"PRECISION AGRICULTURE" AND THE NEW EUROPEAN STRATEGIC VALUE CHAINS FRAMEWORK

[1] **Prof. Dr. Irina Tsakova**, [1] **Assoc. Prof. Dr. Daniela Ventsislavova Georgieva**, [1] **Milena Mitkova**, **PhD Student**, [1), 2)] **Prof. Dr. Teodora Georgieva**
[1)] International Business School
[2)] Sofia University „St. Kliment Ohridski"

Abstract. This report focuses on "precision agriculture" as one of the possibilities to overcome the critical factors and challenges along the supply chains for agricultural and food products or the so called "periphery capacity". It outlines the national priorities for support and development of precision agriculture. Based on a summary overview of the European strategic and statutory documents, it presents the main aspects of the regulatory framework associated with the processes of climate neutrality, autonomy and circular nature of the European economy. It describes the main challenges of the "Twin Transition" and its impact on the agricultural sector as part of the key value chains. In the context of the European regulatory approach based on the interaction between regulatory mechanisms and self-regulation (including through the creation of codes of conduct and best practice sharing), it lists the legislative measures taken to encourage the shortening of the supply chain as one of the key European strategic priorities. In this regard, it discusses the matters related to the legal protection against unfair trade practices in the relations between economic subjects in the supply chain of agricultural and food products as well as examples of self-regulation in the sector such as the voluntary Supply Chain Initiative. The main conclusion is that the need for innovation in precision agriculture is related directly to the active participation of both farmers and the entire supply chain in the development of these technologies. The report gives the results of research of the literature on the development and potential of "precision agriculture" in China and the results of an in-depth study among representatives of the sector aiming to compare the current situation, the motivation and the barriers to the development of precision agriculture in Bulgaria as well as the interrelation of this process and the participation of Bulgarian farmers in value chains.

Keywords: value chain; precision agriculture; innovation potential; agriculture

JEL: K32, Q12, Q16

Introduction

The new economic reality resulting from the consequences of COVID-19 and the war in Ukraine has brought to the fore the strong dependency of Europe on foreign markets. As a result producers and traders are still experiencing difficulties with logistics which also impacts on substantial financial losses and uncertainty. This makes it necessary for the European Union (EU) to focus efforts on the supply chain, respectively value chain, in order to build the autonomy of the European market from other markets and suppliers. In this context, agribusiness in Bulgaria needs to develop its potential of a modern, competitive and dynamic sector of the Bulgarian economy (Petrov, 2021, p. 39). However, the decrease in the share of purchase prices in retail prices in the period 2007-2018 results in inefficiency in the value chain in the sector while, at the same, it transfers revenues from the increased prices to the benefit of processors and traders (Institute of Agrarian Economics, 2020). The **main goal** of this study is to examine the impact of the new

European strategic framework in the area of value chains on the innovation potential in the agrarian sector. The study focuses on the transformative impact of digital technologies which outline the contemporary challenges and possibilities for the sector as encompassed by the concept of "precision agriculture". The **research methods** employed are based on the logical, deductive and comparative methods as well as the methods of analysis and synthesis. Individual, in-depth unstructured interviews with agricultural producers in Bulgaria were carried out for the purposes of the empirical study.

For the purposes of the set goal and sub-goals, the following **research tasks** are identified:

• To carry out a synthesized review of the European strategic and regulatory acts in the agrarian sector in order to identify the main points of the regulatory framework accompanying the processes of climate neutrality, autonomy and circularity of the European economy.

• To carry out an overview of the regulatory framework in order to outline the legislative measures taken to promote the shortening of the supply chain in the area of products such as: food, water, and nutrients, cited as one of the main European strategic priorities.

• To consider issues of legal protection against unfair trading practices in relations between economic entities in the supply chain of agricultural and food products, as well as examples of self-regulation in the sector.

• To analyze „precision agriculture" as one of the possibilities to overcome the critical factors and challenges within the supply chains of agricultural and food products or the so-called „peripheral capacity" in order to outline the national priorities to support and develop precision agriculture.

• To present results of a literature review on the development and potential of „precision agriculture" in China.

• To present and discuss the results of an in-depth study conducted among Bulgarian farmers. The empirical study aims to outline the current conditions, motivation and obstacles for the development of precision agriculture in Bulgaria and the dependence of this process on the participation of Bulgarian agricultural producers in GVC.

The main **hypothesis of the author** is that the Bulgarian agricultural producers do not see any "need" to invest in precision agriculture which is a direct result of numerous interrelated barriers, including the lack of awareness, competences and financial resources. In essence, this could lead to a delay in the process of effective use of precision agriculture by agricultural producers in Bulgaria. **The results** support the literature by presenting more data on „precision agriculture" in Bulgaria as one of the possibilities to overcome the critical factors and challenges within the supply chains of agricultural and food products.

1. Introduction to the topic

As early as 2015, the European Commission noted that the EU trade policy needs to strengthen Europe's position in the global supply chains (EC, 2015, Trade for All). The responsible

management of the global supply chains is essential to aligning the trade policy to the European values and the EU is undertaking diverse initiatives on specific matters, including:

- Initiative in relation to mineral resources from conflict-affected areas;
- Regulations on illegal logging;
- Criteria for biofuel sustainability;
- Business reporting on matters related to supply chains;
- Corporate transparency in payments which extractive and logging companies make to the benefit of governments, etc. (EC, 2014)

In this regard, essential is the availability of clear international rules for corporate social responsibility (CSR) within global value chains. The reason for this is that voluntary corporate social responsibility may result in unfair competition for suppliers which have taken the decision to observe the international labour and environmental standards and, in itself, it is not sufficient to ensure that companies comply fully with the international standards and obligations by implementing a policy of due review. The EC lists several additional factors which are decisive for the development of the global supply chains in the context of the participation of European businesses in them. The growing integration of services in the global value chains will require agreements in support of the digital economy, including free movement of data. Furthermore, production in the global value chain (GVC) is carried out in different jurisdictions with different degrees of protection of human rights and implementation of the legislation in the area of social and labour matters and the environment. This brings to the fore the need to reform the mechanism to settle disputes between investors and States, in particular through the development of a multilateral system of courts.

