# POLISH AGRICULTURE ON THE ROAD TO SUSTAINABLE AGRICULTURE

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European Union (EU) agriculture produces food in sufficient quantity and quality, ensuring food security for EU citizens. Financial support mechanisms under the Common Agricultural Policy (CAP) guarantee affordability for consumers and decent incomes for farmers. In 2019. The European Green Deal (EGD) emphasized the importance of agriculture in climate protection. It set a new direction for change, putting EU farms at the center of sustainable food production. All this meant that existing agricultural practices in the EU allowed for high productivity, but also gave space for sustainable practices. The new financial support mechanisms under the CAP for 2023-2027 have focused on financing agricultural practices that protect the environment. The main purpose of the article is to discuss the future directions of agriculture in EU countries. Based on data on the agricultural sector in Poland, it is shown that an important direction of agricultural development is the digitization of farms and villages, which is a prerequisite for the introduction of precision farming practices. On the one hand, this allows to increase yields and reduce the consumption of natural resources, and in the long run increases productivity in agriculture. On the other hand, it facilitates the implementation of ESG reporting.

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### 1 Introduction

EU farm practices ensure the food security of its citizens and the high position of EU agricultural products in the world (Knudsen, A.S.L., 2011). However, the observed global climate change, environmental degradation and loss of biodiversity are shedding new light on the actions taken by international institutions (EC., 2019a; UN., 2015), which are now prioritizing sustainable practices. The idea of sustainable agriculture is not a new concept in agricultural economics. However, acceptance of the fact that natural resources used for food production are limited now requires more focus. In EU countries, agricultural productivity has been achieved through intensive agriculture practices. Mechanization, digitization, intensive use of chemical fertilizers and pesticides have allowed the EU agricultural sector to achieve high productivity and reduce farmers' labor input, unfortunately at the expense of environmental degradation and structural changes in rural areas.

However, a shift away from intensive agricultural practices seems neither possible nor justified. Intensive agriculture in the EU is essential to ensure food security for EU citizens and a growing global population. Breaking up monocultures may have a regenerative effect on the environment, but it also risks the loss of economic advantage for EU farms in growing crops and breeding animals. There is evidence in the academic literature that downsizing is technically and economically effective only on small-scale farms (Rada, N.E., & Fuglie, K.O., 2019). In light of these facts, the preferred course of action should not be to move away from intensive agriculture altogether, but rather to replace intensive agriculture practices with sustainable and precise practices (Wrzaszcz, 2023).

Precision agriculture is a farm management concept that uses digital technologies to monitor crops and animal breeding and optimize agricultural production decisions (Monteiro, A., Santos, S., & Gonçalves, P., 2021). Smart agriculture solutions are having a significant positive impact on agriculture practices in every type of operation and at every scale of production. The introduction of advanced information technology and artificial intelligence alone provides the precision to achieve higher yields, both in terms of quantity and quality and reduces the burden on nature and the climate (Sharma, S., Verma, K., & Hardaha, P., 2023). Automated control systems, data-driven fertilization and crop protection systems, field robots, drones, soil analysis sensors, and automatic process control are optimizing agricultural production in technical, allocative, economic, but also, importantly, environmental terms. Precision agriculture is changing the living conditions in rural areas, changing the demand for farm labor in terms of quantity and quality, as well as new skills for farm workers (technical and environmental skills).

In addition, precise crop and livestock monitoring tools are an important component of the (future) reporting system under design (Burnaev, E., Mironov, E., Shpilman, A., Mironenko, M., & Katalevsky, D., 2023). This is because it is assumed that through a combination of technical equipment, innovations in the agricultural sector, information and communication technologies, sustainable practices in crop and livestock breeding will be possible, while at the same time the conditions will be created for obtaining the data necessary for ESG reporting on each farm, i.e. the environmental, social and governance impacts of agricultural activities.

The main purpose of the article is to discuss the future directions of agricultural development in European Union countries. Precision agriculture should hold a key place in this discussion among farmers, politicians and academics, as it represents the only way to achieve food security for the citizens of the European Union and the growing global population, and also provides opportunities to achieve the Sustainable Development Goals and the European Green Deal. The digitization of agricultural operations, in the implementation of IT and AI systems on more farms, is seen as an opportunity to reduce their negative impact on the environment, climate and society. The situation in the Polish agricultural sector in Poland provides the background for a discussion on the spread of precision agriculture practices.

The content of the article is presented in the following sections of the article according to the following order. The discussion begins with a section describing the essence of precision agriculture and its development in European Union countries. In the third part, the importance of precision agriculture for the implementation of the goals of the European Green Deal is presented, and the anticipated mechanisms of financial support for farms within the framework of the Common Agricultural Policy for 2023-2027 are described. In the fourth part, the usefulness of using precision methods in ESG reporting of farm activities is signaled. In the last – a discussion of the situation of agriculture in Poland is presented, taking into account the status of implementation of precision agriculture practices on the

way to achieving climate goals. The discussion ends with generalized remarks in the conclusion.

