demeter

TITLE: Pilot 4.2 Consumer Awareness: Milk Quality and Animal Welfare Tracking

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DATE: January 2023

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 857202.

PILOT 4.2
Consumer Awareness: Milk Quality and Animal Welfare Tracking

1 Introduction

DEMETER aims to lead the Digital Transformation of the European agri-food sector based on the rapid adoption of advanced technologies, such as Internet of Things, Artificial Intelligence, Big Data, Decision Support System (DSS), Benchmarking, Earth Observation, etc., to increase performance in multiple aspects of farming operations, as well as to assure the viability and sustainability of the sector in the long term. It aims to put these digital technologies at the service of farmers using a human-in-the-loop approach that constantly focuses on mixing human knowledge and expertise with digital information. DEMETER focuses on interoperability as the main digital enabler, extending the coverage of interoperability across data, platforms, services, applications, and online intelligence, as well as human knowledge, and the implementation of interoperability by connecting farmers and advisors with providers of ICT solutions and machinery.

DEMETER focuses on the deployment of farmer-centric, interoperable smart farming-IoT (Internet of Things) based platforms, to support the digital transformation of Europe's agri-food sector through the rapid adoption of advanced IoT technologies, data science and smart farming, ensuring its long-term viability and sustainability.

Twenty real-world pilot projects, grouped into five pilot clusters, are running within DEMETER to demonstrate and evaluate how agricultural innovations and extended capabilities benefit farmers, technology providers, and society. The topics, scope and size of the pilots are diverse, from saving resources, such as water and energy, to a more environmentally compatible crop management with reduced application of fertilisers and pesticides, to improved animal welfare and the tracing of complete supply chains.

This white paper describes PILOT 4.2 that aims to build a digital eco-system that allows the farmer to monitor animal welfare to improve milk quality, while the processor to optimize the supply chain process by innovating the way to use his data.

2 Importance of digital agriculture

Farming is called to cope with the challenges of increasing food production to meet global demand, while reducing its environmental impact. New digital technologies applied to the European agricultural sector help agriculture to be more efficient, sustainable, and competitive. Artificial intelligence (AI), robotics, Internet of Things (IoT), Edge Computing, 5G, blockchain, and supercomputing are just some of the technologies with enormous potential of enabling the digital transformation of agriculture.

The core of the digital transformation of the agri-food sector lies in the increasing capacity to produce, transfer, and analyse data in ways that were previously not technically or financially feasible, making it possible to record and process a greater volume of agricultural data, while also increasing rural attractiveness, above all for younger generations. Combining real-time machine and environmental data, coming from different sensors through IoT, digital agriculture supports farmers in making better decisions which optimise quality and productivity, reducing waste and increasing efficiency and sustainability.

As it happens in the livestock sector. The use of some wearable devices entered the breeding several years ago but, more recently, their connection via web to computers in-cloud opened alternatives to otherwise unsuccessful business, unable to compete in a global market where even cents have great value.

For example, these wearable devices allow to identify the animal, to monitor its activity and report any abnormalities to a reliable and accurate alert system. An animal that moves little or less than usual is an indication that something is not going well; it may be a trivial inflammation of the limbs or worse a pathological condition. If, on the other hand, animal activity is increasing and it is a female, its oestrus phase could be ideal for conception. If the right moment is missed, it is necessary to wait for a new cycle (21 days on average), and milk production will be delayed by a similar amount of time. As well, these devices open the gates of the milking robot when the cow decides to be milked or, they deny the access if adequate time has not elapsed since the previous session. Thanks to these devices, while the cow takes the robot' care, from udder washing to pre-milking massage, sensors attached to the teats will examine the milk, measuring its fat and protein content or other parameters, such as electrical conductivity, to confirm the health of the udder, a very delicate organ that is easy prey to diseases such as mastitis. If a single parameter indicates

abnormalities, that milk is immediately separated from that of the rest of the herd and the animal reported for appropriate health examinations. Information that will then be invaluable in balancing the diet of each individual animal. The sensors could also inform, almost automatically, about the time between calving, the conception index, the ratio of feed consumed to milk produced.

