**LITERATURE SURVEY**

**AGRICULTURE AND DIGITAL TECHNOLOGY**

***Veronique bellon maurel,Ludovic Brossard,Frédérick Garcia****l* ***and Nathalie Mitton***

**ABSTRACT:**

All over the world, food systems are undergoing profound changes caused by external pressures climate change, organization of value chains, etc. and intrinsic factors innovation, reduction in the number of farmers, etc.. Food security is the number one concern at the global level and is today accompanied by a strong demand for production methods to become more sustainable and for the protection of a living rural structure based on attractive family farming. This is why, as the FAO reminds us, agro ecology is a vital issue in a growing number of countries, including France. In parallel to these changes, agriculture, like all economic sectors, is seeing an upsurge in digital technology. Since the mid-2010s, the concept of “digital agriculture” has emerged. It deﬁnes both a form of agriculture and a food system that uses digital science and technology such as data science and technologies for acquisition satellites, sensors, connected objects, smartphones, etc., transfer and storage 3G/4G/5G coverage, low-speed terrestrial or satellite networks, clouds and on-board or remote processing supercomputers accessible via very high-speed communication networks, artiﬁcial intelligence at all levels of agricultural production and its ecosystem: farms, support services, territories, value chains. Digital technology is often seen by governments and experts as an opportunity to contribute to the development of agriculture for the beneﬁt of farmers, consumers and society in general. But what does this mean? What digital tools should be developed? This white paper aims to shed light on these issues and present research perspectives to better understand, master, prepare, equip and support the deployment of digital technology in agriculture and the food chain, while ta-king into account the way in which it will transform sectors and their ecosystems, with the aim of using it to support the agro ecological transition (AET) and the territorialisation of food and rebalanced supply chains. It is structured in six chapters. After the introduction, presents the challenges of transforming agriculture and food systems. An overview of the state of the art then presents existing digital technologies. The possibilities oﬀered by digital technology for the agro ecological transition and better inclusion in society are then inventoried Identiﬁcation of the risks linked with the uncontrolled development of digital agriculture is just as necessary to avoid or minimize the pitfalls presents the technical issues and challenges identiﬁed that could mobilise our two institutes, INRAE and Inria, but also the French research ecosystem, in particular to develop responsible digital technology for agriculture.

**INTRODUCTION:**

Today, a series of global changes are placing the agri food system under strain. On the one hand, the growing population 9.5 billion people in 2050 according to the UN’s median scenario with a changing diet as in China for example, must be fed while adapting to a context of increasing devastation: climate change, collapse of biodiversity, reduction of resources soil, fresh water, phosphorus. On the other hand, agriculture must accelerate changes to implement livestock production systems that are more respectful of animal welfare and reduce its impact on the environment reduction of the use of inputs such as antimicrobials, fertilisers, pesticides, reasoned use of natural resources such as water, reduction of soil compaction and greenhouse gas emissions, better use of biological regulations and contribute to CO2 storage3 and the preservation of biodiversity. In the last 70years, agricultural dynamics have favoured intensiﬁcation and specialisation. Farm sectors are based on competitive pricing, a phenomenon that is exacerbated by globalisation. Essentially, they are subject to unbalanced power relations between actors with diverse and even divergent interests. In addition, farming is carried out in territories that have, in many cases, become specialised, leading to imbalances. This leads to great complexity in terms of specialisation and interdependence of these elements that ampliﬁes instabilities, multiplies the risks of failure and is ultimately a major hindrance to change. It is therefore crucial to very quickly implement strategies to improve production techniques and ways of organising the agrifood system to increase their resilience. According to the FAO, production can evolve towards two models: either sustainable intensiﬁcation improvement of process eﬃciency and integration into long supply chains, agro ecology, which is based on natural production processes and uses local and sovereign food systems. This second model is now supported by the French EGAlim law6 and many local authorities and citizens. Farm structure is also a point of attention: it is important to provide the conditions for decent work for farmers and protect family farming, which is in the majority in the world. In this context, digital technology could contribute to the virtuous transition toward agroecology in territorialised food systems and the protection of family farming by providing information to better understand these complex systems and individual or collective decision-making support as well as supporting concrete action, exchange, the reconﬁguration of value chains, the development of strategies and policies, etc. It is precisely this path of placing digital technology at the service of the transition to agro ecology and the renewal of food systems that we have chosen to explore in this white paper.

**DIGITAL TECHNOLOGY IN AGRICULTURE: EVIDENCE FROM FARMS ON THE TERRITORY OF AP VOJVODINA**

***Mina Kovljenic,Jovana Skoric,Milena Galetin,Sanja Skoric***

**ABSTRACT:**

Agricultural and rural development is a very current issue in the world. Today, agriculture is expected to meet the growing demands for the production of a sufficient amount of food. So, it is necessary to increase productivity in agriculture, while taking into account the long-term agricultural sustainability. The implementation of digitalization in agriculture leads to increased productivity, enables the growth of agricultural producer’s profits and maintenance of food security. The aim of the paper is to analyze the application of digitalization in agriculture on farms in AP Vojvodina. In the paper 46 farms from the territory of AP Vojvodina were surveyed as part of the research. The results of the research showed that digital technology is still not used enough on farms in AP Vojvodina, and the main limiting factors are financial resources, education and lack of different types of training.

