AI Applications for Food Security in Egypt: Practices, Opportunities, and Challenges

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AI APPLICATIONS FOR
FOOD SECURITY IN EGYPT:
PRACTICES, OPPORTUNITIES, AND CHALLENGES

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Acknowledgements

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INTRODUCTION AND LITERATURE REVIEW

I. BRIEF CONTEXT

In the context of an ever-evolving technological landscape, the intersection of artificial intelligence (AI) governance and food security emerges as a critical domain for improving food systems and supporting sustainable development. This paper explores the relationship between AI governance and food security within the context of Egypt, aiming to investigate how the strategic implementation of AI can enhance the country's food systems, improve its agricultural productivity, and contribute to its overall food security conditions.

The primary objective of this paper is to explore the potential of AI technologies in addressing crucial food security challenges in Egypt. This paper examines both existing and potential AI applications in Egypt's food security sectors. Each example will indicate whether it represents current practice, a growing trend, or an untapped opportunity. By examining current AI use cases and their applicability to food security related sectors, we seek to identify opportunities and barriers for leveraging AI to ensure a stable and secure food supply chain.

Egypt, with its rapidly growing population and limited arable land, faces significant challenges in achieving food security. Traditional agricultural practices are no longer sufficient to meet the increasing demand for food. Therefore, innovative solutions are crucial to enhancing agricultural efficiency, optimizing resource use, and reducing food waste. Essentially, we need to find ways to produce more output with the same number of inputs or less. Effective AI governance can therefore contribute to ensuring that modern solutions are implemented in a manner that is ethical, transparent, and beneficial to all stakeholders involved.

This study is of paramount importance as it addresses both the technological and governance aspects of food security. By focusing on Egypt, we highlight the country's unique challenges and opportunities concerning that intersection, providing insights that can be adapted to similar environments globally. When looking at food security specifically, we will assess its current state using the Food and Agriculture Organization (FAO)'s four pillars framework: availability, accessibility, utilization, and stability. The findings of this paper can offer practical insights and recommendations for policymakers, industry prac-

titioners, and technology developers and enthusiasts to collaboratively enhance food systems through responsible AI governance.

II. CURRENT STATE OF AI IN EGYPT

In this section, we will explore the current state of artificial intelligence (AI) in Egypt through a comprehensive framework that examines six key pillars: government, industry, startups, civil society and academia, talent, and market. This multifaceted approach allows for a well-rounded analysis of how AI is being developed, implemented, and utilized across different sectors and societal domains in Egypt. By dissecting each of these components, we can gain a deeper understanding of the opportunities and challenges that AI presents in the Egyptian context.

1. Government

The government's role in policymaking and regulation sets the foundation for AI development.

The Egyptian government has been active in the AI landscape through strategic initiatives and policies aimed at fostering AI development. The National Artificial Intelligence Strategy (NAIS) was launched to guide these efforts, spearheaded by the National Council for Artificial Intelligence (NCAI). Established in 2019 by the Prime Minister and chaired by the Minister of Communications and Information Technology, the NCAI collaborates with various ministries, academics, and industry experts to outline and implement AI policies.[1,2,3]

Egyptian Charter for Responsible AI

In 2023, Egypt's National Council for Artificial Intelligence announced the launch of the Egyptian Charter for Responsible AI, demonstrating the country's dedication to the deployment of future emerging technologies. The charter provides a framework for the use and development of AI technologies with focus on 6 key principles; "human rights and dignity, fairness and equity, transparency and explainability, accountability and responsibility, privacy and data protection, and

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1   Alaa El-Din, M. (2023, December 27). National Council for Artificial Intelligence reviews second phase of National AI Strategy. *Daily News Egypt*. https://www.dailynewsegypt.com/2023/12/25/national-council-for-artificial-intelligence-reviews-second-phase-of-national-ai-strategy/

2   Egypt Independent. (2023, December 27). Egypt plans to finalize its AI strategy soon. *Egypt Independent*. https://egyptindependent.com/egypt-plans-to-finalize-its-ai-strategy-soon

3   Artificial Intelligence. Ministry of Communications and Information Technology. https://mcit.gov.eg/en/Artificial_Intelligence
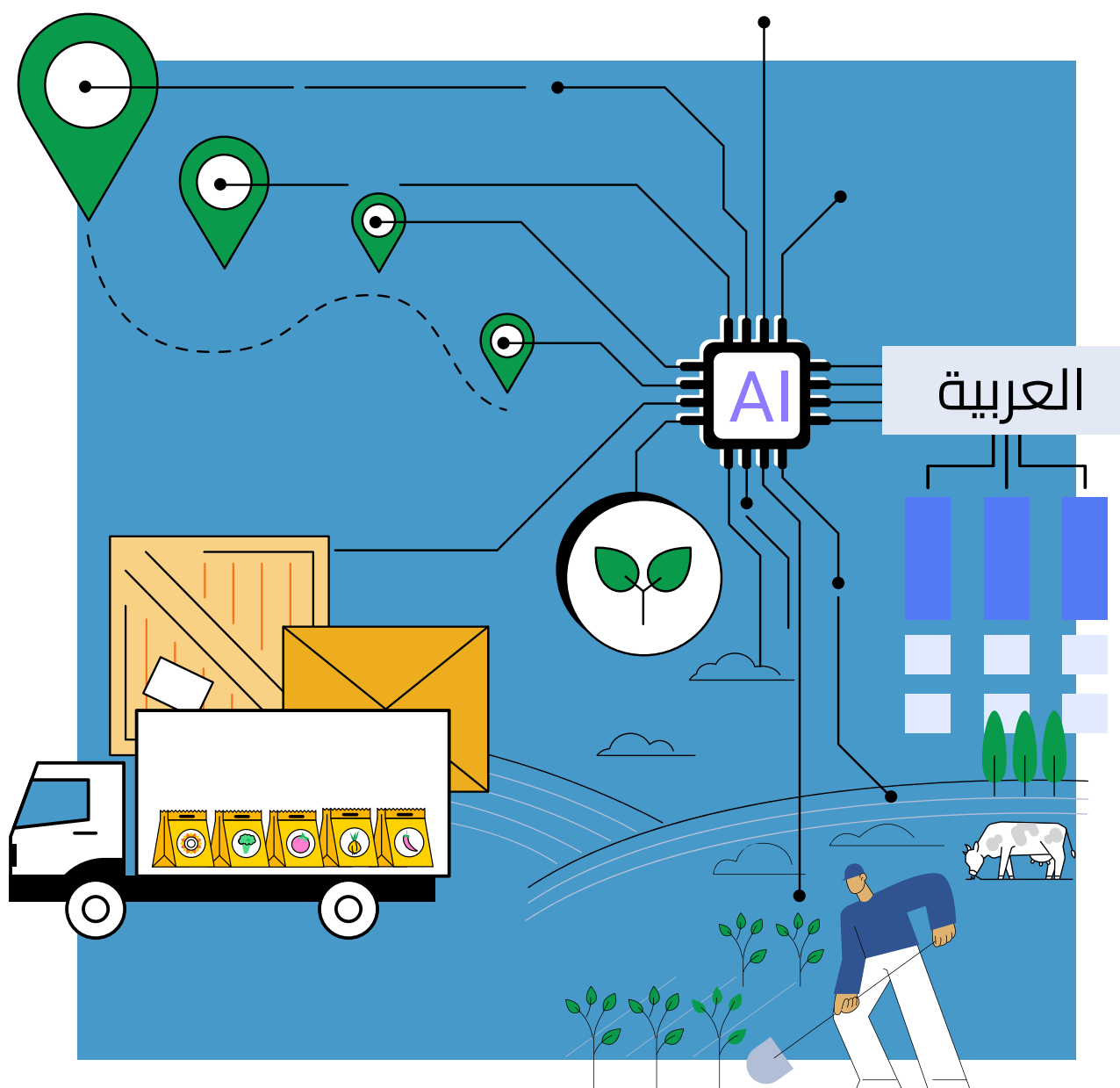
collaboration and international cooperation"[4]. The charter aims to educate citizens on governance frameworks for the responsible use of AI, as well as raise awareness among stakeholders on the ethical implications of AI.[5] The charter also serves as one of the first signals of Egypt's responsible AI readiness and improves the country's stance as an attractive AI destination.[6]

National AI Strategy (NAIS)

The NAIS, introduced in 2019, is designed to integrate AI across multiple sectors, including food security-related sectors such as agriculture, water management, environment, and food supply, to support Egypt's sustainable development goals. The strategy is divided into phases, with the first phase focusing on foundational efforts like enhancing healthcare through AI for early disease detection, improving agricultural planning, and manufacturing infrastructure. This phase also involved initiatives to better process colloquial Egyptian Arabic and address data management challenges.[7,8]

4   Yacoub, A. (2023, May 23). The new 'Egyptian Charter for Responsible AI': between interpretation and enforcement. Synapse Analytics. https://www.synapse-analytics.io/post/the-new-egyptian-charter-for-responsible-ai-between-interpretation-and-enforcement

5   Ministry of Communications and Information Technology. (2023, April 20). Egyptian Charter for Responsible AI Launched. https://mcit.gov.eg/en/Media_Center/Press_Room/Press_Releases/66939

6   Ministry of Communications and Information Technology. (2023, April 20). Egyptian Charter for Responsible AI Launched. https://mcit.gov.eg/en/Media_Center/Press_Room/Press_Releases/66939

7   Egypt Independent. (2023, December 27). Egypt plans to finalize its AI strategy soon. Egypt Independent. https://egyptindependent.com/egypt-plans-to-finalize-its-ai-strategy-soon

8   Artificial Intelligence. Ministry of Communications and Information Technology. https://mcit.gov.eg/en/Artificial_Intelligence

Processing data in Arabic can significantly impact food security in Egypt by enhancing the accessibility and relevance of information for local stakeholders. With a large portion of the population being Arabic-speaking, data presented in the native language can bridge the communication gap, enabling more effective analysis and decision-making across the food supply chain. This can lead to improved resource allocation, better monitoring of food production and distribution, and more responsive policies tailored to local needs. Ultimately, leveraging data in Arabic can contribute to a more resilient and sustainable food system in Egypt.

The second phase, set to begin in 2024, emphasizes six key pillars: governance, enabling environment, information infrastructure, data, human resources, and technology. It aims to adapt to rapid technological advancements and integrate AI further into various sectors, including agriculture, healthcare, and urban management.[9,10]

Examples of Government-led Initiatives

1) **Digital Egypt Platform**: The government launched the ai.gov.eg platform to serve as the central hub for AI activities, including the national AI strategy, capacity-building programs, and details of various AI projects.[11] The platform supports agriculture-specific applications. As of 2024, the Digital Egypt Platform serves as a resource hub for agricultural AI applications, facilitating access to digital services for farmers and agribusinesses.[12] By centralizing AI-related activities, including the national AI strategy, the platform can help coordinate efforts across the food sector, from production to distribution. With AI-driven insights, the government and other stakeholders can optimize supply chains, predict food shortages, and enhance agricultural productivity. The platform's focus on capacity-building programs ensures that local talent is developed to leverage AI technologies, ultimately leading to a more resilient and sustainable food system in Egypt.

2) **AI in Agriculture**: The Ministry of Agriculture and Land Reclamation uses AI for weather data forecasting, crop and soil health monitoring, and reducing pesticide usage to optimize agricultural productivity and sustainability.[13,14] In Egypt, applications helping farmers gain insights from analyzing relevant data aim to enhance their agricultural practices. For instance, satellite imagery may be used to identify land plot boundaries in the Delta to provide irrigation recommendations, better determination of plot ownership, and to promote sustainable land management practices.[15] Moreover, an application named 'Hudhud' or hoopoe–the farmer's smart assistant–is developed as a collaboration between the Ministry of Agriculture and Land Reclamation and the Ministry of Communications and Information Technology (MCIT) to promote digital transformation in the agriculture sector.[16] "Hudhud" is an Arabic mobile application that uses AI to advise farmers on their crop management practices through chatbots that rely on announcements made by the Ministry of Agriculture, as well as weather conditions.[17] As an AI-powered agricultural assistant, Hudhud is currently accessible to a select group of farmers participating in government-led digital transformation initiatives, with plans for broader deployment pending further infrastructure development.[18]

3) **AI in Healthcare**: AI applications are being developed for the early diagnosis of diseases such as diabetes and cancer, addressing the shortage of medical professionals and enhancing healthcare outcomes.[19,20]

9   Egypt Independent. (2023, December 27). Egypt plans to finalize its AI strategy soon. *Egypt Independent.* https://egyptindependent.com/egypt-plans-to-finalize-its-ai-strategy-soon

10   Artificial Intelligence. Ministry of Communications and Information Technology. https://mcit.gov.eg/en/Artificial_Intelligence

11   Alaa El-Din, M. (2021, July 4). Egypt's CIT Minister launches AI platform under National Council for Artificial Intelligence. Daily News Egypt. https://www.dailynewsegypt.com/2021/07/04/egypts-cit-minister-launches-ai-platform-under-national-council-for-artificial-intelligence/

12   OECD. (2023). The MENA-OECD Competitiveness Programme. OECD. https://www.oecd.org/en/about/programmes/mena-oecd-competitiveness-programme.html

13   Egypt Independent. (2023, December 27). Egypt plans to finalize its AI strategy soon. *Egypt Independent.* https://egyptindependent.com/egypt-plans-to-finalize-its-ai-strategy-soon

14   Artificial Intelligence. Ministry of Communications and Information Technology. https://mcit.gov.eg/en/Artificial_Intelligence

15   Enterprise. (2022). How the gov't plans to grow the AI sector: A sitdown with Comms Ministry AI advisor, Sally Radwan (Part II). https://enterprise.press/stories/2022/03/27/how-the-govt-plans-to-grow-the-ai-sector-a-sitdown-with-comms-ministry-ai-advisor-sally-radwan-part-ii-67697/

16   Ministry of Communications and Information Technology. (2021). ICT, Agriculture Ministers Announce Soft Launch of Digital Transformation Services in Agriculture Sector, https://mcit.gov.eg/en/Media_Center/Press_Room/Press_Releases/64824

17   Enterprise. (2022). How the gov't plans to grow the AI sector: A sitdown with Comms Ministry AI advisor, Sally Radwan (Part II). https://enterprise.press/stories/2022/03/27/how-the-govt-plans-to-grow-the-ai-sector-a-sitdown-with-comms-ministry-ai-advisor-sally-radwan-part-ii-67697/

18   Ministry of Communications and Information Technology. (2021). Egypt National Artificial Intelligence Strategy. https://mcit.gov.eg/en/Publication/Publication_Summary/9283

19   Egypt Independent. (2023, December 27). Egypt plans to finalize its AI strategy soon. *Egypt Independent.* https://egyptindependent.com/egypt-plans-to-finalize-its-ai-strategy-soon

20   Artificial Intelligence. Ministry of Communications and Information Technology. https://mcit.gov.eg/en/Artificial_Intelligence

Government's Role in AI

The government's role extends beyond just launching these initiatives to include forming policies that foster a conducive environment for AI development. The NCAI coordinates with various stakeholders to develop a unified strategy that aligns with international best practices, promotes regional and international cooperation, and ensures ethical AI deployment. Efforts to build a robust digital infrastructure and data management systems are crucial enablers of this strategy and are believed to be underway.[21]

In 2020, the MCIT established the Applied Innovation Center (AIC) in collaboration with the NCAI. With the AIC, the MCIT aims to cultivate an environment that helps innovators address national challenges using AI and other emerging technologies. The AIC aims to promote the development of highly skilled human capital, foster innovation, and advocate for the application of best practices in terms of the development and use of AI technologies.[22] The center focuses on several different fields including "artificial intelligence, big data analytics, automation and robotics, the internet of things (IoT), data privacy, cybersecurity, high performance computing (HPC), and more."

By prioritizing AI in national strategies, policies, and collaborations, the Egyptian government is positioning the country as a regional leader in AI, aiming to draw in global tech stakeholders and significantly contribute to the national GDP by 2030 and beyond.[23,24,25]

2. Industry

Industry insights reveal practical applications and innovations driven by established businesses and serve as an indicator as to what is scalable and what is not.

The industry sector (small, medium, and large enterprises) in Egypt has been increasingly embracing artificial intelligence (AI) to drive innovation and enhance efficiency. Established companies across various sectors such as banking, manufacturing, healthcare, and agriculture are integrating AI-based solutions to streamline operations and improve service delivery, but some are also reportedly questioning whether there's more that they should be doing to better embrace the fourth industrial revolution. Despite the presence of more than 71 digital transformation facilitators in the market, according to sortlist [26], much of Egypt's private sector is still struggling to catch up [27,28,29,30].