All these numbers fed the farm management system and help farmers to make more efficient and sustainable decisions, from an economic, environmental, and also social point of view. The development of solutions which makes interoperable already existing digital platforms extend the benefits of the digitalization along the supply chain, bringing more transparency towards the consumers and facilitating the cooperation among the actors of the supply chain.

Nevertheless, some barriers to the adoption of digital solutions still exist. Costs of the infrastructures, lack of initial skills to used them, data privacy concern, inadequate internet connectivity in rural areas are just some of the barriers mentioned in several studies concerning this topic; first, the report “Farmers’ Voice” conducted within DEMETER.

The farm involved in the pilot described in this paper already had an advanced level of digitalization and skilled personnel, thus it has been easier to project and implement the solutions. However, this is not the most common situation, at least in Italy, and the barriers emerged in the analysis ask for policy interventions at a higher level than farms. These could create the context for an efficient digital transformation of agriculture, able to bring advantages not only from an economic point of view with higher earnings, but also, and above all, from an environmental point of view, by helping farmers to be more sustainable.

3 Pilot Overview

The rationale of the pilot is based on three main assumptions. First, quality of milk is closely linked to animal welfare: an adequate eating and resting of animals will increase milk production and quality. Second, the processing companies are interested in milk’s quality levels, as they pay farmers a variable premium, based on pre-defined (on legal basis) quality indicators of milk. Finally, consumers ask for transparency of the food they eat. The pilot implements an information flow optimization across these three dimensions creating an optimized flow of information, ensuring the transparency of all stages.

Challenge

Lots of data are collected through several devices along the milk supply chain, in particular at farm level, but most of them are not effectively used and shared neither among devices nor across the actors of the supply chain, losing the value inherent in the data itself. In fact, albeit the big amount of available data, the farm had not an integrated overview of the several aspects which impact on animal welfare; the processing company lacked an optimize system to control the quality of the milk collected from the breeders; consumers were not in the condition to properly know where the milk comes from. The challenge faced by this pilot was giving a value to these data, facilitating the information flow from the breeders to the consumers.

Aim

The pilot aimed at building a digital eco-system that allows the farmer to monitor animal welfare to improve milk quality, while the processor optimizes the supply chain process by innovating the way to use its data. In this way, the pilot allowed an integration among scattered data, improved the collaboration and the information exchange between the breeding farm and the processing company, improved milk quality measurements, and traced relevant information through a block-chain solution which also reaches consumers.

Who and where

Following a multi-actor approach, the Pilot involved five actors: a farm, a processing company, a farmers' organization, and two technology providers, briefly described below.

MACCARESE

The breeding company Maccarese Spa, the largest dairy farm at Italian level, with 1450 Friesian dairy cows, 600 fattening calves and 3.240 hectares of land, located 20 km far from Rome, in the Lazio Region.

FATTORIA LATTE SANO ROMA

The milk processing company Latte Sano Spa, leader in the Lazio Region for the distribution of milk and dairy products, also through Horeca channel and large-scale retailers.

COLDIRETTI

Coldiretti, the largest farmer's organization at Italian and European level, with about 500,000 active farms among its members from all sizes and covering all sectors, and a management structure widespread in all the Italian territory.

The technology provider Engineering Ingegneria Informatica Spa , the first IT group in Italy and among the top 10 IT groups in Europe, which designs and implements innovative solutions for all major business areas in which digitalization has or will have the biggest impact.

ROTechnology, an innovative SME which designs, develops and validates applications, tools, firmware and hardware components for several markets.

The Pilot is deployed in the premises of Maccarese Spa and of Latte Sano Spa. The pilot envisaged both hardware and software components. The former includes wearable collars to monitor animals' behaviour, two different devices to measure milk components and analyse them, one used at farm level and one at processor level, and one tool for milk tracing used during the milk collection to create representative sampling and transport recording.

Figure 1: Pilot 4.2 - Some hardware components used in the pilot

The software components refer to the development of a traceability system to inspect on a dashboard all the phases of the milk life cycle, and two Decision Support System to estimate animal welfare and predict milk quality, all of them based only on DEMETER Enablers.

