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Developing green and digital skills towards AI use in agriculture

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1. Agriculture Policies in the EU

Agriculture and the agricultural industry are a fairly small part of the EU's GDP, having an estimated gross value of €220.7 billion in 2022, which is accounts for about 1.4% of the EU's GDP in the same year, slightly more than the GDP of Greece in 2022 (Eurostat, Performance of the Agricultural Sector). However, multiple sources indicate that agriculture is at the heart of major EU strategies which have been developed to guide the EU towards a sustainable future. This is meant to be achieved through the use of its main policies as tools for a just transition as well as the promotion of sustainability and environmental protection in the next few years.

A summary of the main and current EU policies related to agriculture is presented in this chapter, with a focus on digitilization and innovation within the agricultural sector, with AI applications integration also included.

Common Agricultural Policy (CAP) and European Green Deal

The main policy within the EU that connects Europe and its farmers is the Common Agricultural Policy (CAP), launched in 1962. Its main aims are to support farmers and improve agricultural productivity, to help European farmers have a sustainable income, to maintain rural areas within the EU and in more recent years, help in dealing with climate change and safekeeping the sustainable management of EU's natural resources. As is natural, the CAP has been evolving continuously to keep up with global trends and ever-changing new challenges that come up over the years.

The European Green Deal and the current EU agricultural policies are closely correlated as they both aim to promote sustainability and resilience, also within the agricultural sector. The European Green Deal addresses climate neutrality, biodiversity conservation, circular economy, sustainable food systems and digitalization and innovation. As agriculture is central to the European Green Deal goals, the CAP is set to be a key tool that can drive the EU towards a sustainable future, with 40% of the CAP budget being climate-relevant.

To this end, in December 2021, the formal adoption of the Common Agricultural Policy reform occurred (CAP 2023-2027), which entered into force on January 1st, 2023. This new CAP resulted in tailored national CAP Strategic Plans, designed by each EU country, which address ten specific objectives (European Commission, 2022). These objectives focus on, among others, environmental sustainability, climate change mitigation and adaptation, the increase of competitiveness through the fostering of knowledge and innovation and digitalization. Although AI integration is not explicitly mentioned, the CAP encourages the adoption of innovative technologies to improve agricultural practices, AI applications being some of them.

EU Digitalization within the European agricultural sector

At the same time, the EU has been promoting the digitalization of the European agricultural sector in order to increase efficiency, sustainability and competitiveness. In shaping the EU's digital future, there is emphasis given in the agriculture sector using latest technologies, including AI, in order for farmers to benefit in terms of sustainability, profitability and new perspectives in the way they work. Uses of such digital means include "data-sharing platforms and ecosystems needed for a common European agricultural data space" and "technologies to optimise water usage, accurately spread seeds and fertilisers, and reduce the need for harmful pesticides, among others" (European Commission, The Digitalisation of the European Agricultural Sector).

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To bolster this initiative, the EU allocated more than €200 million for Research and Innovation (R&I) through Horizon 2020 for the development of digital technologies within the agricultural sector, including AI applications such as machine learning for crop monitoring, predictive analytics for pest control, or robotics for harvesting (European Commission, Digitalisation of the European Agricultural Sector, 2023). Horizon Europe (2021-2027) is also following this path, with EUR 10 billion to be invested in R&I related to food, bioeconomy, natural resources, agriculture, fisheries, aquaculture and environment. In terms of agriculture, emphasis is given to the integration of digital technologies and precision agriculture to improve farming practices and enhance efficiency.

EIP-AGRI and EU CAP Network

The EU has also set up the EU CAP Network, in line with the Regulation of European Parliament and Council to support CAP Strategic Plans. The purpose of the CAP Network is to bring together different stakeholders (administrations, organizations, entrepreneurs, practitioners etc) with a goal of sharing knowledge about agriculture and rural policy. The EU CAP Network includes stakeholders from the Agricultural European Innovation Partnership (EIP-AGRI), which is a policy framework that contributes to sustainable farming while at the same time enhancing competitiveness and fostering innovation through the support of interactive innovation projects, hence promoting digitalization and innovation in agriculture.