Banking and Finance: In the banking sector, AI is being used for credit scoring, fraud detection, and customer service improvements. Banks are leveraging AI to analyze large volumes of transaction data to detect fraudulent activities and predict customer behaviour, enhancing both security and user experience. This use of AI helps banks provide more personalized services and reduce risks associated with lending and transactions.[31,32]

Manufacturing: AI applications in manufacturing include predictive maintenance, quality control, and supply chain optimization. Manufacturers are utilizing AI to predict equipment failures before they occur, thereby reducing downtime and maintenance costs. AI-powered quality control systems are also being used to detect defects in products, ensuring higher standards of production quality.[33,34] The adoption of AI-driven predictive maintenance in Egypt's manufacturing sector is currently more prevalent among larger enterprises, with small and medium-sized enterprises

(SMEs) yet to implement such technologies extensively. A report by Enterprise notes that the

21 Artificial Intelligence. Ministry of Communications and Information Technology. https://mcit.gov.eg/en/Artificial_Intelligence

22 Applied Innovation Center. (n.d.). About Us. https://aic.gov.eg/en/about-us/roadmap

23 Egypt Independent. (2023, December 27). Egypt plans to finalize its AI strategy soon. *Egypt Independent.* https://egyptindependent.com/egypt-plans-to-finalize-its-ai-strategy-soon

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25 Alaa El-Din, M. (2021, July 4). Egypt's CIT Minister launches AI platform under National Council for Artificial Intelligence. Daily News Egypt. https://www.dailynewsegypt.com/2021/07/04/egypts-cit-minister-launches-ai-platform-under-national-council-for-artificial-intelligence/

26 sortlist. Top Digital Transformation agencies in Egypt. https://www.sortlist.com/s/digital-transformation/egypt-eg

27 Telecom Review. (2022, September 5). Egypt: A Catalyst of Digital Transformation, Tech Adoption. Telecom Review. https://www.telecomreview.com/articles/reports-and-coverage/6344-egypt-a-catalyst-of-digital-transformation-tech-adoption

28 Moneim, D. (2021, August 7). Digital transformation: Egypt's means to build back better. Ahram Online. https://english.ahram.org.eg/NewsContent/3/12/418543/Business/Economy/Digital-transformation-Egypt%E2%80%99s-means-to-build-back.aspx

29 Alaa El-Din, M. (2023, December 27). National Council for Artificial Intelligence reviews second phase of National AI Strategy. *Daily News Egypt.* https://www.dailynewsegypt.com/2023/12/25/national-council-for-artificial-intelligence-reviews-second-phase-of-national-ai-strategy/

30 Egypt Independent. (2023, December 27). Egypt plans to finalize its AI strategy soon. *Egypt Independent.* https://egyptindependent.com/egypt-plans-to-finalize-its-ai-strategy-soon

31 Artificial Intelligence. Ministry of Communications and Information Technology. https://mcit.gov.eg/en/Artificial_Intelligence

32 Alaa El-Din, M. (2023, December 27). National Council for Artificial Intelligence reviews second phase of National AI Strategy. *Daily News Egypt.* https://www.dailynewsegypt.com/2023/12/25/national-council-for-artificial-intelligence-reviews-second-phase-of-national-ai-strategy/

33 Artificial Intelligence. Ministry of Communications and Information Technology. https://mcit.gov.eg/en/Artificial_Intelligence

34 Alaa El-Din, M. (2023, December 27). National Council for Artificial Intelligence reviews second phase of National AI Strategy. *Daily News Egypt.* https://www.dailynewsegypt.com/2023/12/25/national-council-for-artificial-intelligence-reviews-second-phase-of-national-ai-strategy/

majority of Egyptian firms are still transitioning from Industry 2.0 to Industry 3.0, indicating a lag in adopting advanced automation technologies like AI-driven predictive maintenance.[35] Additionally, the OECD's Artificial Intelligence Review of Egypt highlights that while Egypt has made progress in implementing AI principles, challenges remain in fully integrating AI across various sectors, including manufacturing.[36]

These insights suggest that while larger manufacturing enterprises in Egypt may have begun adopting AI technologies, SMEs face hurdles such as financial constraints, lack of expertise, and limited infrastructure, hindering widespread implementation of AI-driven predictive maintenance.

Healthcare: The healthcare industry in Egypt is employing AI for early disease detection, patient management, and personalized treatment plans. AI algorithms are assisting doctors in diagnosing diseases such as cancer and diabetes at earlier stages, which improves treatment outcomes. Additionally, AI is being used to manage patient data and streamline hospital operations, leading to more efficient healthcare services.[37,38]

Agriculture: AI in agriculture focuses on improving crop yields, soil health monitoring, efficient water usage, and more. Farmers are using AI to analyze weather patterns, monitor crop health through satellite imagery, monitor livestock health, and optimize irrigation systems. These AI applications help in making informed decisions that in turn enhance agricultural productivity and sustainability.[39,40]

Collaboration and Investment: The NAIS encourages collaboration between the public and private sectors. Large multinational companies are investing in AI research and development centers in Egypt, contributing to the local AI ecosystem. These investments not only bring advanced technologies to the country but also create job opportunities and support the growth and development of local talent.[41,42]

Challenges and Opportunities: While the adoption of AI in the industry sector is growing, challenges such as data privacy, regulatory compliance, and the need for skilled personnel remain. However, the government's intention to build a robust digital infrastructure and provide support through policies and initiatives creates a favorable environment for AI innovation. The industry's embrace of AI presents significant opportunities for economic growth, positioning Egypt as a competitive player in the regional and global market.[43,44,45]

3. Startups

Startups are essential for discovering gaps and opportunities, introducing innovative ways to solving new and old problems, and ultimately highlighting new and emerging AI solutions along the way.

The startup ecosystem in Egypt has been a vibrant contributor to the advancement of artificial intelligence (AI) technologies. Emerging AI startups are focusing on various sectors, driving innovation, and addressing unique local challenges through AI solutions. Many key support organizations and stakeholders, including civil society organizations, academic institutions, international organizations, and governmental agencies have been key in nurturing that enabling environment.[46,47,48]

Government Support and Initiatives: The Egyptian government, recognizing the potential of AI startups, has initiated several programs and policies to support their growth. This includes

35   Enterprise. (2022, April 10). Are Egypt's manufacturing industries embracing the shift to industrial automation?. https://enterprise.press/industries/egypts-manufacturing-industries-embracing-shift-industrial-automation

36   OECD (2024), OECD Artificial Intelligence Review of Egypt, OECD Publishing, Paris, https://doi.org/10.1787/2a282726-en.

37   Artificial Intelligence. Ministry of Communications and Information Technology. https://mcit.gov.eg/en/Artificial_Intelligence

38   Alaa El-Din, M. (2023, December 27). National Council for Artificial Intelligence reviews second phase of National AI Strategy. *Daily News Egypt.* https://www.dailynewsegypt.com/2023/12/25/national-council-for-artificial-intelligence-reviews-second-phase-of-national-ai-strategy/

39   Artificial Intelligence. Ministry of Communications and Information Technology. https://mcit.gov.eg/en/Artificial_Intelligence

40   Alaa El-Din, M. (2023, December 27). National Council for Artificial Intelligence reviews second phase of National AI Strategy. *Daily News Egypt.* https://www.dailynewsegypt.com/2023/12/25/national-council-for-artificial-intelligence-reviews-second-phase-of-national-ai-strategy/

41   Artificial Intelligence. Ministry of Communications and Information Technology. https://mcit.gov.eg/en/Artificial_Intelligence

42   Alaa El-Din, M. (2023, December 27). National Council for Artificial Intelligence reviews second phase of National AI Strategy. *Daily News Egypt.* https://www.dailynewsegypt.com/2023/12/25/national-council-for-artificial-intelligence-reviews-second-phase-of-national-ai-strategy/

43   Artificial Intelligence. Ministry of Communications and Information Technology. https://mcit.gov.eg/en/Artificial_Intelligence

44   Alaa El-Din, M. (2023, December 27). National Council for Artificial Intelligence reviews second phase of National AI Strategy. *Daily News Egypt.* https://www.dailynewsegypt.com/2023/12/25/national-council-for-artificial-intelligence-reviews-second-phase-of-national-ai-strategy/

45   Alaa El-Din, M. (2021, July 4). Egypt's CIT Minister launches AI platform under National Council for Artificial Intelligence. Daily News Egypt. https://www.dailynewsegypt.com/2021/07/04/egypts-cit-minister-launches-ai-platform-under-national-council-for-artificial-intelligence/

46   Alaa El-Din, M. (2023, December 27). National Council for Artificial Intelligence reviews second phase of National AI Strategy. *Daily News Egypt.* https://www.dailynewsegypt.com/2023/12/25/national-council-for-artificial-intelligence-reviews-second-phase-of-national-ai-strategy/

47   Artificial Intelligence. Ministry of Communications and Information Technology. https://mcit.gov.eg/en/Artificial_Intelligence

48   The Next Web. (2022, July 25). Egypt's booming startup scene is becoming the gateway to MENA. *The Next Web.* https://thenextweb.com/news/egypts-booming-startup-scene-gateway-to-mena

the expansion of the Technology Innovation & Entrepreneurship Center (TIEC) and the provision of grants through the Science and Technology Development Fund. These initiatives aim to provide startups with the necessary resources and infrastructure to develop and scale their AI solutions further.[49,50,51]

Sector Focus and Innovation: Egyptian AI startups are making significant strides in various sectors, including healthcare, agriculture, and finance. For instance, startups are developing AI-driven health diagnostics tools, smart farming solutions, and fintech applications to enhance financial inclusion. Specific examples include healthtech startups creating AI tools for early disease detection, agritech companies using AI to optimize crop yields, and fintech startups leveraging AI for better financial services and more seamless experiences.[52,53,54]

Importance of Supporting Startups: Supporting AI startups is crucial as they drive innovation by introducing new solutions to the market, create jobs in their scaleup phases, and contribute to sustainable economic growth. Startups often bring fresh perspectives and agility, allowing for rapid testing, iteration, development and implementation of practical and viable AI solutions. By fostering a supportive environment, the government and other key enablers can ensure that these startups continue to innovate and address critical challenges in various sectors.[55,56]

Support Programs

Various support mechanisms and programs for startups exist, including:

Incubators and Accelerators: Providing mentorship, resources, networks, and funding opportunities. Examples include AUC Venture Labs, Nahdet El Mahrousa, Flat6Labs and Plug and Play, which run incubator and accelerator programs targeting startups across various sectors and stages.[57,58]

Grants and Funding: Through initiatives like the Science and Technology Development Fund and investments from local and international venture capital firms.[59,60]

Training and Capacity Building: Programs aimed at developing the skills needed for AI and tech entrepreneurship, and ones aimed at reskilling and upskilling various segments of the labour force.[61,62,63]

Collaboration and Ecosystem Development: Collaboration between startups, academic institutions, and established businesses is crucial for the development of a robust AI ecosystem. Academic institutions develop and disseminate theoretical knowledge, startups put them into practice to test the markets, and more established companies can help in scaling and growing these innovative solutions. These collaborative efforts are essential for knowledge sharing, skill development, and the overall growth of the AI sector in Egypt. [64,65,66]

4. Civil Society and Academia

Civil society and academia fill in gaps that others are unable or unincentivized to fill, all while

49   Alaa El-Din, M. (2023, December 27). National Council for Artificial Intelligence reviews second phase of National AI Strategy. *Daily News Egypt.* https://www.dailynewsegypt.com/2023/12/25/national-council-for-artificial-intelligence-reviews-second-phase-of-national-ai-strategy/

50   Artificial Intelligence. Ministry of Communications and Information Technology. https://mcit.gov.eg/en/Artificial_Intelligence

51   The Next Web. (2022, July 25). Egypt's booming startup scene is becoming the gateway to MENA. *The Next Web.* https://thenextweb.com/news/egypts-booming-startup-scene-gateway-to-mena

52   Alaa El-Din, M. (2023, December 27). National Council for Artificial Intelligence reviews second phase of National AI Strategy. *Daily News Egypt.* https://www.dailynewsegypt.com/2023/12/25/national-council-for-artificial-intelligence-reviews-second-phase-of-national-ai-strategy/

53   Artificial Intelligence. Ministry of Communications and Information Technology. https://mcit.gov.eg/en/Artificial_Intelligence

54   The Next Web. (2022, July 25). Egypt's booming startup scene is becoming the gateway to MENA. *The Next Web.* https://thenextweb.com/news/egypts-booming-startup-scene-gateway-to-mena

55   Artificial Intelligence. Ministry of Communications and Information Technology. https://mcit.gov.eg/en/Artificial_Intelligence

56   The Next Web. (2022, July 25). Egypt's booming startup scene is becoming the gateway to MENA. *The Next Web.* https://thenextweb.com/news/egypts-booming-startup-scene-gateway-to-mena

57   Ibid.

58   EgyptInnovate. (2022, June 22). Egyptian AI Tech startup, Synapse Analytics raises more than $2M USD in pre-series A funding round to accelerate AI adoption for businesses. *EgyptInnovate.* https://egyptinnovate.com/en/news/egyptian-ai-tech-startup-synapse-analytics-raises-more-2m-usd-pre-series-funding-round

59   The Next Web. (2022, July 25). Egypt's booming startup scene is becoming the gateway to MENA. *The Next Web.* https://thenextweb.com/news/egypts-booming-startup-scene-gateway-to-mena

60   EgyptInnovate. (2022, June 22). Egyptian AI Tech startup, Synapse Analytics raises more than $2M USD in pre-series A funding round to accelerate AI adoption for businesses. *EgyptInnovate.* https://egyptinnovate.com/en/news/egyptian-ai-tech-startup-synapse-analytics-raises-more-2m-usd-pre-series-funding-round

61   Alaa El-Din, M. (2023, December 27). National Council for Artificial Intelligence reviews second phase of National AI Strategy. *Daily News Egypt.* https://www.dailynewsegypt.com/2023/12/25/national-council-for-artificial-intelligence-reviews-second-phase-of-national-ai-strategy/

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64   Alaa El-Din, M. (2023, December 27). National Council for Artificial Intelligence reviews second phase of National AI Strategy. *Daily News Egypt.* https://www.dailynewsegypt.com/2023/12/25/national-council-for-artificial-intelligence-reviews-second-phase-of-national-ai-strategy/

65   Artificial Intelligence. Ministry of Communications and Information Technology. https://mcit.gov.eg/en/Artificial_Intelligence

66   The Next Web. (2022, July 25). Egypt's booming startup scene is becoming the gateway to MENA. *The Next Web.* https://thenextweb.com/news/egypts-booming-startup-scene-gateway-to-mena

ensuring that ethical, social, and community impacts are addressed, while also driving research, education, and community awareness efforts.

Civil society organizations (CSOs) in Egypt play a crucial role in ensuring that artificial intelligence (AI) technologies are developed and deployed in ways that benefit all segments of society. These organizations focus on various aspects, including advocacy, accountability, social service delivery, and fostering inclusive governance.

Social Service Delivery: AI technologies are being harnessed by CSOs to enhance social service delivery. In Egypt, The Sawiris Foundation for Social Development (SFSD) is an example of a local foundation that integrates AI-based capacity building programs in its strategy for development and social inclusion. SFSD has funded various programs aimed at achieving sustainable development in partnership with governmental and private sectors as well as civil society.[67]

Fostering Inclusive Governance: The Canada Fund for Local Initiatives (CFLI) supports projects in Egypt that promote inclusive governance and economic opportunities for marginalized groups. By focusing on these areas, CSOs can ensure that the benefits of AI are equitably distributed and that marginalized communities are not left behind in the digital transformation.[68]

Collaborations and Training: The establishment of the AI Centre in Cairo, in partnership with Italy, is an example of how international collaborations can foster AI development. This centre aims to provide training and support to African nations, facilitating the exchange of knowledge and expertise between Egypt and other neighbouring countries as well. Such initiatives help build local capacities and promote regional cooperation in AI technologies.[69]

Promoting Ethical AI: Reports like "Setting Democratic Ground Rules for AI" emphasize the importance of civil society in promoting ethical AI governance. These reports highlight the need for new institutions and collaborations to manage AI risks and ensure that AI systems reflect democratic values. By engaging in these efforts, CSOs help shape policies that protect individual

rights and promote transparency and accountability in AI development.[70,71]

Educational and Community Initiatives: Civil society also engages in educational initiatives to raise awareness about AI and its implications. These initiatives include workshops, seminars, and community outreach programs that educate the public about AI technologies and their potential impacts on society.[72,73]

Academic Contributions: Academia in Egypt is also a significant player in the AI ecosystem, contributing to research, education, and the development of AI talent. Universities and research institutions collaborate with international bodies and local industries to advance AI knowledge and applications. Programs and initiatives aimed at integrating AI into higher education curricula ensure that students are equipped with the necessary skills to contribute to the AI workforce.

University Programs

Several universities in Egypt have introduced specialized programs in AI and machine learning. Notable institutions include:

- **American University in Cairo (AUC)**: AUC offers comprehensive AI programs and has integrated AI education into its curriculum to prepare students for careers in this rapidly evolving field.[74]
- **Cairo University**: The university has established its first Faculty of Robotics and AI Applications, offering programs that focus on robotics, medical robots, flying robots, service robots, and cognitive robots[75].
- • **German University in Cairo (GUC)**: GUC offers introductory and advanced AI courses, focusing on the foundational

67   Sawiris Foundation for Social Development. (2020, May 7). SFSD sign a new MoU, with the National Management Institute (NMI) in order to implement The Government Leadership Development Program. https://www.sawirisfoundation.org/en/news-events/sfsd-sign-a-new-mou-with-the-national-management-institute-nmi-in-order-to-implement-the-government-leadership-development-program

68   Government of Canada. (2024). The Canada Fund for Local Initiatives – Egypt. *Government of Canada*. https://www.international.gc.ca/world-monde/funding-financement/cfli-fcil/2024/egypt-egypte.aspx?lang=eng

69   Daily News Egypt. (2024, April 22). Egypt, Italy to partner on AI centre in Cairo serving Africa. *Daily News Egypt*. https://www.dailynewsegypt.com/2024/04/22/egypt-italy-to-partner-on-ai-centre-in-cairo-serving-africa/

70   Rancy, A. (2023, October 19). Setting Democratic Ground Rules for AI: Civil Society Strategies. *National Endowment for Democracy*. https://www.ned.org/setting-democratic-ground-rules-for-ai-civil-society-strategies/

71   Ibid.

72   Sanchez, C. (2021, July 8). Civil society can help ensure AI benefits us all. Here's how. *World Economic Forum*. https://www.weforum.org/agenda/2021/07/civil-society-help-ai-benefits/

73   Rancy, A. (2023, October 19). Setting Democratic Ground Rules for AI: Civil Society Strategies. *National Endowment for Democracy*. https://www.ned.org/setting-democratic-ground-rules-for-ai-civil-society-strategies/

74   *The American University in Cairo*. AI in Education at AUC. *The American University in Cairo*. https://www.aucegypt.edu/academics/center-learning-and-teaching/artificial-intelligence

75   Egypt Independent. (2023, February 15). Cairo University to establish its 1st faculty for robotics and AI apps. *Egypt Independent*. https://www.egyptindependent.com/cairo-university-to-establish-its-1st-faculty-for-robotics-and-ai-apps

aspects and applications of AI in various fields[76].

