AgTech7 Curriculum Design

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1 Introduction

The curriculum design was developed as a direct output of the "A Knowledge Alliance of Agribusinesses, Academia and Business Angels for Disruptive Farm-to-Fork Agri-Tech Training (AgTech7)" project. AgTech7 is an Erasmus+ programme (Key Action 2: Cooperation for innovation and the exchange of good practices) funded under the Grant Agreement number 612221. The project is led by the University of Novi Sad (UNS), Serbia along with seven other partners across Europe. The primary aim of the project is to significantly and practically enhance the knowledge of European HEIs'/Research Institutes' students and 'in-house' incubator managers, agribusiness entrepreneurs and business angels on a wide set of agri-tech disruptive farm-to-fork applications. The co-curriculum design is very innovative and unique as it was developed with contributions from various stakeholders such as European HEIs'/Research Institutes', incubator managers, and successful AgriTech entrepreneurs across Europe encompassing both theory and practical skills of AgTech training. The co-curriculum design provides an initial representation of pressing issues concerning a farm to fork strategy[1] in the European Union and how the set of agri-tech disruptive applications help a wide range of stakeholders involved in agribusiness enhance their knowledge and achieve their goal.

From March 2020 to December 2020, the AgTech7 project partners carried out a wide range of activities from internal group discussions, consultations with external educational experts and finally testing the draft co-curriculum design with over 150 stakeholders in deep-dive workshops across Europe. The information collected from the participants after various activities and especially the deep-dive workshops during the first phase of AgTech7 project confirmed that the developed curriculum design for the seven Agtech7 learning modules captured the current and future concerns of farm-to-fork strategies associated to various stakeholders. The co-curriculum design of AgTech7 allowed workshop participants to experience real life challenges with attempting to efficiently implement farm-to-fork strategies in their Agribusiness domain. At the same time the co-curriculum design process also created a networking opportunity with like-minded people to exchange ideas, concerns, and knowledge on how to overcome the farm to fork challenges in Europe's Agri-Food sector. Moreover, the findings of the deep-dive workshops showed that 95% of workshop participants agreed that topics and sub-topics covered in the

1 https://ec.europa.eu/food/sites/food/files/safety/docs/f2f_action-plan_2020_strategy-info_en.pdf

AgTech7 project are highly relevant and timely and 90% of workshop participants would like to follow up on future developments of the AgTech7 learning modules.

The Co-curriculum design of AgTech7 was developed from a European perspective incorporating contributions from academics, incubator manager, entrepreneurs, and relevant stakeholders across Europe.

1.1 Course aim

The AgTech7 project will provide academics, incubator manager, entrepreneurs, and relevant stakeholders across Europe with the theoretical and practical skills to effectively implement Farm-to-Fork strategies in their Agribusiness with the help of AgriTech disruptive applications.

1.2 Overall learning outcomes

The learning modules will use real time case studies and employ a combination of approaches combining industry relevant skills with the necessary theoretical background. The learning modules improve knowledge and know-how of target stakeholders through the topics outlined within each learning module, however the resource material and teaching style is influenced from Problem Based Learning (PBL) based learning. This approach requires a non-traditional learning environment that blends teaching with case studies. This enhances the competence of the participants to deal with real-life problems.

1.3 Learning module structure and specific learning outcomes

The structure of the individual learning modules is based on the need of inter-disciplinary knowledge and multi-actor mobilisation for future AgriTech disruptive applications on the entire farm-to-fork value chain. Despite the recent increase in agribusiness ventures by global conglomerates[2], many European small-scale entrepreneurs, angel investors and incubator managers are still not aware of the benefits the adoption of farm-to-fork disruptive AgriTech can provide in terms of growth and innovation. AgTech7 tried addressing this gap by engaging them in an inter-disciplinary and multi-actor learning process and by showing how disruptive AgriTech can be a gamechanger in agribusiness. This deliverable focused on seven identified necessary knowledge domains that not only help various stakeholders to enhance their knowledge about

[2] For example, Whole Foods bought by Amazon for $13.7 billion, BASF's acquisition of Bayer's seed business for $7 billion, Jeff Bezos' Expedition Fund in Plenty and Google Ventures in Farmers Business Network.

sustainable food system, but also convey how they benefit from adopting farm-to-fork disruptive AgriTech. AgTech7 focuses on seven thematic priorities and these are:

