Applications of Agritech solutions in agriculture and their impact on the development of agricultural insurance – recommendations for Poland

Witold Wiliński, Krzysztof Księżopolski

Abstract

The publication addresses the application of Agritech and Insurtech solutions in agriculture and agricultural insurance. It outlines how these solutions can help address the challenges posed by climate change and enhance the competitiveness of agriculture. Various aspects and applications of Agritech solutions were analysed, with particular emphasis on the agricultural insurance sector. The regulatory framework was outlined, and recommendations were presented for the agricultural sector and the insurance industry. The main conclusions regarding the implementation of Agritech solutions in Polish agriculture relate to the creation of an appropriate institutional framework for cooperation between agricultural research institutions and technology companies, as well as financial support mechanisms to commercialise solutions developed in this field. In turn, the conclusions regarding the application of Insurtech in the agricultural sector focus on improved risk assessment, faster claim settlement, and a higher level of trust between the farmer and the insurer. The study also presents recommendations concerning Agritech and Insurtech solutions in Polish agriculture.

Keywords: Agritech, Insurtech in agriculture, Agriculture 4.0, precision farming, precision agriculture, climate change.

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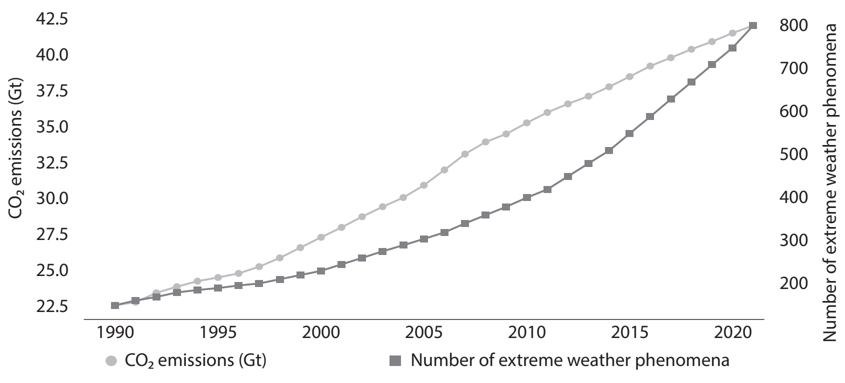
Introduction

Contemporary agriculture faces numerous challenges related to climate, the global market, and the growing demand for food. At the same time, the development of new technologies provides innovative tools to support agricultural production. Among the most rapidly developing areas are precision agriculture and the application of selected Agritech technologies. Equally significant is the impact of technological advancement on agricultural insurance, as it now enables more accurate risk assessment, improved loss monitoring, and greater personalisation of insurance products. From the perspective of the agricultural insurance sector, climate change remains the key factor. It causes extreme weather phenomena and changes the conditions for agricultural activity. A strong correlation between global CO_2 emissions and extreme weather phenomena highlights the growing severity of this issue (Figure 1).

Figure 1. CO_2 emissions and the number of extreme weather phenomena worldwide in 1990–2021



Source: International Disaster Database, https://public.emdat.be/data, access 12.02.2025; Emissions Database for Global Atmospheric Research – EDGAR, Global Greenhouse Gas Emissions, https://edgar.jrc.ec.europa.eu/dataset_ghg2024, access 12.02.2025.

Closely linked to climate change is the issue of limited access to clean freshwater resources for consumption and agricultural production, as well as the occurrence of frosts during the growing season, which result in losses for soft fruit production. This paper aims to analyse the potential of Agritech solutions – understood as technologies supporting agricultural production – with particular emphasis on the agricultural insurance sector in the context of challenges related to climate change adaptation, and to formulate recommendations for Poland.

Agritech: concept, development, and significance

The rapid technological advancement of the 21st century, also referred to as the Industry 4.0 revolution, is currently exerting a significant impact on the agricultural sector. Increasingly effective implementation of automation and digitalisation processes – leveraging artificial intelligence, machine learning, the Internet of Things, big data, cloud computing, and 3D printing – can now be observed beyond traditional industry and service sectors. The Agriculture 4.0 revolution represents a transformative process that is gradually reshaping food production through the adoption of advanced digital technologies. Its origins can be traced back to the late 20th century, when GPS systems and yield mapping, as well as the first elements of so-called precision agriculture – enabling the adaptation of production methods to specific soil and weather conditions – began to be implemented in agriculture. A true breakthrough occurred after 2010, driven by the rapid development of the Internet of Things (IoT), Artificial intelligence and cloud data analysis systems. In agriculture, soil sensors, drones, weather stations, and intelligent cameras have been introduced, enabling real-time monitoring of crop and soil conditions. In modern animal husbandry, by contrast, biometric sensors, GPS collars, video monitoring systems, and intelligent devices for automated feeding and milking are employed, allowing real-time tracking of animal health, activity, and welfare, which facilitates rapid response and the optimisation of production processes. Currently, Agriculture 4.0 is grounded in automation, data analytics, and artificial intelligence. Field robots, autonomous tractors, digital platforms supporting farmers' decision-making, as well as tools for predicting plant diseases and optimising harvests, are now being adopted on an increasingly widespread basis. Blockchain technology, in turn, enables comprehensive tracking of the entire food supply chain – from farm to fork. The Industry 4.0 revolution has also exerted a significant impact on the agricultural insurance sector, transforming the traditional model of risk assessment, claims settlement, and offer personalisation. With digital technology and advanced data analytics, agricultural insurance has become more accurate, flexible, and operationally efficient.