While AUC and GUC are not public, Cairo University is, and other public universities that have added AI programs include Alexandria University, Ain Shams University, and Menoufia University. These programs aim to provide contemporary education and training in AI technologies that prepare students for careers in this rapidly evolving field.[77]

Research Initiatives: Egyptian academic institutions engage in cutting-edge research, often in collaboration with international partners. These research projects cover various AI applications, from healthcare and agriculture to urban planning and smart cities. For example, the World Bank's "Measuring Development 2024" initiative involves Egyptian researchers in exploring how AI can optimize generative AI models for social impact.[78]

By fostering a collaborative environment that includes civil society and academia, Egypt can ensure that AI technologies are developed and deployed in a manner that benefits all segments of society while maintaining ethical standards and promoting inclusive growth.

5. Talent

Examining the talent pool helps us understand the availability and development of necessary skills.

The development of AI talent is crucial for sustaining Egypt's progress in the digital and AI sectors. Various initiatives by the government, private sector, and international organizations are contributing significantly to building a robust AI talent ecosystem in Egypt.

Government Initiatives: The Egyptian government, in collaboration with international organizations, has launched several projects aimed at enhancing digital skills among its workforce. The Information Technology Industry Development Agency (ITIDA) and the United Nations Development Programme (UNDP) have initiated a five-year project to support ICT innovators and entrepreneurs, providing financing opportunities and mentorship to foster a resilient and in-

novative digital landscape in Egypt.[79] This initiative is expected to strengthen Egypt's ICT sector and support the development of local talent.

Private Sector Contributions: Companies like Intelcia are investing in Egypt to tap into the rich talent pool and contribute to the local economy. Intelcia provides extensive training and upskilling programs, ensuring their employees are equipped with the latest industry skills. This investment not only supports the company's operations but also promotes economic growth and creates a sustainable talent pipeline in the region.[80]

International Partnerships: Huawei has been a pivotal player in developing ICT skills among Egyptian youth. Through initiatives like the ICT Talent Development Program, Huawei collaborates with Egyptian universities and government bodies to provide training and development opportunities. Programs such as Seeds for the Future and the ICT Academy offer comprehensive training in AI and other digital skills, preparing young professionals to meet the demands of the tech industry.[81]

Educational Initiatives: Academic institutions in Egypt are also crucial in nurturing AI talent. Universities such as the American University in Cairo (AUC) and Cairo University have introduced specialized AI and machine learning programs. Cairo University, for instance, has established its first Faculty of Robotics and AI Applications, which focuses on cutting-edge research and training in various AI applications.[82] The German University in Cairo (GUC) offers courses that cover both foundational and advanced aspects of AI, preparing students for careers in this field.[83]

By fostering a collaborative environment that includes government initiatives, private sector contributions, academic programs, and international partners, Egypt is building a robust ecosystem to develop and sustain AI tal-

76 German University in Cairo. Introduction to Artificial Intelligence (CSEN 901) Course Catalog. *German University in Cairo* https://www.guc.edu.eg/en/academic_programs/course_catalog/course_details.aspx?courseId=75

77 OECD. (2019). "AI policies and initiatives", in Artificial Intelligence in Society, OECD Publishing, Paris, https://doi.org/10.1787/cf3f3be0-en.

78 World Bank Group. (2024, May 2). Measuring Development 2024: AI, the Next Generation. *World Bank Group.* https://www.worldbank.org/en/events/2024/05/02/measuring-development-2024

79 United Nations Development Programme. (2023, July 13). UNDP, Egypt Government, launch new project to accelerate digital innovation. *United Nations Development Programme.* https://www.undp.org/egypt/press-releases/undp-egypt-government-launch-new-project-accelerate-digital-innovation

80 Alaa El-Din, M. (2023, June 24). Intelcia debuts in Egypt, capitalising on strong Egyptian talent pool. *Daily News Egypt.* https://www.dailynewsegypt.com/2023/06/24/intelcia-debuts-in-egypt-capitalising-on-strong-egyptian-talent-pool/

81 Huawei. (2024, February 26). Huawei Announces Several Digital Talent Initiatives for 2024 at the Huawei Talent Summit. https://www.huawei.com/en/news/2024/2/huawei-talentsummt-2024

82 Egypt Independent. (2023, February 15). Cairo University to establish its 1st faculty for robotics and AI apps. *Egypt Independent.* https://www.egyptindependent.com/cairo-university-to-establish-its-1st-faculty-for-robotics-and-ai-apps

83 German University in Cairo. Introduction to Artificial Intelligence (CSEN 901) Course Catalog. *German University in Cairo.* https://www.guc.edu.eg/en/academic_programs/course_catalog/course_details.aspx?courseId=75

ent. These efforts are crucial for ensuring that the country can meet the growing demands of the AI and ICT sectors, driving economic growth and technological innovation.

6. Markets

The artificial intelligence (AI) market in Egypt is still nascent, however, it is evolving rapidly. Companies like DXwand are starting to help enterprises in various sectors take advantage of generative AI solutions that are already in the global market and ready to be deployed and adapted in local contexts.[84] Other factors like government initiatives, increased awareness amongst young professionals, and investor appetite are among the factors affecting market dynamics.

Government Initiatives: Initiatives such as the National AI Strategy and investments in digital infrastructure are paving the way for widespread AI adoption across various sectors. The government's focus on digital transformation, supported by collaborations with international organizations, is enhancing Egypt's position as a competitive player in the global AI market.[85,86]

Key Sectors:

Several sectors are experiencing significant growth due to AI integration:

1) **Banking and Finance:** The adoption of AI in the banking and finance sector is driven by the need for enhanced security, efficient customer service, and advanced analytics for fraud detection and credit scoring. AI technologies are enabling banks to provide more personalized services and improve operational efficiency.[87]

2) **Healthcare:** AI applications in healthcare, such as predictive diagnostics, personalized treatment plans, and administrative automation, are revolutionizing patient care. These technologies help in early disease detection, efficient resource management, and improved patient outcomes.[88,89]

3) **Retail and E-commerce:** The retail sector is leveraging AI for personalized shopping experiences, inventory management, and customer service automation. AI-powered chatbots and recommendation engines are enhancing customer engagement and driving sales growth

4) **Transportation and Logistics:** AI is playing a crucial role in optimizing logistics, supply chain management, and transportation services. Projects like port development and multimodal transportation are integrating AI to improve efficiency and reduce costs.[90]

Market Dynamics

The AI market in Egypt is characterized by several dynamic factors:

- **Investment and Funding**: Both local and international investors are increasingly investing in AI startups and projects in Egypt. Despite startups struggling to attract regional and global VC investment during the FX crisis that lasted from late 2022 to early 2024, investors are coming back to the Egyptian market with a renewed appetite for tech-based solutions. This influx of capital is driving innovation and helps accelerate the development of new AI applications and use cases even more.[91]

- **Collaborations and Partnerships**: Strategic partnerships between Egyptian companies and global tech giants like Huawei, Microsoft, and SAP are fostering knowledge transfer and technological advancement. These collaborations are crucial for scaling AI solutions and integrating them into various industries

- **Infrastructure Development**: The development of digital infrastructure, including high-speed internet and cloud computing services, is essential for supporting AI technologies. Investments in this area are creating a robust foundation for AI growth in Egypt.[92]

Despite the rapid growth, the AI market in Egypt faces challenges such as data privacy concerns, regulatory hurdles, and the need for skilled talent. However, the government's com-

84   DXwand. (2024). Customer Story. https://dxwand.com/customer-story

85   Kemp, S. (2024, February 23). Digital 2024: Egypt. *DataReportal.* https://datareportal.com/reports/digital-2024-egypt

86   Construction Industry in Egypt Size & Share Analysis–Growth Trends & Forecasts (2024–2029). *Mordor Intelligence.* https://www.mordorintelligence.com/industry-reports/egypt-construction-market

87   Market Research Reports. (2022, November 9). Egypt PESTLE Analysis & Macroeconomic Trends Market Research Report. https://www.marketresearchreports.com/market-research-reports-inc/egypt-pestle-analysis-macroeconomic-trends-market-research-report

88   Perrault, R., & Clark, J. (2024). Artificial Intelligence Index Report 2024. https://aiindex.stanford.edu/wp-content/uploads/2024/05/HAI_AI-Index-Report-2024.pdf

89   Kantar. (2024). Marketing Trends. https://www.kantar.com/campaigns/marketing-trends-2024

90   Kantar. (2024). Marketing Trends. https://www.kantar.com/campaigns/marketing-trends-2024

91   Market Research Reports. (2022, November 9). Egypt PESTLE Analysis & Macroeconomic Trends Market Research Report. https://www.marketresearchreports.com/market-research-reports-inc/egypt-pestle-analysis-macroeconomic-trends-market-research-report

92   Kantar. (2024). Marketing Trends. https://www.kantar.com/campaigns/marketing-trends-2024

mitment to creating a supportive environment for AI innovation presents significant opportunities for growth. By addressing these challenges, Egypt can further strengthen its position in the global AI landscape.[93,94]

III. CURRENT STATE OF FOOD SECURITY IN EGYPT

Food security remains a critical issue in Egypt. We will assess the current state of food security in Egypt using the Food and Agriculture Organization (FAO)'s four pillars framework: availability, accessibility, utilization, and stability. This framework provides a structured approach to understanding the different aspects of food security, highlighting the areas where Egypt is performing well and where improvements are necessary.

Introduction to FAO's Four Pillars Framework

The FAO defines food security as a situation in which all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life. The four pillars of food security are:

1) **Availability:** This pillar focuses on the physical presence of sufficient quantities of food, which can be produced domestically or imported. It considers factors such as agricultural production, food stocks, and trade.

2) **Accessibility:** Accessibility addresses the ability of individuals to obtain food. It involves economic and physical access, considering factors like income levels, food prices, and distribution networks.

3) **Utilization:** Utilization emphasizes the proper biological use of food, requiring a diet that provides sufficient energy and nutrients, as well as the ability to absorb and metabolize those nutrients. It includes considerations of food safety, hygiene, and health conditions.

4) **Stability:** Stability concerns the consistency of food availability, accessibility, and utilization over time. It examines how these factors are affected by economic, environmental, and political conditions, including shocks and seasonal variations.

1. Food Availability

Food availability, one of the four pillars of food security defined by the Food and Agriculture Organization (FAO), focuses on the physical presence of sufficient quantities of food.

Domestic Production: Egypt's agriculture sector is a vital part of its economy, contributing over 12% to the GDP and employing more than 25% of the population.[95] Despite these significant contributions, the sector faces substantial challenges. Rapid urbanization has resulted in the loss of fertile agricultural land, with urban expansion consuming over 75,000 hectares in the past two decades. Additionally, climate change poses a severe threat to crop yields, with projections indicating potential declines of up to 19% for key crops like maize, sugar crops, and fruits and vegetables by 2050.[96,97]

Imports: Egypt is highly reliant on imports to meet its food needs, importing more than half of its staples, including wheat, which is crucial for the country's food security. This dependency makes the country vulnerable to global market fluctuations and price volatility. The Global Hunger Index ranks Egypt 57th out of 121 countries, indicating a moderate level of hunger. High food prices, driven by global supply chain disruptions and inflation, have exacerbated food insecurity, affecting affordability and access.[98,99] Additionally, Egypt has undergone a severe FX crisis from late 2022 to early 2024 that has seen the Egyptian pound lose almost 70% of its value in less than two years.[100] Not only did that fuel the skyrocketing of food prices on its own, but also the cost of importing increased for various other administrative and operational reasons, and the consumer was handed the burden of that cost as well.

Food Waste: Food waste is a significant problem in Egypt, contributing to food insecurity and economic inefficiencies. It is estimated that

93   Perrault, R., & Clark, J. (2024). Artificial Intelligence Index Report 2024. https://aiindex.stanford.edu/wp-content/uploads/2024/05/HAI_AI-Index-Report-2024.pdf

94   Kantar. (2024). Marketing Trends. https://www.kantar.com/campaigns/marketing-trends-2024

95   Agriculture in Egypt–Market Share Analysis, Industry Trends & Statistics, Growth Forecasts 2019–2029. (2024, February). Research and Markets. https://www.researchandmarkets.com/reports/4771958/agriculture-in-egypt-market-share-analysis

96   World Food Programme. (2023). Egypt Country Strategic Plan 2023-2028. https://docs.wfp.org/api/documents/WFP-0000157713/download/?_ga=2.41980901.1775791114.1718143725-1547489956.1702973522

97   Food and Agriculture Organization of the United Nations. (2023, December 13). FAO in Egypt–Redefining resilience in Egypt's agrifood future. Food and Agriculture Organization of the United Nations. https://www.fao.org/egypt/news/detail-events/en/c/1673506/

98   Global Hunger Index. (2023). Global Hunger Index–Egypt. https://www.globalhungerindex.org/egypt.html

99   Al-Riffai, P. (2015). How to Feed Egypt. The Cairo Review of Global Affairs. https://www.thecairoreview.com/essays/how-to-feed-egypt/

100   World Food Programme. (2024, April). Egypt Country Brief. World Food Programme. https://docs.wfp.org/api/documents/WFP-0000158952/download/?_ga=2.27324476.1859290012.1717272277-940864055.1717272277

about 50% of fruits and vegetables in Egypt are wasted due to inadequate storage, transportation, and handling infrastructure. This waste not only reduces the amount of food available for consumption but also represents a loss of income for farmers and contributes to environmental degradation through increased greenhouse gas emissions from decomposing organic waste.[101] Addressing food waste is critical to improving food availability and overall food security in Egypt.

Challenges and Initiatives: The Egyptian government, in collaboration with international organizations like the World Food Programme (WFP) and the Food and Agriculture Organization (FAO), is implementing various initiatives to enhance food availability. The WFP's country strategic plan for 2023-2028 aims to build resilience and improve agricultural productivity through climate-smart agriculture (CSA) practices. These practices include improved irrigation techniques, financial literacy for farmers, and better market connections.[102] Furthermore, the FAO's recent study emphasizes the adoption of CSA technologies and high-value crop production to enhance food security and sustainability. These efforts are crucial in addressing the barriers faced by smallholder farmers, such as high initial costs and limited access to affordable financing.[103]

While Egypt has made significant strides in addressing food availability issues, challenges remain. Urbanization, climate change, dependency on imports, and food waste are critical areas that need ongoing attention and innovative solutions. By continuing to implement and expand on climate-smart agricultural practices, reducing food waste, and strengthening collaborations with international partners, Egypt can improve its food availability and overall food security.

2. Food Accessibility

Food accessibility is a critical pillar of food security, emphasizing the economic and physical ability of individuals to obtain sufficient food.

Economic Barriers: Economic access to food remains a significant challenge in Egypt. High levels of inflation and the rising cost of living have severely impacted the purchasing power of many Egyptians, especially among low-income groups. The World Food Programme (WFP) highlights that domestic food price inflation remains a major issue, affecting the affordability of food for vulnerable populations. As food prices soared, 47% of families living in poverty decreased their spending on food[104], 70% opted for lower quality food, and they decreased their meat, chicken, and dairy intake by 70-85%.[105] This economic strain is exacerbated by the country's heavy reliance on food imports, making it susceptible to global market shocks and fluctuations.[106,107]

Social Protection Programs: To mitigate these challenges, the Egyptian government has implemented various social protection programs aimed at improving food accessibility. The Takaful and Karama program, a conditional cash transfer initiative, targets low-income families to help them afford essential goods, including food. Additionally, the National School Feeding Programme, supported by the WFP, provides nutritious meals to schoolchildren, ensuring that food reaches those most in need.[108,109]

Government and International Initiatives: The Egyptian government, in collaboration with international organizations like the WFP and the Food and Agriculture Organization (FAO), has launched several initiatives to enhance food accessibility. The WFP's strategic plan for 2023-2028 focuses on building resilience and improving livelihoods through climate-smart agricultural practices, vocational training, and financial literacy programs. These initiatives aim to increase economic opportunities for vulnerable populations, thereby improving their access to food.[110,111]

101   Oakey, J. (2022, December 12). Egypt's food security challenges set to grow in 2023. Azure Strategy. https://azure-strategy.com/egypt-remains-exposed-to-food-supply-shocks/

102   World Food Programme. Egypt Country Brief. https://www.wfp.org/countries/egypt

103   Food and Agriculture Organization of the United Nations. (2023, December 13). FAO in Egypt–Redefining resilience in Egypt's agrifood future. *Food and Agriculture Organization of the United Nations*. https://www.fao.org/egypt/news/detail-events/en/c/1673506/

104   المصدر: المعهد الدولي لبحوث السياسات الغذائية، (يناير 2023)، صدمات أسعار الغذاء والوجبات الغذائية بين الأسر الفقيرة في مصر

105   المصدر: المعهد الدولي لبحوث السياسات الغذائية، (يناير 2023)، صدمات أسعار الغذاء والوجبات الغذائية بين الأسر الفقيرة في مصر مؤشر تضخم أسعار المواد الغذائية، مؤشر فرعي من مؤشر التضخم، الجهاز المركزي للتعبئة العامة والإحصاء

106   World Food Programme. (2023). Egypt Country Strategic Plan 2023-2028. https://docs.wfp.org/api/documents/WFP-0000157713/download/?_ga=2.41980901.1775791114.1718143725-1547489956.1702973522

107   Food and Agriculture Organization of the United Nations. (2023, December 13). FAO in Egypt–Redefining resilience in Egypt's agrifood future. *Food and Agriculture Organization of the United Nations*. https://www.fao.org/egypt/news/detail-events/en/c/1673506/

108   World Food Programme. (2023). Egypt Country Strategic Plan 2023-2028. https://docs.wfp.org/api/documents/WFP-0000157713/download/?_ga=2.41980901.1775791114.1718143725-1547489956.1702973522

109   Cultivating New Frontiers in Agriculture. Feed the Future Egypt Food Security and Agribusiness Support. *Cultivating New Frontiers in Agriculture (CNFA)*. https://www.cnfa.org/program/food-security-and-agribusiness-support/

110   World Food Programme. (2023). Egypt Country Strategic Plan 2023-2028. https://docs.wfp.org/api/documents/WFP-0000157713/download/?_ga=2.41980901.1775791114.1718143725-1547489956.1702973522

111   Cultivating New Frontiers in Agriculture. Feed the Future Egypt Food Security and Agribusiness Support. *Cultivating New Frontiers in Agriculture (CNFA)*. https://www.cnfa.org/program/food-security-and-agribusiness-support/

Community and Grassroots Efforts: Various local NGOs and community groups are also working to improve food accessibility. Projects like the Feed the Future Egypt Food Security and Agribusiness Support (FAS) project, funded by USAID, aim to enhance food security and nutrition for smallholder farmers in Upper Egypt. These efforts include improving agricultural practices, developing market connections, and reducing post-harvest losses through better cold chain infrastructure.[112]

While significant strides have been made to improve food accessibility in Egypt, challenges such as high food prices, economic inequality, and reliance on imports persist. By continuing to work on long term sustainable development programs and investing in talent, education, and technology infrastructure, Egypt might be able to improve its food availability conditions. Meanwhile, in the short and medium run, it is crucial to maintain and expand social protection programs to ensure that all citizens have reliable access to sufficient, nutritious food.

