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Program

Welcome session (09:10-09:15)

Vítor João Pereira Domingues Martinho

Keynote Speaker (09:15-09:40)

Progress and opportunities raised by the 4.0 revolution to manage the green (ecosystems and agriculture)

António Dinis Ferreira

(Coordinator Professor - ESAC/IPC; CERNAS Coordinator [Research Center for Natural Resources, Environment and Society])

Parallel Sessions 1 – New Paradigms in the Agricultural Sector (09:45-11:15)

(Session chair: Maria Del Carmen Sánchez Carreira)

- *Sensoring the hydrology and water quality in a small agro-forestry basin* (António Canatário Duarte; Maria Rodríguez-Blanco; and Qian Zhang)
- *Optimizing Intercropping with Deep Learning: A Data-Driven Approach to Sustainable Agriculture* (Carlos Cunha)
- *The Offer for more Natural and Security Agrifood Products* (Maria Lúcia Pato)
- *Comparative Study of Sustainable Agribusiness in American Countries: Is there optimization between Banking Credit and Agriculture 4.0?* (Raimundo Nonato Rodrigues)
- *Smart Farming: Highlights from the Literature* (Vítor João Pereira Domingues Martinho)

Parallel Sessions 2 – Agricultural Markets and New Contexts (11:20-12:25)

(Session chair: Maria Lúcia Pato)

- *Agriculture 4.0: Impact on the Portuguese Almond Market*
  (Artur Morais; Matheus Araújo; and Duarte Faia)

- *Insights on the Dimensions of Agriculture 4.0*
  (Beatriz Topete Lopes de Almeida)

- *Portuguese Potato Markets: Interrelationships with the Digital Transition*
  (Ana Luísa Cardoso; Carla Barradas; and Fátima Barrancos)

- *Agriculture 4.0: Influence on the Blueberry Market*
  (Gisela Nascimento; Gonçalo Costa; Joana Simões; and José Oliveira)

Parallel Sessions 3 – New Technologies and Agricultural Marketing (12:30-13:35)

(Session chair: Carlos Cunha)

- *Digital Transition: Almond Marketing and Industry*
  (Artur Morais; Matheus Araújo; and Duarte Faia)

- *Life Cycle Cost Analysis (LCCA) and Agriculture 4.0*
  (Nuno Trindade Serra)

- *Marketing Strategies for the Potato Sector: Evidence from the Portuguese Context*
  (Ana Luísa Cardoso; Carla Barradas; and Fátima Barrancos)

- *Relationship between Marketing and Agriculture 4.0 in Blueberry Production*
  (Gisela Nascimento; Gonçalo Costa; Joana Simões; and José Oliveira)

Abstracts

Portuguese Potato Markets: Interrelationships with the Digital Transition

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Abstract

The potato crop divides into several varieties. Within the respective varieties, there are several markets. Data from SIMA ("Sistema de Informação de Mercados Agrícolas"), for the producers, show that organic potatoes only have one market, which is the continent. The white and red potatoes have several markets, however, the one with the greatest information is the "Beira Interior". The "Nova Branca" potato is divided into medium and small sizes. In the case of the medium size, the biggest market is the "Ribatejo e Oeste". The small size only presents a single market which is the "Algarve". The "Nova Vermelha" potato medium size has two markets, and the biggest is "Ribatejo e Oeste". Within the mentioned varieties, it can be seen that organic potatoes are one of the best paid in Portugal, surpassing 1 €/kg. The remaining have relatively lower prices. The main producers from European Union are Germany, France, the Netherlands, Belgium and the United Kingdom. The consumption of potatoes has been recognized all over the world due to its importance in human nutrition and food security. The

digital transition may bring interesting contributions to these contexts (INE, 2023; Mordor Intelligence, 2023; SIMA, 2023).

Keywords: Potato, Markets, Artificial Intelligence.