Based on the above and in order to enhance the interaction of different stakeholders, Agricultural Knowledge and Innovation Systems (AKIS) have been set up to support sustainable agricultural development through the dynamic promotion of innovation within the sector. Key components include, among others, a multi-level structure (European, national, regional and local levels), the active participation and involvement of farmers and farming organizations by contribution of practical knowledge and experience, networking and collaboration platforms as well as digitalization and technology integration through digital platforms, smart farming applications and others.

Other policies related to agriculture

There are also other policies and strategies that are also connected to the agricultural sector, as either complementary or part of wider strategies that keep agriculture in a key position. The Rural Development Policy is complementary to the CAP as it supports rural communities by strengthening the sustainability of rural areas environmentally, socially and economically. The Farm to Fork Strategy makes a significant part of the European Green Deal, and its main aim is to promote sustainable food production and consumption within the EU. Its targets of reducing pesticide use, promoting organic farming, and reducing food waste are also closely connected to agriculture, where in come cases, AI applications are also encouraged in order for these targets to be achieved.

Conclusion

While a small sector within the EU's GDP, in recent years, agriculture is increasingly of central and of crucial importance to wider EU strategies such as the European Green Deal. The reformed CAP aims to be a very useful tool towards the achievement of the European Green Deal goals as it addresses different aspects within it, from greening measures to biodiversity conservation and sustainable food consumption.

Given that the agricultural sector is embedded within these strategies, there are several policies that touch upon it, besides the CAP. As the EU is moving towards a digitalized era, it also encourages the agricultural sector stakeholders towards adopting digitalized and innovative practices, in line with the

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European Green Deal goals. Funds are being distributed towards not only innovative practices for farmers which also include AI applications, but also to the continuous and enhanced interaction of agricultural and farming stakeholders, in order to strengthen their interaction and exchange of knowledge and information.

2. AI Policies in the EU

Introduction

In the evolving landscape of global technology, Artificial Intelligence (AI) stands as a cornerstone of innovation and progress, that facilitates life while presenting complex challenges. The European Union (EU) recognises AI's transformative potential for economic growth and societal progress, however, the EU recognizes the challenges, this is the reason for the acceleration of legislative procedures on institutional and national level. This document sets the stage for a broad exploration of the EU's approach and policies towards AI, highlighting their importance in the global technological race (European Commission, 2020).

The EU's historical engagement with AI has been marked by a philosophy that integrates innovation with a strong respect to ethical and societal values. This stance is reflected in the EU's leading role in the global discourse on AI, navigating through the complexities of technological advancements while ensuring alignment with fundamental human rights (European Parliament, 2020). However, the balance between AI prosperity aspects has to be regulated prioritising the protection of final beneficiaries, human beings and the society.

Regulatory Initiatives

The core part of the regulatory framework of the EU, and its ultimate goal, is to establish the AI Act, which is a draft EU law on Artificial Intelligence (AI Act)—the first of its kind in the world, quite promising and politically challenging. It applies to the development, deployment, and use of AI in the EU or when it will affect people in the EU. In addition, a solid risk methodology to define "high-risk" AI systems that pose significant risks to the health, safety, or fundamental rights of persons (Dervishaj, 2020).

The Act prohibits the placing on the market and putting into service of certain AI systems that materially manipulate human behaviour, whereby physical or psychological harms are likely to occur (European Commission, 2020).

On 09/12/2023, the Parliament and Council negotiators reached a provisional agreement on the Artificial Intelligence Act (European Parliament, 2023). The EU AI Act has cleared significant hurdles towards adoption, with representatives from each of the EU member states approving the proposed text on 2 February 2024. This approval sets the stage for the Act to be presented to the EU Parliament for final approval in the coming months, with expectations for it to become law by spring 2024. Following the political agreement reached in December, the final compromise text of the AI Act has been confirmed by Member State representatives, marking a crucial step towards its formal adoption. This development indicates a strong consensus among EU members and paves the way for the European Parliament's final vote on the text.

Once adopted, the AI Act will introduce a comprehensive framework for AI regulation in the EU, categorizing AI systems based on the level of risk they pose and establishing specific obligations for high-risk and general AI systems. Objectionable risk AI systems will be banned, while high-risk systems will be subject to stricter requirements. The Act also outlines obligations for providers of general purpose AI systems, including transparency measures and steps to ensure content generated by AI is clearly identified.