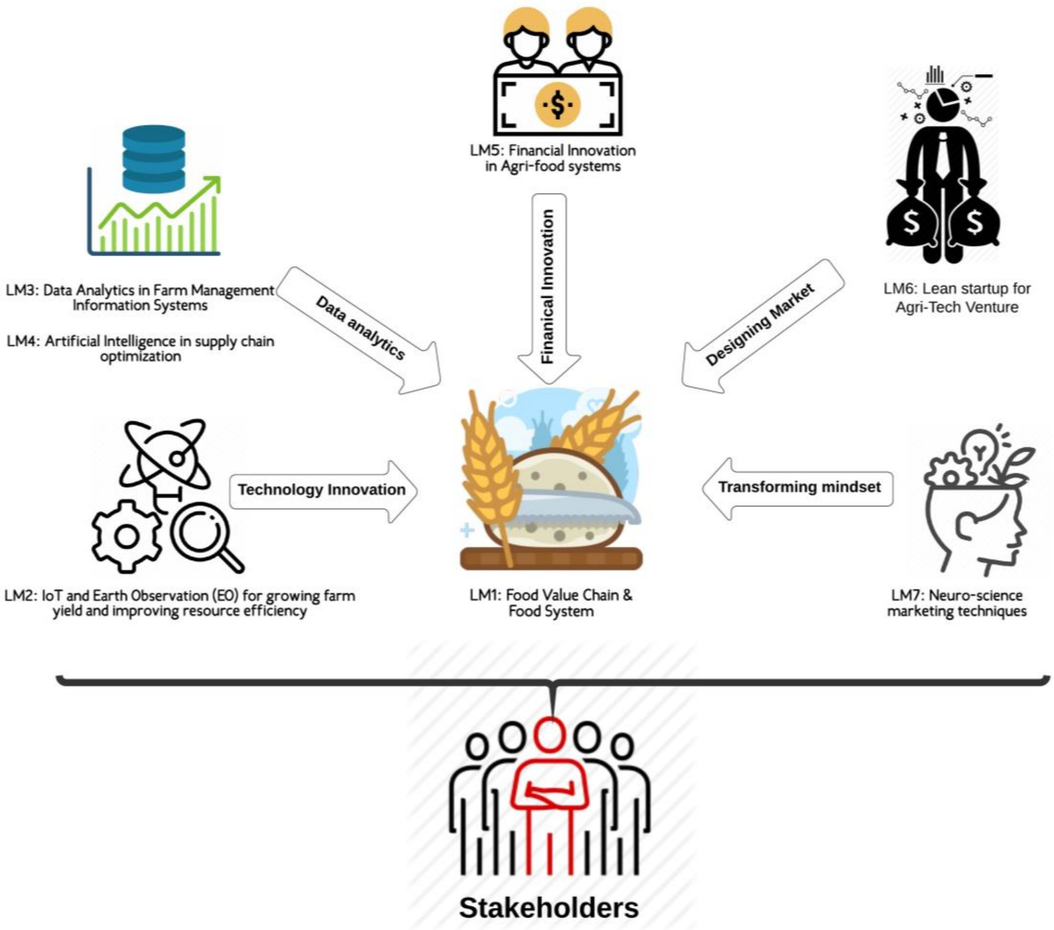

Figure 1: Conceptual design of AgTech7 course modules

Table 1 provides the quick overview of AgTech7 learning module, summary of major topic and delivery method. Further details of each learning modules provided in individual learning module chapters.

Table 1: overview of AgTech7 learning modules, summary of major topics and delivery method

Learning Module	Target Domain	Main topic	Delivery method
Food value chain and food system.	Food system	• Global food system • Global food supply chain • Consequences and impacts of the global food system	• On-line lectures • Study material • Case studies
IoT and Earth Observation (EO) for growing farm yield and improving resource efficiency	Technology Innovation	• Challenges and opportunities of IoT and EO technologies • Decision Support Systems • Irrigation, fertilisation and plant protection technologies	• On-line lectures • Hands-on exercises • Case studies
Data Analytics in Farm Management Information Systems	Data analytics	• Precision agriculture • Data sources • Data analytics in FMIS	• On-line lectures • Hands-on exercises • Case studies
Artificial Intelligence in supply chain optimisation	Data analytics	• supply chain management and logistic • Overview of AI in AgriTech • AI tools in supply chain optimisation	• On-line lectures • Study material • Case studies
Financial Innovation in Agri-food systems	Financial Innovation	• European context of Agri-food sector • Financial innovation in Agri-business • Technology Innovation in Agribusiness	• On-line lectures • Literature study • Case studies
Lean startup for agri-tech ventures	Designing market	• Agritech entrepreneurship • The Lean Startup method • Business Model Design • Investment funding, raising Capital and Pitching	• On-line lectures • Suggested reading and video materials • Use of real-world case studies • Mentoring workshops
Neuro-science marketing techniques	Transforming mindset	• Concepts of neuroscience • Behavioural economics • Choice of food and branding	• On-line lectures • Literature study • Case study

2 Food Value Chain and the Food System

2.1 Module objectives

"The primary aim of this module is to provide an understanding of the global food system and the global food supply and value chain, how they function and how this impacts the environment and society. Technological innovations that increase transparency or change economic and social power will also be presented."

2.2 Learning outcomes

Current food supply chains are complex and involve many stakeholders. Every stage of food production is performed by different stakeholders, and as food supply chains have become globalised and interconnected, they have become more opaque. The importance of food chain transparency has increased. In recent years, several factors have increased the need for transparency, including an increase in the number of food-borne illness outbreaks, increasing consumer demand to know about their food, and a growing awareness of the environmental and ethical impacts of food supply chains. In order to achieve greater transparency, a combination of regulation and technology have to be developed and adopted. Currently, there is a lot of variation around Europe and the world on implemented regulations (e.g., on the use of pesticides) and the adoption of suitable technologies. The global food system and food supply chains operate in a relatively unstructured and complex governance environment. The sharing of information at each stage of the food supply chain, food safety standards, regulations, and food policies vary from country to country. There is a growing use of technologies to enable the collection and sharing of data across supply chains. Several emerging technologies like IoT and Big Data are believed to have great potential in providing greater transparency and ensuring food safety. Here again, there is significant variation among supermarkets in developed countries using complex ERP systems and extensive data analytics, while in other countries the level of technological penetration is limited even for documenting supply of core food products (e.g., coffee, bananas).

