Declarations of interest

None

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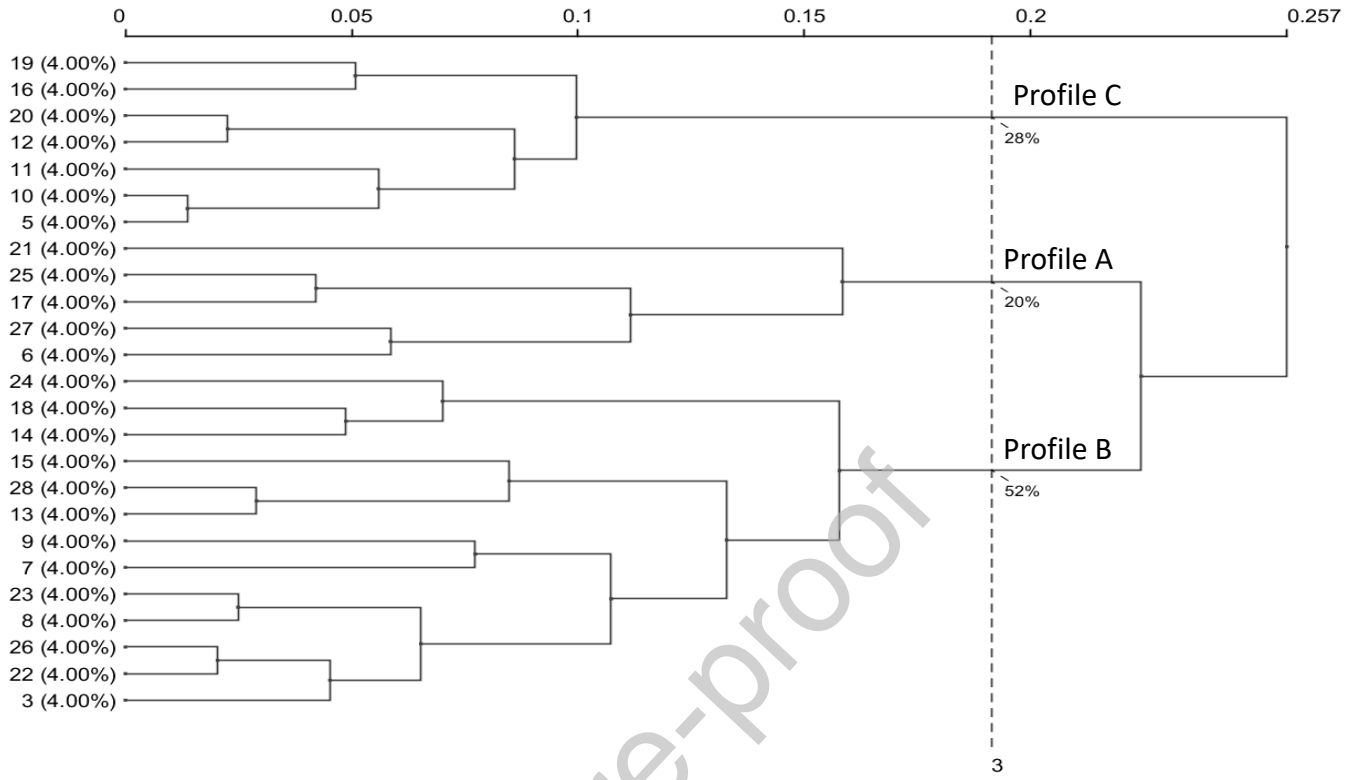
Figure 1 : Dendrogram from the hierarchical ascendant classification (HAC)



Each line represents a farmer with his survey number.
The horizontal axis represents the criterion used (the loss in between-inertia) to group the farmers together during the building of the dendrogram.
The vertical line represents the best split of the dendrogram and defines the three clusters / profiles.