3. Food Utilization

Food utilization is a crucial pillar of food security that focuses on the proper biological use of food, requiring a diet that provides sufficient energy and nutrients, as well as the ability to absorb and metabolize those nutrients.

Nutrition and Malnutrition: Despite improvements, malnutrition remains a significant public health concern in Egypt. The World Food Programme (WFP) reports a stunting rate of 13% among children under five years old, with 4% of children being underweight. In Egypt, 38% of married women suffer from anemia[113], 40% of women between 15 and 49 are overweight, and 56% of women suffer from obesity. These figures highlight the ongoing issues of inadequate nutrition and dietary diversity, which can lead to long-term health problems and hinder cognitive and physical development.[114]

Food Safety: Ensuring food safety is another critical aspect of food utilization. Contaminated food and water can lead to various diseases, undermining the health benefits of the available food. The Food and Agriculture Organization (FAO) has been working with the Egyptian government to improve food safety standards and practices. Initiatives include the implementation of modern phytosanitary measures and the establishment of food safety regulations to prevent the spread of foodborne illnesses.[115]

Health and Hygiene: Access to clean water and proper sanitation facilities is essential for effective food utilization. Inadequate water and sanitation can lead to diseases that impair nutrient absorption. The Egyptian government, supported by international partners like the United Nations and the World Bank, has been working to improve water and sanitation infrastructure, particularly in rural areas. These efforts aim to reduce the incidence of waterborne diseases and improve overall public health.[116]

Public Health Initiatives: The WFP, in collaboration with the Egyptian government, has launched several nutrition-sensitive social protection programs. The "First 1,000 Days" initiative targets pregnant and nursing women and children under two, providing cash transfers to ensure they receive adequate nutrition. Additionally, the National School Feeding Programme provides fortified snacks to schoolchildren, addressing nutritional gaps and promoting better health and educational outcomes.[117,118]

Addressing the challenges related to food utilization is essential for improving food security in Egypt. By enhancing nutrition, ensuring food safety, and improving health and hygiene practices, Egypt can make significant strides towards achieving better health outcomes for its population. Ongoing collaborations with international organizations and the implementation of targeted public health initiatives are critical components of this effort.

4. Food Stability

Food stability is a critical pillar of food security, ensuring that food is consistently available, accessible, and utilizable over time, regardless of economic, environmental, or political conditions.

Economic Volatility: Egypt's food security is highly susceptible to economic fluctuations.

112   Global Cold Chain Alliance. Egypt Food Security and Agribusiness Support. Global Cold Chain Alliance (GCCA). https://www.gcca.org/project/egypt-food-security-and-agribusiness-support-fas/

113   المصدر: الجهاز المركزي للتعبئة العامة والإحصاء، (2021)، المسح الصحي للأسرة المصرية

114   World Food Programme. (2023). Egypt Country Strategic Plan 2023-2028. https://docs.wfp.org/api/documents/WFP-0000157713/download/?_ga=2.41980901.1775791114.1718143725-1547489956.1702973522

115   Food and Agriculture Organization of the United Nations. (2023, December 13). FAO in Egypt–Redefining resilience in Egypt's agrifood future. *Food and Agriculture Organization of the United Nations*. https://www.fao.org/egypt/news/detail-events/en/c/1673506/

116   World Bank Group. (n.d.). The World Bank In Egypt. https://www.worldbank.org/en/country/egypt

117   World Food Programme. (2023). Egypt Country Strategic Plan 2023-2028. https://docs.wfp.org/api/documents/WFP-0000157713/download/?_ga=2.41980901.1775791114.1718143725-1547489956.1702973522

118   World Food Programme. Egypt Country Brief. https://www.wfp.org/countries/egypt

Domestic food price inflation remains a significant challenge, exacerbated by global market volatility and Egypt's latest economic turbulences mentioned earlier in the paper. As a result, food prices can rise sharply, making it difficult for many Egyptians to afford basic staples. The World Bank reports that inflation in lower-middle-income countries, including Egypt, continues to impact food affordability, stressing the importance of stabilizing food prices to ensure food security.[119]

Climate Change: Climate change poses a severe threat to Egypt's agricultural productivity and food stability. Increasing temperatures, changing precipitation patterns, and extreme weather events are affecting crop yields and water availability. The Food and Agriculture Organization (FAO) has been working with the Egyptian government to implement climate-smart agriculture practices to mitigate these impacts and enhance resilience against climate-related shocks.[120] Initiatives include improving irrigation systems, adopting drought-resistant crop varieties, and promoting sustainable land management practices.

Political Factors: Political stability is essential for maintaining food security. The ongoing regional conflicts and political uncertainties can disrupt food supply chains and trade routes, affecting the availability and stability of food supplies. The World Food Programme (WFP) highlights that political stability and effective governance are crucial for ensuring that food systems are resilient and can withstand external shocks.[121]

Government and International Initiatives: The Egyptian government, supported by international organizations like the WFP and FAO, has launched several initiatives to improve food stability. The WFP's country strategic plan for 2023-2028 aims to build resilience among vulnerable populations through various programs, including the "Haya Karima" initiative, which focuses on enhancing livelihoods and social and economic inclusion in rural areas.[122] The WFP actively supports smallholder farmers and Bedouin communities in Egypt by enhancing agricultural practices and improving market access,

thereby contributing to more stable food systems. WFP collaborates with the Egyptian Government to strengthen these communities' capacity to adapt to climate change and improve agricultural productivity through initiatives such as improved irrigation practices, financial literacy, and cash-based transfers.[123]

Additionally, WFP's "Climate Resilience & Empowering Egyptian Farmers" program focuses on supporting farmers with sustainable water management solutions and access to markets, helping mitigate the impact of climate change and increase production. These efforts are part of WFP's broader strategy to build resilience and empower vulnerable communities in Egypt, ensuring more stable and sustainable food systems.[124]

Addressing the challenges related to food stability is essential for improving food security in Egypt. By focusing on mitigating economic volatility, adapting to climate change, and ensuring political stability, Egypt can enhance the resilience of its food systems. Ongoing collaborations with international organizations and the implementation of targeted initiatives are critical for achieving long-term food stability and security.

METHODOLOGY

This paper employs a varied methodology to explore the intersection of artificial intelligence (AI) governance and food security in Egypt. The approach combines a thorough literature review, sector mapping, and expert interviews to provide a comprehensive understanding of the topic.

Literature Review and Sector Mapping

The paper begins with a literature review to familiarize readers with the current state of AI and food security in Egypt. This review includes key reports, studies, and articles from reputable sources such as the Food and Agriculture Organization (FAO), the World Food Programme (WFP), and various academic publications.

Following the literature review, we conduct a detailed mapping of AI applications in key food-related sectors using the FAO's four-pillar framework of food security: availability, accessibility, utilization, and stability. Each pillar helps identify relevant sectors and AI applications:

119   The World Bank. (2024, May 30). Food Security Update–World Bank Response to Rising Food Insecurity. World Bank Group. https://www.worldbank.org/en/topic/agriculture/brief/food-security-update.

120   Food and Agriculture Organization of the United Nations. FAO in Egypt–Climate-Smart Agriculture. *Food and Agriculture Organization of the United Nations*. https://www.fao.org/egypt/en/

121   World Food Programme. (2023). Egypt Country Strategic Plan 2023-2028. https://docs.wfp.org/api/documents/WFP-0000157713/download/?_ga=2.41980901.1775791114.1718143725-1547489956.1702973522

122   World Food Programme. (2023). Egypt Country Strategic Plan 2023-2028. https://docs.wfp.org/api/documents/WFP-0000157713/download/?_ga=2.41980901.1775791114.1718143725-1547489956.1702973522

123   World Food Program USA. (n.d.). Egypt. https://www.wfpusa.org/countries/egypt/

124   World Food Programme. (2024, September 16). Climate Resilience & Empowering Egyptian Farmers. https://www.wfp.org/publications/climate-resilience-empowering-egyptian-farmers

- **Availability**: Agriculture, food production, and food imports.
- **Accessibility**: Logistics, warehousing, transportation, e-commerce, retail, and financial inclusion.
- **Utilization**: Food safety, nutrition, and public health.
- **Stability**: Economic volatility, climate resilience, and political stability.

Expert Interviews

To capture a well-rounded perspective on the intersection of AI governance and food security, we conducted semi-structured interviews with various experts with diverse experience in AI and food-related sectors. The experts interviewed include:

- **Ahmed Abaza**:
  CEO of Synapse Analytics
- **Waleed Naser**:
  CEO of Zr3i
- **Neamat ElTazi**:
  Founder and COO at PoultrySync (formerly known as Abu Erdan)
- **Farah Emara**
  Co-founder and CEO at FreshSource
- **Radwa Elamir**:
  Marketing and PR Manager at Mozare3

Interview Approach

The questions posed during the interviews were mostly customized to align with each interviewee's area of expertise, while still aiming to capture unique perspectives on AI governance and food security. Examples of guiding questions include:

- How do you perceive AI in your sector of operation?
- What are some current and potential AI use cases that you see in the areas around you? And what are the main challenges in implementing them?
- How in your opinion can AI contribute to enhancing food availability, accessibility, utilization, and stability in Egypt?
- What more can the government do to help?

A longer list of questions can be viewed in Annex A.

These interviews provide qualitative insights that complement the literature review and sector mapping, offering a more rounded view of the current landscape and future potential of AI in enhancing food security in Egypt.

AI SOLUTIONS FOR FOOD SECURITY IN EGYPT

In this section, we delve into the various applications of artificial intelligence (AI) across sectors related to food security in Egypt. By mapping these use cases, we aim to provide a thorough overview of how AI technologies are being leveraged to address challenges and enhance the efficiency of food systems. This mapping exercise is structured around the Food and Agriculture Organization (FAO)'s four pillars of food security: availability, accessibility, utilization, and stability.

The integration of AI into food security sectors is transforming traditional practices and driving innovation. In Egypt, AI is being utilized to tackle a range of issues, from improving agricultural productivity and optimizing supply chains to enhancing food safety and managing resources more efficiently. This section identifies and categorizes the specific AI applications within each pillar of food security, offering insights into their impact and potential.

I. AVAILABILITY

By leveraging AI technologies, the agricultural sector in Egypt can significantly improve productivity, optimize resource management, and reduce losses, thereby ensuring a stable supply of food. Below, we map the current AI applications and use cases in key food-related sectors, focusing on agriculture, food production, and food imports.

AI Applications in Agriculture

1) **Precision Agriculture:** Precision agriculture solutions are predominantly in pilot phases, focusing on high-value crops such as cotton and sugarcane, and cover approximately 5% of Egypt's arable land.[125] AI-driven precision agriculture involves the use of machine learning algorithms, drones, and sensors to monitor and manage crops efficiently. This technology helps farmers optimize water usage, apply fertilizers precisely, and monitor crop health in real-time. For instance, the "Hudhud" smart assistant project in Egypt uses AI to provide farmers with tailored ad-

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125   Food and Agriculture Organization of the United Nations. (2020, February). Priorities for Food and Agriculture in the Near East and North Africa Region 2020-2030. https://openknowledge.fao.org/server/api/core/bitstreams/3fd4f548-918d-4e64-8eac-d1bcef48c994/content

vice on crop management and pest control, enhancing agricultural productivity.[126] [127] Moreover, "Plug'n'Grow," an Egyptian startup that develops advanced and economic solutions in agriculture, provides AI-driven hydroponic systems currently utilized by a limited number of farms in the Nile Delta region, with expansion plans contingent on securing additional funding and enhancing infrastructure.[128]

2) **Crop Disease Detection:** AI technologies are being employed to detect and manage crop diseases early. Machine learning models and computer vision techniques can identify signs of disease from images of crops, allowing for timely interventions. For example, the startup "Cropsa" uses AI to diagnose crop diseases by analyzing images uploaded by farmers, providing recommendations for treatment and improving overall crop health.[129] [130] Cropsa Egypt is recognized as a pioneering agritech startup aiming to transform agriculture through its comprehensive marketplace for raw materials and tools. Their mission is to empower farmers and breeders with flexible payment options, secure transportation, and cutting-edge technology solutions, fostering digital transformation and financial inclusion in the sector.[131,132]

Additionally, Egypt's agritech sector is poised for significant growth, with projections indicating that agricultural exports could reach $14 billion by 2030, underscoring the vital role of technology in addressing challenges such as water scarcity and labor shortages.[133]

3) **Smart Irrigation Systems:** AI-powered irrigation systems utilize data from soil sensors and weather forecasts to optimize water use. These systems ensure that crops receive the right amount of water at the right time, conserving water resources and enhancing crop growth. Smart irrigation systems are currently implemented on approximately 2% of farms in arid regions, with the majority of irrigation practices remaining manual or minimally automated.[134] "Plug'n'Grow," employs AI-driven hydroponic systems that adjust water and nutrient supply based on real-time data, significantly improving water efficiency and crop yields.[135,136]

AI Applications in Food Production

1) **Yield Prediction:** AI models are used to predict crop yields based on historical data and real-time inputs such as weather conditions and soil health. These predictions help farmers make informed decisions about planting and harvesting, improving overall productivity. For example, "Agrimatic" uses AI to predict yields and optimize soilless agriculture practices, leading to higher productivity and sustainable farming methods.[137,138]

2) **Supply Chain Optimization:** AI technologies are optimizing the food supply chain by improving logistics and inventory management. AI algorithms analyze data to predict demand, manage stock levels, and streamline distribution processes, ensuring that food products reach consumers efficiently and with minimal waste. "FreshSource" uses data to streamline logistics and connect farmers directly with businesses, reducing food loss and improving market access for smallholder farmers.[139] [140]

126   Farmers Review Africa. (2021, December 8). Egypt launches AI-enabled system to enhance agriculture process. *Farmers Review Africa.* https://farmersreviewafrica.com/egypt-launches-ai-enabled-system-to-enhance-agriculture-process/

127   Ibid.

128   Plug'n'Grow. (n.d.). Home [LinkedIn page]. LinkedIn. Retrieved December 3, 2024. https://www.linkedin.com/company/plug-n-grow/?originalSubdomain=eg

129   Food and Agriculture Organization of the United Nations. FAO in Egypt– Climate-Smart Agriculture. *Food and Agriculture Organization of the United Nations.* https://www.fao.org/egypt/en/

130   Kotb, M. (2023, September 1). Six Egyptian Agritech Startups at the Forefront of Innovation in Agriculture. *Egyptian Streets.* https://egyptianstreets.com/2023/09/01/six-egyptian-agritech-startups-at-the-forefront-of-innovation-in-agriculture/

131   Cropsa Egypt. (n.d.). https://cropsaegypt.com

132   F6S. (n.d.). Cropsa Egypt. https://www.f6s.com/company/cropsa-egypt#about

133   Hutton, J. (2024, November 5). Egypt's Agritech Revolution: $14 Billion Exports by 2030 on the Horizon. AgriTech Insights. https://agritechinsights.com/index.php/2024/11/05/egypts-agritech-revolution-14-billion-exports-by-2030-on-the-horizon/

134   World Bank Group. (2022, July 5). Arab Republic of Egypt Integrated Irrigation Improvement and Management Project and Farm-Level Irrigation Modernization Project. https://documents1.worldbank.org/curated/en/099312308182234337/pdf/IDU038134c250e1d904f280abbc0c6368540a0a6.pdf

135   Food and Agriculture Organization of the United Nations. FAO in Egypt– Climate-Smart Agriculture. *Food and Agriculture Organization of the United Nations.* https://www.fao.org/egypt/en/

136   Kotb, M. (2023, September 1). Six Egyptian Agritech Startups at the Forefront of Innovation in Agriculture. *Egyptian Streets.* https://egyptianstreets.com/2023/09/01/six-egyptian-agritech-startups-at-the-forefront-of-innovation-in-agriculture/

137   Oliveira, R. C. D., & Silva, R. D. D. S. E. (2023). Artificial intelligence in agriculture: benefits, challenges, and trends. *Applied Sciences, 13*(13), 7405.