**INTRODUCTION:**

Today, agriculture is facing numerous challenges and global changes. In the future, according to the UN’s scenario, the growing population will reach 9.5 billion people in 2050 FAO, 2018a which must be fed while adapting to a context of increasing devastation: climate change, collapse of biodiversity, reduction of resources soil, fresh water, phosphorus. Agriculture nowadays must accelerate changes to implement production systems that are more respectful of animal welfare and reduce its impact on the environment reduction of the use of inputs such as fertilisers, pesticides, sustainable use of natural resources such as soil, water, reduction of greenhouse gas emissions and contribute to the preservation of biodiversity Bellon Maurel, Brossard, Garcia, Mitton, Termier, 2022.Although agricultural production is currently suffcient to feed the world, 821 million people still suer from hunger, and processes such as rapid urbanization have important implications for food production and consumption patterns FAO, 2018b. The agri-food sector is still critical for livelihoods and employment, as there are more than 570 million small farms worldwide, and agriculture and food production make up 28% of the total global workforce Lovder, Skoet, Ranei, 2016. Therefore, achieving the UN Sustainable Development Goal of ‘a world without hunger’ by 2030 will require more productive, efficient, sustainable, inclusive and resilient food systems, and this will require transformation of the current agricultural and food system Trendov, Varas, Zeng, 2019. In order to feed everyone without compromising the entire ecosystem and achieve food security, it is urgent to intervene by redesigning an efficient and sustainable food production system Stankov & Roganović, 2022. Rolandi, Brunori, Bacco, Scotti, 2021. Nowadays many rural communities are faced with numerous problems. They have difficulty in reaching markets, there is a lack of public and health services, and depopulation is present which negatively affects sustainable food production. Bearing in mind these challenges implementation of digitalization in agriculture can contribute to both agriculture through efficient use of resources and rural communities through the establishment of new services OECD, 2019; WEF, 2018. Also, implementation of digitalization in agriculture can contribute to achieving the UN Sustainable Development Goals SDGs in rural areas, such as “no poverty”, “zero hunger”, and “climate action” FAO, 2018a; Campbell, Hansen, Rioux, Stirling, Twomlow, Wollenberg, 2018; Pantić et al., 2022. Sustainable food production system is crucial for achieving food security, especially nowadays in crisis situations. The Republic of Serbia has very favorable conditions for the development of various types of agricultural production, and in terms of the volume and structure of available agricultural land, 0.7 hectares of agricultural land, i.e. 0.46 hectares of arable land per person Ministry of Agriculture, Forestry and Water Management of Serbia, 2014. There are a large number of small family farms which are of great importance. However, small family farms don’t have adequate support from the state. The size of farm is crucial for the efficiency of operations in agriculture, so with unfavorable size of farms it is hard to be competitive in the market and in terms of increased competition Munćan, Todorović, Munćan, 2014. In the Republic of Serbia, small farms with fragmented land have high production costs and ineffcient use of resources. Also, farms in Serbia have a low level of technical and technological equipment, small number of livestock per unit of agricultural.

**AGRICULTURE AND DIGITAL TECHNOLOGY TO CONTRIBUTE TO THE TRANSITION TO SUSTAINABLE AGRICULTURE AND FOOD SYSTEMS**

***Véronique Bellon Maurel, Ludovic Brossard***

**ABSTRACT:**

Today, a series of global changes are placing the agri-food system under strain. On the one hand, the growing population (9.5 billion people in 2050 according to the UN’s median scenario) with a changing diet (as in China for example), must be fed while adapting to a context of increasing devastation: climate change, collapse of biodiversity, reduction of resources (soil, fresh water, phosphorus). On the other hand, agriculture must accelerate changes to implement livestock production systems that are more respectful of animal welfare and reduce its impact on the environment (reduction of the use of inputs such as antimicrobials, fertilisers, pesticides, reasoned use of natural resources such as water, reduction of soil compaction and greenhouse gas emissions, better use of biological regulations) and contribute to CO2 storage3 and the preservation of biodiversity.

**INTRODUCTION:**

All over the world, food systems, i.e. “the ways in which humans organise themselves, in space and time, to obtain and consume their food” (Malassis, 1994) are undergoing profound changes caused by external pressures (climate change, value chain organisation, etc.) and intrinsic factors (innovation, reduc-tion in the number of farmers, etc.). Consumption patterns are changing under the pressure of ﬁve types of factors: (i) demographic and lifestyle factors, (ii) economic factors, (iii) cultural and value factors, (iv) technological factors and (v) regulatory factors (Blezat consulting et al., 2017). At a worldwide level, “the primary concern about the future of food and agriculture is knowing whether these systems will be able to feed everyone sustainably and eﬃciently by 2050 and beyond, while meeting the additional demand for agricultural products due to non-food uses” (FAO, 2018a). But while food security is the primary concern at the global level, agroecology,11 and particularly its large-scale deployment – including small farms – are also highlighted by the FAO (FAO, 2018b). Preserving family farming and lively rural structures is instrumental to the attractiveness of agricultural professions, another issue found worldwide. In France, agriculture is turning to the agroecological transition to increase its resilience (adapting to climate change), reduce its environmental impact (fewer pesticides, antibiotics, fertilisers, etc.), respect animal welfare and ensure a decent income for farmers.In parallel to these major changes in food production and consumption patterns, another phenomenon is emerging in food systems, as in all sectors of the economy: the deployment of digital technology oﬀering “versatile technology that is transforming processes and life in all areas across the planet” (Scholz et al., 2018). This is known as digital agriculture.

