BUFF4L.0: at the crossroads between Veterinary and Engineering Sciences in the Industry 4.0 era

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Keywords: Precise Livestock Farming; Smart Farming; One Health Informatics; Innovation

Introduction

Industry 4.0 (I4.0), the so-called fourth industrial revolution, is based on the wide adoption of the IIoT (Industrial Internet of Things) and ICPSs (industrial cyber-physical systems), along with cloud manufacturing-related new paradigms. The purpose of I4.0 is to build a highly flexible production model of personalized and digital products and services, with real-time interactions between people, products and devices during the production process.
The application of such principles for what concerns the livestock field leads to the implementation of IoHAT–related paradigms (Internet of Animal Health Things) that can change animals, machineries and processes into "information objects" by connecting them to the network, so as to help improve the whole Farming Data Management set, and to figure out accordingly "data–driven"–like business models.
This currently goes under the now–known name of Precise Livestock Farming (PLF).

Methods

The whole Buffalo–related dairy production and supply chain represents a leading sector of the entire Agri–food arena, especially in the South Italy. A systematic deployment of integrated (and economically sustainable) solutions of continuous monitoring of quality and salubrity of the production environments is still lacking, which should instead be a basic requirement for policies of environmental sustainability of the productions sites. An approach like that would therefore imply an integrated vision between production characteristics, animal welfare, and security issues, necessary to achieve a better overall quality control of the supply chain as well as a better economic valorisation of the final products. Clearly, the adoptions of quality methods and related tools in this sector have to be triggered and accompanied by deep changes in the philosophy and organizational model of the countryside enterprise, as interesting application areas though not yet entirely investigated. In order to do that, the following fundamental steps are to be implemented:

- identifying the critical process that mainly affect productivity and incomes, along with data to be monitored and measured;
- introducing automated tools for data gathering and measurement, to be integrated within the production chain;
- defining protocols for data analysis, in order to detect as earlier as possible causes of inefficiency within the production processes;

- using the results of the data analysis as input for automated decision-making processes, on which effective management actions rely;
- activating automated control systems, whose tasks need to be documented through the deployment of standard operating procedures (SOPs);
- activating procedures for the monitoring of the outcomes of control and documentation activities, in order to guarantee Quality Improvement and Assurance.

Results

Technologies available for precision livestock and agriculture are currently still at their early development stage, and researchers can, metaphorically, "sightsee grassland" in front of them. The recent increasing awareness for environment–related instances is pushing towards the design of sustainable dairy supply chains, since they are recognized as capable of generating value for consumers. To such purpose, new technical facilities are available to perform objective measurements of critical-to-quality characteristics, which can be directly related to the process outcome, like for instance the functional molecules' contents in the food production, or indirectly related to it, as it is for a variety of environmental factors that can have an influence.
An effective vision of smart farming requires therefore the realization of synergistic actions between farmers, veterinary doctors, biologists, chemists, and engineers, called to work together with the common goals of defining in the first place a set of environmental parameters to be measured via a timely network of sensors (both traditions and biosensors), and then deploying innovative technological platforms to connect the sensors network with an infrastructure for short– and long–range wireless connectivity.
The purpose is to obtain structured field data (for instance from the automated milking systems already during the passage of the buffaloes) to be elaborated via predictive models into complex indicators of environmental sustainability and salubrity, as well as of animal welfare (KPILW: Key Performance Indicators of Livestock Welfare). This implies accordingly:

- developing new knowledge and instruments to realize an "eco-labeling" of the products under a "One Health Informatics" perspective, i.e. with a pronounced attention to the ways the agribusiness production affects the surrounding environment. Such information, not yet fully available, should stand among the bases for an improvement of the overall quality of the production process;
- designing the specific control–and–tracking technology to be deployed with the aim of generating real–time alerts after contamination phenomena of both natural and anthropic origin, or monitoring the production process in order to prevent issues, or to guarantee rapid corrective interventions;
- re-designing the entire supply chain "from the stable to the table".

In addition, livestock farming and cultivations can benefit in monitoring food processing, food safety, and food quality, also by exploiting the new available facilities for on field data acquisition and transmission to data collector centers, where they can be analyzed and compared to benchmarks or other data from different monitoring sites. Digitalizing process-related information at the source helps as well managerial actions, and, in conjunction with diagnostic algorithms, automatic trouble-shooting and interventions, which allow for steady settled conditions time and resource savings.
All these expected results deal with the capability to figure out for a smart farm a realistic dairy supply chain in line on the one hand with the development characteristics of I4.0, but also on the other hand compatible with the so–called TBL approach (Triple Bottom Line), which seeks the sustainability of a system through the pursuing of a balance between social, economic, and environmental targets.

Conclusions

Farming enterprises have definitely to accede and implement quality improvement approaches like the successfully ones widely adopted by industry and service companies. The farmer's new role in

the 4.0 era requires some extensive knowledge, ranging from agronomy and breeding to process development and engineering design, not excluding finance and accounting, marketing, distribution and logistics. Most important, the farmer has to get familiar with new technologies and acquainted of their inherent value and usefulness for the goal he/she is pursuing.

This means heading towards a number of challenges to be solved for any of the I4.0-compliant systems – from networked connection of components, to cyber-security issues and enhanced flexibility, to massive data gathering, just to name a few.

The necessary skills for the achievement of the domain of manufacturing, informatics, and process technologies, in addition to a clear integral vision of the trade as well as high creativity, must be figured out and nurtured as early as possible in an educational environment. Accordingly, terms like "engineering education 4.0" should definitively become also part of the curricula (and modus cogitandi) for students from Animal Productions or Agriculture Sciences.