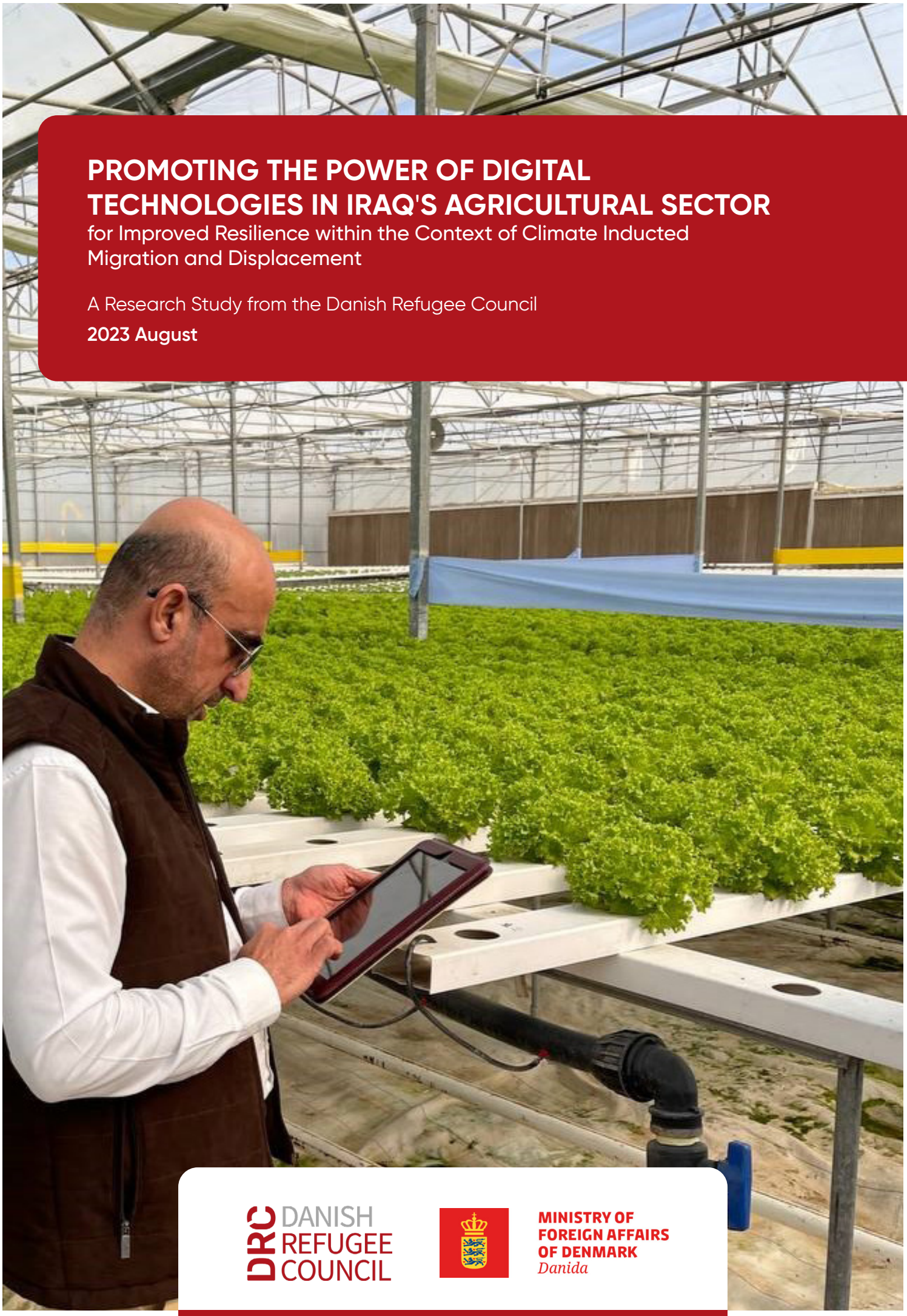
PROMOTING THE POWER OF DIGITAL TECHNOLOGIES IN IRAQ'S AGRICULTURAL SECTOR

for Improved Resilience within the Context of Climate Inducted Migration and Displacement

A Research Study from the Danish Refugee Council

2023 August



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ACKNOWLEDGMENTS

This research has been authored by Yousif K. Khoshnaw of the Smithson Institute for Training and Consultancy[1] and commissioned by the Danish Refugee Council (DRC), to which we extend our gratitude for their support and guidance. We also extend our thanks to the individuals and stakeholders who participated in interviews and provided valuable insights. These collective efforts have been instrumental in the completion of this research.

Research Department, Smithson.

August 2023.

Report design and layout by Crimson - itscrimson.com

1. Smithson

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LIST OF ACRONYMS	
Agence Française de Développement	AFD
Agricultural Research and Extension Institute	AREI
Agro-Climate Zone	AZC
artificial intelligence	AI
Central Statistical Organization	CSO
Chief Executive Officer	CEO
Climate-Smart Agriculture	CSA
Directorate of Agriculture	DoA
European Union	EU
Food and Agriculture Organization	FAO
Gross Domestic Product	GDP
Industrial Revolutions	IR
Internally Displaced Persons	IDP
International Center for Agricultural Research in the Dry Areas	ICARDA
International Organization for Migration	IOM
Internet of Things	IoT
Key Informant Interview	KII
Middle East and North Africa	MEAN
Ministry of Agriculture	MoA
Ministry of Environment	MoE
Ministry of Planning	MoP
Molecular Diversity Preservation International	MDPI
Non-Profit Organization	NGO
United Nations Development Program	UNDP
United Nations Educational Scientific and Cultural Organization	UNESCO
World Food Program	WFP

INTRODUCTION

Iraq has a diverse range of climates across its fertile land, making it an ideal location for various agricultural activities. However, the agriculture sector in Iraq is faced with numerous environmental challenges, including poor water quality, soil salinity, air pollution, waste management issues, and the continued deterioration of key ecosystems, compounded by climate change, conflict, and poor management. Despite these obstacles, the agriculture industry is a vital part of Iraq's economy and is the second-largest contributor to the Gross Domestic Product (GDP) after the oil sector, accounting for 5.9 per cent of the country's GDP in 2020.[2]

In the past several years, crop and livestock production have been significantly affected by the conflict, resulting in substantial damages and losses. This includes damage to machinery and tools, irrigation equipment and systems, and agricultural inputs.[3]

The agricultural industry in Iraq includes farming, livestock, and fisheries, which all play a crucial role in ensuring food security and providing employment and income for millions of Iraqi families, especially those living in rural and peri-urban areas. Based on the data from the Iraqi Ministry of Planning (MoP)s' Central Statistical Organization (CSO), the population of the country has surpassed 40 million. Out of this figure, around 30 per cent of the population lives in rural areas, and within this demographic, 29.3% are young individuals aged between 20-39 years old.[4]

On the other hand, the digital technology industry is demonstrating great promise in the country. More than 39 million cell phones and 2.2 million landlines operate in the country with several telecommunication companies.[5] A study conducted by The United Nations Educational, Scientific and Cultural (UNESCO) Organization concludes that 95 per cent of families in Iraq currently have mobile phones.[6] According to a study conducted by the International Organization for Migration (IOM) on Market Assessment of Tech Sector Businesses in Iraq: Telecommunication and mobile payments are two competitive tech sectors in the country. E(electronic)-commerce, E(electronic)-banking, and digital payments are growing sectors, and tech professionals earn more than double the country's average monthly per capita.[7]

E-commerce includes specialised marketplaces created by individuals as well as small, medium, and large businesses. There are currently a number of established digital marketplaces for goods and services. There are also businesses that provide digital payment solutions and a growing number of startups that are focused on developing new digital technologies and services. According to Think Bank Iraq, 57 per cent of Iraqis have made at least one online purchase in 2020 through the Internet.[8] Various methods are utilised when people conduct online transactions, such as searching and ordering a product through online messaging, applications, and websites and subsequently settling payment through cash or online. Despite the widespread of various technological tools that can be utilised for marketing, the e-commerce sector is currently thriving with opportunities, though it is confronted with various challenges, such as the insufficient digital and physical infrastructure for supply chain and logistics, which poses significant barriers to the growth of the sector. Additionally, the weak digital literacy and skills of the Iraqi population present obstacles to the development of the e-commerce market.[9] Despite these challenges, given that agriculture is a vital economic sector in Iraq and remains of critical importance for economic performance, employment, social stability and food security, digital technology has the potential to play a critical role in ensuring its growth and prosperity.

2. Central Statistical Organization, Ministry of Planning. (2021). Brief Statistics [Data file] page 3. Retrieved from https://www.cosit.gov.iq/StatisticalAbstract-2022/StatisticalAbstract.html
3. World Bank Group. (2018). Iraq reconstruction and investment, part 2: Damage and needs assessment of affected governorates. Page 47. Retrieved from https://documents1.worldbank.org/curated/en/600181520000498420/pdf/123631-REVISED-Iraq-Reconstruction-and-Investment-Part-2-Damage-and-Needs-Assessment-of-Affected-Governorates.pdf
4. Central Statistical Organization, Ministry of Planning. (2021). 2020 Population Estimation [Data file] page 18. Retrieved from https://cosit.gov.iq/documents/population/projection/%D8%AA%D9%82%D8%AF%D9%8A%D8%B1%D8%A7%D8%AA%20%D8%B3%D9%83%D8%A7%D9%86%20%D8%A7%D9%84%D8%B9%D8%B1%D8%A7%D9%82%202020.pdf
5. Central Statistical Organization, Ministry of Planning. (2021). Brief Statistics [Data file] page 11. Retrieved from https://www.cosit.gov.iq/StatisticalAbstract-2022/StatisticalAbstract.html
6. UNESCO. (2019). Assessment of the Labour Market and Skills Analysis, Iraq and Kurdistan Region-Iraq, Information and Communication [Online]. Available at: https://www.humanitarianresponse.info/sites/www.humanitarianresponse.info/files/2019/04/UNESCO-EU-LMS-Report_ICT_20022019.pdf
7. IOM Iraq. (2019). Technology and innovation in Iraq: A market assessment of tech sector businesses in Iraq. Retrieved from: https://edf.iom.int/publications/23/technology-market-assessment-in-iraq.pdf
8. Think Bank Iraq. (2020). E-commerce & the Iraqi consumer. Retrieved from [https://thinkbankiraq.com/iraq-consumer-2020/]
9. Access Partnership. (2023, April). E-commerce in Iraq: Exploring untapped markets in the Middle East. Retrieved from https://accesspartnership.com/e-commerce-in-iraq-exploring-untapped-markets-in-the-middle-east/

CONTEXT

Involving digital technology in agricultural activities can play a critical role in Iraq, helping farmers to adapt to increased temperature, water scarcity and soil degradation. The use of modern technologies in agriculture has become increasingly important due to the need to achieve food security, increase production, and reduce costs. These technologies include sensors, drones, and satellite images to monitor crops and soil conditions and then use this data to optimise irrigation, fertilisation, and pest control. For animal husbandry, drones can monitor flocks of sheep and cattle to perform the duties of the shepherd, in addition to determining the location of the herd through the leader's device. Modern watering systems can also be applied for animal treatment, as well as modern techniques for cutting straw and other technologies.