An essential factor in this process is the observance of the food safety standards for goods allowed freely in the European market which is also related to the creation of clearer rules of origin (ROO) to achieve greater transparency and accountability in supply chains. The next factor which can be identified is the fragmentation of production networks, the vague distinction between import and export because imported raw materials make up a significant part of the export while tariffs pile up with every cross-border trade of the intermediate products. This makes it necessary to introduce harmonised and more efficient customs procedures in Europe and outside which will contribute to facilitating trade and fulfilling the respective requirements while, at the same time, they will contribute to preventing counterfeiting and the influx of illegal, dumping and fake goods in the common market of the EU which undermines economic growth and poses a serious risk for consumers in the EU. A decisive factor for the effective follow-up integration in the global value chains is also the protection and application of intellectual property rights (IPR) (EC, 2015, Trade for All)

The challenges and factors outlined entail the view of the European strategic and legislative policy as a “smart mix of regulatory and voluntary action, which has led to some positive results in the last few years and has enabled businesses to find their own dynamic and innovative measures.” (EPR, 2017) “Information sharing and the exchange of best practices may contribute

to increasing the efficiency of private and public value chain initiatives and achieve positive results." (EPR, 2017). In this regard, the European Economic and Social Committee recommends the introduction of codes of conduct for the internationalised segments of the European product or service value chain, as is the case of sustainable food, many of which remain beyond legal governance. (EESC, 2019a) "There is an opportunity to link global value chains with the local economic fabric, fostering the development of local economies, together with disruptive technologies (block chain, 3D printers, robotics, the internet of Things, energy storage, renewable energy, big data, genetic biology, nanotechnology, etc.), with an inclusive focus: they can also pave the way for local production with lower-cost inputs, especially if the prosumer profile is adopted (and well-regulated), promoting the development of productive and inclusive micro-businesses, in complementarity with the major global value chains." (EESC, 2019a).

It is obvious that the map of the global value chains will be "redrawn" which is a process premised on a number of factors. The trends at the conceptual and strategic levels are becoming clearer and it is a matter of time for the rates of actual restructuring of the economies to pick up speed. This requires particular flexibility of the participants in the process and ability for a fast adaptation. The functional dependency of the businesses connected in global supply chains addresses directly the matter of applying innovative approaches which have an impact on the entire supply chain implementing the overall innovation potential which guarantees its sustainability as well as the competitiveness of its participants. At the same time, there is still an open question as to the need of legislative interventions to activate and encourage the shortening of the supply chain in the agricultural sector.

2. The "twin transition" and its impact on value chains in the agricultural sector

Europe's strategy of new sustainable growth is premised on the European Green Deal which outlines the principles and guidelines for the development of the European economy, a process seen as a "transition to a modern, climate-neutral, highly resource-efficient and competitive industrial base in the EU by 2050 at the latest."(EPR, 2020). This fundamental document is complemented by the Commission Strategy to build the digital future of Europe. (EC, 2020a) "Digital communication, social media interaction, e-commerce, and digital enterprises are steadily transforming our world. They are generating an ever-increasing amount of data, which, if pooled and used, can lead to a completely new means and levels of value creation". These two documents outline the EU plan for environmental and digital transformation (the so called "twin transition") of the economy. In a communication of 10 March 2020, the Commission notes that this twin transition "will affect every part of our economy, society and industry. They will require new technologies, with investment and innovation to match. They will create new products, services, markets and business models. They will shape new types of jobs that do not yet exist which need skills that we do not yet have." This entails, in line with the European Green Deal, an immediate change of direction towards finding more sustainable solutions allowing for effective use of resources, supporting the circular economy and being climate-neutral (EC, 2020b).

The opinion of the European Economic and Social Committee on the strategic developments in industrial policy by 2030 (EESC, 2019b) notes that a fair transition towards a more sustainable industry towards 2050 (Reference from the text cited: See SC/047 OJ C 81 of 2.3.2018, p. 44.) requires Europe to face the following challenges:

- Continued climate change and deteriorating environmental conditions;
- The depletion of the earth's natural resources and biodiversity loss;
- The digitalisation of most industrial sectors will blur the borders between industries and between physical and the virtual world, open sectors to new entrants with a reduction of manual work as a consequence;
- Social inequalities, including growing polarisation on labour markets and youth unemployment, people left behind in regions with declining industries;
- Public loss of trust in government, the political establishment, and the EU and its governance structures, as well as other institutions;
- Demographic changes: ageing, migration, strong growth of the world population and new environmental awareness;
- Concentration of the population in megacities, with integration of infrastructure networks, artificial intelligence, machine and deep learning;
- Shift in consumer preferences (changing consumer behaviour, more environmental awareness, regulation of consumer behaviour by public authorities).

What is essential in this opinion is the stance of the Committee that if the EU policies in the area of climate and the environment aim to create jobs in Europe, it is crucial that the key parts of the value chain enabling those policies be located in Europe. Therefore, it is important that the EU Strategy recognises the importance of value chains and addresses ambitious measures to develop these further. The new industrial strategy supports the identification by the Commission of 14 ecosystems and the inclusive approach uniting all participants operating in a value chain in order to encourage the Europe's leading role in the strategic sectors and competitiveness globally.