138   The Startup Scene. (2018, July 29). 3 Agritech Startups Creating a Farming Revolution in Egypt. *The Startup Scene.* https://thestartupscene.me/BehindTheStartup/3-Agritech-Startups-Creating-a-Farming-Revolution-in-Egypt

139   Food and Agriculture Organization of the United Nations. FAO in Egypt– Climate-Smart Agriculture. *Food and Agriculture Organization of the United Nations.* https://www.fao.org/egypt/en/

140   Kotb, M. (2023, September 1). Six Egyptian Agritech Startups at the Forefront of Innovation in Agriculture. *Egyptian Streets.* https://egyptianstreets.com/2023/09/01/six-egyptian-agritech-startups-at-the-forefront-of-innovation-in-agriculture/

AI Applications in Food Imports

1) **Trade and Import Management:** AI is used to manage agricultural trade and imports by analysing global market trends and optimize import strategies for staple foods like wheat and maize. New import management strategies are under development, primarily explored by the Ministry of Agriculture in pilot projects aimed at optimizing wheat import strategies. A main example is Egypt's investing in Mechanised Raised-Bed Irrigation (MRBI) technology to achieve its short to long term wheat production volumes and quality.[141]

By leveraging predictive analytics, Egypt can better manage its food imports, ensuring a steady supply of essential commodities despite global market fluctuations.[142]

2) **Food Safety and Quality Control:** AI technologies are also applied in the inspection and quality control of imported food products. Machine learning models can detect contaminants and ensure that food meets safety standards before reaching the market, protecting public health and maintaining consumer trust. "Wastilizer," for example, converts animal waste into bio-gas and bio-organic fertilizers, enhancing food safety and supporting sustainable agricultural practices.[143]

Conclusion

The integration of AI in food availability sectors in Egypt is transforming traditional agricultural practices and enhancing food security. By adopting precision agriculture, disease detection, smart irrigation, yield prediction, and supply chain optimization, Egypt can improve food production efficiency, reduce losses, and ensure a stable food supply. Continued support from the government and international collaborations will be crucial in expanding these AI applications and achieving sustainable food security.

II. ACCESSIBILITY

Ensuring that food reaches all segments of the population involves complex logistics and distribution networks. AI is being used to optimize supply chains, manage inventory, and enhance e-commerce platforms. Additionally, AI-driven financial inclusion initiatives are enabling better access to food through digital payment systems and credit scoring.

In this section, we explore the various applications of artificial intelligence (AI) in enhancing food accessibility in Egypt. By leveraging AI technologies, different sectors involved in logistics, distribution, and retail can optimize operations, improve food accessibility, and ensure that all population segments have consistent access to nutritious food. Below, we map the current AI applications and use cases in these sectors.

AI Applications in Logistics and Distribution

1) **Route Planning and Fleet Management:** AI-powered logistics solutions are used in the food distribution sector to optimize route planning and fleet management, ensuring timely and cost-effective delivery of food products. Startups like Trella employ AI to manage logistics operations, helping to reduce transportation costs and improve the reliability of food distribution networks. AI-driven dynamic route optimization algorithms analyze traffic patterns and delivery requirements to create efficient delivery routes, reducing fuel consumption and delivery times.[144][145] Trella has made significant strides in digitizing Egypt's trucking and logistics industry. As of 2020, Trella was collaborating with approximately 50-60 shipper partners and had onboarded around 15,000 to 20,000 trucks across Egypt, and by 2021, it had expanded its operations to Saudi Arabia and Pakistan, aiming to enter every MENA country with support from leading investors.[146,147] In that same year, Trella had over 350 shipper partners, including blue-chip brands such as Coca-Cola, Maersk, Mon-

141   Oirere, S. (2024, November 28). Egypt aiming for wheat self-sufficiency. World Grain. https://www.world-grain.com/articles/20762-egypt-aiming-for-wheat-self-sufficiency

142   The World Bank. (2024, May 30). Food Security Update–World Bank Response to Rising Food Insecurity. World Bank Group. https://www.worldbank.org/en/topic/agriculture/brief/food-security-update.

143   The Startup Scene. (2018, July 29). 3 Agritech Startups Creating a Farming Revolution in Egypt. The Startup Scene. https://thestartupscene.me/BehindTheStartup/3-Agritech-Startups-Creating-a-Farming-Revolution-in-Egypt

144   Vervo Logistics Middle East. (2024, January 3). Three AI Applications Shaping Logistics in 2024. Vervo Logistics Middle East. https://vervologistics.com/blog/ai-applications-in-logistics-2024

145   Sychikova, Y. (2024, March 11). AI in Logistics: Emerging Startups, Challenges and Use Cases. DataRoot Labs. https://datarootlabs.com/blog/ai-in-logistics-emerging-startups-remaining-challenges-and-new-models

146   Adel, M. (2020, March 21). An Egyptian startup whips trucking and logistics industry into shape. Arab News. https://www.arabnews.com/node/1644626/business-economy

147   Quenum, A. C. (2022, April 16). Egypt : Trella, the efficient digital intermediary between shippers and truckers. We Are Tech Africa. https://www.wearetech.africa/en/fils-uk/solutions/egypt-trella-the-efficient-digital-intermediary-between-shippers-and-truckers

di, Henkel, Orascom, and Cemex, and more than 15,000 carrier partners.[148,149]

2) **Autonomous Delivery Vehicles and Drones:** Autonomous vehicles (AVs) and drones equipped with sophisticated AI algorithms are transforming last-mile delivery logistics. These technologies reduce labour costs and enhance delivery efficiency, especially in congested urban areas or remote rural locations. For instance, Roboost has implemented AI-powered route optimization to streamline its logistics operations, achieving significant improvements in delivery speed and cost efficiency.[150,151] Despite clearly having AVs on the agenda, autonomous vehicles remain in early experimental stages in the region, with the majority testing in confined spaces with no long-haul pilots done to date.[152]

AI Applications in Retail and E-commerce

1) **Personalized Shopping Experiences:** AI is being used to provide personalized shopping experiences in the retail sector. For instance, Elmenus uses AI algorithms to offer personalized food recommendations and enhance customer engagement through its platform, making it easier for consumers to find and purchase food products that meet their needs. These AI-driven recommendations help increase customer satisfaction and boost sales by catering to individual preferences. [153,154]

2) **Inventory Management:** AI-driven inventory management systems help retailers maintain optimal stock levels, reducing food wastage and ensuring that essential food items are always available.

148   Adel, M. (2020, March 21). An Egyptian startup whips trucking and logistics industry into shape. Arab News. https://www.arabnews.com/node/1644626/business-economy

149   Hagrass, O. (2021, June 21). Trella closes US$42 million funding round. Trella. https://blog.trella.app/funds/trella-closes-us42-million-funding-round/

150   Sengupta, K. (2024, January 3). How can generative AI drive logistics transformation?. *Maersk.* https://www.maersk.com/insights/digitalisation/2024/01/03/how-can-generative-ai-drive-logistics-transformation

151   Mayer, M. (2023, December 8). Food and Grocery Supply Chain Top of Mind at Manifest 2024. *Food Logistics.* https://www.foodlogistics.com/warehousing/grocery-retail/article/22881292/manifest-llc-food-and-grocery-supply-chain-top-of-mind-at-manifest-2024

152   Schönberg, T. (2023, May 4). No need to wait any longer: Autonomous driving could scale in the Middle East. Roland Berger. https://www.rolandberger.com/en/Insights/Publications/No-need-to-wait-any-longer-Autonomous-driving-could-scale-in-the-Middle-East.html

153   Egypt Business Directory. (2024, April 19). How to incorporate AI into retail operations. *Egypt Business Directory.* https://www.egypt-business.com/news/details/2416-how-to-incorporate-ai-into-retail-operations/432384

154   Jenns, C. (2023, August 10). How is AI used in retail in 2024?. *Retail Insight Network.* https://www.retail-insight-network.com/features/how-is-ai-being-used-in-retail-in-2024/

Breadfast, an online grocery delivery service, uses AI to manage its inventory and optimize its delivery routes, ensuring fresh produce and groceries are delivered efficiently. This minimizes overstocking and understocking, improving overall operational efficiency.[155,156]

AI Applications in Financial Inclusion

1) **Digital Payment Systems:** AI is being leveraged to enhance financial inclusion through digital payment systems. Fawry, a leading fintech company in Egypt, uses AI to provide secure and efficient digital payment solutions, enabling consumers to access and purchase food products easily, thereby improving food accessibility. AI helps in detecting fraudulent transactions and ensuring secure payments, making digital financial services more reliable and accessible.[157,158]

2) **Credit Scoring and Microloans:** AI-powered credit scoring models are helping to provide microloans to smallholder farmers and low-income consumers. PayMob utilizes AI to assess creditworthiness and offer microloans, allowing farmers to invest in their production and consumers to purchase necessary food items on credit. This AI-driven approach enables financial institutions to extend credit to those who may not have traditional credit histories, promoting financial inclusion.[159,160]

III. UTILIZATION

Food utilization focuses on the nutritional quality and safety of food, ensuring that individuals have the knowledge and resources to use food

155   Walmart Corporate News and Information. (2024, March 14). Walmart Commerce Technologies Launches AI-Powered Logistics Product. *Walmart Corporate News and Information.* https://corporate.walmart.com/news/2024/03/14/walmart-commerce-technologies-launches-ai-powered-logistics-product
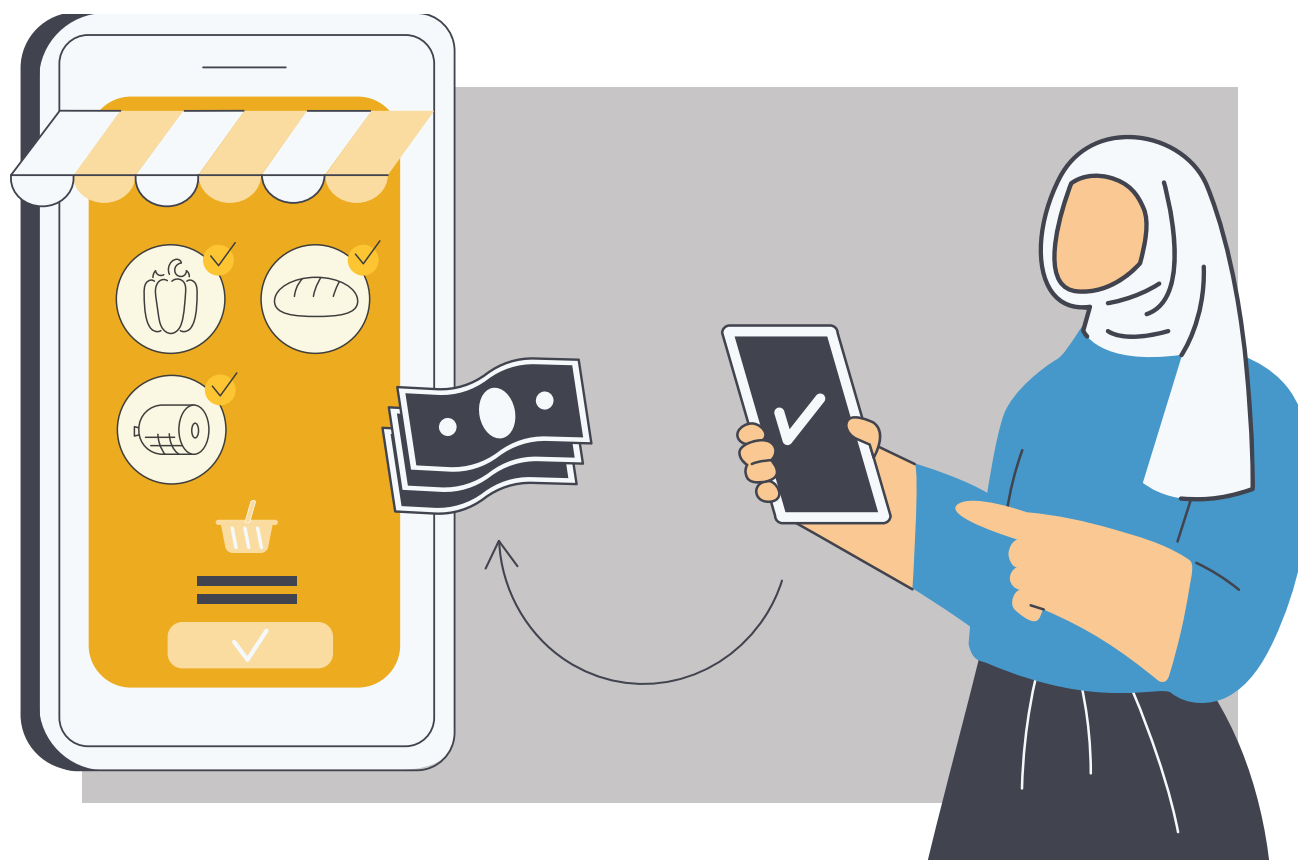
156   Reddy, J. (2024, February 5). The AI Revolution: Transforming Supply Chain and Logistics with Artificial Intelligence. *Supply Chain Brain.* https://www.supplychainbrain.com/articles/38972-the-ai-revolution-transforming-supply-chain-and-logistics-with-artificial-intelligence

157   Zawya. (2021, November 3). Egypt strives to become transport, logistics hub by 2024. *Zawya.* https://www.zawya.com/en/business/egypt-strives-to-become-transport-logistics-hub-by-2024-fs6t3lxi

158   World Food Programme. (2023). Egypt Country Strategic Plan 2023-2028. https://docs.wfp.org/api/documents/WFP-0000157713/download/?_ga=2.41980901.1775791114.1718143725-1547489956.1702973522

159   Food and Agriculture Organization of the United Nations. (2019, July 3). FAO and MALR launch a Digital Agriculture initiative in Egypt. *Food and Agriculture Organization of the United Nations.* https://www.fao.org/egypt/news/detail-events/en/c/1200501/

160   Hafez, T. (2022, March 21). Egypt's AI Roadmap. *Business Monthly.* https://businessmonthlyeg.com/egypts-ai-roadmap/

appropriately for their dietary needs. This section explores the various applications of artificial intelligence (AI) in enhancing food utilization in Egypt, highlighting how AI technologies are being employed to improve food safety, quality control, and nutrition.

AI Applications in Food Safety and Quality Control

1) **Quality Control in Food Processing:** AI technologies are used extensively in the food processing industry to ensure food quality assurance processes. Machine learning algorithms and computer vision systems are employed to detect defects, contaminants, and inconsistencies in food products. For example, the National Food Safety Authority (NFSA) in Egypt utilizes AI-powered systems to inspect fruits and vegetables for bruises or imperfections, ensuring that only high-quality products reach consumers, thus reducing the risk of foodborne illnesses.[161,162] NFSA has implemented AI-driven quality control measures in 10 processing facilities, accounting for 5% of food processing plants nationwide.[163]

2) **Traceability and Supply Chain Transparency:** AI enhances traceability throughout the food supply chain. Blockchain technology combined with AI can track the journey of food products from farm to table, providing detailed information about their origin, handling, and processing conditions. This transparency helps quickly identify and address sources of contamination or quality issues, thereby improving overall food safety. The NFSA has implemented these technologies to monitor food safety standards and compliance across the supply chain.[164,165]

AI Applications in Nutrition

1) **Personalized Nutrition:** AI-based personalised nutrition platforms offer personalized nutrition advice based on individual dietary needs and health conditions. These platforms use data from wearable devices, health records, and dietary habits to create customized meal plans that optimize nutrition and health outcomes. For instance, local health startups in Egypt are developing AI-based apps that analyze users' dietary habits and provide personalized nutrition recommendations to improve health and well-being.[166,167] The Digital Fitness & Well-Being market in Egypt is projected to grow by 10.27% (2024-2029), resulting in a market volume of US$592.90 million in 2029, suggesting a growing interest in health and wellness solutions amongst Egyptian consumers, particularly in urban centers.[168]

2) **Food Waste Reduction:** AI technologies are also used to minimize food waste, a critical aspect of food utilization. Predictive analytics can forecast demand more accurately, helping retailers and food service providers manage inventory better and reduce wastage. Additionally, AI can assist in repurposing food that would otherwise go to waste by identifying opportunities to donate surplus food to communities in need. Organizations like the Egyptian Food Bank are leveraging AI to optimize their food donation processes and minimize waste.[169,170]

AI Applications in Public Health

1) **Monitoring and Predicting Health Trends:** AI monitors and predicts health trends related to nutrition and food consumption. By analyzing large datasets from health surveys, social media, and other sources, AI can identify emerging health issues and dietary patterns. This information can be used to design public health interventions and campaigns to promote healthier eating

161   Ding, H., Tian, J., Yu, W., Wilson, D. I., Young, B. R., Cui, X., … & Li, W. (2023). The application of artificial intelligence and big data in the food industry. *Foods*, *12*(24), 4511.

162   Jafar, A., Bibi, N., Naqvi, R. A., Sadeghi-Niaraki, A., & Jeong, D. (2024). Revolutionizing agriculture with artificial intelligence: plant disease detection methods, applications, and their limitations. *Frontiers in Plant Science*, 15, 1356260.