Solution / Innovation

Demeter's solutions provide the farmer with the awareness about how to solve problems related to animal welfare, while allowing the processor to exploit advanced diagnostic tools for the milk quality analysis through the use of AI technologies.

Key Benefits

The key benefits are to improve the way to understand data, increase the interoperability of services and data in the short supply chain (farmer, processor), use new tools for monitoring and controlling animal welfare and milk quality.

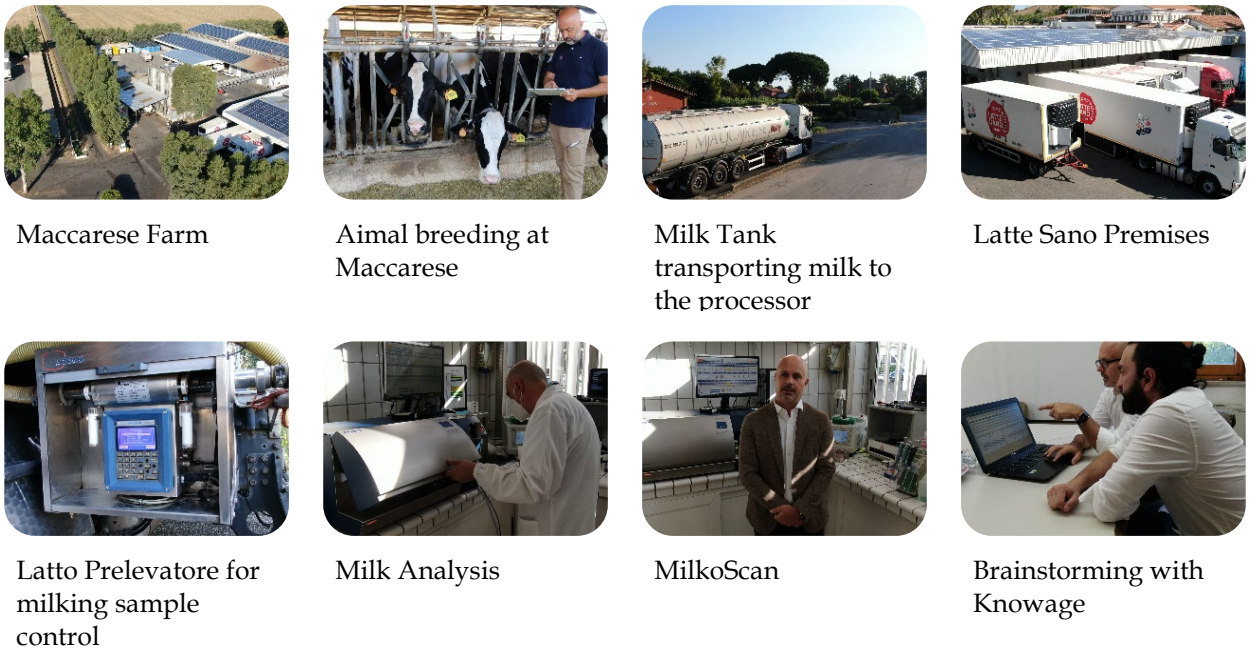

Figure 2: Pilot 4.2 - The premises where the pilot has been implemented

4 DEMETER Integration

Key technologies employed

The Pilot 4.2 technological solution is entirely based on DEMETER enablers. The Pilot implements and uses the following DEMETER Enablers: AIM, Data Security & Privacy, Data management, Brokerage Service Environment, Functional Interoperability Core Enabler, Access Control Server, DEMETER Enabler Hub, DEH-Client Core Enabler, Estimate Animal Welfare Condition, Milk Quality Prediction and Benchmarking system, but also other technologies like Knowage for data visualisation framework and Traceability System a module that implements blockchain technology.