To attain an effective solution for the global food system and food supply chains requires a complete consideration of stakeholders involved and their understanding of a wide range of food supply chain challenges like food insecurity, technology integration, agri-food policies, and sustainability concerns. To achieve this we not only need to consider technology inputs but also create stakeholder coordination at various spatial scales, deal with broad governance concerns, and recognising challenges of sustainability. In coming years, the global food system and food supply chain will face a severe pressure to provide sustainable and secure supply of food to 9 billion people. Maintaining the global socio-ecological system sustainably, achieve greater transparency, and increasing the resource efficiency of the entire value chain with the help of agri-food technology innovations and regulation is the need of the time.

To summarise, the learning outcomes of this course are:

- To provide an overview of the overall global food system, food security, food value chain, and food governance.
- To make course participants aware of food safety, sustainability and transparency challenges.
- To summarise current practices of food safety standards and gaps.
- To make course participants aware of a wide range of emerging technologies like IoT and Big Data analytics and their application at various stages of the food supply chain in a wide range of food products.
- To enable course participants to use gained skills in either group projects or developing test case studies as per participant needs.

2.3 Course content

Part 1: Global food system

- Globalisation of the food production
- Challenges of food value chain and the food system

Part 2: Global supply chains

- Impacts of global food supply chain
- Role of technology in the food value chain
- Drivers, barriers and opportunity for technology

Part 3: Consequences and impacts of the global food system

- Environmental impact
- Social Impact
- Economic impact
- The colonial dimension of the food system

Part 4: Case Studies

- Milk
- Red meat
- Spices /Tea/ Olive oil

2.4 Mode of study

- Lectures
- Literature study
- Individual assignments

- Case studies, and
- Presenting the results to the group

2.5 Recommended study material

Selected examples of articles, book and online study material.

- Bouzembrak, Y., Marvin, H.J.P., 2016. Prediction of food fraud type using data from Rapid Alert System for Food and Feed (RASFF) and Bayesian network modelling. Food Control.
- Ingram, J., 2011. A food system approach to researching food security and its interactions with global environmental change. Food Security.
- Hou, M. A., Grazia, C., & Malorgio, G. (2015). Food safety standards and international supply chain organization:A case study of the Moroccan fruit and vegetable exports. Food Control.
- Kamilaris, A., Fonts, A., & Prenafeta-Boldύ, F. X. (2019). The rise of blockchain technology in agriculture and food supply chains. Trends in Food Science & Technology.
- Mc Carthy, U., Uysal, I., Badia-Melis, R., Mercier, S., O'Donnell, C., Ktenioudaki, A., 2018. Global food security – Issues, challenges and technological solutions. Trends Food Science and Technology.
- Sarpong, S. (2014). Traceability and supply chain complexity: confronting the issues and concerns. European Business Review.
- Trienekens, J.H., Wognum, P.M., Beulens, A.J.M., van der Vorst, J.G.A.J., 2012. Transparency in complex dynamic food supply chains. Advanced Engineering Informatics.
- Vorst, van der, J. G. A. J., Tromp, S. O., & Zee, van der, D. J. (2009). Simulation modelling for food supply chain redesign; integrated decision making on product quality, sustainability and logistics. International Journal of Production Research.
- Yan, J., Erasmus, S.W., Aguilera Toro, M., Huang, H., van Ruth, S.M., 2020. Food fraud: Assessing fraud vulnerability in the extra virgin olive oil supply chain. Food Control.

2.6 Coordinator

Maastricht University / AgTech7 online platform

3 Internet of Things (IoT) and Earth Observation (EO) for Growing Farm Yield and Improving Resource Efficiency

3.1 Module objectives

"The primary aim of the module is to provide understanding, knowledge about Internet of Things (IoT) and Earth Observation (EO) and how they can be used in agriculture for growing farm yield and improving resource efficiency."

3.2 Learning outcomes

Smart Farming is a sector that relies many of its key business process on the Internet of Things (IoT) and Earth Observation (EO) technologies. In the upcoming Common Agricultural Policy (CAP), Precision agriculture and Smart Farming are integral parts, because their combined use leads to an optimal and sustainable production process while allowing the provision of advisory services based on facts. IoT and EO are proposed as the best tools for efficient implementation of the CAP. Until now, EO has been used for annual verification of subsidies claims. Recent technological improvements in big data, data management, available computing power and Copernicus Sentinel data (aerial imagery) allow for the continuous improvement in understanding agri-environmental information for selected agricultural parcels.

In this context, this course will provide an opportunity to students to recognise and learn about data sources (in situ IoT sensors, proximity sensors and soil scanners, EO/ Remote Sensing platforms etc) and efficiently use them to support decision making in agricultural practices. Through this course, students are expected to become familiar with the farming management concept in order to increase the quantity and quality of agricultural products while increasing the selective and effective use of inputs. To make this module more complete, a combination of case studies on "gaiasense" Smart Farming System (SFS) and high accuracy field-level weather forecasts will be shown. In that way, students will focus on real-life examples of how this SFS provides (IoT and EO) data-driven advisory services on fertilisation, irrigation and pest management in practice.

To summarise, the learning outcomes of this course are:

- To provide an overview of IoT and EO technologies and their relevance to agricultural practices and overall production.
- To provide students with a set of skills that will enable them to manage the useful information gathered from IoT and EO devices, including a wide range of physical parameters, aiming to enhance cultivation practices with emphasis on irrigation, pesticides and fertilisers applications.
- To make students acquainted with the skills necessary for managing IoT and EO technology in order to increase farm growth and improve resource utilisation.

