E

联合国粮食及农业组织 | Food and Agriculture Organization of the United Nations | Organisation des Nations Unies pour l'alimentation et l'agriculture | Продовольственная и сельскохозяйственная организация Объединенных Наций | Organización de las Naciones Unidas para la Alimentación y la Agricultura | منظمة الأغذية والزراعة للأمم المتحدة

FAO REGIONAL CONFERENCE FOR THE NEAR EAST

Thirty-fifth Session

Muscat, Sultanate of Oman, 2-4 March 2020

Digital Innovation for promoting Agriculture 4.0 in the Near East and North Africa

Executive Summary

The Near East and North Africa (NENA) region faces a series of challenges related to food security and nutrition, and the degradation of the already scarce natural resources. Conflicts, migration, and climate change exacerbate these challenges. Current trends are clearly unsustainable and if not adequately addressed, will lead to aggravation of the above problems and hinder the achievement of the Sustainable Development Goals (SDGs). To address the challenges of agri-food systems and rural transformation, new development approaches are needed, that combine innovative policies, technologies and organizational processes and practices, and use of digital and other types of innovation for the improvement of agriculture and food systems, into Agriculture 4.0 (the Fourth Agricultural Revolution). Developing, adopting and scaling up of digital innovation technologies requires that the stakeholders and decision-makers develop a better understanding of impact pathways, risks and benefits of technologies, as well as new partnership and business models involving the public and private sectors, civil society and farmer organizations.

Suggested actions by the Regional Conference

Members are invited to:

- recognize the importance of harnessing the potential of digital innovation for promoting Agriculture 4.0, youth employment and accelerating rural transformation in the region;
- enable the emergence and integration of digital, social and policy innovation based on modern science and technology, strong rural organizations, and agroecological innovation that together promote sustainable intensification and boost the productivity and resilience of smallholder farmers;

- provide a policy framework to tap into private sector investment and innovations in digital agriculture in order to extend the benefits of digital technologies to small-scale family farmers. This framework should include awareness and demonstration of digital technologies that are presently little known in rural areas, regulatory measures with a special focus on data governance and an incentive framework to accelerate agriculture digitalization and to facilitate market access;
- increase investment in research and development (R&D) to develop digital solutions that meet the demands of all actors of the agri-food system and develop a regulatory environment that promotes the application of digital technologies and limits the associated risks;
- consider cohesive actions by FAO to support Members in establishing and implementing digital agriculture strategies for the respective countries in the region;
- continuously support and facilitate discussion on the adoption and use of Information and Communication Technologies (ICTs) and share knowledge on innovation and technology, skills and capacity in the region through the FAO e-Agriculture Community of Practice (CoP), within the overarching scope of FAO's Hand-in-Hand initiative;
- acknowledge the results from the Global Forum for Food and Agriculture (GFFA) 2019 Final Communiqué, achieved by FAO and the other International Organizations including the developed concept note for the establishment of an International Platform for Digital Food and Agriculture, and support FAO's efforts to establish this platform as an inclusive and transparent forum to discuss best practices related to the application of digital technologies and a coordination mechanism that promotes interaction among countries and other stakeholders in the region; and
- support development of a regional Digital Agriculture and Innovation Hub, as an ecosystem incubator for digital, social and policy innovation and experimentation in the NENA region, to strengthen skill development, youth and women engagement, increase digital literacy and support training on digital skills for smallholder farmers and other actors in the agri-food system.

Queries on the content of this document may be addressed to:

RNE NERC Secretariat

FAO-RNE-NERC@fao.org

I. Introduction

1. This paper presents a synthetic overview of the digital transformation potential in the agri-food sector in the Near East and North Africa (NENA) region. It looks at public and private initiatives using digital technologies for agriculture and highlights opportunities on how agri-food system actors could mainstream these technologies. The paper is based on a synthesis of seven background papers[1] prepared for the International Forum on Innovation in Agri-Food Systems to achieve the SDGs. All papers have been prepared through a combination of desk review, consultation with actors involved in digital food and agriculture as well as experts from the private and public sectors in the region.

