P-ISSN: 2170-1040 | **Journal of Economic Papers** **Volume: 17 – Issue: 01 (2026), P: 42-54** | **E-ISSN:** 2602-5426

Sustainable Future Through AI: The Rise of Green AI Entrepreneurship in MENA's AgriTech Sector

KERIM Zana Khouloud [1♦], SAIDI Mohamed [2]

[1] LAMAPE Laboratory, Oran Graduate School of Economics (Algeria), kerim.zana@ese-oran.dz
[2] LAMAPE Laboratory, Oran Graduate School of Economics (Algeria), saidi109@yahoo.fr

Received: 01/01/2026 **Accepted:** 12/05/2026 **Published:** 31/05/2026

Abstract:

The MENA region faces critical environmental challenges, including water scarcity, soil degradation, and the growing impact of climate change on agriculture. In response, a new wave of green entrepreneurship is emerging, turning to artificial intelligence (AI) as a powerful tool to drive sustainable change in agriculture. This paper explores the rise of Green AI entrepreneurship in the region's AgriTech sector, highlighting how innovative startups are using AI to make agriculture more efficient, productive, and environmentally friendly. Drawing on case studies from some region's countries, we examine how these ventures are reshaping agriculture through smart solutions. The findings underscore the potential of Green AI to support sustainability goals while creating green economic opportunities. However, challenges such as funding gaps, limited infrastructure, and inconsistent policies remain. The paper concludes with policy and ecosystem recommendations to support and scale Green AI entrepreneurship, positioning MENA as a future-ready region for sustainable agricultural transformation.

Keywords: Artificial Intelligence, Green Entrepreneurship, AgriTech, Sustainable development, MENA.

JEL Classification : O30, L26, Q16, Q56, O53.

♦ **Corresponding author**

1. Introduction:

For thousands of years, agriculture has served as a foundation of human civilisation, providing sustenance and raw materials while sustaining livelihoods. Given recent advancements, the sector stands to benefit significantly from adopting advanced technologies, optimising agricultural processes by tracking and analysing environmental factors such as temperature, smoke, light, soil moisture, humidity, and fire detection (Abdullah et al., 2025, p. 291). The UN Sustainable Development Goals (SDGs) emphasise the importance of food security, calling for ongoing effort and fresh ideas. This message is reflected repeatedly in recent UN reports, especially in the MENA (Middle East and North Africa) region, where water scarcity, desertification, and food insecurity pose acute challenges. Among the most promising responses to these challenges is the rise of green entrepreneurship and startups, which refer to entrepreneurial initiatives aimed at developing environmentally sustainable products, services, and business models.

The literature introduces various terms with distinct meanings to describe the concept of green entrepreneurship, including green entrepreneurship, environmental entrepreneurship, ecological entrepreneurship, sustainable entrepreneurship, eco-entrepreneurship, and eco-preneurship (Nikolaou et al., 2011, p. 02). Moreover, in the papers by Farinelli et al. (2013, p. 05; Haldar, 2019, p. 100), research on green entrepreneurship remains limited and lacks a strong empirical foundation. This may be due, in part, to the challenge of distinguishing between green and non-green entrepreneurship. It was not until the 1990s that studies on green entrepreneurship began to emerge, with scholars such as Bennett (1991), Berle (1991), and Blue (1990) introducing terms like "environmental entrepreneur," "green entrepreneur," "eco-entrepreneur," and "ecopreneur" in their work. However, green entrepreneurship often faces significant barriers, including high costs, limited access to sustainable technologies, a lack of data for informed decision-making, and market uncertainties. As a result, there is a pressing need for enablers that can support the growth and impact of green ventures. In this context, Artificial Intelligence (AI) has emerged as a transformative force with the potential to revolutionise how green entrepreneurs operate and innovate. And especially in agriculture. As mentioned in (Spanaki et al., 2022a, p. 492), unlike many other sectors, the shift from traditional agricultural methods to modern, data-driven approaches isn't just about new technology; it is a necessity. With the urgent need to grow enough food for the growing population and protect the environment, this shift has spurred rapid growth in Agricultural Technology, or AgriTech. No surprise, then, that investors and researchers are pouring into this field, focusing on using AI to make agriculture more efficient and sustainable.

In the MENA region, where agriculture remains vital but constrained by ecological and resource-related limitations, AI-driven green AgriTech holds strategic importance. Policymakers, investors, and innovators are increasingly turning to AI to help address the region's food and environmental challenges. According to (Ryan et al., 2023, p. 02), the agricultural sector is expected to see major investments in AI in the coming years, with an estimated annual growth rate of 25.5% from 2020 to 2026. Even though AI offers exciting possibilities for transforming agriculture and benefiting the environment, its use in green

businesses in the MENA region remains limited, underexplored, and often inconsistent. This raises important questions: *How can AI be used effectively to support eco-friendly companies in MENA's AgriTech industry.*

This study aims to examine how artificial intelligence can support green entrepreneurship in the agricultural sector, with particular attention to the AgriTech ecosystem in the MENA region. It seeks to explore the role of AI in enabling sustainable entrepreneurial practices, identify the key barriers and enabling factors that green entrepreneurs face when integrating AI technologies, and assess how AI-driven AgriTech solutions can respond to pressing regional challenges such as water scarcity, climate stress, and food insecurity. Methodologically, the paper adopts a qualitative approach using a multi-case study design, drawing on a review of relevant academic literature and insights from recent scientific conferences to capture both theoretical and practical perspectives.