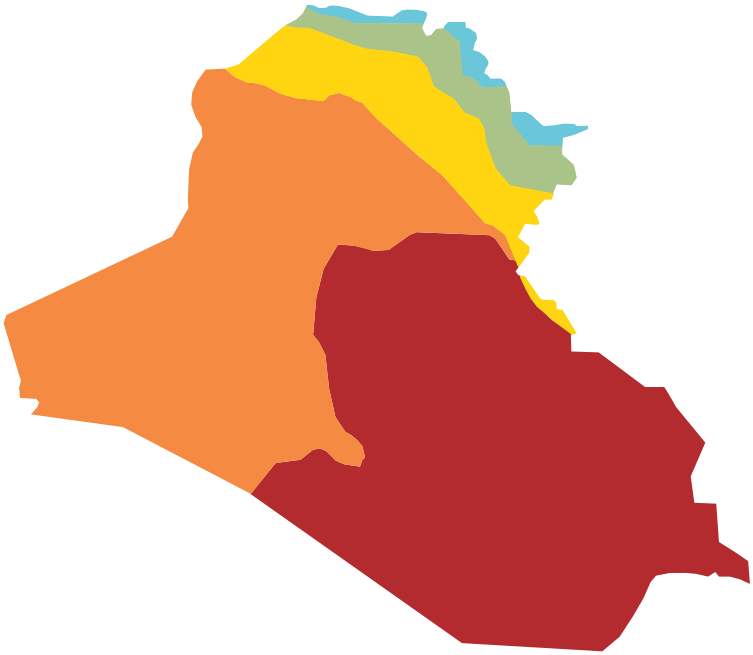
Iraq's agriculture is particularly vulnerable to water scarcity and climate change, as the country is considered among the five top countries affected by climate change globally. Environmental and climate changes in Iraq include changes in rainfall patterns, temperature, and extreme weather events like heat waves and floods. These impacts can have significant effects on crop yields and food security in rural populations. Digital technologies in the field of soil and water can help reduce the amount of water used in irrigation while safeguarding plants from water-stress issues and maintaining the long-term viability of soi. Iraq has a predominantly arid to semi-arid climate, with hot summers and mild winters. Based on satellite-based climate data -and depending on factors such as temperature, rainfall, soil types and vegetation- the country is divided into five Agro-Climate Zone (ACZ)s, which are:[10]

- ACZ 1 represents about 48.8 % of the total area: arid, cool winter, very warm summer
- ACZ 2 about 36.8 % of the total area; arid, mild winter, very warm summer
- ACZ 3 about 8.8 % of the total area; semi-arid, cool winter, very warm summer
- ACZ 4 about 4.2 % of the total area; semi-humid to Mediterranean, cool winter, very warm summer
- ACZ 5 about 1.4 % of the total area; very humid to humid, cold to cool winter, warm summer

However, the major traditional climatic zones known in Iraq are:

Desert zone: This zone covers most of western and southern Iraq and is characterised by very low rainfall and high temperatures. The soil is generally sandy and low in nutrients, and vegetation is sparse. Some crops that can be grown in this zone include date palms, wheat, barley, and alfalfa.

Semi-arid zone: This zone covers much of central and northern Iraq and is characterised by moderate rainfall and temperatures. The soil is generally loamy and moderately fertile, and vegetation is dominated by steppe grasses. Some crops that can be grown in this zone include wheat, barley, sorghum, and cotton.



Agro-Climatic Zones

- ACZ 5: Very Humid to Humid,cold to cool winter, warm summer
- ACZ 4: Semi-humid to Mediterranean, cool winter, very warm summer
- ACZ 3: Semi-arid, cool winter, very warm summer
- ACZ 2: Arid, mild winter, very warm summer
- ACZ 1: Arid, cool winter, very warm summer

ibid

10. I. A. Alwan, H. H. Karim & N. A. Aziz, Hydrological and Agro-Climatic Zones Using Climate Satellite Data in Iraq Republic, June, 2019.

Mediterranean zone: This zone covers the northern mountains of Iraq and is characterised by cool, wet winters and warm and dry summers. The soil is generally deep and fertile, and vegetation includes deciduous forests and shrublands. Some crops that can be grown in this zone include grapes, olives, almonds, and[11] apples.

Highland zone: This zone covers the northeastern mountains of Iraq and is characterised by cold, snowy winters and mild summers. The soil is generally deep and fertile, and vegetation includes coniferous forests and grasslands. Some crops that can be grown in this zone include apples, pears, cherries, and apricots.

DIGITAL TECHNOLOGIES AND AGRICULTURE

Smart agriculture refers to modern methods of agricultural process and production that employ digital technologies and control systems within agricultural enterprises.[12] Many agriculture institutes, organisations and universities around the globe, including the Middle East and North Africa, conduct studies under various names like smart agriculture, digital agriculture, precision agriculture, digital farming, etc. They refer to the use of advanced technology and artificial intelligence (AI) to optimise agricultural processes and production.

Smart agriculture systems gather and analyse data from a wide range of sources, such as weather conditions, soil moisture, plant growth, etc. The aim of using smart agriculture is to equip farmers with real-time data, insights and recommendations that can help them make data-driven decisions about daily farming activities, predict challenges and get advice on managing risks. By and large, digital agriculture aims to enhance the efficiency and sustainability of agriculture by reducing waste, minimising environmental impacts and increasing quality and productivity.

This study uses the term "smart agriculture," which refers to the design, development and use of digital technologies in climate-smart agriculture in the context of Iraq. Smart agriculture involves a wide range of technologies, including sensors, robots, digital communication tools, blockchains, smartphone applications, and computational decisions in both open agriculture and controlled-environment agriculture, such as greenhouses and hydroponic farms.

INDUSTRIAL REVOLUTIONS (IR) IN AGRICULTURE

The concept of the "Industrial Revolution" refers to a period when technological advances and innovation occurred and fundamentally changed how goods are produced. In modern history, four periods of significant technological advancement and societal transformation have emerged, each characterised by a specific set of technological innovations. These four industrial revolutions are defined as follows:

Industry 1.0. refers to the first industrial revolution, which began in the late 18th and early 19th centuries. It is characterised by the replacement of human power [labour intensive] with machine power [decreased labour] to carry out the production activity.

Industry 2.0. refers to the second industrial revolution that occurred in the late 19th and early 20th centuries. It is characterised by mass production facilitated by electricity [also known as the 'green revolution']. This era witnessed the discovery of oil and the construction of railways, both of which expedited the transportation of goods and resources. As a result, the costs of inputs such as pesticides and fertilisers decreased.

Industry 3.0. also known as the Digital Revolution, began in the late 20th century with the introduction of the first programmable production and manufacturing systems, referred to as automation. This revolution aimed to boost efficiency and productivity by harnessing electronic and information technologies. During this period, management effectiveness was improved through processes like fertilisation tracking, specific plot monitoring, and herd tracking.

Industry 4.0. The period began in the early 21st century. It involves various merging of digital elements such as computer, robots, drones, digital production and automation technologies. It integrated computer and internet technologies into the production chain model in a complex system. The primary objective of using these technologies is to develop intelligent production processes that can be managed and directed by computers, make self-decisions and organise themselves. The ultimate goal of utilising Industry 4.0. is to enhance efficiency, minimise cost and reduce production time. Agriculture paralleled with the revolution of Industry 4.0. is called agriculture 4.0. or Smart Agriculture. It is also known as Digital Agriculture or Precision Agriculture.

11. ibid
12. Republic of Turkey, Ministry of Agriculture and Forestry (December 2021). Acceleration of digital transformation in agriculture sector for ensuring sustainable food security. This needs assessment report was prepared under the COMCEC COVID Response. Page 21. Retrieved from https://www.tarimorman.gov.tr/ABDGM/Belgeler/Uluslararas%C4%B1%20Kurulu%C5%9Flar/ACCELERATION%20OF%20TRANSFORMATION%20OF%20DIGITALIZATION%20IN%20AGRICULTURE%20SECTOR.pdf

THE CHALLENGES FACING IRAQ'S AGRICULTURAL SECTOR

Iraq's agricultural sector faces numerous challenges on its path to growth and the assurance of food security and household income for the rural population. The following are some of the challenges:

1. Water scarcity

Water scarcity is a pressing issue in Iraq. The country heavily relies on the Tigris and Euphrates rivers for its water supply, but their flow has been significantly reduced due to upstream dam construction and decreased rainfall. This scarcity has severe consequences on farming, including crop failure and livestock and fishery depletion. Several factors that have contributed to this crisis are inadequate infrastructure, outdated irrigation methods, wastage, soil salinity, inadequate institutional support, and the absence of a regulatory framework for ensuring efficient use and pricing of irrigation water.[13]

2. Climate change

Climate change is significantly affecting agricultural activities and poses a growing threat. Besides, it worsens the effects of existing poor practices, such as deforestation, overgrazing by livestock, rapid urbanisation, desertification and land degradation.[14]

3. Excessive use of resources

Excessive use of resources has contributed to significant environmental and economic repercussions. High use of chemical fertilisers and pesticides, inadequate water management, destruction of green space by rural residents, overgrazing, improper crop rotation and deforestation are practices that hinder long-term agriculture productivity.