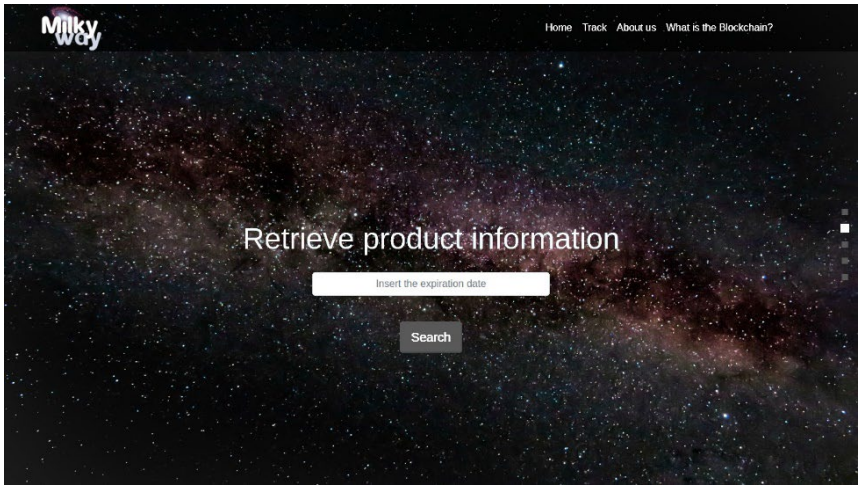

Figure 3: Pilot 4.2- Blockchain Dashboard

DEMETER enablers and other technologies

DEMETER technologies allow pilot stakeholders to add value to data in a context where there is still no full awareness of how technology can help business. In this context, the AIM model is particularly important as it enables interoperability at different application layers: it allows the normalization of IoT information and its ingestion into business logic modules such as Machine Learning algorithms that add value to that information. On the other hand, the DEH gives the possibility to promote solutions and find other partners interested to reuse and improve them. Through the DEH, the involved actors have the possibility to use datasets that could allow them to train the algorithm on which DSSs are based.

Main dashboard developed

The DSS on animal welfare makes possible to evaluate the state of health of the analysed cows, to determine the degree of well-being, in terms of nutrition, hygiene, rest and movement and consequently also to evaluate their productivity (which is strictly connected to their welfare). The information flows, containing the data relating to the nutritional and milking values of the milk produced by the livestock farm, and those relating to the activities and rest periods of the analysed cows, are acquired by Knowage module or DEMETER adaptive visualisation framework, which process them to visualise both the parameters values and the results of the training and prediction algorithm analysis, regarding the cows health status, based on the pathologies like ketosis, mastitis and lameness, obtained by processing data from the Random Forest algorithm.