The paper is organised as follows: it begins by outlining the foundations of artificial intelligence and green entrepreneurship, then examines their intersection and the evolution of AgriTech in the age of AI. This is followed by an analysis of the main challenges associated with implementing AI in green AgriTech ventures, a presentation of successful case studies from the MENA region, and a discussion of the findings, before concluding with key insights and implications.

2. Theoretical background:

2.1 Artificial Intelligence:

For (Shrivastava, 2024, p. 01) AI is the development of computers and machines that can think, learn, and behave in ways that would typically need human intelligence or involve data that is beyond the scope of human analysis. (Dahlke, 2024, p. 02) mentioned that "Artificial intelligence (AI) refers to digital machine-based systems that process inputs, infer concepts, and generate outputs for explicit or implicit objectives. It can be expected to perceive and influence its environment to varying degrees of autonomy. The purpose of fulfilling these objectives is to automate human labour and/or augment human intelligence". Meanwhile, (Raj, 2024, p. 646) defined it as a science focused on performing tasks that require human intelligence. It utilises algorithms and vast amounts of data to enhance various fields, including prediction, health, and security, while also improving production and service performance.

In sum, Artificial Intelligence is a technology that enhances personal and professional efficiency by automating tasks, solving critical problems, and transforming industries. It presents both opportunities and challenges, necessitating responsible integration into society to maximise benefits while mitigating risks.

2.2 Green Entrepreneurship:

Green entrepreneurship is about creating new ways of doing business that help protect our environment. It ties into ideas from industrial ecology and sustainability, like thinking about things from start to finish, such as how products are made, used, and eventually recycled or disposed of (Haldar, 2019, p. 103). This kind of entrepreneurship focuses on innovations in manufacturing or services that aim to conserve natural resources and maintain healthy

ecosystems. For example, activities such as conserving wildlife, eco-friendly tourism, recycling, wastewater treatment, and producing renewable energy all fall under this umbrella. Furthermore, (Nikolaou et al., 2011, p. 03) define it as the process of discovering, creating, and exploiting opportunities to provide new products and services, while also thinking about the economic, social, and environmental impacts. In addition, (Dean & McMullen, 2007, p. 58) see it as the identification and utilisation of economic opportunities arising from environmentally relevant market failures.

Besides,(Kotchen, 2009, p. 28) calls it "eco-entrepreneurship", which means starting new businesses around products or services that create some environmental benefits, even if they aren't completely public goods. However, (Thompson et al., 2011, p. 210) use the term "sustainable entrepreneurship" to describe initiatives that merge sustainable development goals with economic and entrepreneurial ambitions. In brief, this concept centres on ventures that seek to minimize environmental harm while generating economic value and delivering social benefits. Even so, Dean and McMullen point out a difference between environmental and sustainable entrepreneurship. They're related but not exactly the same thing.

2.3 Intersection of AI and Green Entrepreneurship:

The integration of Artificial Intelligence (AI) into green entrepreneurship has emerged as a transformative force, driving both sustainability and operational efficiency. AI technologies, including machine learning, predictive analytics, and IoT, are being leveraged to optimise resource utilisation, reduce environmental impact, and streamline business processes. The following sections outline key ways AI can improve green entrepreneurship.

2.3.1 Processes optimisation:

A. **Resource Optimisation:** AI can analyse data to minimise waste and improve energy utilisation, leading to more sustainable production methods. In this regard, the 4.0 techs (IIoT, 3D printing, cloud computing) are working to reduce waste and downtime, Enable Energy-Efficient data management, and improve material properties by enabling collaborative manufacturing and predictive maintenance over extended distances (Kulova et al., 2024, p. 04). In addition, for (Pratap & Srivarum Venkatesh, 2024, p. 250), algorithms for predictive maintenance are capable of identifying equipment faults before they happen, minimising downtime and cutting down on waste from unplanned malfunctions.

B. **Supply Chain Management:** Forecasting accuracy has been shown to rise by up to 85% with improvements in logistics and forecasting processes, which are crucial for reducing emissions. While, Real-time route optimisation has also significantly reduced delivery times and fuel usage (Kulova et al., 2024, p. 05). Moreover, in (Reshmi & Sopna, 2024, p. 850) paper, predictive analytics driven by AI, Intelligent Automation and Machine learning have become a powerful tool for increasing supply chain sustainability by increasing productivity and reducing waste. In this regard, Amazon uses machine learning algorithms to forecast demand for certain product categories at a fine level. Also, DHL has significantly reduced its carbon footprint and operating expenses by using AI-powered robots to handle packaging and sorting.