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Marketing Strategies for the Potato Sector: Evidence from the Portuguese Context

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Abstract

Taking into account the increase in exports, it is necessary to create ideas through marketing approaches, thus reinforcing internationalization strategies. As potatoes are one of the most nutritious foods, and in Portugal each Portuguese consumes about 88.6 kg/year (Costa, 2022), so having to promote themselves through marketing strategies. With new marketing standards, the industry provides consumers with new market opportunities by using more suitable potato cultivars for their intended purpose. Miss Tata is a new brand that aims to highlight the Portuguese potato in the world, being versatile, colorful, dynamic and cheerful (Porbatata, n.d.). It is a project that reinforces the territorial identity, recognizing the Portuguese potato both abroad and in the country. The new technologies associated with artificial intelligence open new potentialities in these frameworks (INE, 2023; Mordor Intelligence, 2023).

Keywords: Markets, Literature Review, Surveys, Digital Transition

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Sensoring the hydrology and water quality in a small agro-forestry basin

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Abstract

Soil, water and production systems constitute the most important natural resources of a watershed in the rainfed and irrigated agro-forestry ecosystem. Agricultural activities, as part of the natural resource management practice, impact soil and water quality at the watershed level (Wiering et al., 2023). The increases in nutrient losses and riverine nutrient loads have caused the eutrophication of many coastal and freshwater ecosystems (Kennish, 2023). With simulation models, calibrate and validated for certain conditions, these tools are indispensable to configure alternatives uses of soil, and contribute to define Best Management Practices (BMPs) (Duarte et al., 2022). The main objective of this study is evaluating the hydrologic behavior and the dynamics of the nitrogen, salts and sediments in a typical Mediterranean agro-forested basin, under different agricultural systems (irrigated and rainfed conditions), using different types of sensors. A hydrological station was constructed and installed in 2004 to measure runoff at the outlet of the catchment (390 50′ 48″ N, 70 10′ 00″ W). The station consisted of a long-throated flume (with a triangular control section for shallow water conditions and a triangular/trapezoidal section for deep water conditions), designed and calibrated following the procedure described by (Bos et al., 1984). An ultrasonic sensor (“The Probe”, manufactured by Milltronics Process Instruments Inc., Ontario,

Canada), connected to a datalogger, continuously measured and recorded the water level at the flume. The water quality was evaluated by a multiparameter probe (In-Situ TROLL 9500) installed inside a cup, that received water pumped from the stream in time steps of 15 minutes. The parameters of water quality evaluated are, electrical conductivity, temperature, nitrates and turbidity. Rainfall was measured continuously with a tipping bucket rain gauge located next to the hydrological station. The superficial runoff dominates the hydrological response of the study basin during the most significant rainfall events, and the antecedent soil moisture condition is considered a factor of greater importance in the magnitude of the runoff events. The evolution of the nitric nitrogen daily pollution load depends on the volume of runoff at any stage of analysis period and availability of this nutrient in the soil. Its high solubility and mobility determine what appears in both surface runoff and in base flow. For the total dissolved solids daily pollution load, the situation shows, both in the irrigation season and in the rainfall season, an absolute dependence of the runoff volume at the outlet of the study basin, regardless of it is surface or subsurface runoff. The daily pollution load of suspended sediment does not seem dependent on the volume of runoff, except when it has enough power to detach and load the particles out of the basin.

Keywords: Water Quality and Hydrology Sensors, Agro-Forestry Activity, Small Agro-Forestry Basin.

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Progress and opportunities raised by the 4.0 revolution to manage the green (ecosystems and agriculture)

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Abstract

The introduction of new technologies to monitor and govern ecosystems, whether natural or managed (agriculture), presents avenues for new possibilities that can be used to identify risks, improve crop management and a more judicious use of assets.

The new IT tools, such as IoT, AI, Machine learning, unmanned aerial vehicles and ground robots, have the potential to provide high-resolution data regarding properties and processes, and thus revolutionize ecosystem governance, albeit with some difficulties. First, agriculture and natural ecosystems are often located in remote rural areas or in the middle of the wilderness, where communication infrastructure and device powering may be difficult to implement, even considering higher operational costs, with an increased risk of vandalism.

However, the potential for innovation is enormous, in particular if we can mingle together technology with biological processes at different scales. For example, IT tools can enable a more sustainable and competitive form of agriculture, through the timely and judicious use of production factors, which can lead to an increase in biodiversity and better products, with less effort and with the highest added value of the products.