According to the Food and Agriculture Organization of the United Nations (FAO), Precision agriculture (PA) is a management strategy that involves the collection, processing, and analysis of temporal, spatial, and individual plant and animal data, which are then integrated with other information to support management decisions that account for estimated variability. The objective of precision agriculture is to enhance resource use efficiency, increase productivity, quality, profitability, and the sustainability of agricultural production[1].

In turn, the European Parliamentary Research Service defines precision agriculture as a modern farming management concept using digital techniques to monitor and optimise agricultural production processes. Rather than applying the same amount of fertilisers over an entire agricultural field, or feeding a large animal population with equal amounts of feed, PA will measure variations in conditions within a field and adapt its fertilising or harvesting strategy accordingly. Likewise, it will assess the needs and conditions of individual animals in larger herds and optimise feeding on a per-animal basis[2].

In the context of classifying countries by the level of agricultural development, an interesting approach is the classification proposed by the FAO, which divides countries into six groups:

1) countries in protracted crisis – countries affected by prolonged conflicts or humanitarian crises, where food systems are severely disrupted;
2) traditional countries – characterised by low agricultural productivity, limited access to modern distribution channels, and a diet based primarily on primary products;
3) expanding countries – countries undergoing transformation, marked by increasing levels of urbanisation and the initial development of modern food supply chains;
4) diversifying countries – systems characterised by a more varied diet, a developing processing sector, and expanding retail trade;
5) formalising countries – countries with well-established retail structures, high agricultural productivity, and a significant share of processed foods in the diet;
6) industrial countries – the most advanced systems, characterised by a high degree of mechanisation, developed retail trade, and a diet rich in processed foods[3].

In the classification of agri-food systems developed by the FAO, four quantitative indicators play a key role, enabling comparisons of the level of development and food structure across the different countries. The first of these is (1) the agricultural value added per worker, expressed in US dollars at constant prices, which reflects the efficiency and degree of mechanisation of agricultural production. The second

1. Food and Agriculture Organization of the United Nations, *The digitalization of the agricultural sector: A challenge and opportunity for inclusive rural transformation*, 2019, https://www.fao.org/3/ca4887en/ca4887en.pdf, access 9.05.2025.
2. European Parliamentary Research Service (EPRS), P*recision agriculture and digital technologies in EU farming*, 2016, p. 1.
3. Food and Agriculture Organization of the United Nations, *The State of food and agriculture value-driven transformation of agrifood system*, United Nations, Rome 2024, p. 100–101.

indicator is (2) the number of supermarkets per 100,000 inhabitants, which illustrates the development of modern food distribution channels and the level of formalisation of the food market. The third indicator relates to (3) dietary structure, specifically the proportion of calories derived from products other than primary such as cereals and roots, which reflects the diversity of consumption and the share of processed foods in the diet. The fourth indicator is (4) the level of urbanisation, measured as the percentage of the population residing in urban areas[4].

From the perspective of development and the broadly defined Agritech sector, it is undoubtedly the industrial countries – classified in the last of the aforementioned groups – that have the greatest potential to implement the latest technological solutions analysed in this article[5]. This group consists predominantly of OECD countries (with the exception of: Chile, Hungary, Ireland, Latvia, Lithuania, Mexico, Portugal, Slovakia, Slovenia, Turkey, and Poland). Meanwhile, among the countries that are not members of the OECD, this group includes the Bahamas, Hong Kong, Malta, and Uruguay.