### 2 Precision agriculture in European Union

Precision agriculture responds to the contemporary need to implement technical progress in the European Union's agricultural sector, although like any change it raises objections, both among farms primarily for technical and economic reasons, and among food consumers, among others, regarding the introduction of new genomic techniques (NGT) into crops. These concerns, while unfounded, are a significant obstacle to its development. Farmers, despite the knowledge that precision agriculture saves on the use of natural resources, material resources and labor, and that it maximizes production and consequently improves crop and livestock productivity, note the technical difficulties associated with its introduction and the problem of financing capital expenditures. At the center of precision agriculture are IT and AI technologies that communicate with each other and with the farmer. With the assistance of sensors, drones and systems, application maps are created that are able to design crops, and real-time monitoring with them, from the app's position, observes and responds flexibly to environmental risks (Chin, R., Catal, C., & Kassahun, A., 2023). "From the field" data on soil moisture or plant condition, among other things, assists in taking action on irrigation methods or nutrient application methods that ensure farms achieve maximum yields. Similarly, precision livestock breeding methods, i.e. cow ear tags, automated milking systems, automated feed wagons reduce ongoing production costs and allow farmers to achieve higher levels of competitiveness (Martin, T., et al., 2021). Information technology and artificial intelligence in the long term should provide data to facilitate planning, dispatching and recording of activities, creation of templates to facilitate record maintenance, including but not limited to "from the field" documentation, nutrient balancing and optimization of the economic account at the farm level. A major problem for farms in the EU today is the financing of capital expenditures associated with the transition to precision practices.

The implementation of precision agriculture directly affects the economic benefits achieved by farms, allows to customize agricultural treatments for individual plants and animals, reduces production costs. However, the benefits of precision agriculture go beyond economics – precision agriculture reduces, as it reduces the

negative impact of agricultural production on the environment. In 2019 European Green Deal – EDG (EC., 2019a) assigned the agricultural sector a role in achieving EU climate neutrality, pointing out that this can be achieved by, among other things, changing food production practices and delivery methods, and protecting biodiversity on agricultural land. According to an analysis by the European Environment Agency (EEA, 2024), the agricultural sector accounts for 11% of the EU's greenhouse gas emissions, so changing agricultural production techniques to precise ones is key to reducing them.

# 3 European green deal and common agricultural policy in the implementation of precision agriculture

The European Green Deal is a strategy that is a commitment by the European Union to take responsibility for transforming the EU economy into a modern, resourceefficient and competitive economy, achieving zero net greenhouse gas emissions and whose economic growth is decoupled from the use of natural resources (Arabadjieva, K., & Bogojević, S., 2024). The implementation of the EGD for agricultural activities and the related A Farm to Fork Strategy (EC., 2020) and the EU Biodiversity Strategy for 2030 (EC., 2020a) obliges each EU country to prepare a national long-term strategy for climate neutrality – a long-term strategy (EC., 2019). One of its fields in this regard is defining a plan for, among other things, reducing greenhouse gases from the agricultural sector, reducing the use of chemical fertilizers and synthetic pesticides, restoring natural ecosystems and how to achieve them. The way to achieve the country's long-term strategy is through, among other things, the development of sustainable agricultural practices, such as precision agriculture or organic agriculture, as well as the protection of biodiversity. Agricultural activity has always been linked to respect for natural resources, but now the EGD has set measurable tasks for EU agricultural sectors in relation to climate and environmental goals. The need to take climate and environmental aspects into account has led to new mechanisms for financial support of farms under the Common Agricultural Policy (CAP). Under the 2023-2027 CAP (European Parliament, 2021), 40% of the budget has been allocated to financial support for farms that meet climate goals. The revised financial support mechanisms have also been linked to the promotion of other farm ecosystem services (de Groot et al., 2022). Among the important changes in the 2023-2027 CAP are increased spending on climate, environment and animal welfare, as well as the implementation of a new type of payment known as

ecoschemes. Financial support now includes: modernization of farms, e.g., precision agriculture solutions in buildings and structures for animal breeding, crop production activities, e.g., purchase (leasing) of harvesting machinery, other investment expenditures, especially expenditures for improving product quality, innovation, changing the profile of activities. Also noteworthy is the change in approach to financial support for small and medium-sized farms. All the measures taken are aimed at maintaining food security in the EU and the world and achieving EU climate neutrality. Each EU country is required to submit a customized Strategic Plan for its agriculture, in which it indicates concretized goals related to the directions of transformation of agricultural production in connection with the achievement of climate neutrality, along with the possibilities of financial support for the planned activities (interventions).