Innovation can extend to the management of biological processes, namely the management of insects, either pollinators, auxiliaries, pests or vectors of diseases, on the activity of soil fauna and on the development of root systems.

The potential to develop specific sensoring devices is immense, allowing the monitoring of crop development, and environmental and biological parameters, such as plagues and diseases. The available set of electronic devices, whose sensor data is transmitted through a local communication infrastructure, embodies the IoT concept. Bidirectional data transfers are thus possible, allowing several stages of data processing and viewing. Coherent systems may therefore be implemented, which allow device power management, sensor data collecting and remote system control The data is then sent to the cloud, where through Artificial Intelligence methodologies it will be subject to advanced and predictive analyses that will carry out a wide range of predictions and decisions. The potential for new means of data analysis using specific artificial intelligence algorithms is also an added value.

Data handling can also be further improved. The use of a platform that allows decision support solutions through visualization dashboards, with integrated alarms, and autonomous action through commands to equipment in the field is now possible.

Data processing using Artificial Intelligence will provide the basis for the construction of a digital platform that will serve as a decision support system, based on a set of principles such as the optimization of productive activity, in terms of efficiency and effectiveness, taking into account local conditions and resources, the specificities of the agricultural system, the cost of production factors in terms of productivity, the optimization of the use of production factors such as fertilizers, irrigation or energy consumption. This information feeds the local computation (edge) that can perform a set of actions, such as pest control, fertigation management, and the opening and closing of greenhouses.

Agriculture 4.0: Impact on the Portuguese Almond Market

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Abstract

As of 2022, Portugal is the country with the highest percentage growth of almond production in the world, and is self-sufficient in this specific dried fruit. Intending to understand the economic behavior of this food in its agricultural regions, Algarve and Douro, we gathered and analyzed the producer price in the main markets for no processed almond products and their weekly variation, from 2018 to 2023. In addition to it, a literature review was carried out, to try to understand the relationship between the emergence of Agriculture 4.0 and its impact on the agricultural sector markets. Keywords such as "Agriculture 4.0", "Market", "Price" and "Almond" were used, the latter being used to find information also related to the crop chosen as the theme. Information was compiled from 12 articles and studies, in English and Portuguese. In general, the producer price figures showed Algarve as a more stable and increasing value market, in contrast to Douro, more volatile and with considerate price drops in the last 2 years. Agriculture 4.0 and real-time connection to the market's information can be the solution to such unpredictability, with the ability for almond farmers to make more convenient decisions and increase orchards yields and quality, factors that can increase their competitive advantage in the marketplace

(Bešić et al., 2021; Fidalgo et al., 2023; Martins, 2022; Pacheco, 2021; Scuderi et al., 2022; Shafi et al., 2019; Sott et al., 2020; Tamachiro et al., 2022).

Keywords: Agriculture 4.0, Almond, Market, Price

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Digital Transition: Almond Marketing and Industry

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Abstract

To understand the relationship between Agriculture 4.0 and Marketing in the agricultural sector, and the relationship between producer/seller and costumer, a literature review was conducted using keywords such as "Agriculture 4.0", "Marketing", "Strategy" and "Almond", where information was compiled from English and Portuguese articles and studies. Information from other sources was also considered. Modern marketing strategies have emerged to meet customer demands, including online/offline interactions and production cost reduction due to technological advances has led to the globalization of markets. Digital transition brings several new approaches to improve efficiency, sustainability and quality in the chains, which can be used as marketing policies. The use of technologies such as ICT (Information and Communications Technology) and IoT (Internet of Things) has encouraged agricultural companies to embrace market digitalization and interact more effectively with consumers. In the specific case of almond production, some articles highlighted the importance of appropriate marketing strategies, such as promoting almonds in the healthy food sector, to intensify the demand for domestic almonds in Portugal (Kotler et al., 1999; Sturiale & Scuderi, 2011; Cabo et al., 2016; Pattnaik et al., 2018; Equipe TOTVS, 2020; Manogaran et al., 2021).

Keywords: Agriculture 4.0, Literature Review, Surveys.