Traditionally, those countries that were the earliest to develop intensive agriculture are considered the most predisposed to implement Agriculture 4.0. From the point of view of the development of Agriculture 4.0, three elements appear to be of key importance. First, there must be close collaboration between agricultural research centres and the most advanced branches of the technology industry. Second, appropriate mechanisms must be established to ensure the effective transfer of innovation from industry to agriculture. Third, it is essential to ensure that sufficient capital can be allocated to the development of technology. Therefore, the greatest potential for the rapid implementation of Agritech solutions appears to be found in highly developed countries with a tradition of intensive agriculture. By contrast, when it comes to the Polish economy, a clear shortcoming is the lack of financial resources for the development of the latest technologies in agriculture, as well as the relatively low level of collaboration between agricultural research institutions and Industry 4.0. Unless this type of collaboration is intensified in the coming years – and unless appropriate mechanisms are established to support the emergence of new technological solutions and enterprises developing technologies for Agriculture 4.0 (the start-up ecosystem) – Polish agriculture will be compelled to implement solutions developed in other highly developed countries.

4. In developing this indicator, the FAO drew on the work of: Q. Marshall, J. Fanzo, Ch.B. Barrett et al., *Building a Global Food Systems Typology: A New Tool for Reducing Complexity in Food Systems Analysis*, "Frontiers in Sustainable Food Systems" 2021, Vol. 5.
5. See also: defining the concept of industrial countries – OECD Factbook, OECD Economic Outlook, Cambridge Dictionary of Geography.

The use of technology in agricultural insurance

Previous research on agricultural insurance indicates the low effectiveness of the current crop insurance system in Poland. Despite the introduction of the subsidy system in 2006, by 2018 only around 3 million hectares of crops had been insured, whereas the statutory requirement is approximately 7 million hectares[6]. The main barriers to the development of this segment are low profitability for insurers and limited interest among farmers. An analysis of the functioning of subsidised crop insurance in the years 2010–2019 also demonstrated that, despite amendments to the legal regulations, only about 20% of the total cultivated area was actually covered by insurance. Most commonly, it was cereal and rapeseed crops that were insured, which highlights the need to broaden the current scope of insurance coverage[7]. For this reason, regulatory measures were taken in 2024, amending the laws on crop and livestock insurance, expanding the list of crops eligible for insurance premium subsidies, and introducing changes aimed at increasing the insurance availability[8]. Accordingly, the current insurance model in Polish agriculture is undergoing modification. The traditional agricultural insurance model is based mainly on ex post risk assessment, i.e. after an event has occurred. The key features of this model are as follows:

1) risk assessment based on historical data – insurers use weather data, historical loss records, and general statistics for a given region to determine premiums and policy conditions;
2) field inspections – loss assessment usually takes place after a claim has been submitted by the farmer, which necessitates the presence of an expert and can be time-consuming;
3) subjectivity and delays – this process can result in delayed compensation payments and subjective evaluations, undermining farmers' trust in the entire insurance system;
4) limited personalisation – policies are generally standardised and do not account for the specific production conditions of individual farms.

6. S. Kozak, A. Weremczuk, *Evaluation of the crop insurance system in Poland*, "Zeszyty Naukowe SGGW – Ekonomika i Organizacja Gospodarki Żywnościowej" 2019, Vol. 126, p. 41–52.
7. A. Wicka, A. Parlińska, *Evaluation of subsidized crop insurance in Poland*, "Roczniki (Annals)" 2019, Vol. 3.
8. Ustawa z 27 listopada 2024 r. o zmianie ustawy o ubezpieczeniach upraw rolnych i zwierząt gospodarskich, Dz.U. 2024 poz. 1836, https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20240001836, access 27.05. 2025.

In summary, the traditional – current model relies on weather data, estimates, and general forecasts. By contrast, the application of Industry 4.0 technologies enables highly precise, farm-specific risk assessment and insurance pricing based on analyses and forecasts grounded in comprehensively collected and processed data. Accordingly, a transition to the new insurance model is feasible under two conditions: the availability of data and the capacity to process it. The availability of data is made possible through sensors and the use of satellite data (including imagery and monitoring), while analysis can be performed not only with advanced algorithms but also by leveraging artificial intelligence (AI). Summing up, the use of Industry 4.0 technologies in agricultural insurance enables:

1. Improved risk assessment:
   - more accurate forecasting of threats – such as drought, frost, hail, and plant diseases – is made possible by the use of data from sensors, drones, satellites, and meteorological stations;
   - historical yield records, soil type information, and local weather data can be leveraged by insurers to enable individualised calculation of insurance premiums.
2. Automation of the claims settlement process:
   - rapid verification of losses can now be achieved without the need for an assessor's visit, thanks to remote sensing technology and satellite imagery;
   - AI-based systems can automatically compare data from before and after the loss.
3. The development of index insurance[9]:
   - this model is faster, simpler, and more precise.
4. Greater accessibility and personalisation of offers:
   - online comparison and purchase of insurance is now possible for farmers, using mobile applications or agricultural platforms;
   - by analysing data, insurers can tailor policies to the specific needs of individual farms – resulting in so-called "bespoke insurance" solutions.
5. Insurtech collaboration with the agricultural sector:
   - innovative insurance models and analytical tools are now being introduced by new technology firms in the insurance sector (so-called Insurtechs), with these solutions frequently integrated directly into farm management systems.