The Annual Single Market Report 2021 (ASMR, 2021) notes that industrial ecosystems encompass all players involved in the achievement of a certain socio-economic goal: from the smallest start-ups and the largest companies cooperating to satisfy a new market need, the research activities supporting industrial innovation, the regulators steering economic activity through conducive policies, to the services providers and suppliers. This understanding of the essence of industrial ecosystems is replicated in a Commission Communication on the New Industrial Strategy for Europe. "Industrial ecosystems encompass all players operating in a value chain: from the smallest start-ups to the largest companies, from academia to research, service providers to suppliers. And they each have their own features." (EC, 2020c). The Report highlights that 14 industrial ecosystems spanning across the EU have been identified based on their economic and technological relevance, and for their expected contribution to the decarbonisation, digitalisation and resilience of the EU economy. They represent approximately 70% of the EU economy and

80% of the business economy (as a share of value added). These ecosystems are:

1. Aerospace and Defence;
2. Agri-food;
3. Construction;
4. Cultural and Creative Industries;
5. Digital;
6. Electronics;
7. Energy Intensive Industries;
8. Energy-Renewables;
9. Health;
10. Mobility-Transport-Automotive;
11. Proximity, Social Economy and Civil Security;
12. Retail;
13. Textiles;
14. Tourism.

It is important to emphasise that the individual ecosystems are not considered separately but in their interrelation.

3. The agricultural sector as part of the key value chains

According to the new Circular Economy Action Plan adopted through a European Parliament Resolution of 10 February 2021 (EPR,2021), the principles of circular economy should be the core elements of any European and national industrial policy, and of the national Recovery and Resilience Plans of Member States in the framework of the Recovery and Resilience Facility (The resolution refers to the Commission Communication of 11 March 2020 entitled "A new Circular Economy Action Plan: For a cleaner and more competitive Europe" (COM(2020)0098) and the staff working document "Leading the way to a global circular economy: state of play and outlook" (SWD(2020)0100); it also refers to the United Nations 2030 Agenda for Sustainable Development and to the Sustainable Development Goals (SDGs), including SDG 12 "Responsible consumption and production" and SDG 15 "Life on land").

The plan defines 7 key product value chains which will be directly affected by the circular economy; two of them are relevant to this study:

1. Key product value chains: packaging

The European Parliament insists that the Commission should present a legislative proposal without delay, including waste reduction measures and targets to reduce excessive packaging,

including in e-commerce, improve recyclability and minimise the complexity of packaging, increase recycled content, phase out hazardous and harmful substances, and promote reuse. The main goal is for all packaging to be reused or recycled in an economically viable way by 2030. To this end, the Commission is called on to analyse various types of packaging used in e-commerce "to determine best practices in optimising packaging to reduce over-packaging". Attention is also paid to expanding the possibilities for bulk sales to reduce the use of packaging while, at the same time, ensuring food safety and hygiene. The document also focuses on separate collection and sorting of packaging waste in line with Directive (EU) 2018/852 and ensuring its timely transposition by Member States. In this regard, it discusses the option for the "Commission to assess the possibility to revise the identification system for packaging materials (Commission Decision 97/129/EC of 28 January 1997 establishing the identification system for packaging materials pursuant to European Parliament and Council Directive 94/62/EC on packaging and packaging waste (OJ L 50, 20.2.1997, p. 28) to facilitate separate collection for citizens according to the recyclability of packaging."

2. Key product value chains: food, water and nutrients

The document refers to the commitments under the Farm to Fork Strategy (EPR, 2021a) insisting that the Commission should make a legislative proposal to implement the goal of halving food waste by 2030 in line with the commitments under the said Strategy, and based on data reported by Member States in accordance with the Waste Framework Directive. This is related to the inclusion of respective policies on preventing "food loss and food waste along the entire food value chain," taking "measures to close the agricultural nutrient loop, reduce Europe's dependency on imports of vegetable proteins for animal feed and to increase the use of recycled animal manure and other organic nutrients, such as compost and digestate, instead of synthetic fertiliser while ensuring a high level of protection of health and of the environment and ecosystems". It takes into account that the transition to a circular economy is critical to reducing greenhouse gas emissions in the EU and to achieving the EU climate goal by 2030 and the zero greenhouse gas emissions goal not later than 2050 and that there needs to be a fundamental transformation in value chains throughout the economy.

Essential from the point of view of this analysis is the support the Plan expresses for the introduction of digital product passports in order to help companies, consumers and market surveillance authorities to keep track of a product's climate, environmental, social and other impacts throughout the value chain and provide reliable, transparent and easily accessible information about the durability of the product and its maintenance and reuse. In this regard, the Commission should present proposals "to regulate the use of green claims through the establishment of solid and harmonised calculation methods covering the full value chain, based on harmonised indicators and life-cycle assessments such as environmental footprints, including with respect to waste prevention, raw material use, avoidance of harmful substances, durability and longevity of the product as well as design to be repairable and recyclable." In this regard, an emphasis is laid on the need to apply Directive 2005/29/EC (EP, 2005) through proactive measures tackling green claims. The future vision of this key chain is related more to its globalisation with a recommendation for "development of local value chains based on the recycling of bio-waste for the generation of renewable energy, such as biomethane, is supported to create closer links between

rural and urban communities while fully implementing the waste hierarchy."