2.3.2 Promoting Eco-Innovation: The development of environmental consciousness and the pooling of innovative resources are both improved by AI orientation. It generates fresh concepts and effectively reduces the risks and costs associated with innovation. Additionally, by utilising the latest information technology and changing the character of the innovation process, AI orientation serves as a strategic guideline that aids businesses in optimising output (Tian et al., 2023, p. 41). Furthermore, according to (Wang et al., 2024, p. 03), regarding end treatment, machine learning, data processing, and other AI functions can not only gather, disperse, categorise, and recycle various pollutants, but also train and develop AI models to evaluate end pollutant indicators and create optimisation plans to lower pollution emissions.

2.3.3 Data-Driven Decision-Making: Depending on (Kulova et al., 2024, p. 05; Pratap & Srivarum Venkatesh, 2024, p. 251) By offering practical insights obtained from the examination of intricate and huge data sets, AI technologies are effective instruments for environmental management. Additionally, machine learning algorithms can forecast resource consumption trends, detect energy-use inefficiencies, and recommend adjustments that have a major positive environmental impact. At the same time, data analytics allows businesses to track their carbon impact in real time, which promotes more intelligent and adaptable decision-making.

2.3.4 Improving Customer Engagement: AI enhances customer engagement by providing personalised experiences through tools like chatbots and recommendation systems. These technologies not only improve customer satisfaction but also promote eco-friendly products by guiding consumers toward sustainable choices. Starbucks uses this technology to provide customers with information on the route of their coffee, from the farm to their cup. In addition to fostering customer trust, this degree of openness makes providers answerable for their environmental and social obligations (Reshmi & Sopna, 2024, p. 850).

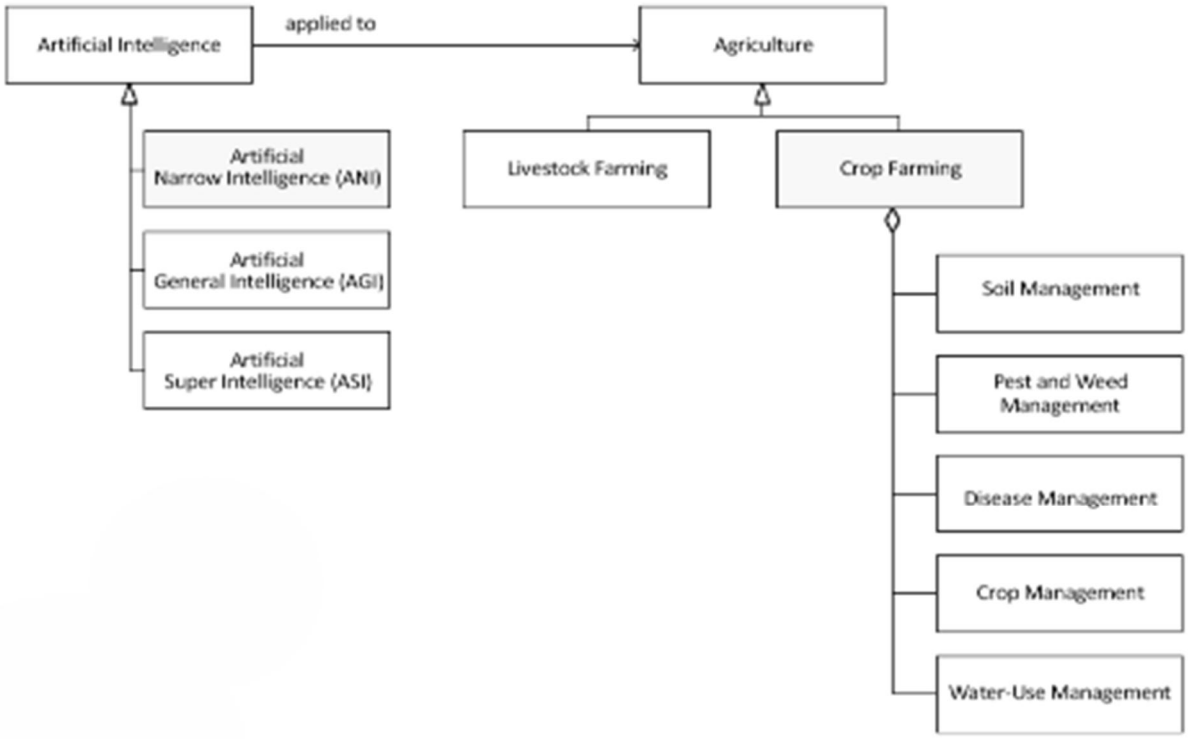
2.3.5 Promoting Sustainable Practices: From the previous sections, it's clear that the combination between AI and Green entrepreneurship play a crucial role in improving sustainability. By employing AI technologies, businesses can optimise their production methods, which leads to reduced waste and improved energy efficiency, ultimately decreasing the environmental footprint of businesses. In (Byčenkaitė & Burinskienė, 2023, p. 179) paper, it is mentioned that applying AI to various business domains can also greatly enhance business sustainability, which is crucial when aiming for zero emissions especially in water supply, logistics, and agriculture, according to the analysis. Likewise, (Reshmi & Sopna, 2024, p. 851) pointed out that Boston Consulting Group created its software as a service (SaaS) application, CO2 AI, to help businesses measure, monitor, and eventually lower carbon emissions. As a result of these developments, experts in AI predicted that the technology will help businesses improve their sustainability initiatives and lessen their environmental impact, which is often achieved by minimising waste, reducing consumption, and optimising resource utilisation. Moreover, AI can facilitate compliance with environmental regulations and industry standards, reducing the risk of non-compliance and associated penalties. By