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The final steps towards the Act's adoption involve the European Parliament's vote on the compromise text, which is expected to be a formality given the broad support among EU Member States. Once the Act is adopted, it will officially enter into force 20 days after its publication in the EU's Official Journal, with a step-by-step implementation period for the new rules.

On the other hand, the AI PACT is a voluntary initiative developed in collaboration with the European Commission and major industry players, including Google. The pact aims to bridge the gap until the AI Act becomes fully enforceable by encouraging companies to adopt and adhere to responsible AI practices ahead of the legal requirements. It serves as a platform for organizations to demonstrate their commitment to ethical AI by making a regulatory security frame related to AI Act compliance and responsible AI use.

Moreover, the AI Pact is a voluntary commitment from organizations to align with the objectives of the upcoming AI Act and implement its measures before the formal deadlines (Reuters, 2023). In addition, it encourages early adoption of ethical AI practices, including risk assessments, data governance, and transparency measures and provides a framework for collaboration and sharing of best practices among EU and non-EU organizations to prepare for AI Act compliance (Trilateral Research, 2024).

The primary difference between the EU AI Act and the AI PACT lies in their nature and enforceability. The EU AI Act is a binding legislative framework that, once adopted, will be enforceable across all EU Member States, with specific obligations and penalties for non-compliance. In contrast, the AI PACT is a voluntary initiative that seeks to encourage proactive compliance and ethical AI practices ahead of the formal legislative requirements.

Foundational Principles of EU AI Policies

The EU's AI policy framework is built on the twin pillars of fostering technological excellence and ensuring trustworthy AI. These principles intent to support a thriving digital economy that is ethically aligned and socially beneficial. Initiatives like Horizon Europe exemplify this approach, showcasing the EU's commitment to innovation that is responsible and beneficial for society (European Commission, 2021).

The strategic deployment of AI across the EU's economic sectors is expected to generate significant productivity gains, driving growth and competitiveness in the global market. For example, the manufacturing sector is placed to transform through smart automation, predictive maintenance, and supply chain optimization, using AI to achieve new efficiencies (European Commission, 2021). Moreover, the EU's focus on digital innovation hubs stands as a testament to its commitment to promoting innovation ecosystems where SMEs can access advanced AI technologies and expertise (European Parliament, 2020). There is a growing interest in the applications of artificial intelligence (AI) in the agri-food sector, therefore, the EU Parliament published a policy study on 'Artificial intelligence in the agri-food sector: Applications, risks and impacts'. The study examined among other issues the costumer protection, food safety and social policies related to the implementation of AI technologies (European Parliament, 2023).

The EU's ethical framework for AI, which emphasizes human oversight, transparency, and accountability, serves as a model for balancing technological advancement with societal values. This framework is critical in sectors where AI has profound implications for individual rights and societal norms, such as law enforcement and social welfare (Dervishaj, 2020). By prioritizing ethical AI, the EU is also exploring ways in which AI can contribute to social justice initiatives, providing a blueprint for leveraging technology in the service of the common good.

The White Paper on Artificial Intelligence, published in 2020, outlines the EU's ambition to excel in AI technology while maintaining a high standard of trustworthiness. This approach is critical for ensuring that AI development aligns with the broader digital strategy of the EU, aiming to enhance digital skills, data accessibility, and technological infrastructure (European Commission, 2020).

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Recent policy developments have significantly influenced AI's role in the EU. The ongoing research and the integration of AI in addressing critical societal issues such as healthcare, climate change, agriculture, and transportation underscore the need for a dynamic and adaptive AI policy landscape. The future vision for the EU's AI policy could be seen as a harmonious integration of AI within society, coupled with continuous innovation and regulatory vigilance (European Parliament, 2020).

Conclusion

The EU's AI policy has not a limited strategy but one that recognizes the importance of global collaboration. The EU actively engages in international forums to contribute to the global governance of AI, promoting standards that reflect its values and interests. This commitment to international dialogue is seen in its participation in organizations such as the Global Partnership on AI (GPAI), where it works alongside partners to foster the responsible development and use of AI (European Commission, 2020).

While the EU's approach to AI policy is noteworthy, it faces inherent challenges. Balancing innovation with regulation poses complex dilemmas, with privacy, surveillance, and global competitiveness at the forefront of policy considerations. The EU's strategic approach to AI policy, standing at the crossroads of innovation and responsibility, will be crucial in shaping the technological and ethical landscape of AI development. The ongoing dialogue among stakeholders is crucial for navigating the complex terrain of AI (Dervishaj, 2020).