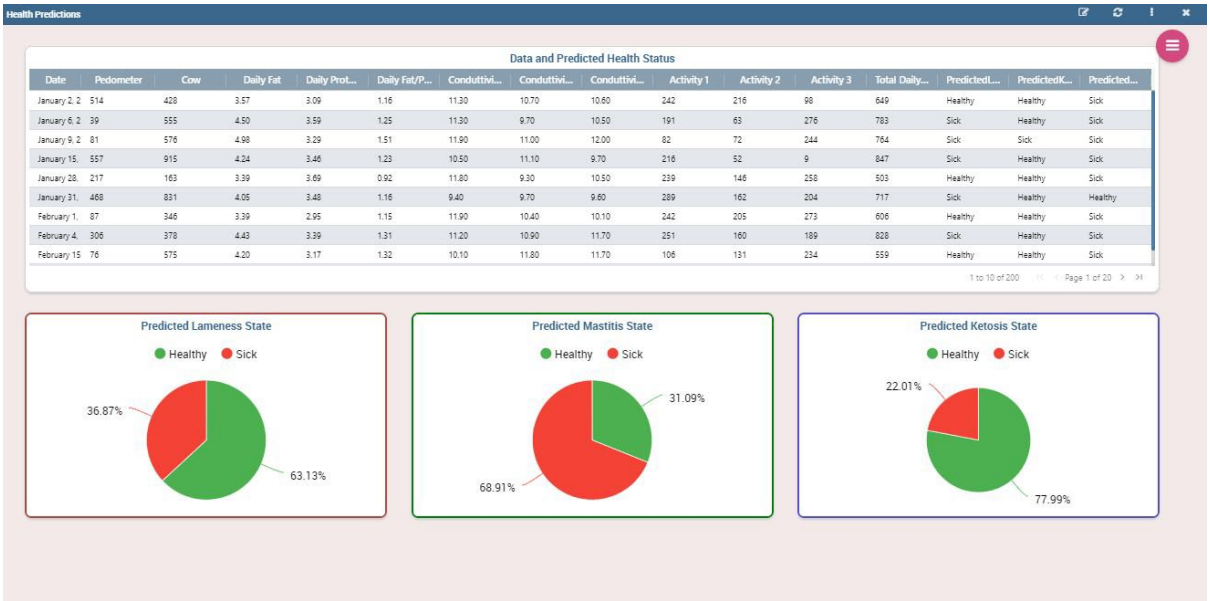

Figure 4: Pilot 4.2 - Animal Welfare Dashboard

The DSS on Milk Quality Prediction, within the milk processing chain, allows to evaluate the analysis of raw and processed milk samples coming from dairy farm, to determine the quality level of the milk, thus identifying the goodness both of the milk arriving at the processing company and of the processed milk ready for packaging, in order to understand if and what choice to make in order to improve its quality.
The analysis of the milk samples taken into consideration by the DSS concerns 2 events: samples collected on arrival of the tanker, before unloading, and samples collected before packaging. The samples are processed by Pilot machinery, a device which analyses them using FTIR (Fourier Transform InfraRed Transform) spectroscopy.

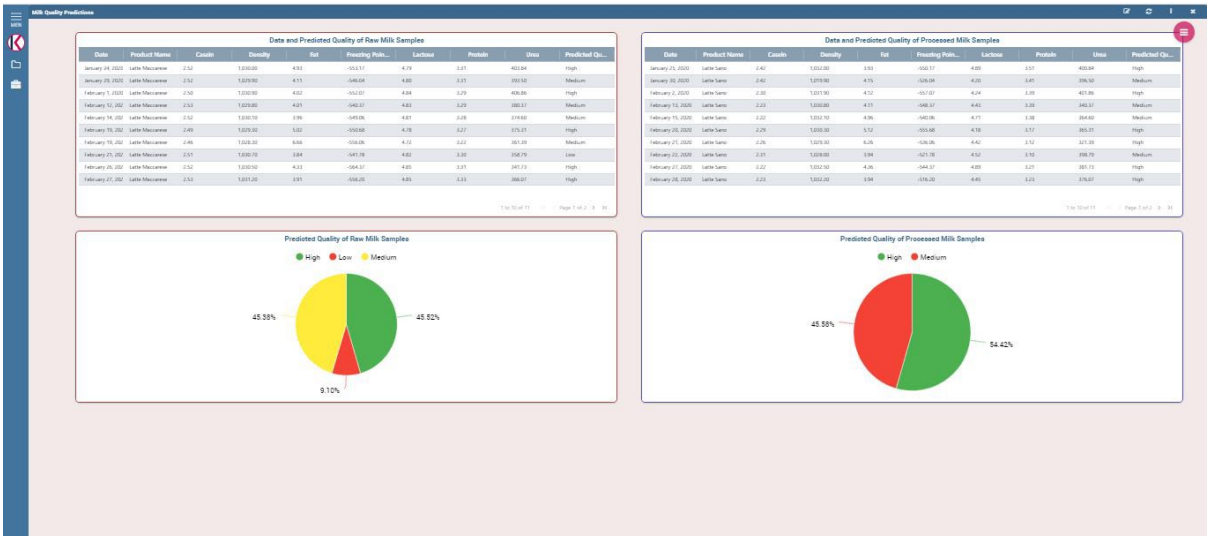

Figure 5: Pilot 4.2 - Milk Quality Prediction

The DSS on Heat Stress allows the analysis and monitoring of the cows exhibiting heat stress. A stressed animal is not affected by a disease, but this problem massively affects the production of quality milk. This new DSS module, introduced in the final stage of the pilot solution development, allows the farmer to monitor heat stress parameters and take decisions on the most exposed animals in the herd. Knowing which animals are most stressed by the heat is very important for the farmer as it serves to take all the necessary countermeasures so that these animals are put at ease without affecting the total milk production.