leveraging AI, businesses can ensure that their operations align with global sustainability standards while maintaining operational efficiency (Kulova et al., 2024, p. 04).

2.4 AgriTech in the age of AI:

AgriTech, or agricultural technology, encompasses the application of innovative technologies to enhance agricultural practices, improve productivity, and ensure sustainability. Moreover, the demand for agricultural technology stems from the urgent goal of sustaining the global population (Spanaki et al., 2022b, p. 493). Otherwise, AgriTech in the age of AI represents the fusion of advanced technology and agriculture to improve efficiency, yields, and sustainability. It leverages AI along with other technologies like robotics, sensors, drones, big data, and IoT to digitise and optimise farming operations (Agarwal et al., 2024, p. 600) (Figure N° 1.).

Figure N° 1. AI & AgriTech



Source : (Ryan et al., 2023, p. 08)

AI helps farmers practice smarter farming by bringing together data from different sources like satellites, drones, soil sensors, and weather reports. With the help of AI, farmers can see what's happening in real-time and make better decisions about watering, adding nutrients, and controlling pests (Ryan et al., 2023, p. 08). Moreover, using AI-powered supply chain tools can significantly boost the flexibility and responsiveness of farming businesses. They help with predicting demand, handling transportation, and managing storage better. This not only cuts down on food waste but also reduces greenhouse gases, especially for fresh items like fruits and vegetables that don't last long (Ganeshkumar et al., 2023, p. 74). As well, (Agarwal et al., 2024, p. 601) mentioned in their paper that using deep learning and computer

vision, AI can spot disease signs on plant leaves and stems pretty accurately. These smart systems can even catch infections early, before any obvious symptoms appear. As shown in (**Figure N° 2**).

Figure N° 2. Disease Detection process



Source: (Agarwal et al., 2024)

In addition, AI offers innovative solutions to environmental challenges by optimising resource use, improving energy efficiency, and supporting conservation. It improves processes like traffic management, supply chains, and water distribution to reduce waste, while AI-driven systems minimise energy consumption in buildings, industries, and transportation. Plus, AI makes renewable energy sources more reliable and affordable. It also plays a role in protecting wildlife, keeping an eye on deforestation, and caring for marine life. All these efforts help us move toward a more sustainable and environmentally friendly future (Debnath & Kumar Basu, 2023, p. 65).

2.5 Challenges in Implementing AI for Green AgriTech Entrepreneurship:

Implementing AI in green AgriTech entrepreneurship offers major opportunities for sustainability and efficiency, but faces significant challenges.

2.5.1 Data Accessibility: The effectiveness of AI algorithms in analysis and decision-making relies on high-quality data. However, businesses often face challenges related to data accessibility, completeness, and reliability, especially concerning sustainability-related information. Ensuring data quality, consistency, and compatibility across multiple systems and sources remains a significant obstacle to leveraging AI for sustainable practices (Reshmi & Sopna, 2024, p. 851).

2.5.2 Data Privacy and Ethical Considerations: The use of AI in sustainable practices raises several ethical and social concerns, including data privacy, algorithmic bias, and equitable access to technology ((Reshmi & Sopna, 2024, p. 851). Additionally, (Pratap & Srivarum Venkatesh, 2024, p. 254) highlighted that AI algorithms reflect the biases present in the data they are trained on. This poses a risk of unintentionally reinforcing existing biases or exacerbating inequalities, particularly if they do not account for the varied impacts of environmental policies on different communities. Also, AI systems rely on large volumes of data, which raises concerns about data privacy and the security of sensitive information. There is a risk that data gathered for sustainability initiatives could be misused, potentially resulting in privacy breaches.

2.5.3 Need for Skilled Professionals: The integration of AI and IoT in sustainable practices requires a workforce skilled in these technologies. The shortage of trained professionals poses a significant challenge to effectively harnessing AI for green initiatives (Kulova et al., 2024, p. 06). Meanwhile, (Reshmi & Sopna, 2024, p. 851) emphasised that implementing AI solutions requires expertise in data science, machine

learning, and AI technologies. However, businesses may struggle to attract and retain skilled professionals capable of developing, deploying, and managing AI-driven sustainability initiatives.