4. Lack of technology

The lack of technology involved in agriculture had impeded the sector's potential for growth and productivity. Limited access to advanced machinery, modern irrigation systems and digital farming techniques has contributed to the inability of farmers to maximise their yield and optimise resource utilisation.

5. Weak research and extension policy

Research and extension are also lacking adequate capacity and policies to support smart agricultural programs in the country. Despite the growing number of research conducted in Iraqi universities on digital technology, extension agents lack the skills to be involved in and provide advice to farmers on the utilisation of digital technology.

13. World Bank Group. (2017). Iraq Systematic Country Diagnostic (Report No. 112333-IQ). Page 96. Retrieved from https://documents1.worldbank.org/curated/en/542811487277729890/pdf/IRAQ-SCD-FINAL-cleared-02132017.pdf
14. World Bank Group. (2017). Iraq Systematic Country Diagnostic (Report No. 112333-IQ). Page 97. Retrieved from https://documents1.worldbank.org/curated/en/542811487277729890/pdf/IRAQ-SCD-FINAL-cleared-02132017.pdf

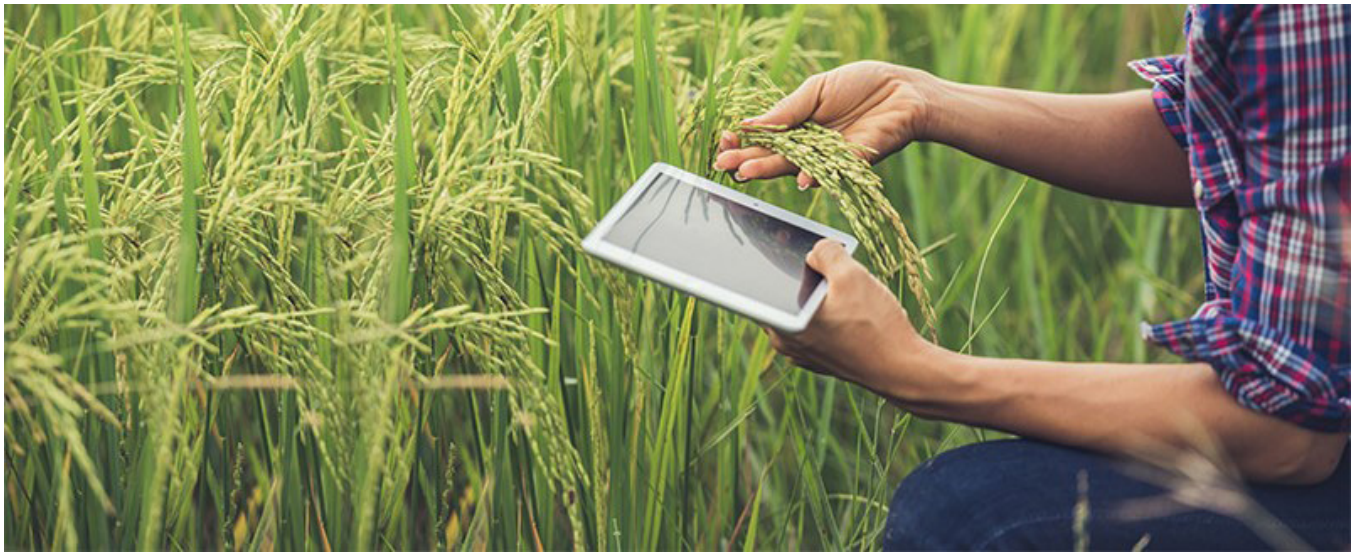
PURPOSE AND SCOPE OF THE STUDY

The purpose of this study was to explore the integration of digital technologies into the agriculture sector to promote climate-resilient farming practices. This initiative stems from the urgency of the climate crisis and aims to enhance resilience among climate-induced migration and displacement. The study explored a comprehensive literature review of Iraq's digital ecosystem. The scope of the study includes several key tasks. Firstly, it mapped the existing digital technologies and stakeholders in Iraq's digital ecosystem that could be involved in climate adaptation and mitigation. Secondly, the study assessed the effectiveness and availability of the current infrastructure that supports the utilisation and development of digital technologies for smart agriculture practices. The study also explored farmers' familiarity and capacity to use these existing or potential digital services. The study identified the obstacles preventing the development and functionality of digital platforms in the smart agricultural sector. Lastly, the study formulated a strategic framework for introducing digital technology into agricultural development in Iraq and recommended practical basic steps for the private sector and international Non-Profit Organizations (NGO) working on smart agriculture in Iraq.

METHODOLOGY AND DATA COLLECTION

After reviewing the literature about the impacts of climate change and water scarcity on agriculture in Iraq, the study selected three ACZs (ACZ1, ACZ2 and ACZ3) for the study geographical area, as these three zones are more impacted by water scarcity and climate change than ACZ4 and ACZ5. The study used a participatory approach to gather data from different stakeholders. Primary and secondary data were used in the study. In the first phase, studies, data sets and information about the utilisation of digital technology in the agricultural sector were reviewed to identify the scope at which technology is used within agrarian practices. Qualitative and quantitative information were collected in the second phase through Key Informant Interviews (KII).

Across the three selected climate zones, the study identified five experienced field researchers in Nineveh, Diyala, Baghdad, Salahaddin and Basra who all have agricultural education backgrounds with various master's and PhD degrees in crops, agricultural machinery and agricultural economy. The field researchers then identified key personnel in their respective areas to participate in the study. The personnel identified were university professors, key authorities in the Ministry of Agriculture (MoA), the Directorate of Agriculture (DoA), private sectors, farmers, experts and NGOs. In total, the study conducted 42 interviews across the five governorates, Nineveh, Diyala, Baghdad, Salahaddin and Basra.



STUDY FINDINGS

THE POTENTIAL OF SMART AGRICULTURE GLOBALLY

Digital technologies have the potential to revolutionise agriculture by making it more efficient, productive and sustainable. Especially because the global agri-food system faces many challenges and a growing population. Climate change, collapse of biodiversity and reduction of resources are among these challenges. Global trade also makes farming sectors to be more based on competitive pricing. It is therefore important to adopt new approaches towards improving production and strengthening the resilience of the agri-food sector.[15]

America and the Netherlands are the top two agricultural product producers in the world, largely due to the investment in smart agriculture and agricultural extension education. Both countries have numerous organisations and institutions dedicated to improving agricultural production, reducing costs, mitigating environmental risks, enhancing irrigation efficiency, and guaranteeing food safety and security.[16] Likewise, due to the use of smart agriculture, the economic return of Australian agricultural products could yield 20.3 billion in the next few years.[17] The importance of smart agriculture lies in its ability to facilitate data collection, information processing, and decision-making, which enhances farming efficiency and productivity by reducing inputs while increasing outputs.[18]

DIGITAL TECHNOLOGIES IN AGRICULTURE IN THE MIDDLE EAST

A study published by the Molecular Diversity Preservation International (MDPI), a Switzerland-based journal, concludes that the implementation of digital technologies in the agri-food sector in the Middle East and North Africa (MENA) countries can enhance development across all three pillars of sustainability: economics, social, and environmental. The study sheds light on desertification issues in Iraq that impact 75 per cent of its land and suggests that incorporating digital technology in intelligent irrigation could promote agricultural development in rural areas, benefiting Internally Displaced Persons (IDP) and returnees who rely on farming for their livelihoods. The authors also suggest that appropriate investment and proper enforcement of social protection could facilitate progress toward social inclusion and vulnerability reduction, particularly for women and youth in the rural labour force.[19]

According to the proceedings paper of the Food and Agriculture Organization (FAO) Regional Conference for the Near East [held in Muscat in March 2020], digital transportation in agriculture in Iraq, Jordan, and Lebanon has the potential to promote farming and increase agricultural productivity and sustainability. The paper highlights zero tillage and conservation cropping in the drylands in northern Iraq. The study also provokes the restriction of the use of digital images and drones for agriculture purposes due to security concerns. Moreover, the study praises Iraq's Directorate of Agricultural Extension initiative for the use of mobile applications to provide recommendations to farmers on date farming.[20]

Another study published in the Earth and Environmental Science journal highlights the challenges associated with the implementation of digital technology in agricultural extension services in Iraq. In particular, the study points out to the farmers' limited capacity to adopt new technologies and the lack of resources available to extension agents for providing digital agricultural extension services.[21]

15. Bellon-Maurel, V., Brossard, L., Garcia, F., Mitton, N., & Termier, A. (2022). Agriculture and Digital Technology. INRAE. Françoise Perret (Designer) & Sophie Barbier (Art Director). ISBN 978-2-7261-1310-3. Page 6-7. https://hal.inrae.fr/hal-03604970/file/white-paper-agriculture-digital-technology-2022_INRIA_HD.pdf
16. Republic of Turkey, Ministry of Agriculture and Forestry (December 2021). Acceleration of digital transformation in agriculture sector for ensuring sustainable food security. This needs assessment report was prepared under the COMCEC COVID Response. Page 37. https://www.researchgate.net/publication/358301789_ACCELERATION_OF_DIGITAL_TRANSFORMATION_IN_AGRICULTURE_SECTOR_FOR_ENSURING_SUSTAINABLE_FOOD_SECURITY_IN_TURKIYE
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20. FAO. (2020). Executive Summary. In Proceedings of the FAO Regional Conference for the Near East: Digital Innovation for Promoting Agriculture 4.0 in the Near East and North Africa, Muscat, Oman, 2-4 March 2020. https://www.fao.org/3/nd262en/nd262en.pdf
21. Al-Hamdany, M. H. S., & Abd Al-Rekibe, H. S. (2021). Environmental Assessment of Al-Rustamiyah Refinery using HYSYS Program. IOP Conference Series: Earth and Environmental Science, 735, 012037. https://doi.org/10.1088/1755-1315/735/1/012037

UTILISATION OF DIGITAL TECHNOLOGIES IN AGRICULTURE IN NEIGHBOURING COUNTRIES

The following are some examples of climate-smart agriculture with the use of digital technologies:

Jordan

Smart DESERT project

The "Smart DESERT" project is a research initiative that began in 2021 in Jordan. The project aims to provide innovative solutions for sustainable agriculture in arid and semi-arid regions in Jordan. The project was funded by The Agence Française de Développement (AFD). The project's main objectives were increasing self-dependence in food production, developing agricultural resources, and improving water use efficiency. The project provided training -which includes packing and marketing- and counselling to farmers to reduce production costs through efficient use of energy, solar power and water management systems.