In the above context, in a resolution of 20 October 2021 on the Farm to Fork Strategy for a fair, healthy and environmentally friendly food system (The Resolution refers to the Commission Communication of 20 May 2020 on a Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system (COM(2020)0381) and the opinion of the European Committee of the Regions of December 2020 on the farm to fork strategy entitled "From farm to fork – the local and regional dimension"), the European Parliament notes the need to "promote transitions to more localised supply chains". The COVID-19 crisis exposed certain deficiencies in the complex food supply chains making evident the need to guarantee long-term food security, sustainability and short supply chains. It envisages "incentives to promote innovative, digital, ecological, regional and sustainable business models for agriculture and artisanal food production, notably through fostering short supply chains such as products with protected geographical indications or designations of origin, respecting single market rules and through approaches including innovative local logistics such as 'green hubs', and the integration of artisanal food production into other services in rural areas such as tourism or gastronomy."

The document also refers to Directive (EU) 2019/633 f the European Parliament and of the Council of 17 April 2019 on unfair trading practices in business-to-business relationships in the agricultural and food supply chain. Its recitals note that, in principle, business risk is inherent in all economic activity, but agricultural production is particularly fraught with uncertainty due to its reliance on biological processes and its exposure to weather conditions. That uncertainty is compounded by the fact that agricultural and food products are to a greater or lesser extent perishable and seasonal. In the current agricultural policy environment that is distinctly more market-oriented than in the past, protection against unfair trading practices has become more important for operators active in the agricultural and food supply chain. In particular, such unfair trading practices are likely to have a negative impact on the living standards of the agricultural community. That impact is understood to be either direct, as it concerns agricultural producers and their organisations as suppliers, or indirect, through a cascading of the consequences of the unfair trading practices occurring in the agricultural and food supply chain in a manner that negatively affects the primary producers in that chain. The number and size of operators vary across the different stages of the agricultural and food supply chain. Differences in bargaining power, which correspond to the economic dependence of the supplier on the buyer, are likely to lead to larger operators imposing unfair trading practices on smaller operators. "Unfair trading practices are particularly harmful for small and medium-sized enterprises (SMEs) in the agricultural and food supply chain. Enterprises larger than SMEs but with an annual turnover not exceeding EUR 350 000 000 should also be protected against unfair trading practices to avoid the costs of such practices being passed on to agricultural producers. The cascading effect on agricultural producers appears to be particularly significant for enterprises with an annual turnover of up to EUR 350 000 000. The protection of intermediary suppliers of agricultural and food products, including processed products, can also serve to avoid the diversion of trade away from agricultural producers and their associations which produce processed products to non-protected suppliers."

The main focus in the two documents referred to is the creation of conditions of transparency and traceability of supply chain to ensure "sustainable supply chains and investments that are free

from adverse environmental impacts including deforestation, forest degradation, ecosystem conversion and degradation and adverse impacts on human rights and governance, to promote good governance and to increase traceability and accountability in global supply chains." Directive (EU) 2019/633 has transposed in the Bulgarian legislation in the Competition Protection Act (Competition Protection Act (promulgated SG, issue 102 of 28 November 2008, latest amendment SG, issue 17 of 26 February 2021). The motivation for the Bill notes that the new Chapter Seven B "Unfair trading practices along the supply chain for agricultural and food products" will combat the consequences of unfair trading practices in the supply chain for agricultural and food products and will protect the interests of economic operators as the weaker party in these supplies. The texts provide for the cases of absolutely prohibited trading practices, conditional prohibitions, scope of the prohibitions for unfair trading practices and exceptions. Together with the statutory means of protection against unfair trading practices in the sector, of importance is the voluntary Food Supply Chain Initiative launched by the private sector.

The Supply Chain Initiative (Official website of the initiative) was set up in 2013 by European associations representing the food and drink industry (FoodDrinkEurope), branded goods manufacturers (AIM), the retail sector (EuroCommerce, ERRT, Independent Retail Europe, Euro Coop), small and medium-sized enterprises (UEAPME), and agricultural traders (CELCAA). The Rules of Governance and Operations of the Initiative lay down that it is a voluntary scheme developed in the context of the European Commission-led High-Level Forum on a Better Functioning Food Supply Chain. Its purpose is to promote good practice in the food supply chain as a basis for fair commercial dealings. It is based on commonly agreed Principles of Good Practice, which companies commit to integrate in their day-to-day operations; a set of process commitments to support their application, dispute resolution options, and the promotion of stakeholder dialogue both at EU and national level.

The Supply Chain Initiative aims to promote good practice among companies in the food supply chain by providing a mechanism to implement and enforce the Principles of Good Practice in Vertical Relationships in the Food Supply Chain. The Initiative is based on a registration system whereby economic operators, including small and medium-sized enterprises, voluntarily commit to implement the Principles of Good Practice (Principles of Good Practice in Vertical Relationships in the Food supply Chain adopted on 29 November 2011 and as they may subsequently be amended) as a basis for their commercial dealings and accept different options for the resolution of disputes. It aims to foster dialogue between the sectors concerned. The Rules apply to food (fresh and processed) and drink products. However, companies which are part of the food and drink chain are encouraged to apply the principles throughout their organisations independently of the nature of the product if similar conditions exist (e.g. similar chain composition, similar product groups, or similar procurement policies).