The literature in the field widely highlights the advantages of applying Industry 4.0 technologies within agricultural insurance. A comprehensive analysis of 148 publications in the field is presented in the study "The digitization of agricultural industry – a systematic literature review on agriculture 4.0", which identifies the current

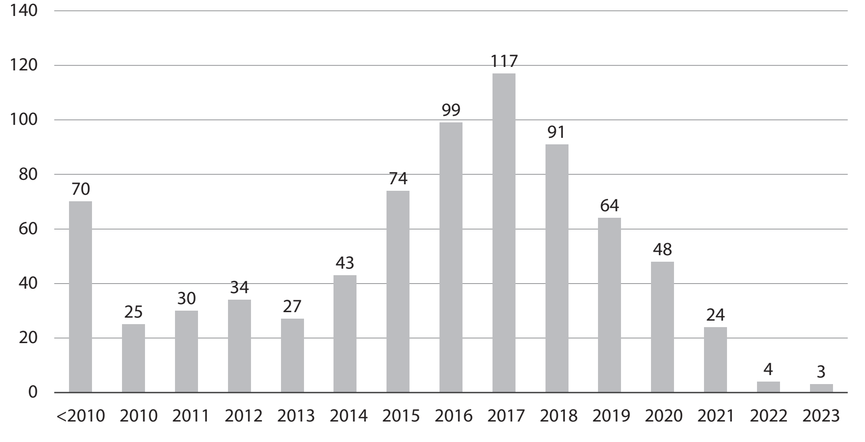
9. Index insurance refers to a type of insurance in which compensation is determined by specific indices, such as rainfall levels or temperature measurements.

level of technological advancement, outlines the prevailing development trends, and discusses the benefits that agriculture derives from the adoption of these technologies[10]. Research is also being conducted into the limitations of technology adoption in agriculture, taking into account factors such as farm size[11], technical challenges related to the use of drones[12] and artificial intelligence[13], regulatory considerations[14], social issues[15], and efficiency[16]. According to a report published by the University of Lucerne in 2025, Western European countries – such as the United Kingdom (194), Germany (114), and France (77) – emerge as the leading European nations in terms of the number of companies operating in the Insurtech sector[17]. A clear lead in market saturation – measured by the number of Insurtech firms[18] per million inhabitants – is also held by Western European countries (1.9 per million), significantly outpacing their Eastern European counterparts (0.56 per million). This may indicate a more favourable financial and regulatory climate for such companies in the older EU member states and the United Kingdom[19].

10. R. Abbasi, P. Martinez, R. Ahmad, *The digitization of agricultural industry – a systematic literature review on agriculture 4.0*, "Smart Agricultural Technology" 2022, Vol. 2, DOI: https://doi.org/10.1016/j.atech.2022.100042.
11. P. Kramarz, H. Runowski, *Possibilities of using digital technologies in agriculture in areas with high agrarian fragmentation*, "Precision Agriculture" 2025, Vol. 26, https://doi.org/10.1007/s11119–025–10244–2.
12. H. Runowski, *Digitalization in agriculture – development opportunities and barriers* [in:] *Management and information technology: New challenges*, (ed.) J. Paliszkiewicz, Warsaw University of Life Sciences, 2020.
13. H. Runowski, P. Kramarz, *Trust in artificial intelligence in agriculture* [in:] *Trust and Artificial Intelligence: Development and Application of AI Technology*, (eds.) J. Paliszkiewicz, J. Gołuchowski, Routledge 2025, https://doi.org/10.4324/9781032627236–21.
14. P. Carcamo, S. Brugler, M. Sahraei, *Artificial Intelligence applications in agriculture need a justice lens to address risks and provide benefits to smallholder farmers*, https://www.researchgate.net/publication/383175357, 2023, access 9.05.2025.
15. H. Barret, C. Rose, *Perceptions of the fourth agricultural revolution: What's in, what's out, and what consequences are anticipated?*, "Sociologia Ruralis" 2022, Vol. 62(2), p. 162–189, https://doi.org/10.1111/soru.12324.
16. B. Chandra, S. Collins, *Smart farming with technologies such as IoT, computer vision, and AI can improve agricultural efficiency, transparency, profitability, and equity for farmers in low-and middle-income countries*, "Communications of the ACM" 2021, Vol. 64(12), p. 75–84, https://doi.org/10.1145/3454008.
17. The term Insurtech refers to the use of technological innovations to generate savings and increase efficiency in the current insurance industry model. For more information, see: T.C. Yan, P. Schulte, D.L.K. Chuen, *InsurTech and FinTech: Banking and Insurance Enablement*, "Handbook of Blockchain, Digital Finance, and Inclusion" 2017, Vol. 1, p. 249–281, Academic Press, Cambridge; Capgemini Financial Services, *World Insurance Report*, Paris 2015.
18. In the cited report, Insurtech companies are defined as entities whose core business, key competencies, or strategic direction of development centre on creating technological solutions for innovative products, services, and processes that enhance, complement, or drive the emergence of new offerings within the insurance industry.
19. See also: C. Pugnetto, F. Schreiber, *IFZ Insurtech Report 2023/2024*, Lucerne University of Applied Science and Art, Lucerne 2025, p. 19–21.