The project utilised digital technologies by developing a smartphone application to provide farmers with an early warning system for natural disasters by providing information on weather conditions and weather forecasting, floods, frosts and other risks. The project targeted local farmers, agricultural home-based business owners in the northeastern Badia region, and Syrian refugees working in agriculture in Jordan. The project linked home-based businesses with the local market through an electronic marketing platform to provide farmers with opportunities to displace their products and access new markets.[22]

Lebanon

SWat project

The SWat project is a remote-controlled irrigation system applied on 50,000 hectares (5% of the Lebanon territory). The aim of the project was to increase the adaptation capacity to economic losses and freshwater depletion induced by climate change. The outcomes of the project were 30 per cent water savings, 10 per cent increased production and 15 per cent administration time savings. The project was funded by the European Union (EU) and implemented in 2018.[23]

Another study published by the Journal of Agricultural Water Management has examined the readiness of Lebanese smallholder farmers to adopt smart irrigation mobile applications in their agricultural practices. The study revealed that 90 per cent of the farmers agreed that the application had enhanced their farm management and productivity.[24]

IOM Iraq has highlighted this project is implemented in Lebanon and suggests that this it could potentially be replicated in various areas in Iraq. The IOM study views that this innovative tool has significant potential for scalability through capacity building, sharing and dissemination of results. The study suggests a pilot system to be implemented with monitoring and measurement of its decreased freshwater withdrawal, energy conservation and productivity gains.[25]

DIGITAL TECHNOLOGIES PRACTICES FOR CLIMATE-SMART AGRICULTURE IN IRAQ

Overall, the use of digital technologies in Iraq's agriculture is still very limited, although there are ongoing efforts to promote the adaptation of digital technology in climate-smart agriculture. In recent years, Iraqi universities, the private sector and international organisations have made various attempts to involve digital technology in their academic and development activities with the aim of increasing efficiency, reducing costs and improving crop yields. However, most of these attempts have remained limited to training, case studies and research. Below are some examples of smart agriculture in Iraq.

- A new smart irrigation system is being tested in a research project in Erbil in cooperation with an American company, the MoA, and Salahaddin University. The system is capable of recovering 75 per cent of the water used compared to drip and sprinkler irrigation systems.[26]
- Studies carried out on utilising the Internet of Things (IoT) for smart irrigation practices by the University of Mosul.[27] In addition, international organisations, such as Future Water [a Netherlands-based organisation], have developed tailored training programs for smart irrigation in Iraq, with a specific emphasis on enhancing salinity control.[28]
- Crop monitoring systems using satellite imagery and remote sensing used by researchers at the University of Sulaimania and Baghdad University as case studies

22. Smart DESERT. (n.d.). About SD. Retrieved April 22, 2023, from https://www.smartdesertproject.com/about-sd/
23. SWat Project. (n.d.). Remote-controlled irrigation system to address water scarcity: The SWat Project. Retrieved from https://www.gwp.org/globalassets/global/gwp-med-files/news-and-activities/med-programme/1st-multistakeholder-consultation/oikos_remote-controlled-irrigation-system-to-address-water-scarcity_the-swat-project.pdf
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25. IOM Iraq. (2022, July). Small Scale Irrigation Infrastructure Development in Iraq: A Feasibility Review. Retrieved from https://edf.iom.int/publications/36/Small-Scale-Irrigation-Final-.pdf.
26. Rudaw. (2022, September 12). Smart irrigation systems to be set in the Kurdistan Region [Television broadcast]. Rudaw TV. https://www.rudaw.net/english/kurdistan/120920221
27. Badran, A. I., & Kashmoola, M. Y. (2021). Smart agriculture; farm irrigation system using IoT. Journal of Information Technology and Software Engineering, 11(3), 1-8. https://www.researchgate.net/publication/348431469_Smart_Agriculture_Farm_Irrigation_System_Using_IoT
28. Future Water the Netherlands. https://www.futurewater.eu/projectcountry/iraq/ or https://rsr.akvo.org/dir/project/9731

to assess greenness, productivity, vegetation growth and model crop yield in smallholder arid and semi-arid farms.[29]

Currently, there are no digital technologies offered by the government or any public sector institute. However, there are individual efforts from the private sector who are interested in smart agriculture and use modern tools such as the utilisation of solar energy to run water wells or desalinate water in remote desert areas.

> *"Reducing water use and employing modern agricultural methods brings life back to rural areas and motivates farmers to improve their farming activities." Haytham A. Khdir at Director of Seed Examination and Certification Department/ Diyala Branch.*

Participant extension agents, farmers and experts revealed that there are currently only a few technological tools used for climate adaptation in farming, livestock breeding and fisheries at the small and medium levels. Examples of these techniques are hydroponic techniques and soil sensors to control humidity, moisture and irrigation systems when referring to the high technology used in agriculture. Drones are used in a few locations in Najaf and Karbala in large-scale farms that are managed by religious shrines. According to key informants, the use of drones in Iraq, including the Kurdistan region, is restricted by the state for security reasons. However, the majority of key informants stressed that digital technologies have not yet been widely recognised at the level of farms in Iraq as a whole.

Through their observation during the field visits, enumerators pointed out that a few farmers have made timid attempts to shift their mechanical farming system with modern advanced technologies in multiple areas in the country, such as using solar systems instead of power generators. Nevertheless, these efforts are individual endeavours and adopting cutting-edge technologies does not involve digitalisation of any kind. Additionally, the attempts of international organisations, the business sector, and the government to incorporate digital technology into climate-smart agriculture are relatively poor due to a lack of funding. However, examples of international organisations' efforts in the modernisation of farming systems in the past few years are limited to training on conservative agriculture, the use of nano-fertilisers, and the development of drought-resistant crop types.

Participant experts said that the Iraqi Agricultural Research and Extension Institute (AREI) institute is capable of providing training to farmers on digital technologies, sensors and irrigation systems if given the necessary training and equipment. They explained that highly skilled individual professionals are keenly interested in keeping abreast of the latest global scientific developments. Nevertheless, there is currently a lack of government support and policy to utilise local expertise to affect positive changes in the farming system to reduce climate change-induced migration in rural areas. According to Dr. Abdulsatar Asmar/Former Head of the International Center for Agricultural Research in the Dry Areas (ICARDA) program in Iraq, the current status of the ARE institute in Iraq is characterised by the absence of a centralised policy that embraces change. Instead, the status quo prevails, with no progress being made towards utilising of digital technologies, leaving agricultural livelihoods in rural areas stagnant and unproductive. Many key participant stakeholders in this study illustrated that apart from the interventions of international organisations, there is no viable mechanism in place by the state to facilitate the utilisation of digital technologies in climate-smart agriculture.

29. O'Riordan, T. (n.d.). Exploring satellite datasets and advanced statistical models to estimate crop production in Iraq [Blog post]. World Pro. Retrieved from https://www.worldpro.org/exploring-satellite-datasets-and-advanced-statistical-models-to-estimate-crop-production-in-iraq/

FARMERS' FAMILIARITY AND CAPACITY TO UTILISE TECHNOLOGIES FOR CLIMATE-SMART AGRICULTURE

Small-scale farmers, who often lack the resources and technology to adapt to the impacts of climate change and water scarcity, are particularly vulnerable to the negative effects of insufficient rainfall, changing precipitation patterns, and declining water sources such as underground water, rivers, and reservoirs. As a result, they experience reduced agricultural productivity and economic losses.

Generally, the most prominent problems facing farmers, especially small-scale farmers, are the adherence to outdated farming methods and a lack of familiarity or knowledge of modern farming methods and their potential economic benefits. Due to their limited resources, small-scale farmers often depend on state support to improve their situation. Still, the state's inability to support all crops or all farmers can lead to neglect of land and significant losses. This situation ultimately forces small-scale farmers to abandon their farms and migrate to urban areas, sell their land and herds, or convert it into residential or commercial complexes. Another negative response to the consequences of climate change and water scarcity is that farmers try to restore their farming activities by digging water wells in an attempt to cope with the lack of water resources. However, due to the depletion of groundwater and the inability of these wells to provide an adequate water supply for their farming activities, many farmers are forced to abandon their farming and migrate to urban areas.

> *"Most farmers are either not familiar with or do not have the interest in using modern devices for digitalisation their farms, and use of modern methods of climate-smart agriculture is minimal, such as intercropping, hydroponics and other farming methods that depend on robots in controlling temperature, humidity, fertilisation and watering, thus reducing labour and increasing yields in quantity and quality." Siad Haytham A. Khdir at Director of Seed Examination and Certification Department / Diyala Branch*

Many small-scale farmers lack access to modern technology and are only familiar with the fundamental principles of smart agriculture and digital technology. Their limited adoption of technology often involves using social media for selling or advertising their products or reviewing weather forecast websites. Furthermore, women have limited access to technology, as it is primarily reserved for men. Nevertheless, the majority of small-scale farmers have access to digital technologies such as mobile phones and the Internet and are interested in learning about smart agriculture technologies that can help them adapt to climate change and water scarcity. For instance, farmers often use simple, smart applications such as weather programs, which enable them to monitor weather conditions and rainfall rates. However, to fully benefit from these technologies, extension and research centres must conduct field observations and provide training and support to farmers, such as training on crop calendars and marketing on social media.