Farms in the EU, especially those engaged in intensive agriculture, are recognizing the benefits of adapting precision agriculture solutions, and customized financial support mechanisms under the CAP are a big incentive to adopt them. However, IT and AI technologies require access to appropriate infrastructure, as well as investment in fixed assets.

The full implementation of the idea of precision agriculture requires the collection and analysis of digital data, which in the long run is expected to allow the creation of a virtual space that is a platform for the exchange of experiences and agricultural practices - economically and environmentally efficient. IT and AI technologies in the long run should provide data to facilitate planning, dispatching and recording of activities, creation of templates to facilitate record-keeping, including "from the field," "from the barn" documentation, balancing nutrients and optimizing the economic calculation, both at the micro and cross-local levels. On the other hand, at the institutional level, precision agriculture will provide rapid control and adjustment of financial support mechanisms, quotas and contracts, enabling greater transparency and facilitating compliance.

Data obtained from precision machines can also be useful for implementing nonfinancial ESG reporting in agriculture.

## 4 ESG reporting in the EU agricultural sector

The European Union's climate policy formulated in the European Green Deal is being implemented rapidly, and one of its manifestations is ESG reporting.

In 2024, the NFRD (European Parliament and of the Council, 2014) was replaced by the CSRD (European Parliament and of the Council, 2022), as a result of which non-financial reporting was replaced by ESG reporting. The main purpose of nonfinancial reporting was to meet investors' needs for information on non-financial factors that could influence effective decision-making in the long term. ESG reporting under CSRD aims to report on corporate sustainability issues that address environmental, social and corporate governance issues, providing greater transparency in this regard. In ESG reports, entities show how they manage risks and evaluate their strategy.

Although the implementation of mandatory ESG reporting stems from the EU CSRD, the implementation schedule is being developed individually by each member country, so the implementation of ESG reporting is not uniform. There are countries in the EU where the implementation of reporting has begun, such as Finland, Slovakia and the Czech Republic, and countries where the implementation schedule process is in the consultation phase, such as Croatia and the Netherlands.

The European Commission has approved the Sustainability Reporting Standards – ESRS (EC., 2023). The standards require a companies to use a value chain approach when disclosing ESG data. If access to information at certain stages of the value chain is difficult, companies are required to disclose this in the report, explaining the steps taken to access the required information. In this way, companies provide accurate information about their entire environmental and social impact.

Agriculture, i.e., farms, is currently not directly covered by ESG reporting, although there are plans for its gradual inclusion. Nevertheless, ESG reporting indirectly supports agriculture's transformation to sustainable agriculture. ESG reporting standards require covered companies to audit their entire supply chain. Therefore, companies that care about reducing the CO<sub>2</sub> footprint of their operations are not indifferent to the carbon footprint of even single, small-scale suppliers, i.e. farms. What's more, these companies can benefit from the potential of sustainable farms, e.g. small-scale organic farms, or farms using precision agriculture practices by deducting  $CO_2$  from their carbon footprint. Regardless of whether or not farms are directly covered by ESG reporting, they must comply with ESG reporting requirements if they want to work with large companies in the long run. The reality is that companies will not be able to work with those farms that are unable to demonstrate their carbon footprint.

### 5 Polish agriculture on the road to sustainable agriculture

The European Green Deal has set specific, quantitative goals for the agricultural sector. By 2030, it is to reduce the use of plant protection products by 50% and mineral fertilizers by 20%, allocate a minimum of 10% of arable land to proenvironmental purposes and a minimum of 25% of agricultural land to organic agriculture. Achieving these ambitious goals depends on the commitment of the country's agricultural sectors.

Polish agriculture currently has a significant position in the EU agricultural sector. According to the Central Statistical Office (2024), in 2022 it ranked 5th in the European Union in terms of agricultural production value, was the largest producer of apples in the EU, ranked 3rd in wheat production and 2nd in rye production, 3rd in milk production and 4th in pork production. At the same time, it is characterized by a large number of small farms, mainly family farms. In addition, a feature of Polish agriculture is the small share of organic crops, much lower than the average for EU agriculture. 3.45% of the cultivated area in Poland is organic, with an average of 9.10% of the organic area in the European Union (Central Statistical Office, 2024).

The position of Polish agriculture has been achieved through consistent efforts to increase the scale of operations and intensify production, but the potential of Polish agriculture is still not used – farms in Poland still need to increase investment, increase innovation. The established goals of the European Green Deal have set new paths of development, in particular, the change towards precision agriculture.

Poland, similar to other EU countries, has included modernization, increased innovation and digitization of farms and rural areas in the CAP Strategic Plan for 2023-2027, and proposed forms of financial support for related investments. The Strategic Plan emphasizes that the development of digitization of farms and rural

areas is a prerequisite for the use of precision solutions, increasing the importance of technology in agricultural production.