The analysis of the data presented in Figure 2 seems noteworthy. These data refer to the number of companies established in the Insurtech industry, broken down by year. While one might expect the number of such companies to have increased most significantly during or immediately after the pandemic, it was in 2017 that the European market saw the highest number of new entrants in this sector, with 117 companies established. The fact that in recent years no more than five new companies have been established annually across Europe points to a highly saturated market. From the standpoint of Insurtech sector growth potential in Poland, these figures indicate that the likelihood of a significant increase in the number of such companies emerging domestically is currently minimal.

Figure 2. Insurtech company formation in Europe between 2010 and 2023



Source: C. Pugnetto, F. Schreiber, IFZ Insurtech Report 2023/2024, Lucerne University of Applied Science and Art, Lucerne 2025, p. 8.

The implementation of these solutions is essential, as the current surge in sudden weather events has led to a rapid increase in compensation payouts, now exceeding the amount of premiums collected. A case in point is Spain's Agroseguro, which in 2023 collected EUR 1.01 billion in premiums (an increase of 16%) while paying out EUR 1.241 billion in claims (up by 56.5%)[20]. The most significant losses were attributable to drought (EUR 496 million) and hailstorms (EUR 375 million). These phenomena are expected to intensify in the near future, as evidenced by the conditions

20. Agroseguro, *Agroseguro's General Shareholders' Meeting approves the accounts for financial year 2023*, https://agroseguro.es/en/agroseguros-general-shareholders-meeting-approves-the-accounts-for-financial-year-2023/, access 10.05.2025.

outlined above and further corroborated by forecasts for the agricultural reinsurance market in Europe. In 2024, this market reached a value of USD 4.87 billion, with forecasts predicting further growth of 12.5% year on year[21].

EU Insurtech legal framework in the context of development of agricultural insurance

The implementation of Insurtech solutions, that is, digital technologies in insurance services, is essential for enhancing the efficiency, accessibility, and flexibility of insurance coverage available to farmers. In this context, EU legal acts serve not only a regulatory and developmental function for this market, but also provide a secure framework for the growth of insurance within the agricultural sector. The advancement of digital technologies in the latter compels legislators to establish legal frameworks that facilitate the adoption of innovation while safeguarding consumer protection and ensuring market stability. The Artificial Intelligence Act and the Digital Operational Resilience Regulation play a pivotal role in this process.

The Artificial Intelligence Act (AI Act), formally Regulation (EU) 2024/1689 of the European Parliament and of the Council of 13 June 2024 laying down harmonised rules on artificial intelligence and amending Regulations (EC) No 300/2008, (EU) No 167/2013, (EU) No 168/2013, (EU) 2018/858, (EU) 2018/1139 and (EU) 2019/2144 and Directives 2014/90/EU, (EU) 2016/797 and (EU) 2020/1828, establishes a legal framework for high-risk AI applications, including, among others, automated decision-making in the insurance sector.

In the context of agricultural insurance, this Act has a significant impact on:
- the potential application of AI systems for weather and climate risk modelling;
- automatic determination of insurance premiums based on satellite and historical data (e.g. soil moisture, precipitation);
- loss assessment and claim settlement using drones, including the application of predictive models.

The AI Act stipulates that artificial intelligence systems deployed in the insurance market should: (1) ensure transparency of risk assessment models, for example by clarifying the factors determining premium levels; (2) avoid algorithmic discrimination, such as systematically undervaluing compensation for

21. Cognitive Market Research, *Europe Agriculture Reinsurance Market Report*, 2024, https://www.cognitivemarketresearch.com, access 9.05.2025.

smaller farms; (3) ensure human oversight, particularly in the claims assessment process.

