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Precision livestock farming: digital innovation for the sustainability of farms and animal welfare

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1. The need for a sustainable and animal-friendly livestock system

The increase in the global population and in middle-class income has led to an increase in meat consumption. Satisfying this request is only possible thanks to intensive livestock farming, which has a strong impact on the environment, in terms of greenhouse gases production, soil and water pollution, deforestation, and the well-being and health of animals¹. Therefore, the growing pressure for a sustainable agri-food chain² and the greater sensitivity towards animals³ have led to questioning this kind of farming, to the point of promoting the consumption of alternative proteins⁴.

¹ According to the “One health” principle, the health of humans and that of the environment and animals are interconnected. This is very important for fighting antimicrobial resistance, connected with inappropriate use of antimicrobials in both human and veterinary medicine.

² E. Cristiani, *Quali regole per un'agricoltura sostenibile?*, «Rivista di diritto agrario», 4, 2019.

³ *Eurobarometer*, «Special Eurobarometer 442: Attitudes of Europeans towards Animal Welfare», <<https://europa.eu/eurobarometer/surveys/detail/2096>>, 16.10.2021.

⁴ E. Sirsi, *Della carne degli animali e del consumo etico*, «Agricoltura, Istituzioni, Mercati», I, 2018.

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In this complex scenario, animal welfare represents a middle ground to ensure sustainable consumption and production of meat, because it limits the environmental impact of farming while ensuring a dignified life for animals⁵.

The *UN Agenda 2030* of 2015 has considered sustainability as a premise for future economic development, defining 17 Sustainable development goals (SDGs). Although animal welfare is not explicitly mentioned among the SDGs, a reciprocal relationship can be found between the implementation of the Agenda and the strengthening of animal welfare⁶, because it stimulates animal productivity, increases the quality of meat, milk, and eggs, fosters the maintenance of genetic diversity, and reduces the environmental impact of the supply chain. To achieve the SDGs, the EU has published the *Green Deal* which includes the *Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system*, both confirming the key role of the livestock sector in the fight against climate change and recognizing animal welfare as an essential element for a sustainable animal production.

2. Precision livestock farming: advantages and functioning

Digital innovation in the agri-food sector, with precision agriculture (PA) and precision livestock farming (PLF), provides valid technological tools to raise the levels of animal welfare in the farms.

Since the '90s, precision agriculture has changed the face of agriculture thanks to the introduction of innovative tools (from multispectral sensors, self-driving agricultural machines, drones to IoT technologies or artificial intelligence)⁷ which provide *«the possibility to do the right thing, in the right place, in the right time and in the right way»*⁸.

Indeed, through digitalization, data are collected, analyzed, and transformed into useful information, so that farmers can make informed decisions and implement more efficient agronomic interventions, being able to use the right amount of a certain product (i.e water or fertilizers), reducing waste, saving time and efforts, while increasing earnings.

For these reasons, PA represents a sustainable model in which the increase in the production and qualitative efficiency of the farm corresponds to a reduction in environmental impacts and production costs.

⁵ L. Leone, *Farm animals welfare under scrutiny: issues unsolved by the Eu legislator*, «European Journal of Legal Studies», 12, 2020, pp. 47 ss.

⁶ L. Keeling *et al.* *Animal Welfare and the United Nations Sustainable Development Goals*, «Frontiers in Veterinary Science», 6, 2019.

⁷ The growing importance of data in PA opens the doors to more digitalized forms of agriculture, such as smart farming or agriculture 4.0.

⁸ F.J. Pierce, P. Nowak, *Aspects of precision agriculture*, «Advances in agronomy», 67, 1999.

In this context, precision livestock farming is «*the management of livestock by continuous, automated, real-time monitoring of production/reproduction, health and welfare of livestock, and environmental impacts*»⁹ through the examination of all the information available on the farm (translated into numerical data) in the light of the compliance to a standard¹⁰.