2.5.4 Economic Constraints: Starting a sustainable business often demands substantial initial investments. Implementing green technologies and adopting eco-friendly practices can lead to higher upfront costs compared to conventional business models (Olubusola Odeyemi et al., 2023, p. 353). As well, (Pratap & Srivarum Venkatesh, 2024, p. 254) noticed that AI-driven automation can result in job displacement, raising ethical concerns about its impact on workers in industries undergoing digital transformation for sustainability efforts. And according to (Reshmi & Sopna, 2024, p. 851), implementing AI solutions for sustainable practices often involves high upfront costs, including hiring experts, developing infrastructure, and investing in technology. In the short term, businesses may struggle to demonstrate the financial benefits of AI-driven sustainability initiatives and accurately measure their return on investment (ROI).

2.5.5 Cultural Resistance: Organizations may face resistance to adopting AI-driven practices due to entrenched corporate cultures and fear of change. Leveraging AI for sustainable practices requires a shift in business mindset, attitudes, and behaviours toward innovation and technology adoption. Organizational inertia, stakeholder resistance to change, and a lack of support can hinder the successful implementation of AI-driven sustainability initiatives (Reshmi & Sopna, 2024, p. 851). As well as, (Olubusola Odeyemi et al., 2023, p. 353) indicated that consumer adoption of green products remains slow. While environmental awareness is growing, purchasing decisions are often influenced by factors like price sensitivity, convenience, and perceived effectiveness of sustainable products.

2.5.6 Limited awareness about environmental impact: The environmental impact of AI techs remains poorly understood, especially regarding their long-term effects. This uncertainty makes it challenging to design AI solutions that are genuinely sustainable and environmentally friendly (Pandey, 2023, p. 3330).

3. Successful Case Studies from MENA region:

This section explores the experiences of AgriTech entrepreneurs in the MENA region, focusing on best practices and outcomes of their sustainability-driven initiatives. It highlights how entrepreneurial solutions address the region's agricultural and environmental challenges.

3.1. Farm AI (Algeria):

Farm AI is an Algerian startup in agriculture technology that creates AI-based tools for farmers. They focus on early detection of plant diseases, using drones equipped with computer-vision models to monitor crops more effectively (*FarmAi*, n.d.). The team attracted international attention after ranking second (silver) in the Tech4Good competition (2023), a milestone that helped raise the startup's profile (E.Idowu, 2023).

Its system combines drone and sensor imagery with computer vision and machine learning to spot early signs of crop disease and stress. It then offers simple guidance for action,

like targeted treatments or quick on-site checks, which helps farmers respond faster and test new methods across larger areas more easily (*FarmAi*, n.d.).

According to (Scott, 2024; Service, 2023), Farm AI is a shining example of green AI entrepreneurship in the MENA region. It helps farmers grow crops more sustainably by focusing on precise, early interventions. Instead of spraying pesticides everywhere or overwatering fields, Farm AI targets specific areas and times, reducing chemical and water use and cutting down on pollution and extra inputs. Its ability to detect plant diseases displays a careful, accurate way of monitoring crops that fits well with eco-friendly farming. Designed as a simple, affordable solution personalised to local needs, Farm AI tackles common challenges like water shortages, small and scattered farms, and limited access to farming advice which are issues that many green projects in Algeria and across the MENA region are trying to solve. Moreover, its local, frugal innovation, supported by international competitions and government recognition, has boosted visibility and resources, offering a model for other green-AI startups in the region (Redaction, 2023).

3.2. Smart for Green (Tunisia):

Smart for Green is a Tunisian cleantech / AgriTech startup that develops IoT + AI systems to detect and predict wildfires, aiming to protect forests and large farms. (*Smart For Green - About | F6S*, n.d.). Their technology brings together a few key tools: first, a network of low-power IoT sensors that monitor things like temperature, humidity, and other environmental factors; second, smart cameras that can spot smoke or fires early on; and third, machine learning models that predict short-term fire risks and send instant alerts to managers or emergency teams. The goal is to shift from just reacting to fires after they start to proactively preventing them and responding quickly when needed (*Welcome - Smart For Green*, n.d.).

Smart for Green shows how green AI businesses in the MENA region are tackling big environmental issues. They focus on problems like wildfire risk and forest conservation, especially in Mediterranean countries. The startup uses sensors installed on-site and smart cameras to cut down on data transfer and provide almost real-time insights locally. This approach is especially helpful in areas where internet connections can be limited. Plus, Smart for Green offers a clear path for other MENA green AI projects to grow from initial local tests to international platforms. They've built credibility and gained attention by participating in major events like COP and Web Summit, along with government programs (media, 2024; Sahli, 2023).