3. Adaptation at National Context

In the era of modern technological advancements, Artificial Intelligence (AI) emerges as a top-level example of change and a significant disruptor across various sectors, with the potential to reshape industries with its profound capabilities. The adaptation of AI, however, is not uniform but influenced by the unique ecosystems of socio-economic, cultural, and political landscapes of individual nations. In Greece the strategic embrace of AI reflects a commitment to progress, while preserving the country's rich cultural heritage (OECD.AI, 2021a). This document explores the diverse strategies and challenges in the national adaptation of AI and also focuses briefly on the description of AI in the national context.

Since the beginning of the 2020s, the Hellenic Ministry of Digital Governance has been given attention to the creation of a national AI strategy (OECD.AI, 2021b). This process has been a collaborative approach involving major stakeholders in Greece, as well as experts from academia, and EU advisors, and it aims to position Greece at the forefront of the digital era.

Diverse Strategies in AI Adoption

In a world where nations like the USA and China, driven by government support and private sector innovation, have set the pace and taken the lead in AI development, Greece is monitoring its own course within the EU's innovation-driven landscape. With the Generative AI Greece 2030 initiative, the nation is aspiring to launch its key sectors – agriculture, tourism, and maritime commerce – into a future sculpted by AI, fueling growth and pioneering progress (Special Secretariat of Foresight, 2023).

Sector-Specific AI Implementation

Healthcare, finance, agriculture, transportation, and public services are key sectors where AI's impact is evidently visible. For instance, in healthcare, AI-driven diagnostics and patient care models are revolutionizing treatments in many countries such as Germany and the UK. This demonstrates AI's transformative potential when aligned with national sector-specific needs. AI applications are among the top priorities for the agricultural sector, improving production results in the field, facilitating the work of the producers and maintaining the products for a longer period.

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In Greece, where agriculture has been one the cornerstones of life for many generations, AI stands ready to revolutionise traditional farming practices (Ministry of Digital Governance, 2023). From precision agriculture powered by AI to sophisticated data analytics for optimizing supply chains, these innovations give hope of a revival for the agricultural sector. Moreover, linking AI with Greece's vibrant tourism and shipping sectors could redefine the country's economic landscape, enhancing experiences and efficiencies through intelligent systems.

Innovation and Research Ecosystem

Greece's vision for AI is developed by the country's learning and research institutions. These knowledge hubs are crucial in organising AI innovations, forging alliances that transcend academia, industry, and government. The role of academic and research institutions is critical in national AI ecosystems. Collaborations between governments, universities, and the private sector in countries like South Korea and Canada have propelled forward AI research and innovation, setting benchmarks for others to follow.

In Greece the formation of a High-Level AI Committee, a move that clearly shows the strategic priority placed on AI, serves as a central point for these collaborative efforts (GSRI, 2024). Initiatives like the digital assistant for online government services represent the tangible benefits of this focus on AI (Ministry of Digital Governance, 2023).

Cultural Values and AI Policy

Cultural values significantly influence AI adoption and policymaking. For example, Japan's approach to AI in eldercare reflects its societal norms and demographic challenges. Additionally, ethical frameworks vary, with countries like Sweden emphasising transparency and user control in AI applications (OECD.AI, 2021c).

Greece's journey in AI is as much about technology as it is about people. Cultural values, the foundation of Greek society, cast a significant influence on AI adoption and policymaking. Ethical considerations, reflective of Greece's societal norms, are interlinked with AI strategies, ensuring that technological progress advances hand in hand with human-centric values.

Conclusion

Emerging AI trends, such as advancements in machine learning and autonomous systems, will continue to impact national strategies. The adaptation of AI is predicted to accelerate, with increasing emphasis on sustainable and ethical AI development. Legislative initiatives, like the proposed AI regulations for distance learning and evaluation (exam), emphasize the nation's proactive stance in sculpting a regulatory framework helpful to ethical AI adoption (Kathimerini.gr).

AI adaptation brings a number of challenges interconnected with opportunities; therefore, it is a double-edged sword. As Greece deals with difficult ethical questions, privacy concerns, and the socio-economic impact of AI, it also stands to obtain the rewards of innovation and enhanced efficiency. The balance of these issues is crucial in the making of national strategies, which must be adaptive, ethical, and inclusive to harness the full spectrum of AI's potential.