The basic objective of PLF is therefore to collect as much data as possible on the animal, considered as a «*complex, individually different, time-varying, and dynamic system*» (CITED), making PLF more ethically sensitive than PA in general¹¹.

Thanks to PLF, the breeder can continuously and directly monitor the animals, even being distant¹². To give some examples, PLF involves GPS, to control the movement of grazing animals, precision feeding technologies, to prepare the right daily feed ration, thermography through infrared cameras, to monitor the state of health of the udder and prevent mastitis, and robotic milking.

In addition to biological parameters, sensors can also detect environmental ones, such as the concentration of carbon dioxide.

PLF system consists of three parts: a physical part (hardware), consisting of sensors and computers, a part for data processing (software), and a part for the transmission of data (network)¹³.

Data collected on the animal are converted into information by an algorithm, whose creation presupposes identifying only those signals capable of capturing and measuring the well-being or health of the animal¹⁴.

3. Obstacles and future scenario

Today livestock is the focus of important reflections, if not of real criticisms, related to sustainability and animal treatment. Climate change leaves no alternative to reduce the environmental footprint of meat production and digital innovation can contribute to this reform increasing the level of animal welfare in the farms.

⁹ D. Berckmans, *General introduction to precision livestock farming*, «Animal Frontiers» 7-1, 2017, p. 7.

¹⁰ F. Abeni, A. Galli, *La zootecnia di precisione: una opportunità per una produzione animale etica e sostenibile*, «Agriregionieuropa», 53, 2018, p. 30.

¹¹ J. Bos *et al.*, *The Quantified Animal: Precision Livestock Farming and the Ethical Implications of Objectification*, «Food Ethics», 2, 2018, p.80.

¹² I. Werkheiser, *Technology and responsibility: a discussion of underexamined risks and concerns in Precision Livestock Farming*, «Animal Frontiers», 10-1, 2020, p. 53.

¹³ A. Pazzona, G. Chessa, *Il ruolo dei sensori nella zootecnia di precisione per il benessere animale e la sostenibilità ambientale*, «Georgofili: atti dell'Accademia dei Georgofili», 12-2, 2015, p. 212.

¹⁴ D. Berckmans, *Basic principles of PLF, gold standard, labelling and field data*, in D. Berckmans, J. Vandermeulen (ed. by) *Precision Livestock Farming '13 - Papers presented at the 6th European Conference on Precision Livestock Farming*, Leuven, Belgium, 2013, pp. 21-29.

Despite the undoubted advantages of PLF, its spread is still held back by a series of obstacles of different nature. There are technological, economic, and legislative obstacles, like the low spread of broadband, the high cost of the equipment, or a regulatory framework often backward or uncertain, as in the case of the ownership of data collected¹⁵.

However, positive outlooks are on the horizon since the F2F Strategy aims to accelerate the spread of fast broadband internet in rural areas, so as to guarantee 100% access by 2025, and the future CAP 2021-2023 seems to reassure its support in the digital transition¹⁶.

Moreover, there are social obstacles, because farmers are not familiar with new technologies and they are concerned about job loss or loss of contact with animals. Nevertheless, on the one hand, work is not stolen by technologies, but rather transformed into intellectual work; on the other hand, the supervision of man and his relationship with the animals cannot be replaced and PLF helps the farmer to know the herd better, especially when the number of animals does not allow direct monitoring.

So the proper use of digital technologies can be a worthy ally in the shift toward a sustainable agri-food sector and it is now up to the legislator to provide the financial and legislative support to stimulate this transition, starting from the creation of a digital culture.

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¹⁵ P. Lattanzi, *L'agricoltura di fronte alla sfida della digitalizzazione. Opportunità e rischi di una nuova rivoluzione*, «Rivista di diritto agrario», 4, 2017, pp. 572 ss.

¹⁶ In Italy PA is considered an investment priority by the National Smart Specialisation Strategy, by the National Recovery and Resilience Plan, and by the National Research Programme 2021-2027.

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