As the key chain under discussion, it should be noted that the UN's Food and Agriculture Organisation (FAO) (EPR, 2016) estimates that the expected rise in the world's population to 9.1 billion by 2050 will require a 60% increase in food supply and a 24 % increase in crop yields in the developed countries by that date, whilst preserving resources for future generations and preventing food waste and losses, which currently account for over one third of global production. The European Parliament Resolution on enhancing innovation and economic development in future

European farm management (Ibid) points out that the EU is the biggest exporter of agricultural products worldwide "making the agri-food sector a key economic pillar of the Union, employing 47 million people in 15 million downstream enterprises in fields such as food processing, retail and services, and contributing to a positive trade balance of EUR 17 802 million that represents 7.2% of the total value of EU exports". In this context, emphasis is placed on the "untapped potential of technology and innovation for the development of new goods and products (relating to food and feed, machinery, biochemistry, biocontrol etc.) which may have the potential to create employment along the whole agri-food value chain." Attention is drawn to the possibilities to provide incentives for agricultural producers in order to boost the public awareness about the work within the food chain and the new production methods. It is also the belief that new information technologies provide ample opportunities to establish new value chains, which may include more direct contact between producers and consumers, with a stronger focus on innovative products, new services and more production differentiation, with the potential to provide new income streams for farmers as well as establishing a more transparent marketplace that will be of benefit to farmers and extend their potential reach; it is pointed out that innovations in the food supply chain could help to ensure a more even distribution of risks. The document recommends the use of management systems specific to individual farms that measure and evaluate the balance of nutrients at farm level linked to the different chains in the production cycle helping to measure the environmental impact of individual farms and calculate farm-specific nutrient balances. At the same time, it notes that more transparency in the supply chains and in production can help consumers to make more informed choices about the products they are buying; and considers that this, in turn, can help farmers to earn higher revenues from their production.

4. Digitalisation in the agrisector. 2030 Digital Compass (EC, 2021) – a strategic vision of the digitalisation of the European society and economy

Digital economy is related to ensuring the security and sustainability of the digital ecosystem and the supply chains. The impact of digitalisation on supply chains is an additional factor towards digital transformation and accompanies the processes of climate neutrality, autonomy and circularity of the European economy. Along with this, the European strategic documents related to digitalisation emphasise the need to protect and enhance the digital sovereignty in the EU and the leadership in strategic international digital value chains as key elements to guarantee strategic autonomy, global competitiveness and sustainable development. Digital technologies will make the building of "periphery capacity" possible. This will allow for collecting data related to agricultural equipment, agri-data in real time, forecasting crops and farm management as well as optimisation of food supply chains. The document under review outlines five key ecosystems in the context of developing the potential of digital technology and agriculture is identified as a key sector in which digital solutions can help to cut global greenhouse gas emissions and pesticide use. The technological possibilities of artificial intelligence offer a prospect for the development of agriculture and the food supply chain. A European Parliament resolution on the comprehensive industrial policy (EP, 2019) notes the areas of impact of new technologies in the food sector which will result in a "more diverse, resilient, regionally adapted and healthy model for the future."

Artificial intelligence "can play in efforts to help tackle food security issues, predict famine and foodborne-disease outbreaks, reduce food loss and waste and improve sustainable management of land, water and other environmental resources critical to ecosystem health". Artificial intelligence can intervene at critical points along the food system value chain from production to consumption and "enhance our capacity to fundamentally alter the way we produce, process and buy food by better informing land-use planning practices." Furthermore, technology can improve resource management and input efficiency, help reduce post-harvest waste and influence consumption choices. Artificial intelligence in the form of precision farming (The term was coined in a study carried out in 2014 by Policy Department B: Structural and Cohesion Policies – Agriculture and Rural Development entitled "Precision Agriculture: An Opportunity for EU Farmers – Potential Support with the CAP 2014-2020".) holds the potential for disruptive transformation of agricultural production, as well as broader land management, by improving land use planning, predicting land use change and monitoring crop health, while also having the potential to transform the prediction of extreme weather events. Together with this, it can "radically alter the delivery of inputs, pest control and farm management" which, on its part, will influence farming practices and the way insurance products are delivered.

A European Parliament resolution on the technological solutions for sustainable agriculture (EP,2016) notes that "precision farming involves the use of automation and other technologies to improve the precision and efficiency of key agricultural management practices, by using system-based approaches to collect and analyse data and optimise interactions between the weather, soil, water and crops, and that precision farming is ultimately designed to lower pesticide, fertiliser and water use while improving soil fertility and optimising yields". As regards the supply chain, emphasis is laid on the need for innovation in precision agriculture to solve the issues with "high cost" in the development and use of some PA technologies, and for farmers and the whole supply chain to be actively involved in the development of these technologies in order to ensure clear benefits at farm level and to help farms become more resilient. Furthermore, the shortening of the agriculture and food chains could lead to reduced costs for energy resources and benefits for the environment. The strategic direction of the need to "promote the transition to more localised supply chains" is further developed in a later EP Parliament – From Farm to Fork(The resolution refers to Commission Communication of 20 May 2020 on a Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system (COM(2020)0381) and on the Opinion of December 2020 of the European Committee of the Regions on the Farm to Fork Strategy entitled "From Farm to Fork – the Local and Regional Dimension") – which outlines the need to ensure long-term food security, sustainability and short supply chains in order to overcome the weaknesses in the complex food supply chains. An attempt to respond to the challenges is the European Strategy for Data (EPR, 2021b) adopted in 2020 and the proposal for a regulation of the European Parliament and of the Council of 25 November 2020 on European data governance (EP, 2022).

In the field of agriculture, support is envisaged for the creation of a common European agricultural data space taking into account the potential of data for agriculture and of the extensive access to it in order to "increase sustainability, competitiveness and the use of resources across the entire agri-food and forestry chains, contribute to the development of innovative and sustainable

techniques, improve access to relevant information for consumers, and reduce food waste and the sector's ecological footprint."