By and large, women face significant oppression in rural areas as they work on agricultural lands and manage household responsibilities. They are disproportionately affected by the challenges of rural environments and social norms. However, they are considered important key economic actors, as they work on producing agricultural goods, such as dairy products. The fact that most of the farming activities in rural areas are done as family businesses, women are enrolled in crop cultivation, weeding and harvesting across the farming process. They are also responsible for caring for animals and poultry, such as feeding and milking. Women also play a vital role in processing agricultural products, such as drying, canning food and processing dairy products. However, many factors such as economic conditions, education, and cultural norms limit their access to digital technologies. For example, societal expectations may prioritise men's access to financial resources and decision-making, limiting women's opportunities to benefit from digital technologies, which results in lower participation in the use of digital technology for women.

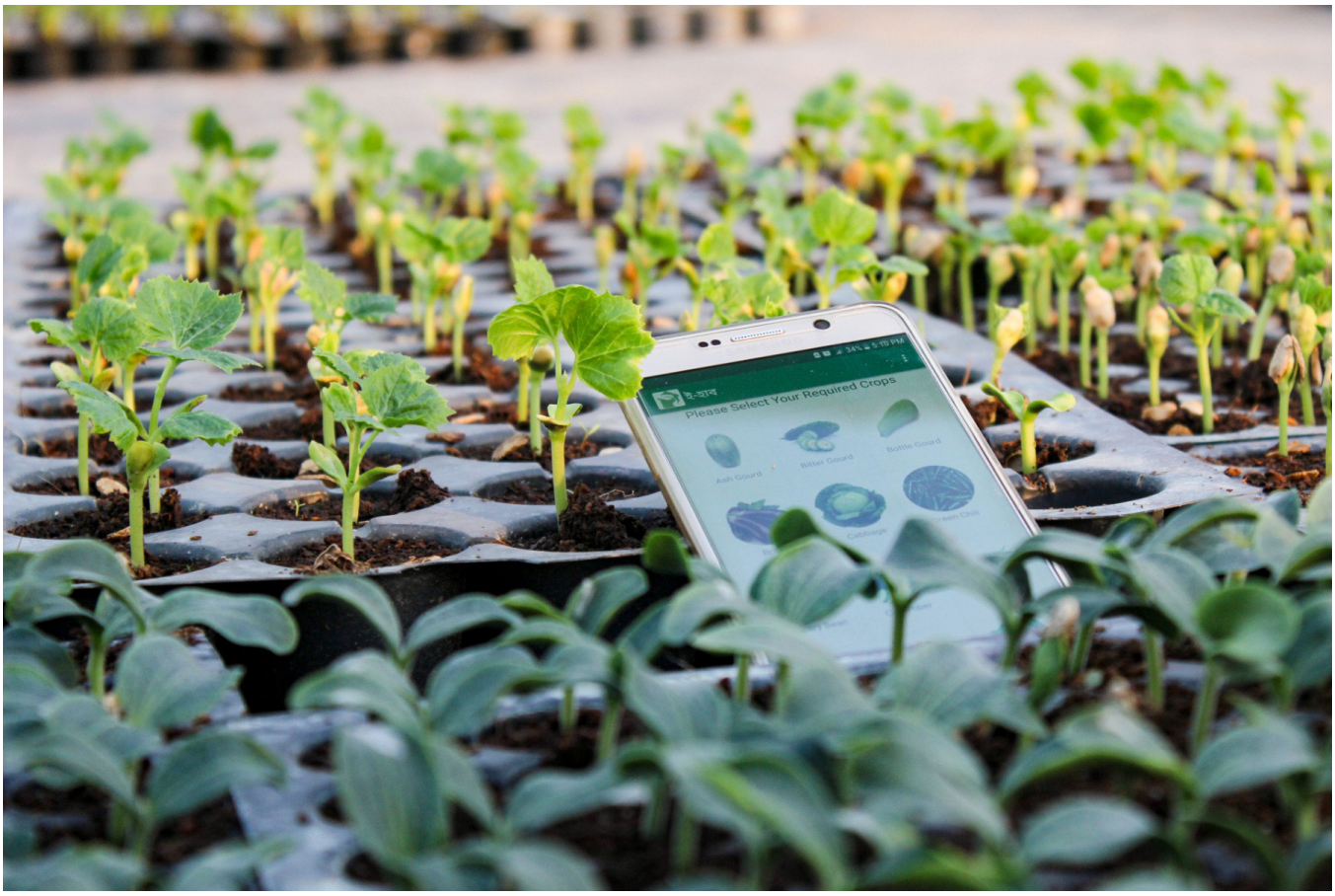
In contrast to small and medium-scale farmers, high-income farmers, for whom farming is their primary income source, are more willing to purchase and utilise technology that can increase crop production because they possess greater purchasing power, which enables them to make substantial investments in advanced technologies and their extensive size of farming makes it more feasible to incorporate modern innovation practices. Consequently, they are eager to adopt modern technologies to assist them in their farming practices.

Despite these differences, most farmers do not currently practice a systematic process of data collection and analysis. The challenges of adopting this approach include farmers' lack of familiarity with this approach and the irregularity of data throughout the agricultural value chain.

THE CURRENT INFRASTRUCTURE OF DIGITAL TECHNOLOGY FOR SMART AGRICULTURE IN IRAQ

The dearth of extension programs relevant to introducing digital technologies to the farming systems in Iraq can be attributed to the country's inadequate adoption of digital technologies. Although many farmers are aware of existing smart agriculture and their consequential advantages, such as enhancement of production quality and yield increase, they generally acquire this knowledge through social media, field trips, seminars, and interactions with extension agents. There is an urgent need to develop a tech-savvy mindset and culture among Iraqi farmers.

In regard to produced digital local data by service providers in Iraq, weather forecasting is the primary digital data provided by the MoA and Ministry of Environment (MoE)through a network of meteorological stations across the country. Weather stations are distributed in the level of districts across all



governorates in Iraq. These stations provide information in the form of daily weather reports on weather conditions such as temperature, humidity, wind intensity and rainfall to help farmers make informed decisions about planting schedules, irrigation and the use of pest control. Farmers usually use mobile phones to access this information. However, no analytical process is conducted on this data. Other data that is publicly available on CSO at MoP's website are information on forest areas, desert areas, decertified and desertification-prone areas, and the volume of pesticides and fertilisers used in farming across all governorates in the county.

Despite the presence of a network of Research and Extension Centers (REC) established by the Iraqi MoA throughout the country at the district and sub-district levels, additional support is needed to address the multifaceted challenges facing Iraqi farmers. The RECs are staffed with knowledgeable professionals who are well-acquainted with the realities of farming in Iraq; they require assistance in tailoring their efforts to meet the diverse farming objectives, interests, and limited educational levels of local farmers. However, few interviewed key informants stressed that the concept of smart agriculture is not fully grasped by all extension agents. Additionally, due to a lack of funds, RECs are unable to provide their extension personnel with the necessary expertise and skills on digital agriculture, which hinders their ability to act as a hub to promote the adoption of digital technology in farming. This is mainly because RECs are technically linked to the MoA, but administratively are linked to their relevant governorates; consequently, their funding is solely reliant on the governorates, putting them in an unbalanced competition with all other sectors at the governorate level.

The adoption of digital technologies in the Iraqi MoA's research and extension centres is limited by policy and financial constraints. Although certain centres have access to soil sensors and mobile applications, a significant number of centres require more advanced technologies, such as satellite images and drones, to enhance their field study programs. The availability of weather data is tied to the weather stations and is currently disseminated to the research centres at the district and sub-district levels. Additionally, Agriculture Institutes and colleges need supplementary funding to effectively integrate cutting-edge digital tools, such as satellite photos and drones, into their programs.

> *"A farmer who is not financially capable does not pursue this sort of technology since their goal is to supply daily nourishment for their family and cover the cost of agricultural inputs. Dr. Maythum Abbas, the Director of the Animal Wealth Section in Thi-Qar*

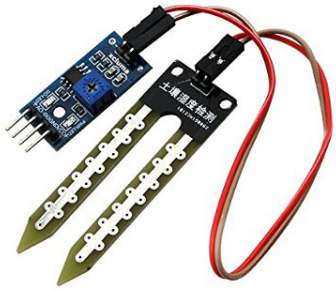
The Division of Agriculture in each governorate has farming data sets at the district and sub-district levels. This data can be highly beneficial when digital technology and smart agriculture are put to use in agriculture by organisations and the private sector.

Due to the limited resources available to farmers for acquiring new equipment and tools to address climate change, as well as their lack of awareness regarding modern technologies such as computers and data analysis tools, their capacity to adapt to these challenges is restricted. Additionally, the government should adopt advanced climate-smart digital technologies in the national level, such as installing remote sensing to predict future climate and issue past and future plant rotation models that are designed based on predicted climate variability and according to locations and scenarios.