3.3 Course content

1. **Challenges and opportunities of IoT and EO technologies in farming**
    - Digitalisation – Role of Information and Communication Technologies (ICT)
    - Analysis of IoT and EO applications
    - Focus on unequal distribution of technology solutions
2. **Decision Support Systems**
    - Examples of DSS with application variability
    - Failure and success factors of DSSs
3. **Irrigation, fertilisation and plant protection technologies**
    - Earth Observation (Drone and satellite images)
    - Accurate Weather forecasting
    - Yield production data
    - Proximal soil and crop sensing data
    - Internet of Things (IoT)
    - GIS & GPS
    - Predicting models
4. **Case studies**
    - “gaiasense” Smart Farming System
    - High accuracy field-level weather forecasts

Mode of teaching

- Lectures
- Literature study
- Hands-on exercises
- Small group engagement in IoT and EO related projects
- Case study, and

- Presenting the results to the group

3.4 Recommended study material

Selected examples of articles, book and online study material.

- Castrignanò et al., (2020). Agricultural Internet of Things and Decision Support for Precision Smart Farming. Academic Press.
- Poonia et al.,(2018)Smart Farming Technologies for Sustainable Agricultural Development. IGI GLOBAL.
- Ayaz M, Mohammad Ammad-uddin M, Sharif Z, Mansour A, Aggoune HM (2019) Internet-of-Things (IoT) based Smart Agriculture: Towards Making the Fields Talk. IEEE Access.
- Kalatzis N., Marianos N., Chatzipapadopoulos F, "IoT and data interoperability in agriculture: A case study on the gaiasenseTM smart farming solution," 2019 Global IoT Summit (GIoTS), Aarhus, Denmark, 2019.
- Marianos N.,Kalatzis N., Sykas D. (2018). "Earth observation for smart farming and cap performance" in "The ever-growing use of Copernicus across Europe's regions", NEREUS/ESA/EC.
- Theopoulos A, Boursianis A, Koukounaras A, Samaras T (2018) Prototype wireless sensor network for real-time measurements in hydroponics cultivation. 7th International Conference on Modern Circuits and Systems Technologies (MOCAST), Thessaloniki, 2018.
- Venkatesan R, Jaspher WKG, Ramalakshmi K (2018) Internet of things based pest management using natural pesticides for small scale organic gardens.Journal of Computational and Theoretical Nanoscience.
- Villarrubia G, De PazJF, De La IglesiaDH, Bajo J (2017) Combining multi-agent systems and wireless sensor networks for monitoring crop irrigation.Sensors.
- European Commission (2016) "The Internet of Things. Digital Agenda for Europe", EuropeanCommission" [Online] Available: https://ec.europa.eu/digital-agenda/en/internet-things.

3.5 Coordinator

NEUROPUBLIC SA / AgTech7 online platform

4 Data Analytics in Farm Management Information Systems

4.1 Module objectives

"The primary aim of this module is to provide an insightful understanding of farm management information systems and summarise data analytics methods that are at the core of farm management information systems. Practical demonstrations of basic data analytics concepts in farm management information systems will also be included as an important part of this module."

4.2 Learning outcomes

There is increasing pressure on the agricultural sector to change the production focus from quantity to quality and sustainability. In that manner, managerial tasks are currently shifting to a new paradigm, requiring more attention on environmental impact, delivery terms, and documentation of quality and growth conditions. Advances in precision agriculture, in terms of information and communication technologies, along with development of agricultural machinery, allow farmers to gain a vast amount of site-specific data which ultimately can optimise decision making on a fine resolution. However, this automatically collected data is not used because of data logistic problems, leaving a gap between data acquisition and its efficient use in current farm management practice. To overcome this gap and provide the most appropriate on-farm management interventions, an integrated solution is needed to improve decision making in the future.

The aim of the Farm Management Information Systems is to help and improve operational farm management with optimal on-farm decisions. With a rich source of information coming from heterogenous sensory technologies coupled with data analytics, FMIS allow locally based planning and enable applications of site-specific agricultural management using the tools and knowledge of crop science, agricultural engineering, and geo-statistics.

This course will equip the student with the knowledge required to understand Farm Management Information Systems that integrate precision agriculture activities into a holistic system. On completion of this module, students will clearly understand a range of aspects of FMIS, including basic concepts of data analytics that are at the core of such systems. Lectures will also include practical demonstrations of data analytics methods in FMIS.

To summarise, the learning outcome of this course are:

- To provide a brief overview of different data sources.
- To provide understanding of agriculture data-driven solutions in FMIS.
- To equip course participants with a basic set of skills to handle geographic information systems data and provide interpretations with data analytics.
- To enable students to run Python exercises and visualise results in QGIS and thus understand principles of data analytics in FMIS (e.g., deriving satellite-based indexes, yield monitoring, variable rate applications, etc.)
- To provide students with a set of skills to evaluate different FMIS and provide consultancy on their usage and to use it in future projects.