5. National priorities for the Republic of Bulgaria – precision agriculture

The goal to build precision agriculture enshrined in EU strategic documents is reflected in the National Development Programme BULGARIA 2030 (NDPB 2030) adopted by Protocol No. 67 of the Council of Ministers of 02.12.2020 (The document is based on the vision, goals and priorities of the National Development Programme BULGARIA 2030 approved by Decision No. 33 of the Council of Ministers of 20 January 2020. Three strategic goals are set: accelerated economic development, demographic upswing and reduction of inequalities, the implementation of which is envisaged through targeted policies and interventions, grouped into five interconnected and integrated development axes and 13 national priorities. The Programme consists of detailed strategies for the priorities, an indicative financial framework, a preliminary impact assessment for main macroeconomic indicators based on the implementation of the interventions envisaged, as well as a mechanism for monitoring the implementation of the strategic document), noting that, in the past years, there has been a swift adoption of digital technologies in all sectors of the economy, including in agriculture. Investments for modernisation and technologies for precision agriculture are key to improving the efficiency of production in the sector, boosting its potential for a more environmentally friendly and less resource-intensive production of food and developing the value chain. In this sense, note is made of the importance to apply the Digitalisation Strategy for Agriculture and Rural Areas in the Republic of Bulgaria (Digitalisation Strategy for Agriculture and Rural Areas in the Republic of Bulgaria adopted by Decision No. 247 of the Council of Ministers of 02.05.2019) which sets out the medium-term strategic framework for the policy of digital transformation of agriculture in the country.

NDPB 2030 contains a priority of direct relevance to this analysis (All 13 priorities identified are interrelated directly and have an indirect impact on all other policy areas, including those covered by this study) with three specific areas of impact:

3. Priority 6 (Sustainable agriculture) with five sub-priorities, including:

3.1 Sub-priority 6.1 (Structural and sectoral balance of agriculture) The main focus of the agricultural policy will be the acceleration of restructuring processes in the sector – strengthening small family farms, striking the right balance between plant-growing and animal husbandry and their sub-sectors, the introduction of young people into the agricultural business.

Areas of impact:

- Plant production – The existing imbalance between the different production strands of plant-growing will be addressed through targeted support (linked to the production support, investment and market support) for the development of intensive sub-sectors with higher added value production potential – vegetable production, fruit and wine production, for which the country has favourable conditions for development.

• Economic potential of small agricultural farms – Investment will be encouraged to modernise and deploy innovative solutions, improve their market access, increase the knowledge and professional skills of farmers, and mechanisms for more balanced income support will be implemented.

3.2 Sub-priority 6.3 (Competitiveness of the agricultural sector)

The basis for increasing the competitiveness of agriculture is made up of increased production efficiency, accelerated uptake of innovation, productivity growth, improved marketing and market organisation of supply, finding access to new markets. The improved competitiveness will contribute to increasing the added value of agriculture, create greater resilience of the industry and increase its capacity to respond to environmental and social challenges and commitments.

The following areas of impact are envisaged:

• Modernisation, innovation and digital technologies in farms – Particular focus will be given to interventions aimed at the uptake of innovation and digital solutions, including precision agriculture. The application of modern information and communication technologies in agriculture will increase its potential for more productive, environmentally friendly and less resourced food production. A comprehensive Electronic Information System will be built in agriculture which will allow the electronisation of information flows from and to carry out administrative activity and electronisation of services provided to farmers.

• Market position of farmers – Strengthening farmers' market positions will contribute to a fairer distribution of the added value created along the food chain, allow them to overcome food price volatility crises more easily, reduce the processing industry's dependence on imports of raw materials. Measures are envisaged to encourage the association of farmers, promote vertical integration between producers and processors of agricultural products, shorten food supply chains.

The vision and goals along with the measures to implement them as envisaged in the Programme are complemented by

The Digitalisation Strategy for Agriculture and Rural Areas in the Republic of Bulgaria adopted by Decision No. 247 of the Council of Ministers of 02.05.2019 sets out the following areas of impact:

1. Building and development of appropriate digital infrastructure for communication and connectivity;

2. Investment for modernisation and technology for precious agriculture;

3. Development of digital networks and use of software applications in work management and decision making;

4. Training and advice to develop digital skills and qualifications;

5. Research activities and innovation, partnership for innovation exchange and transfer development of experiment infrastructure and access to it;

6. Development of the digitalisation of public administration and administrative services in the Agriculture sector;

7. Use of Blockchain in the Agriculture sector;

8. Smart Villages;

9. Data processing, sharing and protection.

Some of the measures laid down in the Action Plan are investments for modernisation and technologies for precision agriculture, development of digital networks and use of software applications in work management and decision making, research activities and innovation, partnership for innovation exchange and transfer, development of the experiment infrastructure and access to it, and others.

An essential measure is the envisaged continuing of work to strengthen and develop the work of the existing digital innovation hubs in agriculture which, as innovative ecosystems, are capable of providing a full set of services adjusted to the actual needs of the respective stakeholder hub participant:

1. Project development;

2. Skills and education;

3. Access to finance;

4. Incubator/accelerator support;

5. Testing and validation;

6. Provision of technical infrastructure;

7. Contract research;

8. Strategic R&D;

9. Lobbying;

10. Ecosystem learning;

11. Strategy Development;

12. Community building.

The building of a Blockchain platform in the Agriculture sector is another essential measure laid down in the document. It notes that "at a certain stage of the development of the digitalisation of Bulgarian agriculture, the Ministry of Agriculture, Food and Forests will encompass a sufficient number of processes and data to be able to track yields in real time. The Ministry needs to elaborate a gradual plan to lead to the successful use of a Blockchain platform in agriculture."