163   المصدر: الهيئة القومية لسلامة الغذاء. (10 ديسمبر 2024). الهيئة القومية لسلامة الغذاء وشركة فيكسد مصر للحلول الرقمية وأمن المعلومات تعلنان عن شراكة استراتيجية لتطوير وميكنة منظومة مراقبة إنتاج وتداول الغذاء في السوق المحلي. https://www.nfsa.gov.eg/ar-eg/home/index?aspxerrorpath=/en/reports/2023

164   Food and Agriculture Organization of the United Nations. (2019, July 3). FAO and MALR launch a Digital Agriculture initiative in Egypt. *Food and Agriculture Organization of the United Nations.* https://www.fao.org/egypt/news/detail-events/en/c/1200501/

165   Jafar, A., Bibi, N., Naqvi, R. A., Sadeghi-Niaraki, A., & Jeong, D. (2024). Revolutionizing agriculture with artificial intelligence: plant disease detection methods, applications, and their limitations. *Frontiers in Plant Science*, 15, 1356260.

166   Egypt Business Directory. (2023, March 18). Top Innovative AI-Based Startups in Egypt. Egypt Business Directory. https://www.egypt-business.com/web/details/2311-top-innovative-ai-based-startups-in-egypt-2023/426836

167   Ding, H., Tian, J., Yu, W., Wilson, D. I., Young, B. R., Cui, X., … & Li, W. (2023). The application of artificial intelligence and big data in the food industry. *Foods*, *12*(24), 4511.

168   Statista. (2024). Digital Fitness & Well-Being–Egypt. https://www.statista.com/outlook/hmo/digital-health/digital-fitness-well-being/egypt

169   MAGNiTT. Food & Beverage Startups in Egypt. https://magnitt.com/en-eg/startups/food-and-beverage

170   Jafar, A., Bibi, N., Naqvi, R. A., Sadeghi-Niaraki, A., & Jeong, D. (2024). Revolutionizing agriculture with artificial intelligence: plant disease detection methods, applications, and their limitations. *Frontiers in Plant Science*, 15, 1356260.

habits. The Ministry of Health in Egypt utilizes AI analytics to track and address nutritional deficiencies in various regions.[171,172]

2) **Enhancing Food Fortification Programs:** AI optimizes food fortification programs by determining the most effective ways to add essential nutrients to commonly consumed foods. This ensures that populations receive adequate micronutrients, addressing issues such as anemia and vitamin deficiencies prevalent in certain regions. The NFSA collaborates with international organizations to implement AI-driven strategies for food fortification.[173,174]

171   Food and Agriculture Organization of the United Nations. (2019, July 3). FAO and MALR launch a Digital Agriculture initiative in Egypt. *Food and Agriculture Organization of the United Nations.* https://www.fao.org/egypt/news/detail-events/en/c/1200501/

172   Ding, H., Tian, J., Yu, W., Wilson, D. I., Young, B. R., Cui, X., ... & Li, W. (2023). The application of artificial intelligence and big data in the food industry. *Foods*, *12*(24), 4511.

173   Ding, H., Tian, J., Yu, W., Wilson, D. I., Young, B. R., Cui, X., ... & Li, W. (2023). The application of artificial intelligence and big data in the food industry. *Foods*, *12*(24), 4511.

174   Jafar, A., Bibi, N., Naqvi, R. A., Sadeghi-Niaraki, A., & Jeong, D. (2024). Revolutionizing agriculture with artificial intelligence: plant disease detection methods, applications, and their limitations. *Frontiers in Plant Science*, *15*, 1356260.
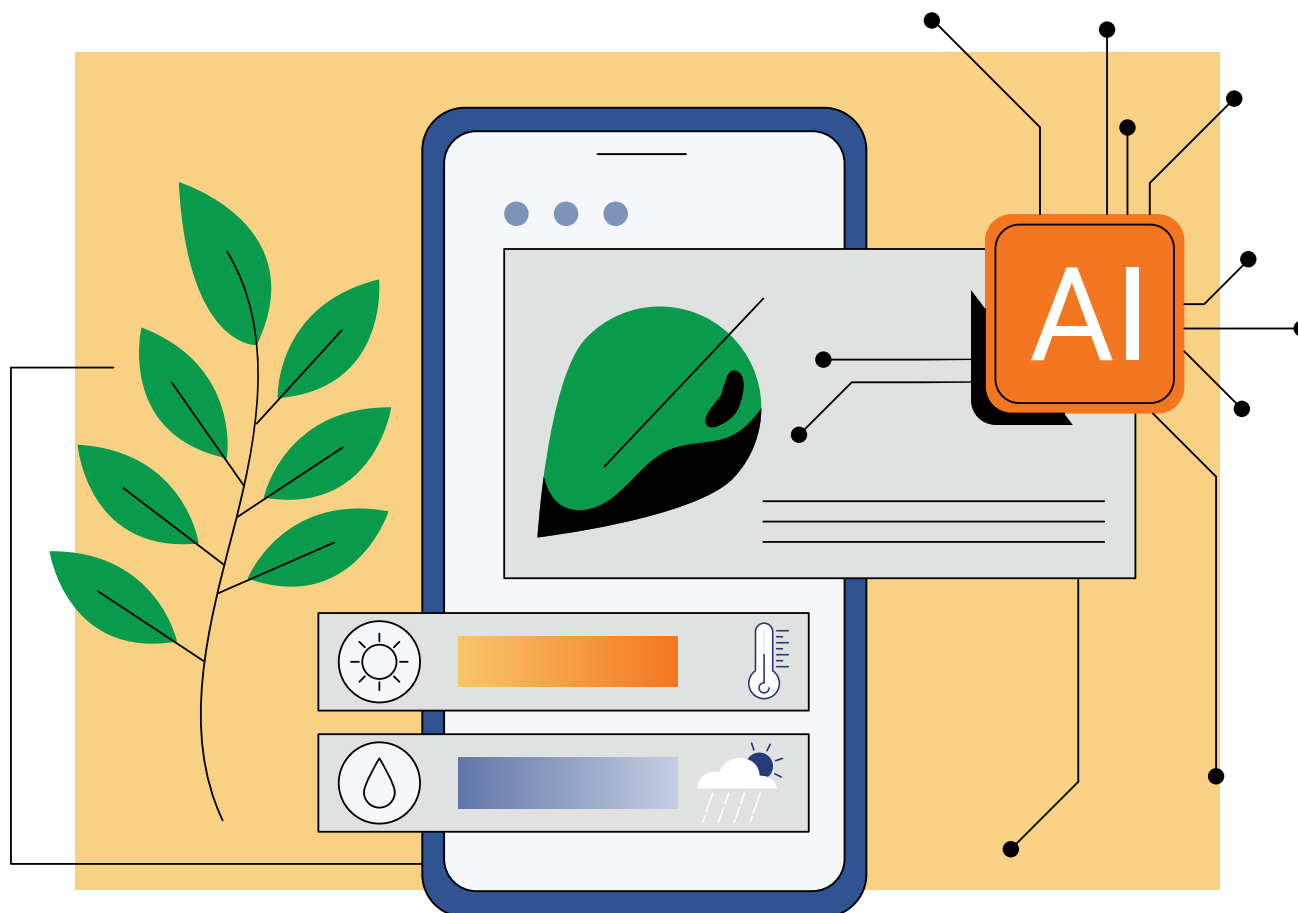
Conclusion

The application of AI in food utilization sectors in Egypt is transforming how food safety, quality control, and nutrition are managed. By leveraging AI technologies, Egypt can enhance the safety and nutritional value of its food supply, reduce waste, and improve public health outcomes. Ongoing research and collaboration with international organizations will be crucial in expanding these AI applications and achieving sustainable food security.

IV. STABILITY

Food stability focuses on ensuring consistent availability and access to food over time, despite potential disruptions from various sources like climate change, economic fluctuations, or political instability. Here are some AI applications and use cases in the food stability space in Egypt, along with examples of startups and organizations implementing these technologies:

Predictive Analytics for Crop Yields

- **Application**: AI-driven predictive analytics are used to forecast crop yields, help-

ing farmers and policymakers plan for potential shortages or surpluses. These systems analyze weather patterns, soil conditions, and historical crop data to make accurate predictions.

- **Example**: Gro Intelligence, an AI company, provides comprehensive data analytics tools that help predict agricultural outputs and identify potential supply chain disruptions. Their platform uses AI to simulate complex scenarios and forecast crop yields, which is crucial for maintaining food stability in Egypt.[175]

Climate Change Impact Assessment

- **Application**: AI models assess the impact of climate change on agricultural production, enabling better planning and adaptation strategies. These models can predict extreme weather events and their potential effects on crop yields.
- **Example**: The World Food Programme (WFP) in Egypt uses AI to monitor climate-related risks and develop early warning systems. These systems help in preparing for and mitigating the effects of adverse weather conditions on food production.[176]

Supply Chain Optimization

- **Application**: AI optimizes food supply chains by predicting demand, managing inventory, and reducing waste. This ensures that food supplies remain stable even during disruptions.
- **Example**: Weelo, a digital supply chain platform in Egypt, uses AI and machine learning to enhance the efficiency of supply chain operations. Their platform helps retailers and suppliers optimize inventory management and reduce waste, contributing to food stability.[177]

Digital Twins for Agriculture

- **Application**: Digital twins use AI to create virtual models of agricultural systems, allowing for real-time monitoring and management. These models help predict outcomes and optimize agricultural practices.

- **Example**: AI-powered digital twins are being explored by various organizations to enhance agricultural productivity and resilience. These digital replicas help in making informed decisions about resource allocation and crop management, ensuring consistent food production.[178]

Early Warning Systems

- **Application**: AI-driven early warning systems monitor environmental and market conditions to provide alerts about potential disruptions. These systems use real-time data to predict issues like droughts, floods, or market volatility.
- **Example**: The Ministry of Agriculture in Egypt is collaborating with international bodies to implement AI-based early warning systems for agricultural risks. These systems help farmers and policymakers prepare for adverse events, maintaining food stability in the face of potential threats[179] [180] AI-driven early warning systems are operational in regions prone to drought, covering approximately 10% of Egypt's farmland, with plans for nationwide expansion.[181]

Food Security and Policy Planning

- **Application**: AI supports strategic policy planning by providing insights into food security trends and potential risks. These insights help in developing policies that enhance food stability.
- **Example**: The Egyptian government, with support from organizations like the WFP, uses AI to analyze food security data and plan interventions. This includes assessing the impact of economic policies on food availability and access.[182]

V. KEY OPERATORS

Please see Annex B for a list of exemplary startups and organisations that operate in food security-related areas.

175   Gro Intelligence. AI & The Future of Food Security: Using AI to Build Food System Resilience and Opportunity in a Changing Climate. https://gro-intelligence.com/

176   World Food Programme. (2019). Egypt Country Strategic Plan 2018-2023. https://www.wfp.org/operations/eg02-egypt-country-strategic-plan-2018-2023

177   Egypt Business Directory. (2023, March 18). Top Innovative AI-Based Startups in Egypt. Egypt Business Directory. https://www.egypt-business.com/web/details/2311-top-innovative-ai-based-startups-in-egypt-2023/426836

178   Egypt Business Directory. (2023, March 18). Top Innovative AI-Based Startups in Egypt. Egypt Business Directory. https://www.egypt-business.com/web/details/2311-top-innovative-ai-based-startups-in-egypt-2023/426836

179   World Food Programme. (2019). Egypt Country Strategic Plan 2018-2023. https://www.wfp.org/operations/eg02-egypt-country-strategic-plan-2018-2023

180   Egypt Business Directory. (2023, March 18). Top Innovative AI-Based Startups in Egypt. Egypt Business Directory. https://www.egypt-business.com/web/details/2311-top-innovative-ai-based-startups-in-egypt-2023/426836

181   World Bank Group. (2021). Egypt: Climate risk country profile. https://climateknowledgeportal.worldbank.org/sites/default/files/2021-04/15723-WB_Egypt%20Country%20Profile-WEB-2_0.pdf

182   World Food Programme. (2019). Egypt Country Strategic Plan 2018-2023. https://www.wfp.org/operations/eg02-egypt-country-strategic-plan-2018-2023

ANALYSIS AND DISCUSSION

The dawn of artificial intelligence (AI) in agriculture is poised to revolutionize the industry worldwide. In the Middle East and North Africa (MENA) region, particularly in Egypt, this transformation is beginning to take shape. The following synthesis, based on in-depth interviews with leaders from Mozare3, Zr3i, Synapse Analytics, FreshSource, and Abu Erdan, explores the current state of AI in Egyptian agriculture and food supply chains, its challenges, opportunities, and the policies needed to foster growth. These insights not only highlight the potential of AI but also paint a picture of a possible path towards a more sustainable and efficient food system.

I. THE PROMISE OF AI IN EGYPTIAN AGRICULTURE

Initial Hesitations and Growing Acceptance

The journey of AI integration in Egypt's agriculture sector has been marked by a mix of scepticism and optimism. Radwa Elamir from Mozare3 recalls the initial hesitation from farmers and stakeholders. The novel idea of using AI in traditional farming seemed alien and unnecessary to many. However, as AI-driven solutions began to demonstrate tangible benefits such as efficiency gains, cost reductions, and improved crop health, attitudes started to shift. This change was more evident in international markets where Mozare3 also operates, and there is hope that Egyptian farmers will soon follow suit.

Neamat El-Tazi from Abu Erdan echoed these sentiments, particularly in the poultry farming sector. The initial resistance was rooted in the unfamiliarity with AI and the fear of complexity. However, as success stories from other countries emerged, showcasing how AI could improve poultry health and operational efficiency, the Egyptian poultry sector began to see the value in these innovations.

The Evolution Towards Data-Driven Farming

The vision for the future of Egyptian agriculture is one where data and automation play central roles. Waleed Nasr from Zr3i envisions a sector dominated by precision agriculture, where AI and IoT are used to meticulously manage every aspect of farming. This includes optimizing irrigation, fertilization, and crop management through advanced data analytics and remote sensing technologies.

In the realm of supply chains, Farah Emara from FreshSource has already started implementing data-driven solutions. By using a scraper tool to update fruit and vegetable prices hourly, FreshSource can better plan and forecast, ensuring timely delivery of high-quality produce at an expected price. This approach not only reduces waste but also enhances market efficiency, a critical factor in a country where food loss due to poor logistics is a significant issue.

II. OVERCOMING CHALLENGES: TALENT AND FINANCIAL BARRIERS

The Talent Conundrum

A major hurdle in the widespread adoption of AI in Egypt's agricultural sector is the scarcity of skilled talent. Both Mozare3 and Synapse Analytics have highlighted the gap in senior-level AI professionals who are essential for developing and managing sophisticated AI systems. Ahmed Abaza from Synapse Analytics pointed out that while there is an abundance of junior and mid-level talent, the lack of experienced professionals often leads to a brain drain, with many opting to work abroad for better opportunities.

Efforts to build this talent pool are underway, but progress is slow. Training programs and collaborations with academic institutions are crucial to bridge this gap. Synapse Analytics has been involved in several governmental projects aimed at enhancing AI education, but more needs to be done to retain and develop talent within the country.

Financial and Regulatory Hurdles

Securing funding for AI projects in Egypt remains a significant challenge. The lack of understanding and support from local investors often forces companies to look abroad for investment. Emara from FreshSource noted that the venture capital climate in Egypt has been particularly challenging over the past year, with many investors pulling out due to economic uncertainties.

Moreover, the regulatory environment in Egypt is not yet equipped to support the rapid deployment of AI solutions. Abaza discussed the difficulties faced when trying to implement AI-driven credit scoring systems due to unclear regulatory guidelines. This lack of a supportive framework often leads to delays and additional bureaucratic hurdles, stifling innovation, and pushing startups and innovators away.

III. SEIZING OPPORTUNITIES: AI'S TRANSFORMATIVE POTENTIAL

Precision Agriculture and Remote Sensing

Zr3i's work in remote sensing and precision agriculture offers a glimpse into the transformative potential of AI. By using satellite imagery and AI-driven analytics, farmers can make informed decisions that enhance productivity and sustainability. This technology is particularly vital for addressing Egypt's challenges with water scarcity and soil degradation. Precision agriculture allows for efficient resource management, ensuring that every drop of water and every patch of soil is used optimally.

Supply Chain Efficiency

FreshSource's innovative use of data-driven tools to manage supply chains demonstrates how AI can significantly improve market efficiency. The scraper tool that updates produce prices hourly helps in better planning and reduces waste. This kind of technology ensures that fresh produce reaches consumers in the best possible condition and at the agreed upon/expected price, reducing food loss and enhancing food security.