4.3 Course content

1. **Core concept of precision agriculture**

   - Current practices of FMIS
   - Understanding and identifying temporal and spatial variability
   - Drivers of variability (e.g., soil, weather, farm management)

2. **Data sources**

   - Drone and satellite images
   - Climate data
   - Yield production data
   - Proximal soil and crop sensing data
   - Internet of Things (IoT)

3. **Data analytics in FMIS**

   - Data management
   - Geographic information systems
   - Machine learning: clustering, classification, prediction
   - Examples of data analytics (Python and QGIS demonstrations)

4. **Case studies**

   - Yield monitoring and mapping
   - Weed mapping
   - Variable-rate applications
   - Crop production cycle optimisation

4.4 Mode of teaching

- Lectures;
- Literature study;
- Hands-on exercises in Google Colab and QGIS;
- Case study, and

- Presenting the results to the group;

4.5 Recommended study material

Selected examples of articles, book and online study material.

- D. Kent Shannon, David E. Clay, Newell R. Kitchen (2020). Precision Agriculture Basics. John Wiley & Sons.
- Nicolas Baghdadi, Clément Mallet, Mehrez Zribi (2018). QGIS and Applications in Agriculture and Forest. John Wiley & Sons.
- Villa-Henriksen, A., Edwards, G. T., Pesonen, L. A., Green, O., & Sørensen, C. A. G. (2020). Internet of Things in arable farming: Implementation, applications, challenges and potential. Biosystems Engineering.
- Saiz-Rubio, V., & Rovira-Más, F. (2020). From smart farming towards agriculture 5.0: a review on crop data management. Agronomy.
- Bacco, M., Barsocchi, P., Ferro, E., Gotta, A., & Ruggeri, M. (2019). The digitisation of agriculture: a survey of research activities on smart farming. Array.
- Maestrini, B., & Basso, B. (2018). Predicting spatial patterns of within-field crop yield variability. Field Crops Research.
- Van Evert, F. K., Fountas, S., Jakovetic, D., Crnojevic, V., Travlos, I., & Kempenaar, C. (2017). Big data for weed control and crop protection. Weed Research.

4.6 Coordinator

BioSense Institute / AgTech7 online platform

5 Artificial Intelligence in Supply Chain Optimisation

5.1 Module objectives

"The primary purpose of this module is to explore the application of artificial intelligence to optimise the overall food-supply chain. Modules will include hands-on demonstrations of AI concepts in supply chain issues. "

5.2 Learning outcomes

In recent years agricultural production has increased worldwide with a different pace across regions and commodities. Disruptive technologies are playing a critical role in increased production and efficiency in overall food supply chain management. Farmers and Agri-tech businesses are constantly facing complex and critical decisions in agricultural production and supply chain management. These decisions include production efficiency, efficiency in logistics, on- and off-farm planning and scheduling, sales forecasting and precise agricultural processes to scale and serve the demand of rapidly growing population. Parallelly, global challenges are putting a limitation on a wide range of stakeholder involved in Agri-food system to reducing fossil energy consumption, GHG emission and reducing organisational and operational costs along the supply chain.

Traditionally, stakeholders used their experience and judgement to make such decisions. However, as the food demand is growing exponentially, farming and supply chain management practices also shifted toward short production runs and cut the costs in production methods. These added complications also made the decision-making process more complex. Many of the one and off-farm processes have become more automated and allow greater control of the supply chain. At the same time these processes also started generating enormous amounts of data coming from a wide variety of sensors across the food-supply chain. As the agribusiness are becoming more complex data analytics tool such as artificial intelligence (AI) have received increasing attention from both practitioners and researchers in the Agri-food domain. AI can effectively predict anomalies in the trajectory of the supply chain and optimise the entire process and help stakeholders making effective decisions supply chain operations. Several AI techniques, such as neural networks, genetic algorithms, fuzzy logic and evolutionary strategies have been applied successfully.

The course module will provide an opportunity to students to recognise and learn about Artificial Intelligence applications in agricultural practices and supply chain optimisation. Through this course student will learn fundamentals and application of various artificial intelligence techniques to assist decisionmakers in tackling key problems in the supply chain optimisation. AI application case studies will be explored for optimising the supply chain cost management, waste reduction, enhanced delivery timing and order-fulfilling volumes. Finally, the module will explore the statistical nature of agricultural data and supply chains in particular.

To summarise, the learning outcome of this course are:

- To provide an overview of artificial intelligence (AI) and its application in Agribusiness supply chain.
- To make course participants aware of agribusiness supply chain management and logistics.
- To make course participants aware of a wide range of sensory technologies and data generated from these technologies.
- Providing students with a set of skills to evaluate different supply chain management systems and provide consultancy on their usage and to use it in future projects.
- To provide course participants with a set of skills that will enable them to manage the useful information gathered from sensors across the food supply chain, including decisions made by AI applications based on data gathered from the food supply chain

5.3 Course content

1. **Overview aartificial intelligence**
    - Search and planning
    - Expert systems
    - Machine learning and neural networks method
2. **Data sources like sensor**
    - Temperature, pressure, and humidity sensors
    - Vision sensors
    - Sensors for structure/quality of soil/products
3. **Digital technologies**
    - Barcode, RFID, NFC
    - IoT/IIoT
4. **Logistics**
    - Production, materials handling, and packaging
    - Inventory and transportation
    - Warehousing
5. **Supply chain management and logistic**

- Flows of material and Information
- Flows of equipment, financial and human resources,
- Flows of intangible resources (relations between companies)

6. Case studies

- Milk production
- Beef production

5.4 Mode of teaching

- Lectures
- Literature study
- Case study, and
- Presenting the results to the group

5.5 Recommended study material

Selected examples of articles, book and online study material.