6. Precision agriculture in China – factors and barriers to its implementation

In 2021, the market values of precision agriculture in China registered an increase of close to 43% in comparison to 2017 and it is expected that this positive trend will continue in the coming years (Global data). Statutory documents are adopted at the national level along with initiatives in support of modernisation and development of artificial intelligence and application of smart solutions to process agricultural products, agricultural green smart supply chains and other integrated digital applications (Artificial Intelligence Strategy of China). Farmers in China are mainly small family farms applying traditional productions methods. Farmland is fragmented (Kendall et al., 2022) and there has been an increase in the number of farmers working part-time together with an increase in labour costs (Zhang et al., 2017). In this regard, studies in the field find that, regardless of the measures to promote the use of precision agriculture in the country adopted and applied by the Chinese Government, it is considered inappropriate and unnecessary by small-sized producers (Kendall et al., 2017). As a result, the implementation of precision agriculture in China is still low (Wenjing et al., 2020) which is also impacted by the poor interest of producers from small and medium-sized farms to apply this type of agriculture (Kendall et al., 2017). A factor acting as an incentive for the use of precision agriculture technologies in China is the participation of producers in physical demonstrations. Still, Wenjing L. Et al. (2020) find that, after a certain period of implementation of precision agriculture technologies, a large part of the farmers in provinces in China stop using them. The main reasons for this given include financial restrictions, difficulties in finding support for the implementation of the technologies and impossibility to conclude contracts with suitable suppliers. In addition, the question about profitability when using precision agriculture remains open. Even though studies in the field are indicative of a positive return on investment, it is still small and insignificant in amount for the farmers (Schimmelpfennig, 2016). Additional barriers to the application of precision agriculture in China are:

- lack of producers' competences to use the technologies;
- lack of sufficient information presented in a suitable way to the producers about the essence of precision agriculture, precision food management and crop management;
- small share of farmers who use computers and/or smart phones or GPS systems in comparison to those using traditional low-technology methods;
- producers take primarily short-term decisions based on the uncertainty of the environment and the impact of external economic and political factors while the use of precision agriculture has a return mainly in the long term;
- small size of farmland and poor adjustment of technology for small farms;
- unwillingness of the owners of farmland which is not cultivated to lease it to potential farmers and the turning of such land into forests by their owners;
- existence of financial risks believed to be untenable by small farmers;
- lack of understanding about the benefits for nature from the application of precision agriculture;
- restrictions for the agricultural producers who may apply for state funding to implement precision agriculture technology;

- concerns of farmers as to the durability and maintenance of the technologies (battery useful life, chemical storage capacity, necessary resources for repairs, etc.);
- land reforms in China;
- inappropriate market segmentation based on the features and behavioural profile of the farmers in the different provinces in China;
- farmers' age as well as lack of workforce as a result of the population's internal migration to large cities.

A study by Kendall et al. (2022) presents the view that Chinese farmers (small family producers) are "open" to the adoption and implementation of precision agriculture technologies. However, the barriers indicated have a negative impact on the dissemination and sustainable use of technologies. Based on the idea that the more informed a person is the greater the chance of taking an informed management decision is, it can be assume that an essential factor to the implementation of precision agriculture technology is the level of awareness about the benefits (economic and environmental) and the possibilities for financial security of the technology. In China, such information is usually obtained through the use of mobile phone platforms (WeChat), through word of mouth in rural communities, from the internet. At the same time, encouragement is given for the use of formal and informal educational mechanisms to improve the dialogue with end users (Kendall et al., 2022). Still, it is considered that Chinese farmers have limited information about precision agriculture and the application of technologies related to it (Bornwell & Xianbao, 2021, p. 80).

7. Research about the awareness of farmers in Bulgaria in relation to precision agriculture

In-depth interviews were carried out in order to identify the recognisability of precision agriculture among Bulgarian producers. The goal is to identify the attitude of the interviewees to the implementation of new technologies and potential barriers in this area.

A total of 10 in-depth interviews were held in the period August-September 2022. The target group encompasses agricultural producers (individuals) whose farms are family ones – micro (have areas from 0.5 to 1 ha at their disposal), small (have areas from 1 to 5 ha at their disposal) and medium-sized (have areas from 5 to 30 ha at their disposal). The interviews were conducted by telephone with an average duration of 30 minutes, and the interviewees were mostly male and aged between 22 and 45 years. Half of the interviewees have higher education in an area other than agriculture while the other half have completed secondary education. All respondents offer their produce nationally and regionally.

Half of the interviews state that they are familiar with the term "precision agriculture." Only one farmer uses GPS and drones provided by an external company to check the soil. It is noteworthy that the producer who indicated that he uses GPS and drones defends the thesis that the main reason for not using precision agriculture technologies is the lack of trust in them and the use of traditional production methods. In addition, the interviewees say that they do not use digital tools in their work and, if necessary, they resort to an external supply for a given service. The majority of the agricultural producers taking part in the survey are of the opinion that the

investments in precision agriculture technology are too big, do not have the expected return and are suitable for farms of large sizes mainly.

In order to determine the attitude of the interviewees to new technologies and innovations, and hence to the sustainable use of precision agriculture, a question was asked related to whether they implemented new or improved processes, products, services or management organizations for the purpose of economic development of production, cost reduction and optimization of activity (see table 1). As a result of the answers received, it can be assumed that manufacturers do not prioritize innovations in their activity, considering them as „unprofitable". Due to financial constraints, some small farms do not have devices for measuring nitrates. In this context, the farmers consider as a main priority „more farmers' markets to be organized so farmers can sell their production". In addition, the interviewees indicate that they do not use digital tools in their activities, as they are using an external provider for digital services if necessary. As the main reasons for the non-use of this type of technology, barriers of a primarily financial nature can be cited, as well as the vision of individuals that this is not applicable for farms of such small sizes. The considerations regarding the use of alternative sources of electricity by individuals are also of the same type. Although the desire of one of the interviewees to implement technologies for alternative electricity is shared, problematic aspects are reported in the frequent power outages and insufficiently developed infrastructure in places.