The Digital Operational Resilience Regulation (DORA), Regulation (EU) 2022/2554 of the European Parliament and of the Council of 14 December 2022 on digital operational resilience for the financial sector and amending Regulations (EC) No 1060/2009, (EU) No 648/2012, (EU) No 600/2014, (EU) No 909/2014 and (EU) 2016/1011.

This regulation has a significant impact on the agricultural Insurtech sector by introducing harmonised rules on the digital resilience of financial institutions, including insurance companies operating through digital technologies. For Insurtech companies offering agricultural insurance products based on satellite data, IoT, or artificial intelligence, DORA entails an obligation to implement ICT risk management procedures, conduct resilience testing of their systems, and report cyber incidents. The introduction of these obligations increases digital service security for farmers, strengthens trust in state-of-the-art solutions, and promotes the development of innovative insurance products in the agricultural sector.

Actions undertaken by the European Union and national authorities

Agriculture has been identified as one of the key priorities for the newly appointed European Commission, which took office on 1 December 2024. One of the main objectives for the new European Commission is to foster a competitive and resilient agricultural sector and food system, safeguard biodiversity, and ensure effective adaptation to climate change and preparedness for its impacts[22]. These objectives are to be achieved through targeted investment and innovation, as well as intensified efforts to strengthen resilience and preparedness for climate change[23]. In February 2025, the European Commission presented "A Vision for Agriculture and Food". Shaping together an attractive farming and agri-food sector for future generations"[24].

22. European Union, *An Ambitious Plan for Agriculture*, https://poland.representation.ec.europa.eu/news/ambitny-plan-dla-rolnictwa-2025–02–19_pl?prefLang=en, access 8.05.2025.
23. European Union, *Sustaining our quality of life: food security, water and nature*, https://commission.europa.eu/priorities-2024–2029/quality-life_en, access 8.05.2025.
24. European Commission, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, A Vision for Agriculture and Food: Shaping together an attractive farming and agri-food sector for future generations*, Brussels, COM(2025) 75, https://eur-lex.europa.eu/legal-content/PL/TXT/PDF/?uri=CELEX:52025DC0075, access 5.02.2025.

The above document highlights, among other aspects, the advancement of digitalisation, which is intended to support the achievement of these priorities. To further intensify these efforts, the European Commission has announced the launch of an EU digital strategy for agriculture[25]. The analysis presented in the vision entitled "Digital Transition: Long-term Implications for EU Farmers and Rural Communities" references specific technologies, such as drones and robotics[26]. The vision for agriculture to 2040 will provide renewed impetus to existing programmes and projects in the area under review, particularly as the European Commission has recognised the significance of sudden phenomena both in terms of their occurrence and in relation to ensuring food security.

In turn, the "Boosting Agricultural Insurance based on Earth Observation data (BEACON)" project, implemented between 2019 and 2022 as part of the Horizon 2020 programme, focused on the development of insurance solutions based on satellite data. The aim of the project was to enhance the efficiency and transparency of agricultural insurance by leveraging Earth observation data, primarily from satellite sources. The project consortium comprised 11 partners from six EU countries, including technology firms, insurers, and research institutes, with a total budget of EUR 5 million, the majority of which was sourced from EU funding. The outcome of the project was the development of the BEACON platform, which integrates meteorological data, satellite imagery, and index-based models. This platform enables the automatic monitoring of weather-related risks such as drought, hail, or flooding. Consequently, real-time crop monitoring allows for rapid assessment of damage, enabling the disbursement of index-based compensation without the need for on-site inspections. Tests conducted by insurers in Greece, Spain, and Italy have demonstrated that the implementation of these solutions has reduced policy administration costs by between 15% and 20%. Upon completion of the project, its outcomes were made publicly available and commercialised. At the same time, the outcomes of the project proved so successful that they are now regarded as a benchmark for collaboration between the agriculture, insurance, and space technology sectors. Key BEACON platform components, such as index-based insurance and automated crop monitoring systems, have been integrated by insurance companies and agricultural organisations in Greece, Spain, and Italy. In summary, BEACON technologies are currently employed as a foundation for developing digital insurance products and for conducting climate risk analyses in agriculture. The project was continued as part of the development of the Common

25. Y. Barabanova, M. Krzysztofowicz, *Digital Transition: Long-term Implications for EU Farmers and Rural Communities*, Publications Office of the European Union, Luxembourg 2023, doi:10.2760/286916, JRC134571.
26. Ibidem, p. 19.