- Stuart J. Russell, Stuart Jonathan Russell, Peter Norvig, Ernest Davis (2020). Artificial Intelligence: A Modern Approach. Prentice Hall.
- Yan Zhang, Paris Kitsos (2019). Security in RFID and Sensor Networks. Security in RFID and Sensor Networks.
- Dawei Lu (2011). Fundamentals of supply chain management Dawei Lu & Ventus Publishing ApS.
- Yuhong Dong, Zetian Fu, Stevan Stankovski, Siyu Wang, Xinxing Li, Nutritional Quality and Safety Traceability System for China's Leafy Vegetable Supply Chain Based on Fault Tree Analysis and QR Code, (2020) IEEE Access
- Prodanović, R., Rančić, D., Vulić, I., Zorić, N., Bogićević, D., Ostojić, G., Sarang, S., Stankovski, S., Wireless sensor network in agriculture: Model of cyber security, (2020) Sensors (Switzerland), 20 (23), art. no. 6747, pp. 1-22. DOI: 10.3390/s20236747
- Stankovski, Stevan; Ostojic, Gordana; Senk, Ivana; Rakic-Skokovic, Marija; Trivunovic, Snezana; Kucevic, Denis, Dairy cow monitoring by RFID, Scientia Agricola, pp 75-80, 2012.
- Stankovski, Stevan; Lazarević, Milovan; Ostojić, Gordana; Ćosić, Ilija; Puric, Radenko, RFID technology in product/part tracking during the whole life cycle, Assembly Automation, 2009.

- Stankovski, Stevan; Ostojić, Gordana; Nićin, Miroslav; Baranovski, Igor; Tarjan, Laslo, Edge Computing for Fault Detection in Smart Systems, ICIST 2020 Proceedings, pp 22-26, 2020.

5.6 Coordinator

University of Novi Sad (UNS) , Serbia / AgTech7 online platform

6 Financial Innovation in Agri-food Systems

6.1 Module objectives

"The primary aim of this module is to explore how innovative financial instruments can empower agricultural productivity through technology and collaboration among actors along the value-chain."

6.2 Learning outcomes

Financial incentives, innovative funding and insurance instruments are increasingly regarded as core tools to build a resilient and inclusive agricultural sector. This module will summarise the European agricultural sector in terms of market size and trends, principal actors, challenges and policies. The module will showcase a set of innovative financing schemes that are essential for innovating and empowering the agricultural sector in terms of productivity, security and resilience, inclusiveness, triple bottom line, and other critical performance indicators. For each financing scheme, the module will exhibit a use case. Technology and data-driven solutions are presented as key enablers to help agribusinesses to better access financial services and external capital.

This module will provide a firm knowledge base to interpret the current state of the market and expect its trends. The module will provide practical uses cases of how innovative financial instruments impact the sector through integrating big data, smart infrastructure and other technologies. Such knowledge is crucial to have a comprehensive overview of the spectrum of funding options available to businesses and early-stage companies operating in the industry and to brace the demand and development of forward-looking, resilient and inclusive financial services. On completion of this module, students will have a clear understanding of how the European agricultural sector works financially and will master a set of methodological tools to assess the framework and expected outcomes of innovative financing solutions.

To summarise, the learning outcome of this course are:

- To enable students to understand the size and structure of the agricultural sector in Europe and globally, highlighting key challenges and trends.
- To make students aware of the European context of the Agri-business sector, including the outlook of the agri-food sector under the UN Sustainable Development Goals, the fundamental regulation and frameworks shaping the

industry, and main private and public actors involved in financing the agri-food value chains.

- To provide students with an understanding of the positioning of European countries in terms of development and adoptions of technologies and tech enabled business models.
- To boost the skills and abilities of students to identify and access innovative financial instruments, with purpose of widening access to capital, mitigating risk, reducing operating costs, reaching the unbanked population, and more.
- To make students aware of case studies and best practices in financing innovation in the agri-food sector.

6.3 Course content

1. **Overview of the Agri-food sector**
    - Key figures and market trends
    - Product and process innovation in agri-food production
2. **European context of Agri-food sector**
    - Key stakeholders
    - EU agriculture policy
    - EU innovation and performance
3. **Financial innovation in Agri-business**
    - Financial instrument types
        - *Credit*: Microfinance & Mobile Money
        - *Equity*: 3Fs & Angel Investment & Venture Capital , Accelerator funding, EIT Calls
        - *Risk sharing*: Public Private Partnerships, (Micro)insurances, Grants
    - Financing for innovation (e.g., R7D grants, subsidies and market investment)
    - Finding & reaching (impact) investors
4. **The role of technology in enabling Innovation in Agribusiness**
    - Technology and data driven innovations
    - Technological leadership
5. **Case Studies**
    - Alibaba: Credit Rating, Supply Chain Finance and Offline & Offline Lending
    - Excel BitCom: In-kind Financing

6.4 Mode of teaching

- Lectures
- Literature study
- Case study, and
- Presenting the results to the group

6.5 Recommended study material

Selected examples of articles, book and online study material.