Understanding diverse national approaches to AI is crucial in a globalised world. International collaboration and knowledge exchange will play a vital role in addressing the challenges of AI adaptation. As AI starts reshaping global landscapes, national strategies will need to be agile and responsive to technological advancements.

In the EU, Greece's commitment to AI is a dynamic highlight, symbolising both economic ambition and societal enrichment. The integration of national policies with EU legislation is central to this narrative, positioning Greece as a proactive contributor to the EU's digital future.

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4. National Legislation Frameworks

Given that AI technologies are a fairly new topic that countries, including EU countries, increasingly rely on to facilitate several aspects of different sectors, steps have been taken in order to create legal frameworks which will safely integrate them to national policies while at the same time moving forward to effectively regulating them.

As previously mentioned, the EU has established the AI Act, which is a draft EU law on Artificial Intelligence, aiming to "ensure better conditions for the development and use of this innovative technology" (European Parliament Topics, 2023). In most EU countries, institutional frameworks regarding AI have been established and national strategies have been drafted up or are in the process of being drafted, which encompass applications in many different sectors. A common observation is that a significant number of countries have made provisions regarding different sectors such as education, health, economy, public governance etc., but few have specific provisions on agriculture. For example, France established a 5-year national AI strategy in 2018, revised in 2021, which promoted, among others, data sharing in agriculture by funding several data hub projects.

The emerging trend of AI use in different sectors led countries to create legal frameworks to regulate the development and utilization of relevant AI tools. In Greece, in terms of steps towards regulating AI technology development and use, on July 27, 2022, Law 4961/2022 was published in the Official Gazette, in which a national framework for regulating the use of AI technologies was introduced, for both public and private sectors. Law 4961/2022 sets up a framework to "ensure the rights of natural persons and legal entities, strengthening accountability and transparency in the use of artificial intelligence (AI) systems, and complementing the existing institutional framework for cybersecurity" (Data Guidance, 2023).

Through this law, which entered into force in March 2023, a Coordination Committee for AI was established in 2023, which is responsible for drafting the aforementioned National Strategy for AI and formulating AI policies through the establishment of key indicators on activities pertaining to AI. A Monitoring Committee was also introduced, aiming to ensure fair implementation, coordinate relevant authorities, and oversee its application. This specific legal framework that has been produced aims to establish "horizontal and vertical obligations" for both public and private bodies within Greece, while also providing guidelines which protect the rights of legal entities and natural persons and strengthening transparency and ethical use.

At the same time, a national strategy for AI is currently being developed since 2020, with the Greek Ministry of Digital Governance (MDG) taking steps towards integrating AI in different sectors involved in the digital transformation of the country. The National AI strategy is part of the main axes of the Bible of Digital Transformation Bible 2020-2025, which aims at transitioning the country to a future of digitalization. The objectives include the determination of the conditions for the development of AI, the data policy as well as the development and use of AI technologies on an ethical basis. Different interventions and projects are already underway under the Bible of Digital Transformation, with 23 projects directly related to the digital transformation of the agricultural sector. While AI is again not specifically mentioned, it is understood that parts of these projects will also pertain to the use of AI in the agricultural sector.

However, in an ever-changing global environment where AI applications are continuously evolving, Greece is committed to continuing to shape the legal framework relating to these technologies, while the Greek Ministry of Digital Governance continues to spearhead the development of the National Strategy for AI. As Europe is embracing AI as a useful tool in almost all sectors of economy while also setting up a coherent framework to regulate it, Greece is following suit by committing to adapt relevant national policies which will address the challenges emerging from the development and

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implementation of AI technologies. The agricultural sector, which is a significant part of Greece's economy, does not seem to be prioritized over other sectors, it is however evident that any future legislative adjustments will include it in an all-encompassing legal framework.

5. AI Technologies & Applications in Agriculture Industry

Introduction

The agricultural industry is a fundamental factor for the financial capacity of many states globally. Statistics show that agriculture contributed 4.3 percent of the share of economic sectors in the global gross domestic product (GDP) in 2021 (Statista, 2021). During global financial crises, funds tend to invest in land and agriculture. In past decades being a farmer was connected to hardship in the field, practicing the basics in agricultural activities and farming. However, the capacity of the practitioners in the field was reaching to the level of personal work and the actual outcome was depended also on weather conditions and other unexpected environmental changes.