European Agricultural Data Space (CEADS) and the AgriDataSpace and SmartAgriHubs initiatives. The CEADS initiative aims to facilitate the secure and transparent sharing of agricultural data among farmers, insurance companies, and public institutions. Originally, it operated within the framework of the European Data Exchange Strategy[27] and was intended to accelerate the digital and green transformation of agriculture, reduce administrative burdens, and lay the foundations for the deployment of powerful, emerging artificial intelligence tools. The document outlines a proposed approach to data spaces in relation to governance and business models, as well as a plan for a technical reference architecture. In addition to the discussion of enabling framework conditions, the document specifically analyses how various stakeholders – including policymakers at both EU and national levels, sectoral organisations (such as farmers' associations and cooperatives, as well as producer groups), industry actors (particularly agricultural machinery manufacturers), and innovators such as start-ups – can contribute to the implementation of data spaces[28]. This has resulted in the creation of an ecosystem with two levels of analysis – macro and micro – facilitating the establishment of cross-sectoral agreements on data sharing. A timeline for the achievement of objectives and milestones has also been established, spanning 60 months from 1 January 2025. In practice, this enables enterprises to operate in this area and to develop advanced analytical methods supporting management processes at various levels.

In this context, research projects such as DEMETER and ATLAS have been developed, aimed at integrating IoT technologies, artificial intelligence, and data analytics into the agricultural sector. The objective of DEMETER (Building an Interoperable, Data-Driven, Innovative Ecosystem for Smart Agriculture) was to develop an open, interoperable digital platform for precision agriculture, enabling seamless integration of diverse agricultural technologies – including sensors, IoT platforms, and applications – without the need for their modification, and to enhance the utilisation of agricultural data by farmers and agribusinesses. The project results were as follows: Twenty pilot implementations were carried out across 18 EU countries, encompassing activities such as animal, crop, and operational efficiency monitoring, the establishment of an open database and ICT component repository for agriculture, and a significant increase in interoperability between digital service providers in the agricultural sector.

27. European Union, *A European Strategy for Data*, https://digital-strategy.ec.europa.eu/en/policies/strategy-data, access 9.05.2025.
28. Agri DataSpace, *Building a European framework for the secure and trusted data space for agriculture*, Policy Brief, September 2024, https://agridataspace-csa.eu/wp-content/uploads/2024/09/AGRIDATA-SPACE-FINAL-BROCHURE-V5.pdf, access 9.05.2025.

The objectives of ATLAS (Agricultural Interoperability and Analysis System) in turn included: (1) the development of an open, cloud-based platform for the integration of agricultural data systems; (2) fostering the creation of applications capable of analysing data from multiple sources – including agricultural machinery, drones, satellites, and sensors; and (3) promoting innovation in the Agritech sector through an accelerator programme for start-ups. The project results were as follows: (1) the implementation of over 13 pilot projects leveraging artificial intelligence and IoT data; (2) the development of a suite of APIs facilitating interoperability between systems used by agricultural producers and technology providers; and (3) a grant programme for 30 start-ups and SMEs, supporting the advancement of solutions based on the ATLAS platform. Both projects were carried out between 2019 and 2023.

Recommendations

The adoption of new technologies in agriculture aligns with the global trend towards the digitalisation of production and management processes. The advancement of AI has enabled us to process vast amounts of information with ease and at a relatively low cost. The integration of digitalisation, AI, and agriculture is now a reality, delivering tangible benefits not only to farmers but also to enterprises and institutions – both private and public – operating within the agricultural sector. Entities operating within European Union Member States are at varying stages of adopting these solutions, a disparity attributable to national innovation policies, the potential of the agricultural sector, its agrarian structure, as well as the capacity of private institutions active in this domain. It is worth emphasising that Poland, particularly in the Insurtech sphere, ranks among the European countries with the lowest level of implementation of such solutions (see Table 3). The application of Agritech within the current structure of Polish agriculture – which is characterised by significant variation in average farm size (ranging from 4.36 hectares in the Małopolskie Voivodeship to 33.50 hectares in the Zachodniopomorskie Voivodeship[29]) and in the number of farmers per 100 hectares (from 3 in Zachodniopomorskie Voivodeship to 26.3 in Małopolskie Voivodeship[30]) – may serve as a factor in sustaining or even enhancing the competitiveness of production in small farms and fostering their specialisation, owing to advances in automation and robotics. Turning to specific recommendations:

29. Agency for Restructuring and Modernisation of Agriculture, *Średnia powierzchnia gruntów rolnych w gospodarstwie w 2024 roku*, https://www.gov.pl/web/arimr/srednia-powierzchnia-gruntow-rolnych-w-gospodarstwie-w-2024-roku, access 9.05.2025.
30. GUS, *Rocznik Statystyczny Rolnictwa*, Warszawa 2024, p. 96.