- Cremades, A. (2016). The art of startup fundraising: pitching investors, negotiating the deal, and everything else entrepreneurs need to know. John Wiley & Sons.
- Bureau, J. C., & Swinnen, J. (2018). EU policies and global food security. Global food security.
- Caro, M. P., Ali, M. S., Vecchio, M., & Giaffreda, R. (2018, May). Blockchain-based traceability in Agri-Food supply chain management: A practical implementation. In 2018 IoT Vertical and Topical Summit on Agriculture-Tuscany (IOT Tuscany) IEEE.
- Deng, Haiyan, Ruifa Hu, Carl Pray, and Yanhong Jin. "Impact of government policies on private R&D investment in agricultural biotechnology: Evidence from chemical and pesticide firms in China." Technological Forecasting and Social Change.
- Gao, Liangliang, Dingqiang Sun, and Cuiping Ma. "The impact of farmland transfers on agricultural investment in china: A perspective of transaction cost economics." China & World Economy.
- Ibragimov, Z., Lyeonov, S., & Pimonenko, T. (2019). Green investing for SDGS: EU experience for developing countries. Economic and Social Development: Book of Proceedings.
- Jia, X., & Desa, G. (2020). Social entrepreneurship and impact investment in rural–urban transformation: An orientation to systemic social innovation and symposium findings. Agriculture and Human Values.
- Miranda, J., Ponce, P., Molina, A., & Wright, P. (2019). Sensing, smart and sustainable technologies for Agri-Food 4.0. Computers in Industry.
- Moral performances in agricultural investment projects. Environment and Planning A: Economy and Space.

6.6 Coordinator

EBAN / AgTech7 online platform

7 Lean Startup for AgriTech Ventures

7.1 Module objective

"The primary purpose of this module is to raise awareness about the basics of entrepreneurship and the lean startup method applied in the agriculture sector. The training aims to guide the learners through the steps necessary to turn a business idea into a successful agritech venture. The learners will experience practical tools and actionable techniques in a 'hands-on' and practical deployment approach."

7.2 Learning outcomes

The current developments in agriculture such as developments in agricultural technologies, shifting demand in terms of locality, healthy eating, personalised products and services, sustainability concerns, increasing interest and investments in agri-tech shows the need for a course in agri-tech entrepreneurship.

The key challenges which agri-tech startups often face such as the ability to evaluate future scenarios and to understand real world market needs, to understand local dynamics, to establish communication with institutional consumers, investors and stakeholders, to access financial resources, technical support or consultancy will be answered by this module.

To summarise, the learning outcomes of this course are:

- Expressing the basic principles and concepts of entrepreneurship and lean startup method.
- Designing new business models for an agritech startup by using the relevant tools (e.g. business model canvas, value proposition canvas, etc).
- Explaining the importance of idea validation and use the necessary tools to perform it.
- Expressing the importance of pivoting and the need to pivot the original idea according to customers' feedback if necessary.
- Recognizing the importance of a competition and market analysis, and conduct an economic feasibility study using budgeting as a tool.
- Recognizing existing investment funding/grants and raising capital opportunities and developing a set of skills for pitching an agri-tech business idea in front of investors.

7.3 Course content

1. **Introduction to the Basics of Agritech Entrepreneurship and the current state of agriculture**
   - Entrepreneurship, startups, new ventures, current trends, interests and regulations in agritech, agriculture sector's local/international trends,
   - Governmental/EU investment programmes
2. **The Lean Startup Methodology**
   - Lean Startup, value proposition, minimum viable product, customer development, idea generation, idea validation, pivoting
3. **Business Model Design**
   - Business model generation, customers segments, channels, customer relationships, marketing and competition analysis, agritech markets, revenue models, key activities, key resources, key partners, cost models
4. **Economic Feasibility Analysis and Budgeting**
   - Budget, feasibility analysis, working capital, cash-flow, revenues, costs, investments, agribusiness specific KPIs
5. **Investment Funding, Raising Capital and Pitching**
   - Business Angel, Venture Capital, Seed Capital, Private Equity, Bootstrapping, Crowdfunding, IPO (Initial Public Offering), FFFs (Friends, Family and Fools), Regional/ National/ International agribusiness support funds, pitching, public speaking, body language, pitch decks
6. **Agri-tech Venture Case Studies**
   - Agri-tech ventures, start-ups, case studies (categories: food security, blockchain, finance, etc. related to the other 6 modules.)

7.4 Mode of teaching

- Lectures (online or offline depending on the type of the training),
- Suggested reading and video materials,
- Use of case studies,
- Participatory engagement with local AgriTech business
- A mentoring based project development

7.5 Recommended study material

Selected examples of articles, book and online study material.

- Blank, S.G. (2007). The four steps to the epiphany: Successful strategies for products that win. California: S.G. Blank.
- Blank, S.G. & Dorf, B. (2012). The Startup Owner's Manual. K&S Ranch, Inc.
- Ries, E. (2011). The Lean Startup. Crown Business.
- Chernev, A. (2017). The Business Model: How to Develop New Products, Create Market Value and Make the Competition Irrelevant. Cerebellum Press.
- Imke, S. (2016). Applying The Business Model Canvas: A Practical Guide For Small Business. KSI Enterprises.
- Blank, S. (2013, May). Why The Lean Start-Up Changes Everything, Harvard Business Review.
- Trammell, J. (2015, January 20). The Best Definition of Entrepreneurship I've Heard So Far. Khorus.
- Fielt, E. (2013). Conceptualising Business Models: Definitions, Frameworks and Classifications. Journal of Business Models.
- Girotra, K., Netessine, S. (2014, July–August). Four Paths to Business Model Innovation. Harvard Business Review.
- Casadesus-Masanell, R., Ricart, J.E. (2011, January–February). How to Design a Winning Business Model. Harvard Business Review.
- Peralta, C. B.dL., Echeveste, M. E., Martins, V. L. M., & Lermen, F. H. (2020). Applying the framework to identify customer value: A case of sustainable product in agriculture. Journal of Cleaner Production.