**ONTOLOGIES FOR THE INTERNET OF THINGS**

***PictureSara ,HachemPictureThiago, TeixeiraPictureValérie Issarny***

**ABSTRACT:**

Challenges the Internet of Things (IoT) is facing are directly inherited from today's Internet. However, they are amplified by the anticipated large scale deployments of devices and services, information flow and direct user involvment in the IoT. Challenges are many and we focus on addressing those related to scalability, heterogeneity of IoT components, and the highly dynamic and unknown nature of the network topology. In this paper, we give an overview of a service-oriented middleware solution that addresses those challenges using semantic technologies to provide interoperability and flexibility. We especially focus on modeling a set of ontologies that describe devices and their functionalities and thoroughly model the domain of physics. The physics domain is indeed at the core of the IoT, as it allows the approximation and estimation of functionalities usually provided by things. Those functionalities will be deployed as services on appropriate devices through our middleware.

**INTRODUCTION:**

In the realm of Internet of Things (IoT), the intersection of device functionalities and the principles of physics forms the cornerstone of innovation and development. Our project is dedicated to crafting a comprehensive set of ontologies that intricately describe devices and their functionalities while deeply modeling the domain of physics. This approach not only fosters interoperability among diverse IoT ecosystems but also nurtures flexibility in deploying services on appropriate devices through our middleware.Understanding the Physics Domain. Physics serves as the bedrock upon which IoT functionalities are built. It enables the approximation and estimation of various functionalities typically provided by IoT devices. By delving into the domain of physics, we aim to capture the essence of how devices interact with their environment, perceive data, and execute tasks. From basic principles like motion and energy to complex phenomena such as electromagnetism and quantum mechanics, our ontologies strive to encapsulate the entirety of physical laws relevant to IoT applications. Modeling Devices and Functionalities. Devices in the IoT landscape come in myriad forms, ranging from simple sensors to sophisticated actuators. Each device possesses unique functionalities tailored to specific use cases. Our ontologies meticulously describe these devices, their attributes, capabilities, and interactions. By leveraging ontological modeling, we ensure a standardized representation of devices across heterogeneous IoT environments, fostering seamless integration and interoperability.

**ENABLING CYBER-PHYSICAL SYSTEMS WITH MACHINE-TO-MACHINE TECHNOLOGIES**

***JiafuWan,Hehua Yan, Qiang Liu***

**ABSTRACT:**

In recent years, Cyber-Physical Systems CPS has emerged as a promising direction to enrich the interactions between physical and virtual worlds. While Machine-to-Machine M2M, Wireless Sensor Networks WSNs and CPS are quite similar in many networking aspects, there are still some major differences. In this paper, we first review several concepts and terms, including M2M, WSNs, CPS and Internet of Things IoT. Then, we conduct a case study exemplified by home M2M networks, and outline the further research proposals of M2M communications. On this basis, a case of CPS, Human-Cyber-Physical System HCPS to achieve system safety and efficiency for connected vehicles, is proposed, and the research proposals and challenges for HCPS are summarised. Finally, we carry out a comparison of M2M and CPS to demonstrate how M2M systems with the capabilities of decision-making and real-time control can be upgraded to CPS.

**INTRODUCTION:**

In the realm of connected vehicles, ensuring both system safety and efficiency is paramount for the seamless integration of smart transportation systems into our daily lives. To address this challenge, a proposed approach involves the utilization of Human-Cyber-Physical Systems (HCPS). HCPS integrates human users, computational elements, and physical components into a unified system, enabling enhanced decision-making, real-time control, and adaptive behaviors. Research Proposals for HCPS in Connected Vehicles. Integration of Human Factors: Investigate the role of human drivers within HCPS, considering factors such as cognition, behavior, and trust in autonomous functionalities. Dynamic Risk Assessment: Develop algorithms and models for real-time risk assessment, incorporating data from vehicle sensors, environmental factors, and traffic conditions to enhance system safety. Adaptive Control Strategies: Design adaptive control mechanisms that optimize vehicle operations based on real-time feedback, traffic patterns, and user preferences to improve efficiency and reduce congestion. Cybersecurity Measures: Implement robust cybersecurity protocols to safeguard HCPS-enabled vehicles from cyber threats and ensure data integrity and privacy. Human-Machine Interface (HMI) Design: Explore intuitive HMI designs that facilitate seamless interaction between drivers and HCPS functionalities, promoting user acceptance and trust.