Financial Inclusion and Market Dynamics

AI's role in financial inclusion is another critical area with vast potential. Synapse Analytics developed an algorithm to predict wheat prices, which, if deployed, could save Egypt millions of dollars annually. Additionally, AI is already revolutionizing credit scoring by assessing unconventional data points to predict creditworthiness, providing better access to financial services for underbanked populations in a seamless manner. This democratization of financial services can empower small-scale farmers and other marginalized groups, enhancing their ability to invest in better farming practices and technologies, and

expanding their access to financial instruments that would help them grow their working capital and consequently their disposable incomes.
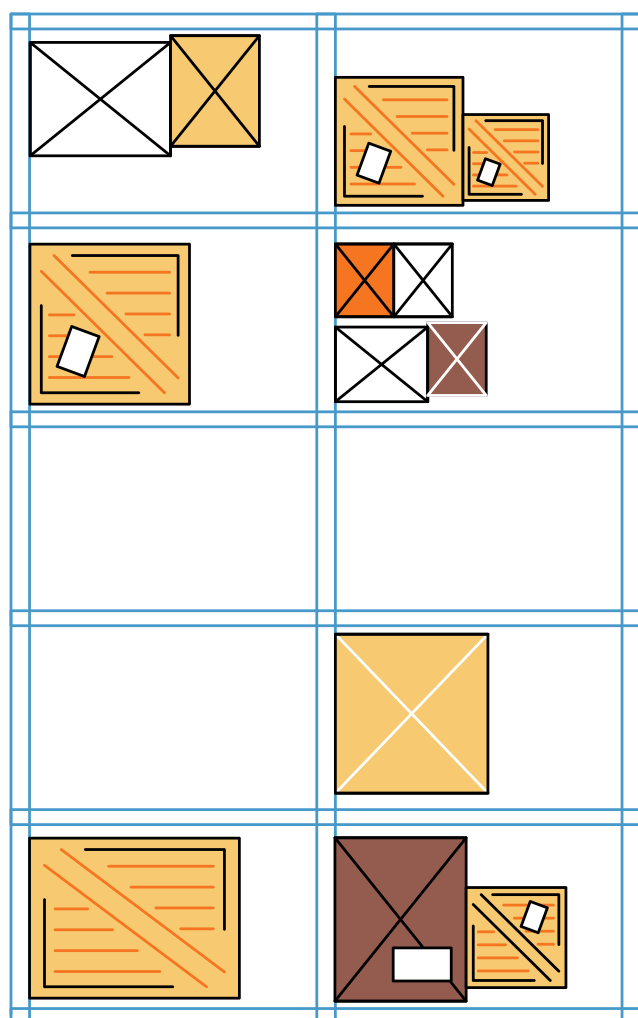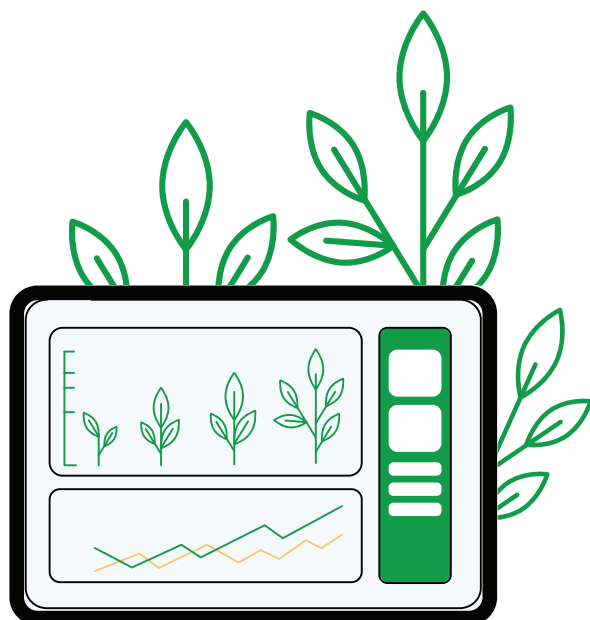
IV. SWOT ANALYSIS OF EGYPT'S AI READINESS IN FOOD SECURITY

STRENGTHS

1. Strong Political Will; Government Initiatives and Vision:

- Egypt Vision 2030 and the Sustainable Agriculture Development Strategy 2030 aim to integrate AI and digital transformation into various sectors, including agriculture. These initiatives are supported by multiple government bodies such as the Ministry of Communications and Information Technology (MCIT) and the Ministry of Agriculture and Land Reclamation (MALR).[183]

2. Technological Infrastructure:

- The government has invested heavily in digital infrastructure, including a $35 billion rural fiber-optic project to enhance connectivity across over 4,500 villages. This improved digital infrastructure supports the implementation of AI technologies in agriculture.[184]

3. Existing AI Applications and Innovations:

- Successful AI applications such as PoultrySync's (Abu Erdan) farm management tools, and Zr3i's remote sensing for precision agriculture demonstrate the potential for AI to enhance efficiency and productivity in agriculture.[185]

4. Support from International Organizations:

- Partnerships with international bodies like the US Agency for International Devel-

183   Oxford Business Group. (2022). Digitalisation is key to bolstering Egypt's food and water security. https://oxfordbusinessgroup.com/reports/egypt/2022-report/economy/tools-of-the-trade-digitalisation-is-key-to-efforts-to-bolster-food-and-water-security

184   Business Today Egypt. (2023, April 26). Egypt launches charter for the responsible use of AI. https://www.businesstodayegypt.com/Article/4/2244/Egypt-launches-charter-for-the-responsible-use-of-AI

185   Business Monthly Egypt. (2022, March 21). Egypt's AI Roadmap. https://businessmonthlyeg.com/egypts-ai-roadmap/

186   Femise. (2023, August 20). Egypt advocates an integrated Water-Energy-Food Nexus (WEFN) approach, Femise delivers its guidelines. https://www.femise.org/articles/legypte-prone-une-approche-nexus-eau-energie-a-limentation-le-femise-livre-ses-orientations/

opment and the International Food Policy Research Institute provide additional support and resources for AI initiatives in Egypt.[186]

5. Existence of Strong Support Organizations

- Some key enabling organizations like incubators and accelerators have access to world class mentors and networks that can help Egyptian innovations take flight.[187]

WEAKNESSES

1. Talent Gaps and Brain Drain:

- There is a significant shortage of senior-level AI talent within the country. Many highly skilled professionals leave Egypt for better opportunities abroad, creating a gap in expertise necessary for advancing AI in agriculture.[188]

2. Regulatory Challenges:

- The regulatory framework for AI in Egypt is still developing. Unclear and sometimes obstructive regulations can hinder the deployment of innovative AI solutions, as seen with Synapse Analytics' challenges in implementing AI-driven credit scoring.[189]

3. Financial Barriers:

- Limited understanding and support from local investors make it challenging for AI startups to secure funding. Economic instability and currency devaluation further exacerbate these financial constraints.[190]

4. Awareness and Education:

- A lack of awareness among farmers and other food chain stakeholders (including traditional operators) about the benefits of AI and digital tools hampers adoption. Many in the food sector are not tech-savvy and require extensive training to effectively use and make the best of new technologies.[191]

OPPORTUNITIES

1. Expansion of AI in Agriculture:

- There is significant potential for AI to improve agricultural practices, from precision farming to enhanced supply chain management. Integrating AI at smaller farm levels and across different agricultural processes can lead to substantial gains in productivity and sustainability.[192]

2. Policy Support and Incentives:

- The government's charter for responsible AI use and the National AI Strategy provides a framework for ethical and effective AI deployment. Policies that offer financial incentives and subsidies for adopting AI technologies can further drive innovation.[193]

3. Collaborations and Partnerships:

- Collaborations with international tech partners and local beneficiaries can enhance the development and implementation of AI solutions. These partnerships can also facilitate knowledge transfer and capacity building.[194]

4. Climate Change Adaptation:

- AI can play a crucial role in helping Egypt

187   International Data Corporation (IDC). (2024). IDC Egypt CIO Summit 2024–"Innovations in App Modernization: Shaping the Digital Future. https://www.idc.com/event/idc-egypt-cio-summit-2024

188   Business Monthly Egypt. (2022, March 21). Egypt's AI Roadmap. https://businessmonthlyeg.com/egypts-ai-roadmap/

189   Business Today Egypt. (2023, April 26). Egypt launches charter for the responsible use of AI. https://www.businesstodayegypt.com/Article/4/2244/Egypt-launches-charter-for-the-responsible-use-of-AI

190   Business Monthly Egypt. (2022, March 21). Egypt's AI Roadmap. https://businessmonthlyeg.com/egypts-ai-roadmap/

191   Femise. (2023, August 20). Egypt advocates an integrated Water-Energy-Food Nexus (WEFN) approach, Femise delivers its guidelines. https://www.femise.org/articles/legypte-prone-une-approche-nexus-eau-energie-a-limentation-le-femise-livre-ses-orientations/

192   Business Monthly Egypt. (2022, March 21). Egypt's AI Roadmap. https://businessmonthlyeg.com/egypts-ai-roadmap/

193   Business Today Egypt. (2023, April 26). Egypt launches charter for the responsible use of AI. https://www.businesstodayegypt.com/Article/4/2244/Egypt-launches-charter-for-the-responsible-use-of-AI

194   International Data Corporation (IDC). (2024). IDC Egypt CIO Summit 2024–"Innovations in App Modernization: Shaping the Digital Future. https://www.idc.com/event/idc-egypt-cio-summit-2024

195   Femise. (2023, August 20). Egypt advocates an integrated Water-Energy-Food Nexus (WEFN) approach, Femise delivers its guidelines. https://www.femise.org/articles/legypte-prone-une-approche-nexus-eau-energie-a-limentation-le-femise-livre-ses-orientations/

196   Business Monthly Egypt. (2022, March 21). Egypt's AI Roadmap. https://businessmonthlyeg.com/egypts-ai-roadmap/

adapt to climate change. Technologies for better water management, crop disease detection, and efficient resource use can mitigate some of the adverse effects of climate change on agriculture.[195]

THREATS

1. Economic Instability:

- Economic fluctuations and currency devaluation pose significant risks to funding and investment in AI projects. This instability can deter both local and international investors.[196]

2. Environmental Challenges:

- Climate change presents a persistent threat to agriculture in Egypt. Rising temperatures, water scarcity, and reduced arable land could undermine efforts to improve food security, even with advanced AI technologies.[197]

3. Resistance to Change:

- Cultural resistance and skepticism towards new technologies can slow down the adoption of AI. Farmers and stake-holders who are accustomed to traditional methods may be hesitant to embrace AI-driven solutions.[198]

4. Cybersecurity Risks:

- Increased reliance on digital and AI technologies raises concerns about data security and privacy. Ensuring robust cybersecurity measures is essential to protect sensitive agricultural data and maintain trust in AI systems.[199]

- Therefore, Egypt's readiness for integrating AI into its agricultural sector presents a mixed picture. While there are significant strengths and opportunities, particularly with government support and technological infrastructure, the country also faces notable weaknesses and threats. Addressing these challenges through targeted policies, investment in education and infrastructure, and fostering a supportive regulatory environment will be crucial for leveraging AI to enhance food security in Egypt and prepare the country and its industries to withstand what is yet to come its way.

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197   Femise. (2023, August 20). Egypt advocates an integrated Water-Energy-Food Nexus (WEFN) approach, Femise delivers its guidelines. https://www.femise.org/articles/legypte-prone-une-approche-nexus-eau-energie-a-limentation-le-femise-livre-ses-orientations/

198   International Data Corporation (IDC). (2024). IDC Egypt CIO Summit 2024–"Innovations in App Modernization: Shaping the Digital Future. https://www.idc.com/event/idc-egypt-cio-summit-2024

199   International Data Corporation (IDC). (2024). IDC Egypt CIO Summit 2024–"Innovations in App Modernization: Shaping the Digital Future. https://www.idc.com/event/idc-egypt-cio-summit-2024
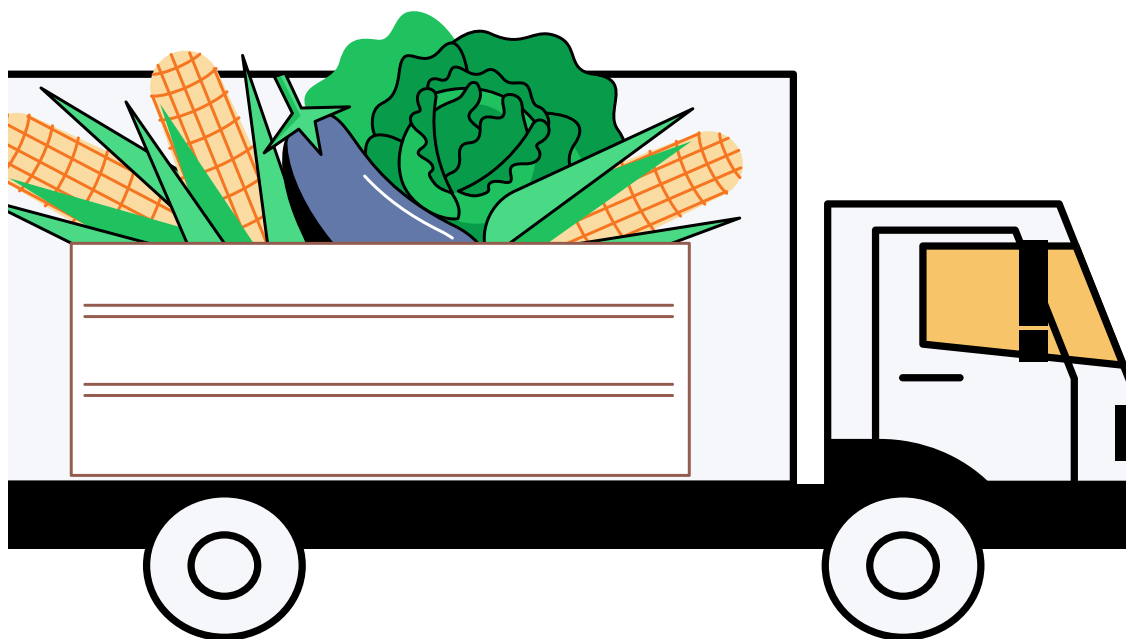
INSIGHTS AND POLICY RECOMMENDATIONS

I.   KEY INSIGHTS

Below are some of the key insights we have derived from the research we have conducted so far:

- **Exploration and Experimentation**: While some AI use cases are more mature than others, the field overall is ripe for exploration. Experimentation serves as an entry point for integrating AI into Egypt's food security strategies.

- **Bridging Gaps**: The gap between business leaders and tech innovators remains wide. Enhanced interdisciplinary collaboration that includes AI technologists, agricultural scientists, policymakers, and community leaders is crucial for bridging this divide and ensuring AI solutions are contextually relevant.

- **Stakeholder Awareness and Training**: Many stakeholders are unaware of how rapidly AI is evolving. Tailored educational programs and training are essential for all parts of the food supply chain to improve understanding and foster the adoption of AI technologies.

- **Adapting to Major Trends**: The major trends in AI and technology are largely beyond our region's control. Creating adaptive strategies and pilot projects can help stakeholders leverage these technologies for food security.

- **AI's Role in Solving Problems**: AI has the potential to solve many problems within Egypt's food system, though many issues may also be addressed with low-tech solutions. It's vital to discern where AI can be most effectively applied.

- **Unique AI Use Cases**: While there are currently no prominent food-related AI use cases unique to Egypt, there is significant potential to develop such applications, especially through pilot projects that could serve as practical case studies.

- **Fragmentation and Varied Awareness**: The food security stakeholder community is fragmented, with varying levels of AI
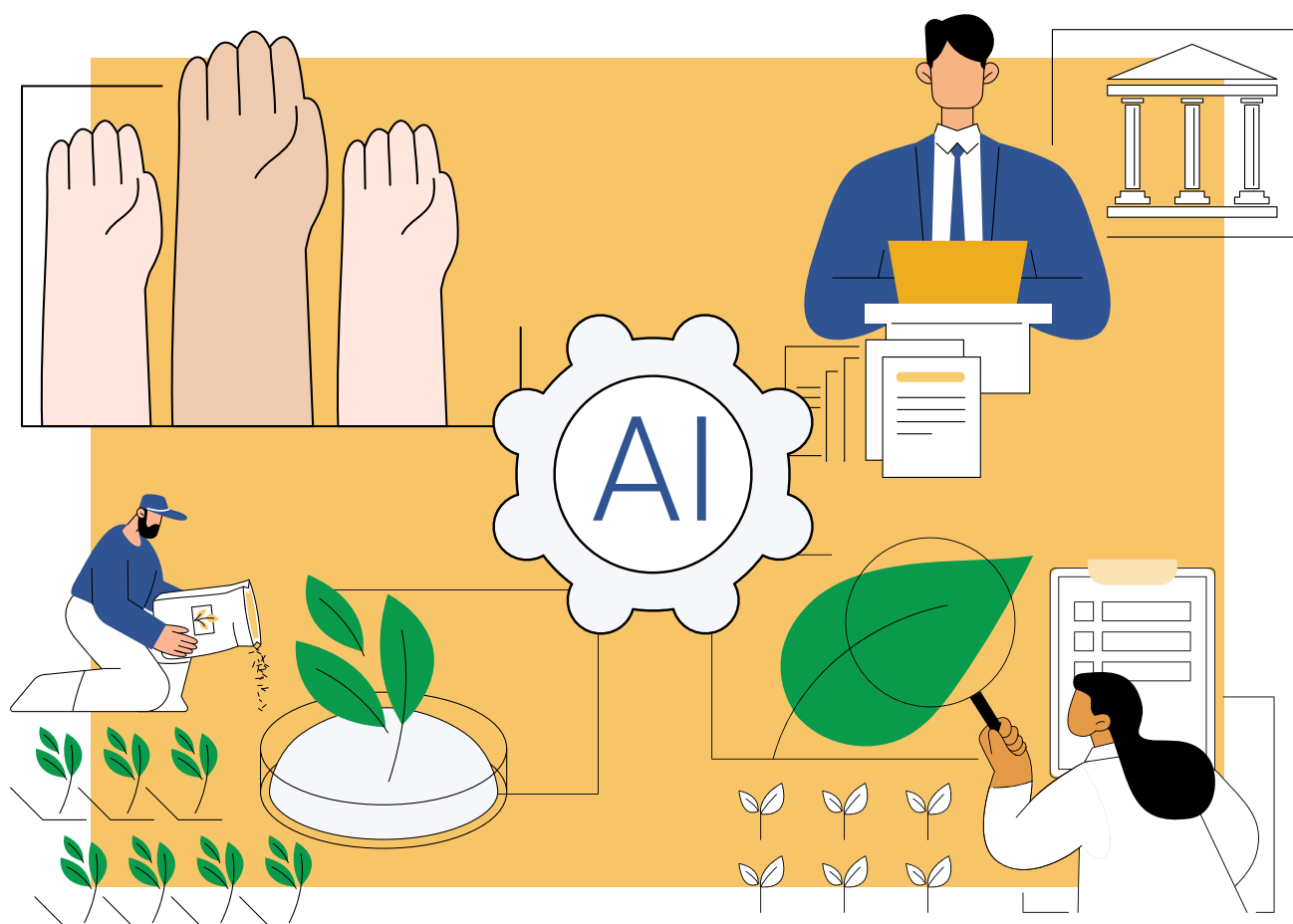
awareness and readiness. Developing ethical AI use frameworks and guidelines can help unify and guide stakeholders.