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Insights on the Dimensions of Agriculture 4.0

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Abstract

Agriculture is one of the primary sectors of society, with great influence at the economic, social and political levels. In addition to its essential role in food production, it also influences human settlements and increases national wealth. Therefore, Agriculture 4.0, being marked by technological revolutions, such as the development of machines with artificial intelligence, has proven to be essential to achieve the objectives that prevail in today's society. Being a current topic and of great interest, our main objectives are to understand what is proposed, in which way can we take advantage of its benefits, as well as develop the impact of 4.0 technologies in this field, drawing the attention of the agricultural sector to this growing need (Wambembe, 2022). In addition, improve profitability and enhance possible businesses, highlighting the fact that, with the use of new technologies, we can counteract waste and increase sustainability (Raimundo, 2021). To achieve what we propose, the method we choose was a literature survey. In due course, we hope to contribute to the practice of sustainable agriculture and encourage the use of continuous innovation processes, developing how artificial intelligence influences or can influence smarter, more productive and consistent practices.

Keywords: Artificial intelligence, Profitability, Sustainable agriculture, Innovation processes.

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Optimizing Intercropping with Deep Learning: A Data-Driven Approach to Sustainable Agriculture

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Abstract

Agriculture significantly contributes to greenhouse gas emissions, soil degradation, and water pollution. Agriculture 4.0 can help reduce the environmental impacts of farming and contribute to a more sustainable food system, by adopting sustainable farming practices such as precision irrigation, integrated pest management, and regenerative agriculture (Tilman et al., 2011). Also, robotics, automation, and artificial intelligence can help farmers optimize their operations, reduce labor costs, and improve efficiency (Clercq et al., 2018). This can free up resources and allow farmers to focus on more strategic tasks such as decision-making and business planning. Combining different plant species in a single agricultural system is called intercropping or mixed cropping. This agricultural technique has been used for thousands of years in various world regions and is still commonly practiced today. Intercropping can improve soil fertility by increasing the amount of nitrogen-fixing bacteria and fungi in the soil (Finke & Snyder, 2008; Macdonald & Singh, 2014; Altieri et al., 2015). Legumes, such as beans and peas, are often used in intercropping systems because they fix nitrogen from the air and make it available to other plants. Also, by mixing different plant species in a field, farmers can create a diverse ecosystem that attracts beneficial insects and repels pests. For example, intercropping marigolds with vegetables has been shown to reduce pest infestations and increase crop yields (Xie et al., 2017). This can be done while increasing the yield by efficiently using available resources such as light, water, and nutrients. Plants with different root systems can also help to reduce competition for resources and increase overall productivity. This

work aims to develop a deep-learning prediction system for identifying the best combination of plant species and respective layouts to promote sustainable agriculture. It involves the following objectives:

1. Investigate the potential of deep learning for predicting the best combination of plant species and their layout in intercropping systems.
2. Collect and preprocess data on different plant species, soil types, weather conditions, and other relevant variables for training the deep learning model.
3. Develop and optimize the deep learning model using convolutional neural networks, recurrent neural networks, or deep belief networks.
4. Evaluate the performance of the deep learning model in predicting the best combination of plant species and their layout in intercropping systems.
5. Compare the performance of the deep learning model with other machine learning models and traditional intercropping practices.
6. Discuss the potential benefits of using the deep learning prediction system, including increased yields, reduced environmental impacts, and enhanced sustainability.
7. Identify the limitations and challenges of using deep learning for intercropping optimization and suggest areas for further research.

Developing a deep learning system for predicting the right intercropping combinations involves complex steps, including data collection, preprocessing, feature selection, model selection, training, evaluation, and deployment. However, by leveraging the power of deep learning, farmers can make data-driven decisions and optimize their intercropping practices to achieve better yields, reduce environmental impacts, and increase sustainability. The key steps involved in developing such a system are the following:

Data Collection: The first step in developing a deep learning system for intercropping is to collect data on different crop combinations, soil types, weather conditions, and other relevant variables. This data can be collected through field experiments, surveys, or other sources.