Table 1: Responses of interviewed farmers to some of the asked questions

Theme	***Answers***	***Stated reason***
Innovation implementation	No	„We are small producers and there is no technical need, as it is expensive"
	Yes	„It was necessary to innovate in the process of packaging and shipping to the end customer"
	No	„It is unprofitable for such small areas to implement anything, all machines and equipment are for rent"
	No	„We are expecting funding"
Sources of agricultural information and news	Internet and the Fair in Plovdiv	N/A
	Internet	N/A
	„Internet and especially exhibitions abroad and in Bulgaria (organized by manufacturers), for example in Hanover there are good exhibitions"	N/A
	Television (Agro TV) and Internet	„There are no local markets, which limits the possibility of exchanging information"
	None	N/A

Applied digital solutions	None	N/A
	None	„We use an external company to test the soil“
	None	„We only use an irrigation system“
Use of alternative energy sources	No	„It is technically impossible in our area for example to use solar panels, besides it is expensive because we have almost no electricity, we are far from a substation“
	No	„We don‘t use electricity“
	No	„But we have desires to have as soon as possible“
	No	„It is too expensive“
Risks and benefits of precision agriculture	Not applicable to small producers	„It is too expensive and not so much affective“
	There is no point in investing in such technologies	„It is unprofitable and has no significant benefits“
	Distrust of results and benefits	„The farmer is used to working in an old-fashioned matter. Not that it is expensive or inefficient, he just doesn‘t trust such technologies. We do no-till production, but farmers don‘t trust it“
	Not worth the investment	„This is for larger arrays. It is too expensive and there is no point in it“

Source: Based on the results of individual interviews, N=10

The main reasons given not to use precision agriculture technology include:

- lack of sufficient knowledge and trust in new technology;
- financial restrictions;
- small size of farms.

The concerns related to the use of alternative electricity sources are of the same type. An additional barrier proves to be the insufficiently developed infrastructure and, as a result, the frequent power losses.

In order to determine the main communication channels that can be used to disseminate information about precision agriculture, a question was asked about where they get the data they need to carry out their activities. For the most part, the people participating in the survey indicated the Internet and their participation in national and international fairs and exhibitions. As a weak point in the dissemination of information, it is indicated that local markets are not organized at the local level to support direct access to customers, and from there to identify the needs of end users, as a factor motivating the need to implement innovations and new technologies (see table 1).

8. Discussion

A priority of the Bulgarian agricultural producers is the fast selling of the produce. As a result, their management decisions are mainly short-term and in the context of the frequent economic and political changes. It is also important that, in the past years, climate change has exerted a significant impact on productivity, placing the farmers in conditions of greater uncertainty. Even though the sample is not representative for Bulgaria, it can be assumed that precision agriculture is not sufficiently familiar to the public and, hence, the attitude to it is mainly negative. Producers who, in essence, apply new technologies are more likely to implement precision agriculture in their work as well. Such a situation was also established with respect to the Chinese producers.

The primary barriers for the Bulgarian agricultural producers, also reported in the studies related to China, are mainly financial in nature. The lack of a clear vision as to the possible profitability in practice has a demotivating effect with respect to a producer's decision to buy appropriate technology. Another factor with an impact influencing the non-use of precision agriculture both for Bulgarian and for Chinese farmers is the idea that it is meant for large farms mainly.

9. Conclusion

The main advantages of using precision agriculture technologies are both economic (based on reducing costs in agriculture and increasing productivity through targeted management of variables in fields and among animals) and environmental (accurate use of manure, pesticides and antimicrobial means). The Government has a fundamental role to stimulate the use of precision agriculture through boosting the awareness of the benefits of precision agriculture, applying appropriate tax incentives and possibilities to finance the implementation of high-technology solutions and others. In parallel, representatives of government institutions and the non-governmental sector need to conduct information campaigns focusing on the long-term benefits of implementing precision agriculture.

Potential barriers related to the lack of competences in the area can be overcome with training, development of simplified yet effective training and information mobile applications, and development of appropriate educational disciplines in secondary schools and universities. It is also necessary to adapt the precision agriculture technologies to the needs of small and medium-sized farms and agricultural producers. In addition, the functional dependency of the undertakings connected in global supply chains is related directly to the question of applying innovative approaches impacting the entire global supply chain utilising the overall innovation potential which will guarantee its stability and the competitiveness of its participants.

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Prof. Dr. Irina Tsakova
International Business School
Botevgrad, Bulgaria
E-mail: itsakova@ibsedu.bg

Assoc. Prof. Dr. Daniela Ventsislavova Georgieva
ORCID Id: 0000-0002-5752-0344
Web of Science Researcher ID: ABD-6628-2021
Scopus Number: 57194270351
International Business School
Botevgrad, Bulgaria
E-mail: dgeorgieva@ibsedu.bg

Milena Mitkova, PhD student
International Business School
Botevgrad, Bulgaria
E-mail: bgaccountant.mail@abv.bg

Prof. Dr. Teodora Georgieva
International Business School
Botevgrad, Bulgaria
Sofia University „St. Kliment Ohridski“
Faculty of Economics & Business Administration
Sofia, Bulgaria
E-mail: tgeorgieva@ibsedu.bg