The integration of Artificial Intelligence (AI) into agriculture is producing a revolution across the global agricultural landscape, introducing an era of efficiency and innovation previously unreachable. This transformation is evident on the size of farms of North America, the diverse agricultural lands of Europe, and the complicated in terms of landscape fields of Greece. Each region, with its distinct challenges and opportunities, discovers in AI an adaptable ally to improve traditional farming methods, giving a boost to the agricultural sector.

From global to local innovations in agriculture

AI stands as a foundational pillar of modern agriculture worldwide, providing advanced solutions in crop surveillance, risk management, and resource allocation. Innovations such as self-operating tractors, AI-powered drones, and intelligent irrigation systems embody AI's significant influence (Ray, 2019). These technologies enhance operational efficiency and contribute to the sustainable farming movement by optimizing resource usage, thereby limiting the ecological impact (Smith, 2021).

AI's influence is growing in European Agriculture. Europe's agricultural AI narrative is distinguished by a strong commitment to sustainability and accuracy. The EU's Common Agricultural Policy emphasizes the importance of AI's integration to empower European agribusiness competitiveness while safeguarding the environment (European Commission, 2021). Nations like the Netherlands and Germany are at the forefront of AI deployment for greenhouse automation and animal farming, demonstrating AI's potential to increase productivity across varied agricultural situations (Van der Ploeg, 2020).

The Emergence of AI in Greek Agriculture is also worth noting. In Greece, where agriculture holds a central economic and cultural role, AI is starting to leave a significant mark. The nation's digital strategy aims to integrate AI across diverse agricultural practices, from the cultivation of olive groves to vineyards and fruit production. Initiatives in AI-assisted disease identification and accurate predictive signals foreseeing upcoming issues, as well as AI methods in longer maintenance of products and logistics, provide a potential to the development of Greek agriculture (Ministry of Digital Governance, 2023).

Innovation in practice

Sustainable farming is a critical aspect of AI in modern agriculture. AI aids in promoting sustainable practices by optimizing water usage and reducing the need for chemical fertilizers, thereby minimizing environmental impact (The Silicon Review, 2024). Also, precision agriculture has emerged as a key AI application, enabling farmers to manage their crops and soil more effectively. AI-powered drones and

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automated machinery facilitate efficient crop monitoring and harvesting. Additionally, remote sensing technology, through satellite imagery combined with AI analytics, provides critical insights into crop health and soil conditions (V7 Labs, 2023).

For instance, in the USA, AI-based soil analysis tools are helping farmers optimize fertilizer use (Think with Niche, 2024). These case studies demonstrate the practical benefits and flexibility of AI in agriculture. In the Netherlands, AI-driven greenhouse farming has significantly increased production, making a comparatively small country to produce enough for covering internal needs and exporting globally, making agricultural economy an important factor for financial development.

In addition, AI in animal farming introduced applications to monitoring animal health and behavior, enhancing breeding, feeding, and disease prevention strategies. This not only improves animal welfare but also optimizes productivity of meat and dairy products, as well as reproduction.

Conclusion

To sum up, AI is positioned to play a critical role in the future of agriculture. With the ongoing advancements in AI technology, the agricultural sector is set to become more efficient, sustainable, and productive (TYM, 2023), understanding these technologies and their applications is crucial in shaping the future of global agriculture. The development of AI solutions for the agri industry will attract more capital for research and investments. However, the major challenge is how to connect and train the ordinary farmer to access and operate the new AI solutions for the field. In addition, the accessibility of AI technologies is still not affordable by small producers, as on the contrary, of big producers.

6. Pedagogical Practices and Trainings

In 2022, agriculture contributed around 3.76 percent to the GDP of Greece, which is slightly higher than in previous years (Statista, 2024). The Greek agricultural sector employs approximately 400,000 people and rural inhabitants represent about 31% of the Greek population, a number that is higher than the EU average. While unemployment especially in young ages remains an issue in the agricultural sector in Greece, the Greek CAP Plan pledges to follow the goals of the common agricultural policy, especially when it comes to shifting to digital agriculture. Innovation and new technologies are encouraged and promoted, while also focusing on young entrepreneurship and addressing digital literacy gaps.