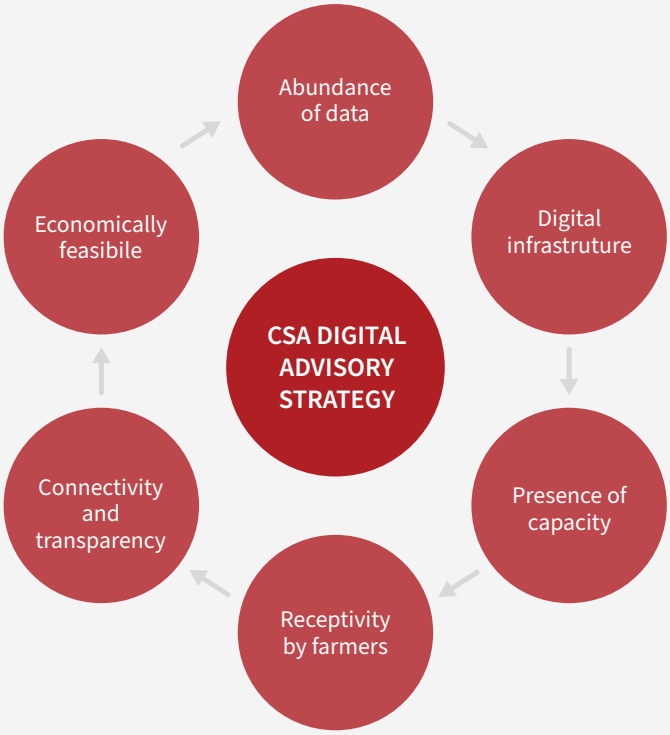
CLIMATE-SMART AGRICULTURE (CSA) DIGITAL STRATEGY ACTORS

Climate-smart Agriculture digital advisory is currently not present in Iraq. However, its roadmap can be proposed according to the current digital infrastructure, context and stakeholders in the country. The results of the study summarised the requirements for establishing a CSA digital strategy to six fundamental needs that each need can be carried out by a group of actors:

- **Abundance of data** (possible actors: government institutions, universities and research centres)
- **Digital infrastructure** (possible actors, government institutions, universities and research centres)
- **Presence of capacity** (possible actors, government institutions, universities and research centres, private sector)
- **Receptivity by farmers** (possible actors: farmers, rural women, cooperatives, extension centres)
- **Economic feasibility for small-scale farmers** (possible actors: research centres, private sector)
- **Connectivity and transparency** (possible actors: cooperatives, farmers unions, extension centres, research centres, private sector)



Soil Humidity Sensor



Currently, there are various actors that are/can be involved in digital technologies for agriculture across Iraq:

Universities have an educational and research role and play a major role in introducing innovative practices for climate-smart agriculture. They can help extension agents and farmers with education and training on how to use digital agriculture effectively, collaborate with government agencies and private companies to provide farmers with access to digital technologies, produce precision agriculture models, crop growth models, and predictions of future weather pattern and promoting artificial intelligence and machine learning.

Examples of science institutions that can contribute to the digital agricultural improvement are:

- Department of Remote Sensing and GIS at the College of Science/University of Baghdad[30] that provides learning services on remote sensing, digital images, data analysis of satellite images and digital data.
- The College of Remote Sensing and Geophysics at Al-Karkh University of Science in Baghdad.[31]
- Department of Extension and Transfer of Agricultural Technologies, the Department of Desertification and the Department of Machinery and Agricultural Machines at the College of Agricultural Engineering Sciences at the Iraqi universities.[32]

> *"Farming here is done traditionally, where skills in farming activities are inherited, and there are no contemporary agricultural methods. Farmers have never adopted digitalisation practices: Abbas al-Musawi, CEO of the al-Musawi Company for farming supplies and equipment in Basra.*

Agriculture directorates and environmental directorates at the MoA and MoE in Iraq are important governmental bodies responsible for implementing agricultural policies and programs at the governorate level. In each of Iraq's 19 governorates, there is a Directorate of Agriculture (DoA) that operates under the supervision of the MoA and the relevant governorate. The main functions of DoA relevant to digital agriculture are developing food security and sustainable agricultural local policies and programs in accordance with the national policies, maintaining data on farming, production and marketing on the level of the governorate, providing technical advice and guidance to Research and Extension centres in the governorate, supervision and evaluating agriculture programs and coordination with international organisations and the private sector to implement smart agriculture projects.

Agricultural Research and Extension Centers, Iraq has several ARE centres that play a crucial role in the development and promotion of agriculture in the country. The main functions of ARECs relevant to digital agriculture are providing technical guidance to extension agents for training, implementing digital agriculture field demonstration/implementing pilot projects on production, processing and marketing in cooperation with private sector and international organisations, conducting awareness and training course for farmers, and assessing digital agriculture status and improvement needs in the respective region.

The private sector can connect farmers with digital technology tools and devices. They can also help farmers with training and extension services. They can engage in consultancy and partnership with NGOs in introducing practical digital solutions for small and medium-scale farmers.

Digital technology professional consultants can have a considerable role in introducing locally adopted solutions to the local farming system. Key informants interviewed shared that urgently needed professions related to the development of digital technologies for smart agriculture in Iraq are agricultural engineers who are trained to install controlled irrigation systems, drip irrigation, or centre pivot irrigation. Professions for agricultural engineers trained to operate self-driving agricultural equipment connected to satellites, professions for laboratory managers who measure all physical and chemical properties of soil and qualitative characteristics of crops, vegetables, and fruits, as well as all requirements for genetic studies and devices for examining genetic, physical, and colour purity, and many others.

30. The college is established in 2015. https://sc.uobaghdad.edu.iq/?page_id=8336
31. https://rgc.kus.edu.iq/
32. The department ETAT is established in 1987, the department of Desertification is established in 2013 and the department of MAM established in 1977. https://en.uobaghdad.edu.iq/

CURRENT INITIATIVES

International organisations and the private sector have undertaken various promising initiatives concerning climate-smart agricultural practices, encompassing different fields such as cropping, livestock keeping, and fishery. These initiatives have centred around conservation agriculture, the improvement of pastures, the use of greenhouses, and the adoption of new irrigation systems. Notably, these programs have been implemented by leading organisations such as the United Nations Development Program (UNDP), the FAO, and the World Food Program (WFP).

These initiatives aim to support farmers by providing them with essential resources such as drought-tolerant seeds, fertiliser, advanced machinery, and training. Additionally, they provided public agricultural institutions with laboratory equipment and tools to facilitate research and development in climate-smart agriculture. These initiatives are expected to contribute significantly to enhancing the resilience of farmers against climate change and water scarcity, improving agricultural productivity, and promoting sustainable agricultural practices. Below are some of these programs:

WaPOR Program to improve water productivity in Iraq and the Middle East. The program is about using Remote Sensing to monitor water productivity through open access to remotely sensed derived data. The aim of the program is to help partner countries in developing their capacity to monitor and improve water-land productivity in agriculture. The program is funded by the Ministry of Foreign Affairs of the Netherlands and implemented by the FAO. The program is being implemented in al-Garap area in Thi Qar Governorate.[33]

Digital hydroponic multi-span greenhouses were established in Erbil and Sulaymaniya in the Kurdistan region. The projects aim to introduce new technologies to optimise water use and maximise yield. The companies working in this regard are providing both technologies and extension services to the farmers in the region.[34]

Kishtukal [agriculture in Kurdish] is a weekly agricultural extension and news program that showcases agricultural practices in the Kurdistan region. The program has a rich online presence on both YouTube and Facebook, with over 500 episodes, each approximately 20 minutes long. It covers a wide array of topics related to agriculture, including modern farming techniques, sustainable practices, livestock rearing, fishing methods, and more.[35]

MAYDAN is a mobile app that facilitates agricultural input supply marketing. The application is available in Kurdish, Arabic, and English, offering marketing services to input suppliers, farmers, livestock owners, and their customers.

Mobile money has gained significant popularity in Iraq in recent years, providing convenient digital payment, money transfer, and bill payment services. Several companies now offer mobile money services in Iraq, including ZainCash, Asiacell Pay, Korek Money, NassWallet, and FastPay.

Online Marketing is a rapidly growing industry in Iraq, driven by the increasing number of people using the Internet to connect with businesses and make purchases. The field includes various platforms such as social media, websites, and mobile apps. The key focus for online marketing service providers lies in improving product-content information, creating engaging video and photo content, and implementing effective product tracking strategies. Food delivery companies are excellent examples of marketing service providers that utilise online platforms to promote all types of food offerings.

MAPPING PRIVATE SECTOR

Iraq's digital technology-based private sector is underdeveloped. The involvement of the private sector is more focused on the sectors of communication, media, software development and online marketing. However, their involvement in introducing high-tech and digital advancement in Iraqi agriculture has to address several obstacles encountered with the farming system in Iraq, as the vast majority of agricultural producers are classified as small and medium-sized businesses.

THE IMPORTANCE OF DIGITIZING CLIMATE-SMART AGRICULTURE INFORMATION

- Learning reaches more people and faster compared to traditional agricultural extension and agricultural media.
- Cost of learning will be down, as agricultural extension is very expensive when it is used for climate-smart agriculture
- Digital technology can be designed with the local context and be tailored to local needs, especially when it is linked with market information and local products needs
- Digital information can provide real-time data and interactive with farmers and consumers for decision making.

33. https://iraq.un.org/en/194385-new-agreement-between-ministry-water-resources-and-fao-introduces-innovative-tools-monitor and https://www.fao.org/in-action/remote-sensing-for-water-productivity/en
34. Eco Consult Company, Projects. https://ecoconsult.jo/our-projects
35. Kishtukal program. https://www.youtube.com/@Kishtukal/featured

In recent years, there have been commendable efforts in the Kurdistan region and throughout Iraq to connect the agricultural sector to investment laws and regulations. As a result, a few companies have outlined their focus to agriculture investment by embracing high-tech solutions and digitalisation.[36] ECO Consult company serves as an example of such companies, having established multi-span greenhouse projects in Iraq, which are either high or medium-scale digitalised agriculture and operate completely automated without the need for human intervention.

The above context reveals that any approach aimed at introducing digital technology into agricultural development should ensure that technological innovation is tailored to the distinct needs, affordability and scale of the farmers, maximising the benefits and impact of this digital advancement in Iraq's agricultural sector. Aside from land size, limited access to simplified technologies, lack of technical skills and language and localisation are other factors that undermine the introduction of digital technology to small and medium-scale farmers. Hence, the majority of the small efforts to digitalise small and medium-scale farming systems are being made by uncertified small companies or non-agriculture companies, such as companies working in electricity and solar systems and Information Technology (IT) groups.