Data Preprocessing: Once the data is collected, it needs to be preprocessed to remove any outliers, missing values, or irrelevant variables. This step is essential for ensuring the accuracy and reliability of the machine-learning model.

Feature Selection: After preprocessing the data, the next step is to select the most relevant features for the deep learning model. This step can involve statistical analysis or domain expertise to determine which variables are most important for predicting the right intercropping combinations.

Model Selection: Many different deep learning algorithms can be used for predicting intercropping combinations. The choice of the algorithm will depend on the nature of the data and the specific problem being addressed.

Model Training: The deep learning model is trained using the preprocessed data and the selected features. The training process involves optimizing the model parameters to minimize the error between the predicted and actual values.

Model Evaluation: Once the model is trained, it needs to be evaluated to ensure that it is accurate and reliable. This step involves testing the model on a data set not used for training and comparing the predicted values to the actual values.

Deployment: The final step is to deploy the deep learning model in a production environment, where it can be used to predict the right intercropping combinations in real time.

We expected the following results:

1. A deep learning model that accurately predicts the best combination of plant species and their layout in intercropping systems based on a range of input variables such as soil type, climate, plant characteristics, and farming practices.
2. Improved yields and reduced environmental impacts in intercropping systems using the deep learning prediction system compared to traditional intercropping practices or other machine learning models.
3. Identification of the most important input variables for predicting the best combination of plant species and their layout in intercropping systems, providing insights into the factors that affect intercropping success.
4. Validation of the potential of deep learning for transforming intercropping practices into more data-driven, efficient, and sustainable systems.
5. Identification of the limitations and challenges of using deep learning for intercropping optimization, providing guidance for further research and development in the field.

Overall, the expected results of this work could have significant implications for improving the efficiency, sustainability, and resilience of intercropping systems, helping to address the challenges of climate change, and biodiversity loss in agriculture.

Keywords:

Deep learning, Intercropping, Prediction system

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Agriculture 4.0: Influence on the Blueberry Market

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Abstract

Agriculture 4.0 is changing and challenging the agronomic world, promoting precision and sustainability. Thus, it is essential to study this object to understand the influence of this on production and the economic and social results. The work aims is to understand the link between the blueberry markets and how Agriculture 4.0 can improve the high quality and quantity of blueberry, providing better markets to the producers and transformers and better quality to the consumer. This work was made with several data about prices at the producers during the weeks of harvest for four years, from 2018 to 2022, to understand the market tendency during that time between different years. After this, the work was done by searching on the Web of Science about the theme the study is about. The major result of this work is the understanding of volatile prices over the years, but in the same way, it has been interesting to understand the huge possibilities for farmers and/or other economic agents of the blueberry industry. It is a sector in great development, in the past, at the present e in the future, with so many potentialities.

Keywords: Blueberry, Market, Agriculture

Relationship between Marketing and Agriculture 4.0 in Blueberry Production

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Abstract

Agriculture 4.0 is influencing the way of farming around the world. Marketing is a set of strategies that different economical agents can use to promote their products in specific markets and different ideas for selling the product. This work aims to understand the link between blueberry marketing and agriculture 4.0, to find other ways to promote different projects and products based on blueberries. The search for this work was made by searching on the Web of Sciences about the theme the study is about and collecting information from different sources. The major result of this work is the understanding of the way marketing opens so many doors to producers in searching for new markets and new products for selling the idea more than the product itself.

Keywords: Blueberry, Marketing, Agriculture, Innovation

The Offer for more Natural and Security Agrifood Products

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Abstract

Due to the attention that has been paid to sustainability and food safety issues, new ways of access to food products are gaining emphasis (Pato, 2020). In this context, community supported agriculture (CSA) can be an interested alternative. If there are different schemes under CSA, they all aim at connecting producers and consumers and offer quality and safety products, in a short distance (Firmino, 2018). A notable initiate that combines familiar and regenerative agriculture and CSA is located in the the Viseu Dão-Lafões Region (RVDL), more precisely in one of the most interior communities of the region. In an era dominated by mass agriculture, the objective of this study is to analyze the opportunities and threats to implement a project of familiar and regenerative agriculture combined with CSA. In order to allow a deeper analysis, a case study methodology is used. In addition to an exploratory interview with the entrepreneurs of the initiative, it was observed and analyzed the social network of the unit and other electronic documents about the same. The desire to have a life closer to nature, were the basis for the entrepreneurs choosing this new project of regenerative agriculture. The emphasis in product, process and marketing innovation is a reality. Although in an initial phase, for income reasons, they recently started a CSA program – every week they offer to consumers a basket with organic products, also allowing visits to the farm and a very personal interaction with what they do. In this momentum, thanks to the increasing demand of the organic baskets, the entrepreneurs do not have enough production for all existing demand, being necessary increase production. As Pato (2020), claimed before, for the success of this type of