3.3. ReNile (Egypt):

Founded in 2017 by Hazem Eltawab, it began as a university-linked project focused on smart ways to monitor the environment before evolving into a full-fledged AgriTech startup. The company gained national visibility after appearing on the Egyptian version of Shark Tank, where they first got offers for $150,000. That initial support soon turned into a successful funding round of $450,000. Riding this wave of success, ReNile is now looking to grow across the region, opening a new factory in Saudi Arabia and forming a key partnership in Kuwait. These steps are expected to lead to contracts worth about EGP 40 million (roughly USD 1.3 million) by 2025 (Cairo scene, 2025; Room, 2025).

ReNile offers comprehensive IoT solutions for agriculture that connect everything from real-time monitoring and emergency alerts to remote automation and in-depth data analysis, all through a cloud-based platform. Its technology works with many types of farms, including aquaculture, hydroponics, greenhouses, open-field crops, and poultry farms. It also supports specialized systems like RAS and Biofloc setups. The company also has unique products like Duma, a portable device for measuring environmental conditions, and Aedes, an IoT solution aimed at monitoring water and air quality to help optimize resources (*ReNile - Best Technical Solutions for Fish Farms*, n.d.). This company showcases Green-AI entrepreneurship in MENA by using automation and data-driven precision to optimize water, energy, and resource use. Their solutions help farms produce more while wasting less, especially in areas where traditional farming is tough. Thanks to support from investors and positive media coverage, ReNile is quickly establishing itself as a leader in AI-driven agriculture that's not just innovative but also sustainable and climate-friendly(Koba, 2025).

4. Discussion:

The three case studies illustrate how green AI entrepreneurship in the MENA region is addressing urgent environmental and agricultural challenges with innovative tech solutions. Even though their projects are different in scope and approach, they all aim to use resources more efficiently, protect nature, and better prepare for climate change's challenges.

From a technological perspective, these three companies show a range of ways AI can be integrated and applied. Farm AI uses computer vision and machine learning with drones to monitor agriculture, helping farmers spot plant diseases early and take targeted action. This means less chemicals are needed, and water can be used more wisely. Smart for Green uses edge computing, smart sensors, and AI to predict and prevent wildfires, protecting forests and wildlife. While, ReNile focuses on complete IoT solutions for managing aquaculture and greenhouses, using environmental sensors, cloud data analysis, and automation to improve water quality, cut down waste, and boost production.

Furthermore, in terms of sustainability impact, it's clear that AI can bring real environmental benefits. Farm AI helps manage pests and diseases more precisely, which means less need for chemical pesticides. Smart for Green has early warning systems that can help prevent wildfires, protecting forests and capturing carbon. ReNile's solutions improve fish farming, saving resources and lowering pollution risks. All together, these efforts support important regional goals like food security, saving water, and fighting climate change, aligning well with the United Nations Sustainable Development Goals.

However, there are still some common obstacles to deal with. Expanding AI tech in MENA's agricultural and environmental sectors requires overcoming infrastructure limitations (limited internet in rural areas for IoT devices), regulatory barriers (especially for drone operations and data sharing), and financial accessibility for smallholder farmers who often lack the capital to invest in advanced systems. On top of that, it's important to keep data local and ensure AI models can work well across the region's different farms and ecosystems.

5. Conclusion:

The cases mentioned in this paper show that green AI entrepreneurship can serve as a powerful catalyst for environmental and economic transformation in the MENA region. By using advanced tech to tackle region-specific sustainability issues like optimising agricultural inputs, detecting wildfires early, and improving water quality management. Their solutions reduce environmental impact, enhance productivity, and show strong potential for scalability across the region. Success has been supported by partnerships, competitions, and visibility, which emphasise how important good policies, funding, and infrastructure are. Overall, these examples prove that locally personalised, tech-focused solutions can strengthen resilience and help MENA become a key player in the global green economy. And depending on (E.Idowu, 2023; Sahli, 2023; Writer, 2025), to accelerate the growth and impact of green AI entrepreneurship in the MENA region, the following actions are recommended:

- Policy Support and Regulation: Governments should establish clear and supportive regulatory frameworks for green AI applications, including data governance, environmental standards, and incentives for sustainable innovation;
- Funding and investment: Encourage partnerships between public and private sectors, establish green investment funds, and explore impact financing to provide accessible capital for early-stage and scaling startups;
- Building skills: Develop training programs and knowledge-sharing platforms to enhance technical skills, entrepreneurial capabilities, and cross-border collaboration among innovators;
- Infrastructure Development: Invest in digital tools and renewable energy sources to support AI-driven sustainability solutions, especially in rural and underserved areas;
- Regional Collaboration: Build networks across MENA where startups can exchange ideas, develop new technologies together, and access bigger markets.

By implementing these measures, the MENA region can create a more enabling environment for green AI entrepreneurship, ensuring these initiatives can grow sustainably and truly make a difference for the region's environment, economy, and community goals.