The study concludes that the technology and digital ecosystem relevant to smart agriculture in Iraq fall into two categories: large-scale agricultural companies and small-scale non-agricultural-based companies. Large-scale agricultural companies are actively implementing medium to high-tech and digitalised agricultural hydroponic projects in accordance with Iraq's investment laws and regulations. These companies help agricultural investors with implementing multi-span greenhouses for hydroponic agriculture. Efforts of such companies allow local companies to make substantial investments in agricultural businesses. However, no business-based initiatives have been done in Iraq targeting other types of agricultural projects. The second type of companies are small-scale, non-agricultural-based companies. They are operating their main business activities in non-agriculture sectors such as electricity and information technology; however, they can offer technological and digitalisation solutions for small and medium-scale farming systems. These companies can connect small and medium-scale farmers with digital technology tools and devices. They can help farmers with remote control for their water well operation and irrigation systems. They can provide digital services like installing sensors, creating guidance on plant diseases and planning rotation. They can also create digital platforms that connect farmers with markets, buyers, and other agricultural stakeholders.

36. Jongerden, J., Wolters, W., & Dijkxhoorn, Y. (2018). Explorative Study Agricultural Development in Iraq and the federal Kurdistan Autonomous Region: Final Report. The Government of The Netherlands, p 10. https://www.agroberichtenbuitenland.nl/binaries/agroberichtenbuitenland/documenten/rapporten/2018/11/09/wageningen-iraq-agri-development-report-2018/Wageningen+Iraq+Agri+Development+Report+2018.pdf

BARRIERS TO INVOLVING THE PRIVATE SECTOR IN TECHNOLOGICAL AND DIGITAL SOLUTIONS IN SMALL AND MEDIUM-SCALE FARMING

Difficulty in customisation: Difficulties in adopting to small and medium-scale farmers. Many agricultural digitalisation technologies are developed and optimised for large-scale farming operations. While small and medium-scale farmers engage in mixed agricultural activities, such as farming and livestock. This makes it difficult to customise large-scale digital solutions for small and medium-scale farmers' specific needs, climate conditions and land size.

Difficulty in Scalability: Scalability is a significant challenge in the adoption of digital solutions for small and medium-scale farmers in Iraq, as farming systems vary from region to region. These technologies may not be suitable for scale-up, as small and medium-scale farmers' digital solution needs are diverse depending on their practice and region.

Lack of trust: Small and medium-scale farmers may hesitate to adopt new digital solutions due to a lack of confidence or unfamiliarity with the technology. They might prefer to rely on traditional knowledge and practices that have been passed down through generations. For example, farmers in rural areas may be hesitant to use mobile money transfers to market their products. Also, accepting digital technologies may require a significant shift in mindset and a willingness to adopt new approaches, which can be met with resistance or scepticism.

Technical Skills and Knowledge Gap: Adopting and effectively utilising digital technologies require a certain level of technical skills and knowledge. Small and medium-scale farmers may lack the necessary skills and expertise to understand and leverage these technologies for their agricultural practices. The knowledge gap will be even more complicated if the digital tools are not available in local languages.

Lack of government policies and regulators: Iraq, including the Kurdistan Region, lacks specific regulatory frameworks and policies addressing the use of digital technologies in agriculture. This increases the uncertainty for NGOs and the private sector in implementing digital solutions in their programs, particularly in conflict-affected areas. Drones, for example, are strictly prohibited in both the Kurdistan Region and Iraq as a whole.

High cost: The initial cost of implementing digital technology solutions, such as purchasing sensors, software and their maintenance costs, can be a barrier for small and medium-scale farmers with limited financial resources.

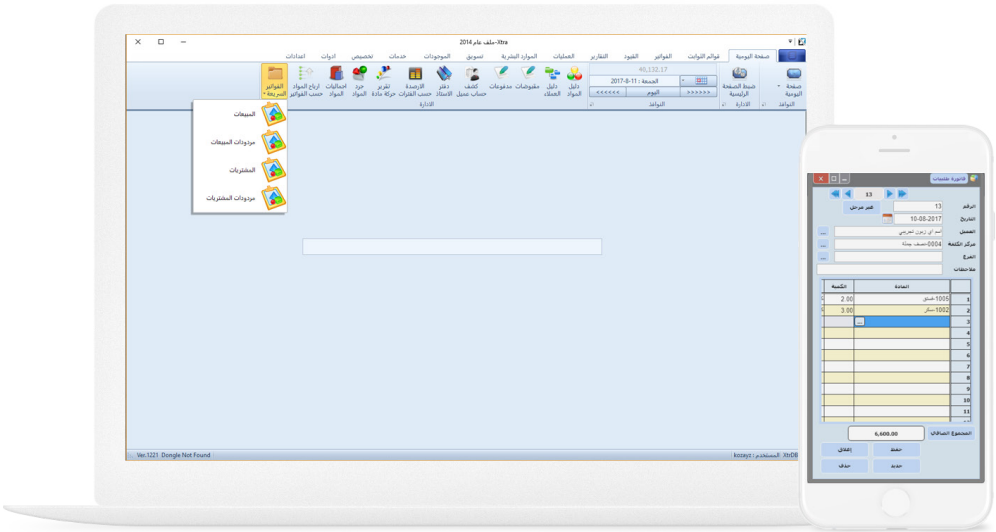
OPPORTUNITIES TO INVOLVE THE PRIVATE SECTOR IN TECHNOLOGICAL AND DIGITAL SOLUTIONS IN SMALL AND MEDIUM-SCALE FARMING

Providing consultancy: Large-scale agricultural companies can play an active role in providing consultation to NGOs, as well as training and extension services to small and medium-scale farmers.

Providing digital tools and training: Large-scale agricultural companies can play an active role in introducing digital technologies while building business relationships with small and medium-scale farmers by providing inputs, digital tools, and training services.

Providing innovative and adaptive digital tools: Small-scale non-agricultural companies can play a role in delivering innovative digital solutions for farming in small and medium-scale farming systems. These companies have more flexible capabilities in localising and adapting digital tools to meet the specific needs of local farmers. For example, small IT groups can create simplified mobile applications connected to sensors to diagnose local plant diseases, and small electricity companies can connect remotely controlled solar systems that are related to irrigation and flowmeter systems for small and medium-scale farmers.

Establishing partnership: Small-scale non-agricultural companies can establish partnerships with large-scale agricultural companies and NGOs as sub-recipients to supply and implement projects that involve locally adaptive digital solutions for small and medium-scale farmers.



SMART AGRICULTURE STRATEGY FOR SMALL AND MEDIUM-SCALE FARMERS

The humanitarian context has undergone a significant shift in recent years, shifting towards a more development-oriented approach. The aim is to address the needs of all Iraqis, not solely limited to those directly affected by conflicts.[37] On the other hand, agricultural activities, such as farming, livestock rearing, and fishing, are primarily carried out by small and medium-scale farmers. These farmers are crucial for food production, food security, and income generation among peri-urban and rural populations. As a result, international initiatives are now working to strengthen small and medium-scale farmers by engaging and supporting various economic actors involved in the agricultural value chains, including actors working in the incorporation of digital technology into the agricultural value chains.

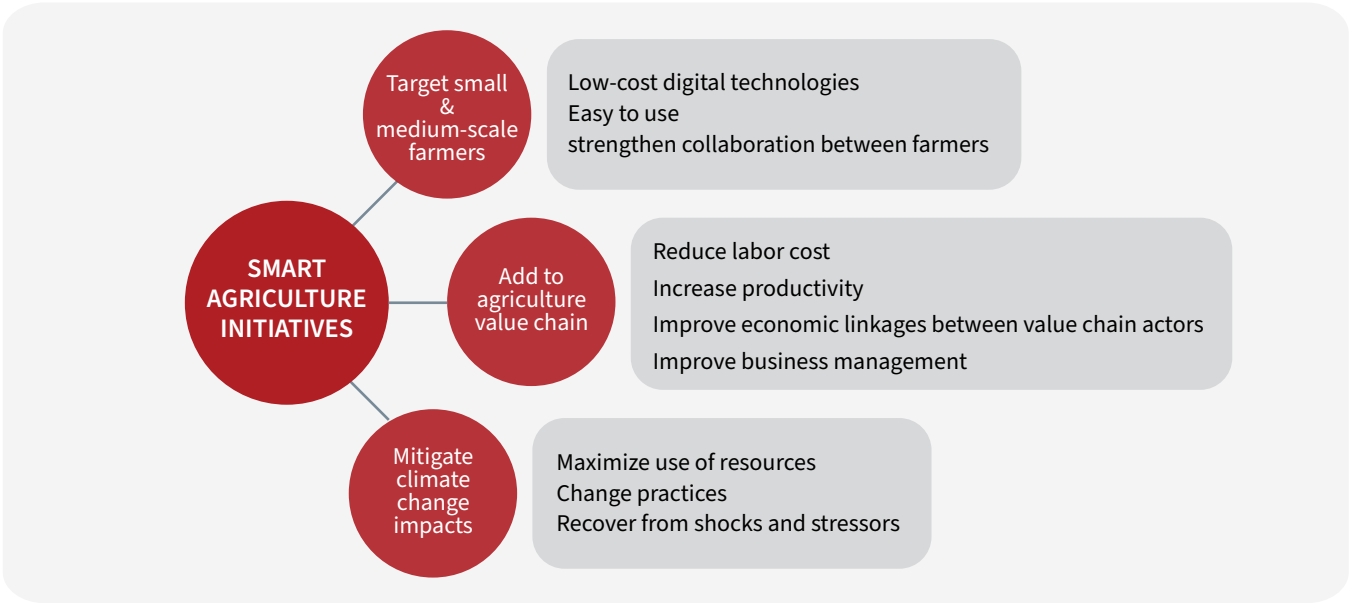
To achieve success, the study outlines a strategy for companies and international organisations that work in involving digital technology in agricultural development in Iraq. The strategy is built on three pillars: i) Targeting small and medium-scale Farmers, ii) Addressing deficiencies and potential growth areas in agricultural value chains, and iii) Mitigating the impact of climate change and water scarcity. This strategy can be leveraged as a general framework for the digitalisation of small and medium-scale agricultural projects in Iraq; however, the study provides more specific subject-based suggestions in the recommendation section.