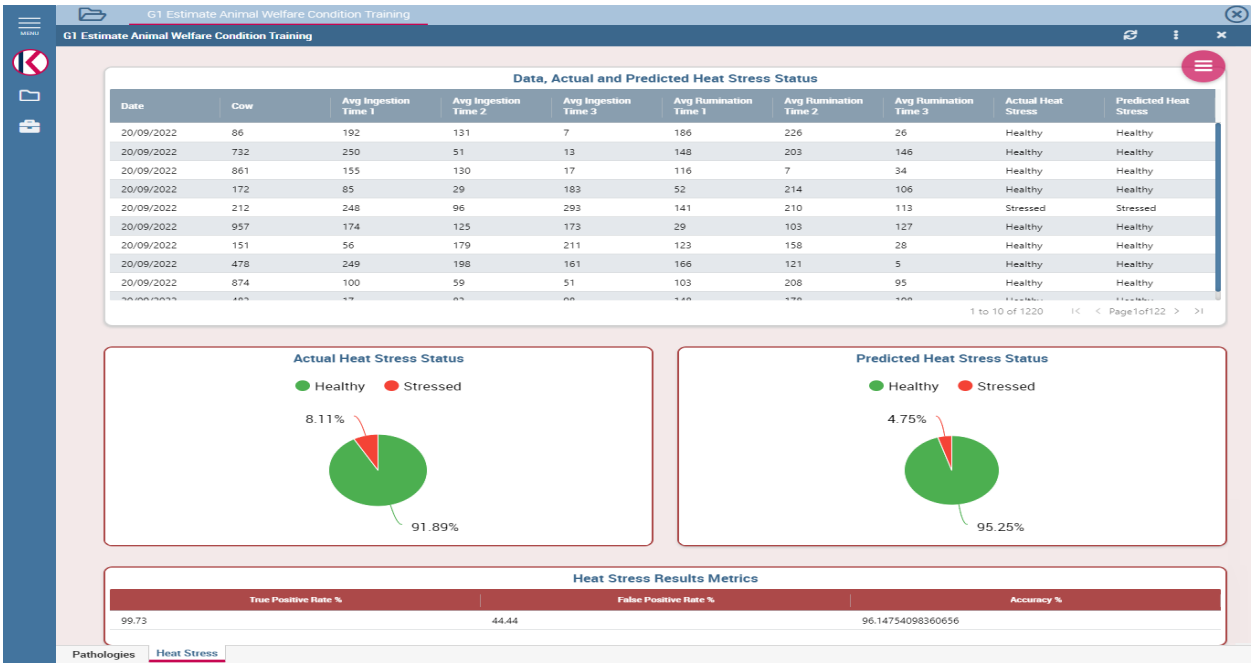

Figure 6: Pilot 4.2 - Heat Stress

5 Feedback from farmers

Since the definition of the DEMETER proposal, the partners of this pilot have been involved in the construction of the action. Both the farmer and the processor have been consulted to identify their specific needs and to develop a solution suitable for them. This process has been conducted through a series of meetings during which, step-by-step, two pilot rounds run.

The continuous exchange between tech providers and rural stakeholders, facilitated by the farmer's organization partner of the pilot, allowed to properly identify the requirements in relation to the DSS for animal welfare and milk quality and to define the parameters to be analysed, the benchmarking indicators, the thresholds to keep under control specific pathologies, and the specific KPIs to monitor the effectiveness

of the pilot itself. Further, with a multi-actor approach, also the draft of the mock-up of the DSS and then its final version has been designed and finalized.

Through demo and tests, the solution has been further developed mediating between the needs expressed by the stakeholders and the technical possibilities offered by the available technology.

Moreover, the stakeholders have been involved in the surveys conducted by the DEMETER project to evaluate the advancement of the pilots and their results have been discussed in following meetings to adjust some aspects of the pilot itself.
this section, please give an overview of how you engage with the farmers on your pilot covering the following points. (Please use full sentences and paragraphs, not bullet points).

Figure 7: DEMETER promoted during the Villaggio Coldiretti.

The stakeholders have been also involved in the drafting of the contents of the video describing the pilot and, of course, in its production with interviews to their representatives in the premises of the farm and of the processing company.