6. References:

Abdullah, Haque, H. M. U., Ahmad, N., Aini, Q. U. A., & Saeed, A. (2025). AGRITECH: A Smart System for Sustainable Farming. *VAWKUM Transactions on Computer Sciences*, *13*, 290–306. https://doi.org/10.21015/vtcs.v13i1.2138

Agarwal, R., Bhardwaj, I., Sharma, A. K., Sanghi, A., & Agarwal, G. (2024). Innovations in Agri-Tech: A Review of Artificial Intelligence Applications and Challenges in Modern Agriculture. *Proceedings - 2024 2nd International Conference on Advanced Computing and Communication Technologies, ICACCTech 2024*, 599–604. https://doi.org/10.1109/ICACCTech65084.2024.00101

Byčenkaitė, G., & Burinskienė, A. (2023). APPLYING GREEN TECHNOLOGIES TO IMPROVE BUSINESS SUSTAINABILITY. *13th International Scientific Conference "Business and Management 2023."* https://doi.org/10.3846/bm.2023.1055

cairo scene, news. (2025, January). *Egypt's ReNile secures $450,000 investment*. Https://Www.Wamda.Com/2025/01/Egypt-Renile-Secures-450000-Investment?

Dahlke, J. (2024). *A.I. go by many names: towards a sociotechnical definition of artificial intelligence*. http://arxiv.org/abs/2410.13452

Dean, T. J., & McMullen, J. S. (2007). Toward a theory of sustainable entrepreneurship: Reducing environmental degradation through entrepreneurial action. *Journal of Business Venturing*, *22*, 50–76. https://doi.org/10.1016/j.jbusvent.2005.09.003

Debnath, B., & Kumar Basu, S. (2023). AI-POWERED PRECISION AGRICULTURE: RESHAPING FARMING FOR EFFICIENCY, SUSTAINABILITY, AND GLOBAL IMPACT. *International Journal on Agricultural Sciences*, *14*, 63–66. https://doi.org/10.53390/ijas.2023.14203

E.Idowu, A. (2023, January 12). *Tech4Good Declares Algerian AI Startup, FARM AI, Silver Level Competition Winner*. Https://Theouut.Com/Tech4good-Declares-Algerian-Ai-Startup-Farm-Ai-Silver-Level-Competition-Winner/?

Farinelli, F., Bottini, M., Akkoyunlu, S., & Aerni, P. (2013). *(PDF) Green entrepreneurship: The missing link towards a greener economy*. Https://Www.Researchgate.Net/Publication/285170513_Green_entrepreneurship_The_missing_link_towards_a_greener_economy.

FarmAi. (n.d.). Https://Www.Farm-Ai.Org/.

Ganeshkumar, C., Sankar, J. G., & David, A. (2023). Impact of Artificial Intelligence on Agriculture Value Chain Performance: Agritech Perspective. In *Blockchain, IoT, and AI Technologies for Supply Chain Management* (pp. 71–98). CRC Press. https://doi.org/10.1201/9781003264521-4

Haldar, S. (2019). Green entrepreneurship in theory and practice: Insights from India. *International Journal of Green Economics*, *13*, 99–119. https://doi.org/10.1504/IJGE.2019.103232

Koba, M. (2025). *Hazem Salaheldin Eltawab Provides Smart Solutions for Sustainable Agriculture*. Https://Www.Wearetech.Africa/En/Fils-Uk/Tech-Stars/Hazem-Salaheldin-Eltawab-Provides-Smart-Solutions-for-Sustainable-Agriculture?

Kotchen, M. J. (2009). Some microeconomics of eco-entrepreneurship. *Advances in the Study of Entrepreneurship, Innovation, and Economic Growth*, *20*, 25–37. https://doi.org/10.1108/S1048-4736(2009)0000020005

Kulova, I., Nikolova-Alexieva, V., & Peev, K. (2024). Advancing green entrepreneurship through Industry 4.0 technologies: an analysis of sustainable manufacturing and logistics optimization. *BIO Web of Conferences*, *130*. https://doi.org/10.1051/bioconf/202413005001

media, C. (2024, September). *Smart For Green : L'Innovation Tunisienne au Service de la Préservation des Forêts - Cosmos*. Https://Cosmosmedia.Net/Fr/Smart-for-Green-Linnovation-Tunisienne-Au-Service-de-La-Preservation-Des-Forets/.

Nikolaou, E. I., Ierapetritis, D., & Tsagarakis, K. P. (2011). An evaluation of the prospects of green entrepreneurship development using a SWOT analysis. *International Journal of Sustainable Development and World Ecology*, *18*, 1–16. https://doi.org/10.1080/13504509.2011.543565

Olubusola Odeyemi, O., Oluwadamilare Usman, F., Zamanjomane Mhlongo, N., Adijat Elufioye, O., & Ugochukwu Ike, C. (2023). Sustainable entrepreneurship: A review of green business practices and environmental impact. *World Journal of Advanced Research and Reviews*, *21*, 346–358. https://doi.org/10.30574/wjarr.2024.21.2.0461