Recognising the pivotal role played by small and medium-scale farmers in Iraq's agriculture, the strategy seeks to empower them through local companies by utilising low-cost digital tools and platforms. The emphasis should be on user-friendly solutions, ensuring that even farmers with limited technological experience can easily integrate digital practices into their agricultural activities. This can be done by benefiting from the experiences of large-scale agricultural companies with extension services, introducing digital tools they already use and building partnerships with small non-agricultural companies and international organisations, while small non-agricultural companies can benefit from providing innovative and localised digital solutions for farmers to create technologies tailored to the needs of small and medium-scale farmers. This will foster collaboration between different actors and create an avenue for knowledge-sharing and best-practice dissemination, targeting small and medium-scale farmers.

The strategy emphasises that any approach aimed at digitising farming practices should be centred around agriculture value chains to effectively address deficiencies and potential growth within the chains. And should focus on reducing labour costs and optimising resource efficiency. In addition, the introduced digital technology should facilitate improved business linkages between various actors in the value chains through market digitalisation. This includes better coordination between smallholder farmers, suppliers, processors, and distributors. Furthermore, the strategy seeks to empower small and medium-scale farmers with digital tools for better business management, providing access to real-time market information and reducing uncertainties and risks associated with farmers' agricultural endeavours.

In the face of climate change and water scarcity increasing impact, the strategy places a strong emphasis on maximising the efficient use of resources, such as water, fertilisers and pesticides. Smart irrigation systems, weather forecasting tools, and the introduction of data-driven farming practices such as crop rotation modelling and soil reservation practices linked to digital technology enable more sustainable agricultural practices and natural resources.

AGRICULTURAL DIGITALIZATION STRATEGY FOR SMALL AND MEDIUM-SCALE FARMERS



37. OCHA Iraq, 2022. https://reliefweb.int/report/iraq/iraq-humanitarian-transition-overview-2023-february-2023-enarku

RECOMMENDATIONS

The value chain in agriculture refers to a series of stages involved in the production, processing, and distribution of agricultural products. The stages can vary depending on the specific agricultural sector and product. There are often gaps in these value chains due to a number of factors, of which some of these factors are due to the lack of technology. Digital technology can help to fill the gaps across the value chains in a number of ways. For example, they can improve farmers' access and management to inputs, access to learning materials, reduce inputs' cost, time-saving, improve processing efficiency, access to market information, etc.

The following are some recommendations that can be applied to small and medium-scale farmers across the stages of their production in peri-urban and rural areas in Iraq.

Input supply:

Recommended digital technologies:

- Online marketplaces or mobile apps that connect farmers with local suppliers for convenient purchase of seeds, fertilisers, pesticides and equipment.
- Agricultural advisory apps provide real-time information on recommended inputs, crop varieties and farming techniques based on local conditions.
- Sensor-based technologies for monitoring moisture, temperature and acidity of silage during processing when it is wilting
- Sensor-based technologies for monitoring moisture, temperature and acidity of compost during processing when it is wilting

Production:

Recommended digital technologies:

- Sensor-based technologies for monitoring soil moisture, temperature and nutrients to optimise irrigation and fertilisation.
- Software programs connected to digital flowmeters and water pumps to control irrigation according to crop type and operated remotely. This can be done by connecting the water well pump and flow meter with specially designed software that allows water according to pre-selected times and pre-selected amount of water per crop type.
- Software program connected to solar system and water pump to operate water well and apply irrigation. It works for irrigation control and monitoring, has a user-friendly interface, and is compatible with mobile devices such as smartphones or tablets.
- Handheld soil testers for soil testing. They are portable devices that analyse soil samples to provide information about nutrient levels, pH balance, and other soil properties. Small-scale farmers can use these testers to assess the soil fertility of their fields accurately. The results help them make informed decisions regarding fertiliser application, soil amendments, and crop selection.
- Develop software connected to sensors and cameras that can identify diseases and suggest pest control management. This can be done by photographing the plant's leaf and diagnosing the types of disease and possible treatments.
- Crop Sensors: Crop sensors are devices that measure and monitor plant characteristics such as leaf chlorophyll content, biomass, and canopy temperature. These sensors provide real-time data about crop health and growth, helping farmers optimise fertiliser application rates, irrigation schedules, and pest control interventions. By tailoring inputs based on specific crop needs, farmers can minimise resource wastage and improve yields.
- Mobile application for animal feed and vet services based on type of animal and age.
- Low-cost sensor-based devices for greenhouses that monitor temperature and humidity levels in storage facilities, providing real-time alerts to prevent spoilage and losses.
- Software or mobile app for recording and tracking farming activities across the production stage like planting schedules, pest and disease control and yield.
- Mobile apps that deliver localised weather forecasts, pest and disease alerts and instruction to control and management, enabling farmers to make informed decisions.
- Training app programs and digital resources that educate farmers about composting techniques, promoting the sustainable management of agricultural waste and soil fertility.

Harvesting and storage:

Recommended digital technologies:

- Sensor-based technologies or tools for assessing crop maturity and determining the optimal time for harvest
- Tools for milk testing in the farm gate for livestock owners and milk collectors, including examining the rate of water and fat.
- Temperature and humidity monitoring systems ensure proper storage conditions of harvested crops/collected milk/processed dairy products.
- Barcode systems to track and trace products, particularly for group farmers and associations, during storage and transportation.

Processing:

Recommended digital technologies:

- Automated storing and grading machines for efficient processing of harvested crops.
- Automated machines for milk testing in the dairy processing centres. The devices are able to provide data on water ratio, fat ratio and PH in the milk. The device is used in dairy processing centres.
- Installing honey testing labs in selected districts with a high number of beekeepers to categorise types of honey and identify adulterated honey
- Software or mobile app for managing processing operations, inventory and selling.

Marketing:

Recommended digital technologies:

- Software or mobile app for recording and tracking farming activities across the value chain from inputs to marketing, providing farmers information about the cost of input, inventory, sale and net profit.
- Online marketing platforms for direct farmer-to-consumer sales, enabling small and medium-scale farmers to reach a broader customer base
- Enhance digital payment for convenience transactions between farmers and consumers.

ANNEX

Note: the following are EXAMPLES of local companies that have the capacity to conduct/implement activities relevant to smart agriculture projects in Iraq

LIST OF SOME LOCAL COMPANIES WORKING ON DIGITAL TECHNOLOGIES RELEVANT TO AGRICULTURE DEVELOPMENT IN IRAQ

#	COMPANY		AREA OF WORKING	CONTACT INFORMATIO
1	Eco Consult	Erbil	Vertical agriculture and hydroponic Design and implement auto-control hydroponic project for vegetable growing.	Bardkhan M. Amin Baderkhan.amin@ecoconsult.jo +964 750 499 1111
2	GIS SAZY	Sulaimaniya	Remote sensing and drones Prepare geographical maps according to soil, land-scape cover and survey by using drones.	gissazy@gmail.com 00964 750 892 3735
3	Al-Hadbaa Company	Nineveh	Provide solar system equipment and instalation for water wells	Zaid Alhafedh zaid@alhadbaa.com 00964 770 303 2096
4	Qala Company	Erbil	Installing remote-control irrigation and solar system Design and implement remote control irrigations connected to solar systems	Dr. Younis Khalid info@qalaec.com +964 750 479 0685
5	Al Kurd	Erbil	Installing remote-control irrigation and solar system Design and implement remote control irrigations connected to solar systems	Dr. Younis Khalid info@qalaec.com +964 750 479 0685
6	Al bait al Iraqi	Baghdad	Producing Satellite images Producing satellite images and calculating yield before harvesting and categorise soil type	Muthanna Al Bayati info@bi4edm.com +964 770 444 0571
7	GIS Iraq Land	Thi Qar	Producing Satellite images Producing satellite images on interpreting information on soil type	00964 771 621 5289
8	Green Eastland	Erbil	Adopting technology in agriculture greenhouses in the level of multi-span greenhouses. They offer training in environmental control in greenhouses	https://www.greeneas-tlan.com/ 00974 750 451 4111
9	Agrimatco	Iraq	Adopting technology in agriculture greenhouses in the level of multipin greenhouses. The offer training in environmental control in greenhouses	00964 772 266 0989

#	COMPANY		AREA OF WORKING	CONTACT INFORMATION
10	Iraqi Spark	Baghdad	Offering services on digital marketing	https://www.linkedin.com/company/iraqispark/about/ 00964 750 038 9258
11	Xtra Iraq	Erbil	Creating various customised software small and medium business management	xtra.co.com 00964 750 100 3360 info@ xtra.co.com
12	Tarseem	Baghdad	Conduct survey for land using GIS and high digitalised tech	0773 060 2620 info@tarseem.com.iq tarseem.com
13	Bagdad Ag Development Co. LtD	Baghdad	Providing intelligent irrigation services, supply and management.	infor@ad.come.iq 00964 770 873 3103
14	Ibyte.dev	Erbil	Providing IT tools such as software and mobile apps, and solution for various businesses	https://www.linkedin.com/company/ibytedev/about/ 00964750 414 1973
15	Kurdsoft	Erbil	Providing IT solution for various businesses and designing online platforms	info@blackace.tech 00964 750 555 1 999
16	Black Ace	Erbil	Provide software development and design services, including web development and mobile app development	info@lucid-source.com 00964 (0) 750 275 7000
17	Zaidoon Solutions	Baghdad	Providing solutions is a digital marketing agency that specialises in helping SMBs	zaidoon.jm@gmail.com
18	Megawolf	Baghdad	Providing digital network solutions	info@megawolf.network 00974 770 911 0213
19	Digic	Erbil	Providing digital marketing agency that offers a range of services to businesses, including mobile development apps and database and software development	info@digic-services.co 00964-751 404 8464 00964 751 404 5424

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