Table 1: Number of surveys carried out by species and equipment type

Species	Gestating sows GS				Dairy cows DC					Broiler BR		
Number of animals	< 245		> 300		< 85		> 105			< 25000		> 40000
System	ESF	FAS	ESF	FAS	MR	HD	MR	HD	MR + HD	BEC	AW + BEC	AW + BEC
Number of farms per category	3	2	2	1	2	2	4	1	1	2	1	4
Number of farms : total	8 farms				10 farms					7 farms		
Herd size (min/max)	263 gestating sows (150 - 430)				106 dairy cows (50 – 190)					2840 m^2 (1000 – 8100)		
Utilised agricultural area (ha)(min/max)	115 (0 – 305)				147 (70 – 305)					52 (0 – 70)		
Average age	42				45					50		

ESF : electronic sow feeding ; FAS : free access stall ; MR : milking robot ; HD : heat detector ; BEC : barn electronic controller ; AW : automatic weighing system

Table 2: Characteristics of the equipment studied and consequences of human-animal interactions

Species	Gestating sows GS	Dairy cows DC		Broiler chickens BC	
Equipment	Individual feeding (ESF, free-access stalls)	Milking robot	Heat detectors	Barn electronic controllers	Automatic weighing device
Main functions of the equipment	Sensor: feed consumption. Automaton: feed distribution.	Sensor: quantity and quality of milk, frequency of milking, etc. Automaton: milking	Sensor: animals' activity (heat suspicion).	Sensor: atmosphere parameters of the barn, animals' water, feed consumption, animal weights. Automaton: regulates building equipment (fans, aeration hatches, ...).	Sensor: daily growth. Automaton: weight of a sample of chickens and individual weights.
Changes in terms of farmer-animal interactions	Farmer no longer associated with meals. The farmer moves through the animals for interventions (vaccinations, ultrasounds, …).	No direct watching, no daily touching 2 times a day. Possible need to push certain animals, put down straw, observe, etc.	No direct watching. Directly call the inseminator as soon as the sensor sends an alert, or visual verification before making	No longer moves among his or her animals to operate heating and ventilation equipment. The farmer moves among his or her animals to remove dead birds, to check	No manually weighing (and no longer touching the animals).

			the call.	that everything is going well and to make occasional repairs.	

Table 3. Main topics and questions of the semi-structured interview

Topics	Main questions
Profession of a livestock farmer	farmer's motivations, place of animals, definition of a "good farmer"
Introduction of PLF tools	reasons for the farmer to acquire the equipment, methods of adoption and transition
Management of PLF	use of data, observation of animals, changes in practices related to animals
Human-animal relationship	the farmer's definition of a good human-animal relationship, challenges and factors behind a good human-animal relationship in livestock farming, relational practices implemented
PLF and the evolution of the profession	farmer's representations of changes

Table 4: The variables used in the statistical analysis

1) Active variables involved in the composition of profiles on representations of the profession, of the animal and of the human-animal relationships) :
- Variables resulting from the analysis of the discourse of the livestock farmer
Sources of satisfaction in the profession
Motivations for becoming a livestock farmer
To see the animals, the first task in the morning
Visual observation of heat in addition to alerts by the equipment
Task fully delegated to the machine
Strategies for familiarizing heifers or gilts
Definition of a good human-animal relationship
Estimated score of the current human-animal relationship
- Variables from closed questionnaire responses (degrees of agreement)
Poultry / cows / sows have a memory
There is a link between the welfare of the farmer and the well-being of the poultry / cows / sows
The livestock farming profession has many downsides
The livestock farming profession is rewarding
The livestock farming profession is exciting
Enjoys touching animals
Enjoys talking to animals
Enjoys observing animals
Enjoys selling animals

2) Supplementary variables on uses of PLF (not involved in the construction of profiles but may appear as characteristics of certain classes and bring additional information to describe the profiles)

- *Farm and farmer characteristics*

Animal species raised on the farm

PLF equipment

Number of AWU (Animal Welfare Unit) (continuous variable)

Gender M / F

- *Variables from closed questionnaire responses (degrees of agreement)*

Since the arrival of the new tools, has the feeling of knowing animals better individually

Since the arrival of the new tools, finds the human-animal relationship is (better, unchanged, worse)

Likes the modernity of the profession with the new technologies

PLF can improve the human-animal relationship

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