initiative, local authorities should provide the necessary support they need to keep on developing their action.

Keywords: Regenerative Agriculture, Community Support Agriculture, Innovation, Security

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Life Cycle Cost Analysis (LCCA) and Agriculture 4.0

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Abstract

The impact of costs in carrying out a process is one of the major problems in agriculture. Around the world, agriculture has always been a sector that has depended on many innovations to become efficient in its production systems, thus solving the most varied challenges of the global market. Currently, Agriculture 4.0 is the great mediator of solutions for the agri-food sector. Given this scenario, we propose a research on the application of Life-Cycle Cost Analysis (LCCA) in the agri-food sector, intending to demonstrate its effectiveness in the Agriculture 4.0 theme. The LCCA has as a tool the ability to translate the distribution of costs over a given period of time, and the operational "life" of an asset. It can help the farmer to develop a better strategy from an economic point of view. This type of analysis allows for effective management of farm overheads. With this, the control of costs and investments becomes more transparent and realistic. As methodologies, content exploration research, descriptive research and explanatory research may be used. Thus, this study is framed as exploratory research, as it involves bibliographic surveys and demonstrates the analysis of examples that stimulate understanding. This will provide a search for which methodology or aid to use in the preparation of an LCCA in the area of agricultural production, as an important tool of analysis (Silva, 2017; Neto, 2018; TOTVS, 2020; Aiko News, 2022; Nogueira, 2023).

Keywords: Life Cycle Cost Analysis, Maintenance Costs, Economic Strategy, Methods and Analyzes to be applied.

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Comparative Study of Sustainable Agribusiness in American Countries: Is there optimization between Banking Credit and Agriculture 4.0?

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Abstract

The agriculture 4.0, with the use of modern technologies and equipment, seeks constant improvement of the management process in agribusiness, aiming at productivity gains, higher sales volumes, generation of qualified jobs and reduced environmental impact. All of this demands a range of investments, in an economic environment that is increasingly lacking in financial resources. This article aims to carry out a comparative study between countries in the Americas (North, Central and South), verifying the relationship between the contribution of resources in the agricultural sector, via bank financing, and sustainable development, considering the dimensions of the Triple Bottom Line, Economic, Social and Environmental. The method used is empirical-analytical, through the analysis of the indicators Credit to Agriculture, Employment Indicators: Agriculture and Emissions Totals available in the FAOSTAT database, in the period from 2012 to 2021. It is expected, with the results obtained, to obtain information that point to improvements in the optimization of resources contributed in Agriculture 4.0.

Keywords: Digital Transition, FAOSTAT, Triple Bottom Line.

Smart Farming: Highlights from the Literature

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Abstract

The agricultural sector is one of the strategic sectors for any country, considering its importance for the food security and sovereignty. Nonetheless, the current and future challenges for the sector are diverse and are related, for example, to the environmental changes, loss of biodiversity, human health problems, increasing of the population worldwide and the new contexts created by the pandemic and the international conflicts. These frameworks call for new paradigms in agriculture and here the technologies associated with the artificial intelligence may bring interesting added value. In this perspective, this research aims to bring more insights from the literature about the diverse domains of the smart farming. To achieve these objectives, various documents from the scientific databases were taken into account for the topics related to the subjects here considered. These documents were assessed through bibliometric analysis. The main findings obtained highlight the importance of the digital transition for an agriculture more competitive in the food chains.

Keywords: Agriculture 4.0, Literature Review, Bibliometric Analysis

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