- it is necessary to increase the number of emerging Polish entities in the Agritech sector by introducing financial support mechanisms to foster collaboration between agricultural research institutions and Industry 4.0 enterprises;
- appropriate commercialisation mechanisms should be established for Polish solutions in the broadly defined Agritech and Insurtech sectors within agriculture;
- educational initiatives should be undertaken targeting the broadly understood agricultural sector, focusing on the implementation of Agritech and Insurtech solutions that enhance the efficiency and profitability of Polish agricultural production;
- financial support mechanisms should be established to facilitate the implementation of Agritech solutions for small and medium-sized farms;
- a regulatory framework should be established to govern the development of Agritech solutions in areas that have not yet been sufficiently addressed by EU legislation;
- the collection of data and the operation of AI should be based on servers located in Poland to ensure digital sovereignty and a high level of cybersecurity.

Finally, it is worth emphasising that the implementation of cutting-edge technologies in the agricultural insurance sector reduces operational costs, thereby enabling more competitive pricing of products and services. It also serves as one of the tools facilitating adaptive measures in response to the potential impacts of climate change.

In summary, Agritech is transforming the landscape of modern agriculture by providing tools for more efficient and sustainable farm management. Its application within the agricultural insurance sector contributes to improved risk assessment, expedited claims settlement, and a higher level of trust between farmers and insurers. However, further development of this sector requires cooperation between research institutions, public administration, tech companies, and the insurance sector. Eventually, this could lead to fair, safe, accessible, and more cost-effective solutions.

Table 3. The characteristics of the Insurtech sector in European countries in terms of the types of technologies employed

Country/Region	N	Density	M&D	PD&P	CS	AM	Inf	Dig/Aut	A/AI	IoT	DLT
United Kingdom	194	2.88	80	98	89	1	2	113	68	9	4
Germans	114	1.36	65	35	43	3	1	89	22	0	3
France	77	1.13	57	15	19	2	0	57	19	0	1
Switzerland	66	7.49	31	27	24	1	0	35	21	5	5
Southern Europe	**105**	**0.52**	**76**	**33**	**36**	**0**	**0**	**75**	**26**	**3**	**1**
Spain	43	0.90	33	14	16	0	0	30	12	1	0
Italy	38	0.64	27	13	12	0	0	26	9	2	1
Portugal	21	2.01	13	6	8	0	0	16	5	0	0
Greece	2	0.02	2	0	0	0	0	2	0	0	0
Cyprus	1	1.10	1	0	0	0	0	1	0	0	0
Western Europe	**84**	**1.90**	**30**	**39**	**43**	**0**	**0**	**48**	**31**	**1**	**4**
The Netherlands	26	1.47	11	10	14	0	0	18	7	0	1
Austria	19	2.10	6	7	11	0	0	12	7	0	0
Ireland	19	3.73	6	9	8	0	0	12	5	1	1
Belgium	14	1.20	5	8	7	0	0	4	9	0	1
Luxembourg	6	9.19	2	5	3	0	0	2	3	0	1
Scandinavia	61	2.23	34	15	22	4	1	48	12	1	0
Sweden	30	2.86	13	7	11	4	0	22	7	1	0
Norway	12	2.20	8	3	6	0	1	11	1	0	0
Denmark	12	2.03	9	2	2	0	0	11	1	0	0
Finland	7	1.26	4	3	3	0	0	4	3	0	0
Central and Eastern Europe	**52**	**0.S6**	**26**	**18**	**24**	**0**	**0**	**34**	**17**	**1**	**0**
Poland	27	0.71	16	10	10	0	0	17	9	1	0
Estonia	8	5.93	2	3	6	0	0	5	3	0	0
Romania	5	0.26	2	3	4	0	0	4	1	0	0
Lithuania	4	1.41	2	*0*	2	0	0	3	1	0	0
Czech Republic	3	0.28	1	0	2	0	0	1	2	0	0
Slovenia	2	0.95	1	1	0	0	0	2	0	0	0
Hungary	1	0.10	1	0	0	0	0	1	0	0	0
Slovakia	1	0.18	1	0	0	0	0	1	0	0	0
Croatia	1	0.26	0	1	0	0	0	0	1	0	0
Total	**753**	**1.27**	**399**	**280**	**300**	**11**	**4**	**499**	**216**	**20**	**18**

Where: N – number of Insurtech companies, **Density** – number of Insurtech companies per 1 million inhabitants, **M&D** – Marketing and Distribution, **PD&P** – Product Development and Pricing, **CS** – Customer Service, **AM** – Asset Management, **Inf** – Infrastructure, **Dig/Aut** – Digitalisation/Automation, **A/AI** – Analytical Tools/AI, **IoT** – Internet of Things, **DLT** – Distributed Ledger Technology.

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