7.6 Coordinator

YASAR UNIVERSITY / AgTech7 online platform

8 Neuro-Science Marketing Techniques for Shifting Diets and Personalised Branding

8.1 Module objectives

"The primary goal for this module is to summarise neuromarketing techniques that can create effective food branding strategies and increase behaviour change toward health diet."

8.2 Learning outcomes

To understand the truly complex decision-making and consumption environment, modern marketing is focused on studying purchasing decisions from a multidisciplinary perspective. In order to create value in today's competitive and fast-moving environment, it is vital to understand the consumer's experience. Neuromarketing holds promise in offering insights about consumer behaviour and is expected to revolutionise the fields of economics and marketing.

Neuroimaging data could give a more precise sign of the underlying preferences than data from standard market research studies. Learning the importance of brand and labelled information would be beneficial to people interested to create effective food branding strategies and increase behaviour change. This could allow product concepts to be tested rapidly and permit more efficient allocation of resources. The field of food choice and consumption is complex, as it involves both rational and irrational substrates. Individual decisions which lead to a certain choice that determines behaviour occur rapidly, and often without complete rational control. The neuromarketing discipline draws from neuroscience and behavioural economics to examine both conscious and unconscious emotional and perceptual reactions, and therefore can offer more information than traditional marketing approaches. Decision-making processes about food are influenced by a complex set of emotions, attitudes, and values that are difficult to assess just by self-reports or interviews.

This module will equip the student with the knowledge required to understand how neuroscience tools are employed for consumer-led product development and personalised branding. The goal for this course is to summarise neuromarketing techniques that can create effective food branding strategies and increase behaviour change. It aims to make students aware of what neuromarketing is, and gain in depth understanding of the neurobiological mechanisms underlying consumer preferences and choice processes. This module also aims to teach students the ethical guidelines used in neuroscience, and how to apply principles of psychology and neuroeconomics to determine consumer behaviour and preferences. The aim is to use this knowledge to construct and influence the brand choice of their target audiences. This will enable students to use effectively neuromarketing research output in their branding strategy, to affect dietary preferences.

To summarise, the learning outcome of this course are:

- To provide an overview of neuroscience tools and brain anatomy related to dietary preferences and brand selection.
- To make students aware of the ethical guidelines for neuroscientific research.
- To teach students about how decision-making theories and research helped us understand basic drivers of judgment.
- To provide students with a set of skills that they can use to develop a strategic approach to personalised marketing and to affect dietary preference.

8.3 Course content

1. **Basic concepts of neuroscience**
    - Brain functionality
    - Neuroscience tools
    - Ethical guidelines, credibility & ease of application
2. **Behavioural economics - Neuroeconomics**
    - Decision making theories
    - Basic principles that drive judgment
3. **Choice of food and branding**
    - Eeural and chemical pathways of self-control, reward and evaluation
    - Food preference formation and modification
    - Optimise visibility practices and brand identity
4. **Case studies**
    - Use of fMRI to understand consumers' preferences in relation to brand
    - Use of eye-tracking to evaluate attention to packaging and nutritional information
    - Use of electroencephalogram (EEG) in food advertisement research to evaluate the impact of specific odors during tasting

8.4 Mode of teaching

- Lectures
- Literature study
- Case study, and

- Presenting the results to the group

8.5 Recommended study material

Selected examples of articles, book and online study material.

- Ariely D. (2009) Predictably Irrational: The Hidden Forces That Shape Our Decisions. Harper Press
- Gazzaniga, M., Ivry, R. B., & Mangun, G. R. (2019) Cognitive Neuroscience: The Biology of the Mind. W. W. Norton & Company
- Boyland, E. J., & Christiansen, P. (2015). Brands and Food-Related Decision Making in the Laboratory: How Does Food Branding Affect Acute Consumer Choice, Preference, and Intake Behaviours? A Systematic Review of Recent Experimental Findings. Journal of Agricultural & Food Industrial Organization.
- Cherubino, P., Martinez-Levy, A. C., Caratù, M., Cartocci, G., Di Flumeri, G., Modica, E., Rossi, D., Mancini, M., & Trettel, A. (2019). Consumer Behaviour through the Eyes of Neurophysiological Measures: State-of-the-Art and Future Trends. Computational Intelligence and Neuroscience.
- Giacalone, D. (2018). Sensory and Consumer Approaches for Targeted Product Development in the Agro-Food Sector. In Case Studies in the Traditional Food Sector.
- Hakim, A., & Levy, D. J. (2019). A gateway to consumers' minds: Achievements, caveats, and prospects of electroencephalography-based prediction in neuromarketing. Wiley Interdisciplinary Reviews: Cognitive Science.
- Hsu, M., & Yoon, C. (2015). The neuroscience of consumer choice. Current Opinion in Behavioral Science.
- Kessler, S. J., Jiang, F., & Hurley, R. A. (2020). The State of Automated Facial Expression Analysis (AFEA) in Evaluating Consumer Packaged Beverages. Beverages.
- Shahriari, M., Feiz, D., Zarei, A., & Kashi, E. (2019). The Meta-Analysis of Neuro-Marketing Studies: Past, Present and Future. Neuroethics.

8.6 Coordinator

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