Pandey, A. K. (2023). *International Journal of Mathematics And Computer Research*. Https://Ijmcr.in/Index.Php/Ijmcr/Article/View/545/451. https://doi.org/10.47191/ijmcr/v11i4.03

Pratap, S., & Srivarum Venkatesh, K. (2024). *View of THE ROLE OF AI IN ENHANCING GREEN MANAGEMENT AND ADVANCING DIGITAL LEAN PRACTICES FOR SUSTAINABLE EFFICIENCY*. Https://Www.Granthaalayahpublication.Org/Arts-Journal/ShodhKosh/Article/View/1725/1348. https://doi.org/10.29121/shodhkosh.v5.i6.2024.1725

Raj, A. (2024). Artificial Intelligence. *International Journal for Research in Applied Science and Engineering Technology*, *12*, 646–655. https://doi.org/10.22214/ijraset.2024.64695

Redaction. (2023, February 13). *SevenG advocates for smart, dynamic, and efficient farming with FarmAI*. Https://Www.Wearetech.Africa/En/Fils-Uk/Solutions/Seveng-Advocates-for-Smart-Dynamic-and-Efficient-Farming-with-Farmai?

ReNile - Best technical solutions for fish farms. (n.d.). Https://Renile.Net/.

Reshmi, J., & Sopna, V. M. (2024). Effect of AI on the Sustainable Practices of Enterprises. *International Journal of Advanced Research in Science, Communication and Technology*, 848–853. https://doi.org/10.48175/ijarsct-18399

Room, R. P. (2025, January). *ReNile Secures $450,000 Investment: Egyptian Agritech Startup Sets Sights on Regional Expansion*. Https://Www.Rasmal.Com/Renile-Secures-450000-Investment/?

Ryan, M., Isakhanyan, G., & Tekinerdogan, B. (2023). An interdisciplinary approach to artificial intelligence in agriculture. *NJAS: Impact in Agricultural and Life Sciences*, *95*. https://doi.org/10.1080/27685241.2023.2168568

Sahli, N. (2023). *What Went Down for Smart For Green at COP28 UAE - Smart For Green*. Https://Smartforgreen.Com/What-Went-down-for-Smart-for-Green-at-Cop28/?

Scott. (2024, January 23). *FarmAI "Achieving Social Innovation Through Farming Technology: FarmAI's Journey as Global Techno Entrepreneurship Competition Winners" - PIM Global*. Https://Www.Pimglobal.Org/Harvesting-Innovation-Farmais-Unfolding-Journey-Post-Global-Competition/?

Service, A. P. (2023, January 9). *President Tebboune congratulates startup "Farm AI," ranks second globally*. Https://Www.Aps.Dz/En/Algeria/46332-President-Tebboune-Congratulates-Startup-Farm-Ai-Ranks-Second-Globally?

Shrivastava, Dr. A. (2024). Artificial Intelligence (AI): Evolution, Methodologies, and Applications. *International Journal for Research in Applied Science and Engineering Technology*, *12*, 5501–5505. https://doi.org/10.22214/ijraset.2024.61241

Smart For Green - About | F6S. (n.d.). Https://Www.F6s.Com/Smart-for-Green.

Spanaki, K., Sivarajah, U., Fakhimi, M., Despoudi, S., & Irani, Z. (2022a). Disruptive technologies in agricultural operations: a systematic review of AI-driven AgriTech research. In *Annals of Operations Research* (Vol. 308, Issues 1–2, pp. 491–524). Springer. https://doi.org/10.1007/s10479-020-03922-z

Spanaki, K., Sivarajah, U., Fakhimi, M., Despoudi, S., & Irani, Z. (2022b). Disruptive technologies in agricultural operations: a systematic review of AI-driven AgriTech research. In *Annals of Operations Research* (Vol. 308, Issues 1–2, pp. 491–524). Springer. https://doi.org/10.1007/s10479-020-03922-z

Thompson, N., Kiefer, K., & York, J. G. (2011). *Distinctions not Dichotomies: Exploring Social, Sustainable, and Environmental Entrepreneurship* (pp. 201–229). https://doi.org/10.1108/s1074-7540(2011)0000013012

Tian, C., Wu, J., & Xiao, Y. (2023). Research on Impact of Artificial Intelligence Orientation on Enterprise Green Innovation. *International Journal of Business and Economics Research*. https://doi.org/10.11648/j.ijber.20231201.16

Wang, J., Wang, X., Sun, F., & Li, X. (2024). The Functional Mechanisms through Which Artificial Intelligence Influences the Innovation of Green Processes of Enterprises. *Systems*, *12*. https://doi.org/10.3390/systems12090378

Welcome - Smart For Green. (n.d.). Https://Smartforgreen.Com/En/?

Writer, S. (2025). *Egyptian Agritech Startup ReNile Eyes Regional Growth with New Funding*. Https://Launchbaseafrica.Com/2025/01/06/Egyptian-Agritech-Startup-Renile-Eyes-Regional-Growth-with-New-Funding/?