The main challenges of digitization of farms and rural areas in Poland include:

- support for the development and modernization of IT infrastructure in rural areas,
- bridging territorial disparities in Internet access between rural and urban areas,
- modernization of farms in particular in the field of automation and digitization of production,
- creation and implementation of innovative applications and open IT platforms through which remote consulting is possible,
- digitization in the implementation of agricultural policy instruments facilitating the development and dissemination of tools for optimization of agricultural production processes,
- improvement of digital, market and technological competence of farmers and rural residents (Plan, 2023).

Interventions to support precision agriculture solutions envisioned in the CAP Strategic Plan 2023-2027 include financial support to farms for investments that increase their competitiveness, investments that improve the welfare of cattle and pigs, investments that contribute to environmental and climate protection, sector interventions – fruits and vegetables. In addition, it was highlighted that an important group of activities planned for support are investments in rural infrastructure and the implementation of the smart village concept. The CAP Strategic Plan 2023-2027 also includes a plan for financial support within the framework of cooperation of EPI Operational Groups and activities referred to as the "Leader" program. Supported activities are implemented in four areas (from A to D).

Examples of activities covered by financial support for Polish farms within the framework of the presented CAP Strategic Plan 2023-2027 are realized investments in navigation systems for tractors and agricultural machinery, systems for increasing the precision of machine guidance, systems for controlling the dosage of fertilizers,

plant protection products, seed, feed, antibiotics, water necessary for production, feed robots, feed tapping devices, yield mapping systems, telemetry systems, decision support systems, robots and autonomous systems, e.g. robots for strawberry harvesting, robots for recognizing and eradicating weeds, walking fencing system in pastures, automated animal selection and weighing systems, cleaning robots.

In providing support under each area, it was assumed that the main result of the activities planned for funding is the digitization of farms and rural areas, so the main criterion for selecting supported activities is investment in digital solutions, regardless of the areas of intervention. As a result, there has been significant digitization of Polish farms and rural areas. In 2023, the Internet in Poland was available to an average of 85.32% of people using it regularly, an increase of 3.96% compared to 2020 and an increase of as much as 25.45% compared to 2013. People living in cities and urban areas compared to those living in rural areas use the Internet more regularly. Internet access in rural areas may be an obstacle to the full implementation of precision agriculture. In Poland, as in the rest of the EU, the development of digital infrastructure is supported by the European Funds Program for Digital Development, the National Plan for Rebuilding and Increasing Resilience and national funds. In addition, the development of digitization in the agricultural sector is funded under Horizon 2020, Horizon Europe or the Digital Europe program. The measures finance extensive investments related to financial outlays for providing Internet access, eliminating so-called "white spots", i.e. digitally excluded regions, implementing satellite monitoring systems and developing maps of agricultural areas. The aim of all the measures covered by the financial support is to increase the economic efficiency of agricultural production and reduce the negative impact of agricultural production on the environment, optimize the use of natural resources, which should bring the EU agricultural sector closer to achieving the set goals of the European Green Deal.

### 6 Conclusions

The European Green Deal has set a path for the European Union's agricultural development, which includes increasing resource efficiency, improving the competitiveness of production and reducing its negative impact on the environment. Precision agriculture is one of the key tenets of this development. The article examines the essence of precision agriculture and identifies its key elements – from

monitoring and data collection systems to decision support tools and automated application technologies. Attention was paid to the diversity of applied solutions, such as satellite technologies, soil sensors, drones, GPS systems or yield mapping, which enable production to be carried out in a more precise and cost-effective manner. As a result, it is assumed that a digital platform will be created to promote good practices among users of agricultural technologies. The platform should also be a valuable tool for designing future Common Agricultural Policy programs and ESG reporting.

The purpose of the article was to discuss the future directions of of agricultural development in European Union countries. Precision agriculture currently occupies a key place in the discussion of the implementation of the sustainable development goals of the Sustainable Development Goals and the European Green Deal. It is seen as an opportunity to simultaneously increase the efficiency of agricultural operations and reduce their negative environmental, climate and social impacts. Precision agriculture allows the acquisition of new data that can reveal the impact of agricultural activities on the environment, society and governance. The development of precision agriculture is of particular importance due to the need to balance agricultural activities to the requirements of the European Green Deal and EU climate policy. There is growing interest among farms in implementing precision agriculture practices.

The results of the analysis carried out in the Polish agricultural sector provide a basis for further research on precision agriculture practices, which should focus, on the one hand, on comparing the costs and benefits (economic and environmental) of implementing digital technologies in the agricultural sector, analyzing the return on investment in precision agriculture, and, on the other hand, learning about the level of preparedness of farms to meet future requirements for reporting the environmental, social and corporate governance impacts of agricultural activities – ESG reporting.

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488