Pedagogical approaches and training programs addressing the digital literacy gap among agriculture workers

Aiming to keep up with the challenges of the transition to a digitalized agricultural sector, there are several pedagogical approaches and training programs that are being implemented to address the digital literacy gap among agriculture workers in Greece.

For example, the Lifelong Learning Centre of the Agricultural University of Athens regularly organizes such seminars and training programs which are specifically designed to cover topics such as precision farming, data management, agricultural drones and smart farming practices (KEDIVIM AUA). It also organizes, upskilling and retraining programs in high-demand industries with a focus on digital and green skills under the “Greece 2.0 – National Recovery and Resilience Plan”. These trainings include digital geospatial technologies (G.I.S., Drones, Satellite Images), geospatial technologies and Location Intelligence in Digital Agriculture, Technologies and advanced methods of control and traceability of agricultural products and food, etc.

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There are often collaborations between public institutions, research or academic institutions and private sector stakeholders or industry partners with a purpose of designing training programs and educational resources on addressing digital literacy among agriculture workers. The Agricultural University of Athens is organizing such programs with different stakeholders from the private sector in order to provide high-quality educational materials relevant to the digital transformation of the agriculture sector for agriculture workers.

Agricultural extension services, including the Hellenic Agricultural Organization (ELGO) "DEMETER" and other Agricultural Cooperatives, also play an important role in providing training to farmers in Greece, with a focus on young farmers. They organize field demonstrations, on-farm training sessions, and training programs to promote digital literacy and adoption of digital tools in agriculture. Through these training programs, innovation and entrepreneurship are promoted in accordance with modern technological developments. Specialized knowledge is offered, so that farmers are able to cope with the demands of their profession, especially when integrating innovation and following developments of technology.

As well, there are several online resources and seminars that are offered by agricultural organizations and educational institutions, specifically webinars, e-learning modules and others, which contribute to bridging digital literacy gaps. Institutions such as the Agricultural University of Athens and the Agricultural university of Thessaloniki offer different webinars pertaining to digital upskilling of farmers. National and Kapodistrian University of Athens offers e-learning courses on the adoption of innovations in the agricultural sector as well as the digital transformation of agricultural enterprises through innovative practices and modern technologies.

Best practices and successful training initiatives

Greece also has participated in EU-funded projects aimed at enhancing digital literacy and innovation in agriculture. Greece was part of the South-East Regional Cluster of the SmartAgriHubs project, which involves facilitating farmers' access to "cutting edge ICT technologies tailored to farmers' individual needs". It also helped farmers access and use digital innovative applications which respond to their needs, all while building their capacities. IoF2020 (Internet of Food and Farm 2020) was a project focused on precision farming which involved Greek partners and provided training and support to farmers, researchers, and agri-tech startups. These projects facilitated knowledge exchange, technology transfer, and capacity building in digital agriculture.

Greece is also currently part of the Demeter project, which aims at adopting advances IoT technologies, AI applications and smart farming among others to lead European digital transformation in agriculture. The project is meant to help farmers by building on their already existing experience while at the same time focusing on digital information. As such, the Hellenic Agricultural Organisation (ELGO) completed a full-day farming school under the Demeter project, where a number of farmers trained on a teaching farm in Central Macedonia, learning sustainable techniques from expert instructors. Topics covered were "integrated pest management, efficient irrigation, soil management, harvest and post-harvest management, animal husbandry, and agricultural machinery operation", showcasing a fine example of a best practice on addressing digital literacy among agriculture workers.

Another pedagogical approach could also be found in pilot agricultural projects. There are several pilot projects running in Greece, under either EU funds or other sources of funding, which focus on innovative methods of farming. Several pilot farms can be found in Greece, which focus on innovative methods of farming, such as regenerative farming (AgriCapture CO2 project, Regenerative Farms Greece). Other pilot farms focus on precision agriculture services where AI applications are of crucial

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importance (AgriBIT project). In these pilot projects, farmers could observe and learn more about applications of digital means, including AI, as these projects showcase innovative farming practices, such as sensor-based irrigation systems, precision fertilization, and crop monitoring using satellite imagery.

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AI4Agri Project website: https://www.ai-4-agri.eu/

AI4Agri Project e-Learning Platform: https://ai4agri-elearning.eu/

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