- **Small Scale Integration Challenges**: A significant gap exists in integrating AI solutions at the smaller farm level, mainly due to cost and complexity.

- **Investor Education**: Awareness and understanding of AI among Egyptian investors are limited. Various investor development mechanisms like investor training programs, AI-specific investment networks, public-private partnerships, and other mechanisms, could play a pivotal role in driving both governmental support and private sector investment in AI.

- **Digital and Open Data Initiatives**: Egypt has a wealth of data that is not yet digital. High-quality, structured public data is a cornerstone of innovation; hence, there is a dire need for robust open data initiatives to support AI applications.

- **Ethical and Compliance Concerns**: Regulatory environments that restrict deployment to on-premise solutions present challenges. Discussions about compliance and regulations need to be part of broader dialogues on AI governance to ensure they support rather than stifle innovation.

- **AI and Climate Resilience**: Exploring AI's role in enhancing climate resilience in agriculture could be crucial, as predictive analytics for weather, crop diseases, and pest invasions can significantly affect productivity and food security.

- **Leveraging Traditional Knowledge**: Integrating AI with traditional agricultural knowledge ensures that technological advances enhance rather than replace the invaluable wisdom of local farmers.

- **Incentives for AI Development**: Establishing incentives for AI research and development tailored to the unique challenges of the Egyptian food system can encourage innovation and practical solutions in this sector.

II. POLICY RECOMMENDATIONS

Based on insights from interviews with key stakeholders and extensive research, here are specific policy recommendations to enhance AI integration in Egypt's food security related sectors:

1. Investment in Digital Infrastructure

a. Expand Rural Connectivity: Continue expanding digital infrastructure to rural areas, ensuring reliable internet connectivity.

b. Smart Agriculture Systems: Invest in smart agriculture systems, such as IoT sensors and precision farming technologies, to optimize water use, soil management, and crop monitoring.

2. Education and Training Programs

a. Upskill and Reskill Programs: Develop comprehensive training programs for farmers and agricultural workers to familiarize them with AI and digital tools, focusing on practical applications and demonstrating the tangible benefits of AI in agriculture. This is best done via partnerships with local NGOs and other implementing partners in regional areas.

b. Collaboration with Academic Institutions: Partner with universities and research institutions to create specialized curricula and research opportunities in AI and agriculture, building a pipeline of skilled professionals who are aware of the existing opportunities, stakeholders, and market dynamics.

3. Financial Incentives and Support

a. Subsidies and Grants: Offer subsidy programs, tax breaks, and grants to farmers and agritech startups adopting AI technologies, lowering entry barriers and encouraging wider adoption.

b. Venture Capital and Investment: Facilitate access to venture capital for AI-driven agritech startups through public-private partnerships, creating a favorable invest-

ment climate for innovation by aligning the interests of various key stakeholders.

4. Regulatory Framework and Data Governance

a. Clear AI Regulations: Develop clear and supportive regulations for AI in agriculture, including guidelines for AI applications, data privacy, and security, ensuring responsible and ethical use.

b. Data Sharing Initiatives: Promote open data initiatives to provide researchers and companies with access to valuable agricultural data, establishing standards for data sharing and privacy.

5. Supportive Ecosystem and Collaboration

a. Multi-Stakeholder Collaboration: Encourage collaboration between government agencies, private sector companies, and international organizations to enhance knowledge transfer, capacity building, and the development of localized AI solutions.

6. Climate Change Adaptation

a. Sustainable Farming Practices: Promote AI-driven sustainable farming practices that reduce environmental impact and enhance food security, incentivizing practices that conserve water, improve soil health, and increase crop resilience to climate variability.

7. Enhanced AI Ethics and Compliance Framework

a. Ethical AI Development: Implement a national framework for ethical AI development, focusing on transparency, accountability, and fair labor practices.

b. Compliance Monitoring: Establish a body to monitor and enforce AI regulations, protecting small-scale farmers from potential exploitation.

8. Promotion of Local AI Solutions

a. Local AI Development Programs: Support the development of AI solutions tailored to the specific needs of Egyptian agri-

culture, fostering innovation at regional innovation hubs.

b. Community-Based AI Implementations: Promote community-led AI projects that involve local farmers in the design and implementation, ensuring technology addresses real-world challenges.

9. Adaptive AI Technologies for Climate Resilience

a. AI for Weather Adaptation: Invest in AI technologies that provide advanced weather forecasting, aiding farmers and farmer cooperatives in adapting to climate variability.

b. AI-Driven Disaster Response: Develop AI systems that predict and mitigate the impacts of agricultural pests, diseases, and extreme weather events.

10. Digital Literacy and Inclusion

a. Digital Literacy Campaigns: Launch nationwide campaigns to improve digital literacy among farmers and other agricultural workers, focusing on the safe use of AI and digital tools and positioning technology as a support tool rather than a threat.

b. Inclusive AI Development: Ensure that AI development processes involve diverse groups, addressing specific challenges and needs of farmers and other stakeholders.

c. Implementing these policy recommendations can create a conducive environment for the integration of AI in Egypt's food sectors. By addressing infrastructure, education, financial, regulatory, and collaborative needs, Egypt can harness the full potential of AI to enhance food security, boost productivity, and ensure sustainable agricultural practices and a more healthy and sustainable food system.

FURTHER RESEARCH

The integration of artificial intelligence (AI) in Egypt's agricultural sector presents vast opportunities and significant challenges. To fully harness the potential of AI for enhancing food security and promoting sustainable agricultural practices, several areas require further research. This section outlines key areas where additional investigation can provide valuable insights and drive the advancement of AI in agriculture.

1. AI Adoption and Implementation Models

Understanding Barriers and Drivers:

- Comprehensive studies on the specific barriers to AI adoption in Egyptian agriculture, including socio-cultural, economic, and technological factors, can provide actionable insights. Research should focus on identifying the most effective strategies to overcome resistance and facilitate smoother adoption.[200]
- Investigate successful AI implementation models from other countries with similar agricultural profiles. Comparative studies can help identify best practices and adaptable solutions for Egypt.[201]

2. Impact Assessment of AI Technologies

Measuring Effectiveness and Efficiency:

- Conduct empirical research to assess the impact of AI technologies on agricultural productivity, resource efficiency, and economic outcomes. This includes evaluating specific AI applications such as precision agriculture, crop monitoring, and supply chain optimization.[202]
- Longitudinal studies to measure the sustainability and long-term benefits of AI interventions in agriculture, considering environmental, economic, and social dimensions.[203]

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200   Oxford Business Group. (2022). Digitalisation is key to bolstering Egypt's food and water security. https://oxfordbusinessgroup.com/reports/egypt/2022-report/economy/tools-of-the-trade-digitalisation-is-key-to-efforts-to-bolster-food-and-water-security

201   Oxford Business Group. (2022). Digitalisation is key to bolstering Egypt's food and water security. https://oxfordbusinessgroup.com/reports/egypt/2022-report/economy/tools-of-the-trade-digitalisation-is-key-to-efforts-to-bolster-food-and-water-security

202   Business Today Egypt. (2023, April 26). Egypt launches charter for the responsible use of AI. https://www.businesstodayegypt.com/Article/4/2244/Egypt-launches-charter-for-the-responsible-use-of-AI

203   Business Today Egypt. (2023, April 26). Egypt launches charter for the responsible use of AI. https://www.businesstodayegypt.com/Article/4/2244/Egypt-launches-charter-for-the-responsible-use-of-AI

3. Skill Development and Education Programs

Evaluating Training Programs:

- Research the effectiveness of current education and training programs in developing AI competencies among farmers and agricultural professionals. Identify gaps in existing curricula and propose enhancements to better prepare the workforce for AI integration.[204]
- Explore innovative educational models and partnerships that can accelerate skill development, such as collaboration between universities, research institutions, and the private sector. [205]

4. Policy and Regulatory Frameworks

Designing Supportive Policies:

- Analyze the current regulatory environment for AI in agriculture and identify areas where policies can be improved to foster innovation while ensuring ethical and responsible use of AI. Comparative policy analysis with other countries can provide valuable benchmarks.[206]
- Investigate the role of government incentives and subsidies in promoting AI adoption in agriculture. Assess the impact of financial support mechanisms on accelerating technological uptake among small and medium-sized farms.[207]

5. Data Management and Privacy

Enhancing Data Utilization:

- Research best practices in data management and privacy to develop frameworks that facilitate data sharing while protecting stakeholders' interests. This includes studying the implementation of open data initiatives and their impact on innovation.[208]

- Explore advanced data analytics techniques to optimize the use of agricultural data for decision-making and predictive modeling. Investigate the potential of integrating multiple data sources for comprehensive insights.[209]

6. Climate Change Adaptation

Developing Resilient Agricultural Practices:

- Investigate the role of AI in developing climate-resilient agricultural practices. Research should focus on AI applications that can mitigate the impacts of climate change, such as improved water management, pest and disease prediction, and adaptive cropping strategies.[210]
- Conduct scenario planning and simulation studies to understand the potential impacts of climate variability on agriculture and identify AI-driven solutions that can enhance resilience.[211]

Further research in these areas will provide deeper insights into the challenges and opportunities associated with AI integration in Egypt's agricultural sector. By addressing these research gaps, stakeholders can develop more effective strategies to leverage AI for improving food security, promoting sustainable practices, and driving economic growth in the agricultural sector. The insights gained from this research will be instrumental in guiding policy decisions, educational programs, and technological innovations that can transform agriculture in Egypt and beyond.

204 Business Monthly Egypt. (2022, March 21). Egypt's AI Roadmap. https://businessmonthlyeg.com/egypts-ai-roadmap/

205 Business Monthly Egypt. (2022, March 21). Egypt's AI Roadmap. https://businessmonthlyeg.com/egypts-ai-roadmap/

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207 Femise. (2023, August 20). Egypt advocates an integrated Water-Energy-Food Nexus (WEFN) approach, Femise delivers its guidelines. https://www.femise.org/articles/legypte-prone-une-approche-nexus-eau-energie-a-limentation-le-femise-livre-ses-orientations/

208 International Data Corporation (IDC). (2024). IDC Egypt CIO Summit 2024–"Innovations in App Modernization: Shaping the Digital Future. https://www.idc.com/event/idc-egypt-cio-summit-2024

209 International Data Corporation (IDC). (2024). IDC Egypt CIO Summit 2024–"Innovations in App Modernization: Shaping the Digital Future. https://www.idc.com/event/idc-egypt-cio-summit-2024

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211 Femise. (2023, August 20). Egypt advocates an integrated Water-Energy-Food Nexus (WEFN) approach, Femise delivers its guidelines. https://www.femise.org/articles/legypte-prone-une-approche-nexus-eau-energie-a-limentation-le-femise-livre-ses-orientations/

ANNEX

ANNEX A: INTERVIEW QUESTIONS

Below is a list of more examples of interview questions we posed to experts we interviewed.

- We want to start by hearing your current assessment of the AI space in Egypt, particularly with regard to:
  - Access to finance
  - Regulatory environment (registration, licensing, IP, etc.)
  - Market challenges
  - Cultural perspectives, from other sectors and within the sector
- What can you tell us about your experience applying and deploying AI products/services in food related sectors, like agriculture, import/export, logistics, distribution, retail, etc.?
- What potential for AI do you see in those areas?
- And what from your opinion needs to be done or changed for this potential to be realized?
- Who do you suggest we talk to? Given that you understand the objective of our study
- Anything else you'd like to add?

We went on several tangents along the interviews to uncover more details and depth regarding various points that were all guided by the overall objective of the paper.

ANNEX B: KEY OPERATORS

Below is a table with some key startups and organizations that operate in and around food security related sectors, that use AI as part of their solution, program, or operation.

ORGANIZATION NAME	TYPE OF ORGANIZATION	BRIEF DESCRIPTION
Mozare3	Agritech Startup	An agri-fintech enterprise providing financial solutions, market access, and agronomy expertise to smallholder farmers [source](https://egyptianstreets.com/2024/03/27/six-egyptian-agritech-startups-at-the-forefront-of-innovation-in-agriculture)
Zr3i	Agritech Startup	Uses satellite technology to provide real-time insights and data-driven crop insurance policies to farmers [source](https://egyptianstreets.com/2024/03/27/six-egyptian-agritech-startups-at-the-forefront-of-innovation-in-agriculture)
FreshSource	Agritech Startup	Connects farmers directly with businesses to reduce food loss and streamline logistics [source](https://egyptianstreets.com/2024/03/27/six-egyptian-agritech-startups-at-the-forefront-of-innovation-in-agriculture)

Cropsa	Agritech Startup	Integrated platform for agricultural production, minimizing losses and enhancing yields [source](https://egyptianstreets.com/2024/03/27/six-egyptian-agritech-startups-at-the-forefront-of-innovation-in-agriculture)
Plug'n'Grow	Agritech Startup	Uses hydroponic technology to reduce water usage and increase crop yields [source](https://egyptianstreets.com/2024/03/27/six-egyptian-agritech-startups-at-the-forefront-of-innovation-in-agriculture)
Askova	Agritech Startup	Specializes in smart agriculture solutions using AI to optimize farming practices [source](https://egyptianstreets.com/2024/03/27/six-egyptian-agritech-startups-at-the-forefront-of-innovation-in-agriculture)
Cropway	Agritech Startup	Provides sustainable AgTech supply chain solutions [source](https://www.startus-insights.com)
Algaenite	Agritech Startup	Produces biofertilizers from nitrogen-fixing microalgae [source](https://www.startus-insights.com)
Talpalabs	Agritech Startup	Focuses on weather condition monitoring for agriculture [source](https://www.startus-insights.com)
Nanobubble Agritech	Agritech Startup	Offers an irrigation retrofit system using nanobubble technology [source](https://www.startus-insights.com)
Ground Truth Agriculture	Agritech Startup	Manages grain supply chains using AI [source](https://www.startus-insights.com)
Agrobit	Agritech Startup	Uses agricultural photogrammetry for precision farming [source](https://www.startus-insights.com)
YieldX	Agritech Startup	Provides biosecurity solutions for poultry farms using AI [source](https://www.startus-insights.com)
Bug Mars	Agritech Startup	Optimizes insect farm management through AI [source](https://www.startus-insights.com)

Agristry	Agritech Startup	Offers crop mapping and drone imagery analysis [source](https://www.startus-insights.com)
RoboCare	Agritech Startup	Develops early-stage plant disease detection systems [source](https://www.startus-insights.com)
Weelo	Supply Chain Optimization	Digital supply chain solution using AI for retailers and suppliers [source](https://www.egypt-business.com)
AvidBeam Technologies	Quality Control	AI-based video analytics for quality control [source](https://www.egypt-business.com)
Crowd Analyzer	Market Analytics	AI and NLP for social media analytics [source](https://www.egypt-business.com)
WideBot	Customer Engagement	AI-driven chatbots for customer care [source](https://www.egypt-business.com)
DevisionX	AI-Vision Solutions	No-code AI platform for vision solutions [source](https://www.egypt-business.com)
Takamol	Food Waste Reduction	AI for optimizing food donations and waste reduction [source](https://www.gro-intelligence.com)
Mowafer Care	Personalized Nutrition	Personalized nutrition advice using AI [source](https://www.gro-intelligence.com)
WFP Egypt	Food Security	Uses AI for food security data analysis and policy planning [source](https://www.wfp.org)
Gro Intelligence	Data Analytics	Provides comprehensive data analytics tools for agriculture [source](https://www.gro-intelligence.com)
Clara Analytics	Healthcare	AI for workers' compensation claims [source](https://www.gro-intelligence.com)
Agrimatic Farms	Agritech Startup	AI-driven hydroponic farming [source](https://www.gro-intelligence.com)
Pylon	Energy Efficiency	AI for utility management [source](https://www.gro-intelligence.com)

Digital Egypt	Government Initiative	Government initiative for digital transformation [source](https://www.gro-intelligence.com)
Paymob	Fintech	Digital payment solutions [source](https://www.gro-intelligence.com)
Vapulus	Fintech	AI-driven payment gateway [source](https://www.gro-intelligence.com)
Fawry	Fintech	Digital payment platform [source](https://www.gro-intelligence.com)
Swvl	Transportation	App-based mass transit system [source](https://www.gro-intelligence.com)
Tawfeer Market	E-commerce	AI for inventory management and demand forecasting [source](https://www.gro-intelligence.com)
Breadfast	E-commerce	On-demand grocery delivery using AI [source](https://www.gro-intelligence.com)
Halan	Transportation	On-demand transportation service using AI [source](https://www.gro-intelligence.com)
Instabug	Software	AI-powered bug and crash reporting [source](https://www.gro-intelligence.com)
MaxAB	E-commerce	AI for inventory and supply chain management [source](https://www.gro-intelligence.com)
Elmenus	E-commerce	AI-driven food discovery and delivery [source](https://www.gro-intelligence.com)
Tareeqi	Logistics	AI-based route optimization for logistics [source](https://www.gro-intelligence.com)
Intella	Technology	AI for text analysis and sentiment analysis [source](https://www.gro-intelligence.com)
Tawseel	Logistics	AI for delivery and logistics [source](https://www.gro-intelligence.com)

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ON RESPONSIBLE AI
مرصد الشرق الأوسط وشمال إفريقيا للذكاء الإصطناعي المسؤول

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Onsi Sawiris School of Business
Access to Knowledge for Development Center

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