Finally, to raise awareness on the pilot and on the overall DEMETER project, the farmers' organization partner of the pilot publishes a set of articles on its online newspaper sent via email to 340,000 users and promoted the DEMETER project during the exhibition named "Villaggio Coldiretti", organized in several Italian towns, which is attended by a huge number of visitors (around 800K) including citizens, farmers, advisors, institutions, students.

6 Benefits

The solution implemented in pilot 4.2 it has brought benefits to farmers in many ways: a decision support system (DDS) like the module Estimate Animal Welfare Condition and Milk Quality Prediction is a professional's tool which helps Maccarese to make informed and intelligent business decisions, allowing for more informed decision-making and improving efficiency in dealing with issues or operations, planning, and even management. An inclusive and holistic system now allows the farm to monitor the health of the herd, as well as the quality of the milk but also and

above all to constantly check the state of heat stress to counter climate change which unfortunately will represent soon the main challenge in livestock farms.

Furthermore, a traceability system based on the blockchain technology it's important for the farmers and processing companies because it guarantees the authenticity of the milk data that, shared with the consumer, ensures a greater value of the final product.

KPIs

Pilot 4.2 KPIs describes the performances achieved with the use of the technologies introduced by DEMETER. These are mainly KPIs that have interested the farmer, including Animal Welfare and Milk Quality. The following table shows in detail all the characteristics of the KPIs defined in pilot 4.2, such as the description of the KPI, the value before DEMETER, the measurement period and the values that occurred throughout the project:

Pilot KPIs	KPI Target	Baseline	Measurement Period	Measurements over time
Animal Welfare Detailed description: percentage of healthy cows(no ketosis, mastitis, lameness)	>90%	88%	Monthly	90% May 2022, 91% June 2022 92% July 2022, August 92%, 92% September 2022, 93% October 2022
Milk Quality (milk protein content) Detailed description: Increase in percentage of milk protein content	>3.35%	3.29%	Season	3.29% January - June 2021, 3.31% July - December 2021, 3.34 January - June 2022
Milk Quality (milk fat content) Detailed description: Increase in percentage of milk fat content	>3.85%	3.85%	Season	3,85 January - June 2021, 3,86 July - December 2021, 3.87 January - June 2022

Figure 8: Pilot 4.2 KPI

7 Conclusion

The pilot focuses on implementing an information flow optimization across different actors of the milk supply chain – from farmers to consumers – ensuring the transparency of all stages. In particular, the information flow optimization includes the breeding and milking with a focus on animal welfare and optimization of farm activities; transportation of milk, with a focus on product safety; processing, with a focus on quality of the final product; labelling, with a focus on information to consumers.

The rationale of the pilot is based on three main assumptions: first, quality of milk is closely linked to welfare of animals: an adequate eating and resting of animals will increase milk production and quality and will lead to increased dairy yields. Second, processing companies are interested in milk's quality levels, as they pay farmers a

variable premium, based on pre-defined (on legal basis) quality indicators of milk. Third, consumers ask for transparency of the food they eat. The pilot aimed at connecting these three dimensions creating an optimized flow of information.

Thus, running along the milk supply chain, the farmer benefitted of the new different process of monitoring of animal wellbeing. The DEMETER project gave them not only the possibility of acquiring new devices to monitor the rumination, feeding habits and breathing of the animal, but also to have an integrated solution which allows them to visualize data in an aggregated way and to exchange them with one of their main suppliers, the processing company partner of the pilot. More generally, as the farmer himself reported, the pilot helped the company to be more sensitive about data sharing, to understand the value of data, and the importance of interoperability between systems, machinery, services, and processes.

For the processing company, the participation at the pilot gave the opportunity to explore a different way of managing information and take value from data. From an experience-based approach, based on paper documents and locally saved data not connected with other system, to an aggregated and holistic visualization which simplifies their daily work of analysis of the incoming milk and trace the entire milk processing.

The final step, i.e., the consumers acceptance, has not been yet tested but for several years now, studies on consumers' behaviour have shown an increasing focus on conscious purchasing choices which has in fair and clear food labels their main tool.

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