2. The green revolution of the 1960s-70s, gave a much-needed push towards ensuring global food security, although smallholder agriculture in the NENA region did not really benefit from this progress. During this period, the introduction of new high-yielding varieties of seeds, use of chemical fertilizers and agro-chemicals and controlled water supply, resulted in increased crop yields around the world. Post the success of the green revolution, the advent of genetic modification further pushed the ability to increase food production. As population growth, climate change and shrinking natural resources define the problems of the future, there is a need for another revolution with a paradigm shift towards sustainability. Digital food and agriculture provides the most scope for that much-needed disruption.

3. Digital agriculture is the result of the Fourth Industrial Revolution (Industry 4.0). Industry 4.0 refers to an emerging trend towards automation, using information technology to connect the stakeholders and exploiting data for business value. The technologies contributing to this revolution include cyber-physical systems, Internet of Things (IoT), cloud computing, big data analytics, artificial intelligence and machine learning (AI/ML) and mobile applications.

4. It is important to note that digital agriculture (Agriculture 4.0) is not just about improving the practice of farming. It refers to changing how the entire agri-food system value chain works, from sourcing the necessary inputs for farming to crop production to the distribution, processing and retailing of the harvest to optimizing end-consumer experience.

II. Trends and challenges of smallholder agriculture in the NENA region

5. The World Development Indicators recently summarized the major trends, threats and opportunities of agri-food systems.[2] [3] In the NENA region, demographic issues are the key drivers of these trends, putting pressure on natural resources and driving urbanization, rural poverty, unemployment and precarious employment, as well as increasing the rural-urban income gap, leading to distress migration. A number of countries in the region, including Algeria, Egypt, Jordan, Libya, Oman and Saudi Arabia, stand to gain from a demographic dividend, whereby the share of the working-age population is larger than that of the non-working-age population. With nearly half of the region's population under the age of 24, the potential for economic growth and social change, particularly in rural areas, is unprecedented. Yet this potential can only be realized if the necessary policies are in place to ensure rural transformation, youth inclusion and creation of decent work opportunities in the rural areas.

6. Small-scale family farming is still the backbone of rural communities in the NENA region, producing more than 80 percent of agricultural production on 75 to 85 percent of the agricultural landholdings. Yet, in most countries, national priorities do not reflect their important role and their

[1] List of background papers : **i)** How digital technologies are changing agriculture in the Maghreb Region (FAO, 2020); **ii)** Revitalization of the Agri-Food Sector in Mashreq: Focus on Iraq, Jordan, and Lebanon (AUB, World Bank, FAO, ESCWA, CMI, 2020); **iii)** Agricultural Challenges in the GCC Countries and the Potential of Digital Transformation and Protected Agriculture (FAO, 2020); **iv)** Agriculture and Food Systems Innovations: The Case of the Near East and North Africa (NENA) Region (GKI, FAO, 2020); **v)** Digital Innovation for Promoting Decent Rural Employment in Agriculture for Youth and Women in the NENA region (FAO, 2020); **vi)** Technology and digital Innovation to improve Plant Health (FAO, 2020); **vii)** Social innovations and trends in the Near East and North Africa. Examples and opportunities for action (FAO, 2020); **viii)** IFAD Background paper on Digital Extension for NENA Region (IFAD, 2020).

[2] Serraj and Pingali, eds. 2019. Agriculture & Food Systems to 2050: Global Trends, Challenges and Opportunities. Singapore. World Scientific. Accessed Jan. 2020. https://www.worldscientific.com/doi/pdf/10.1142/11212

[3] FAO, 2017. The future of food and agriculture; http://www.fao.org/3/a-i6583e.pdf

potential contribution to the countries' social and economic development. Rural areas have inadequate infrastructure and poor services compared to urban areas, and the majority of the poor live in rural areas.

7. Land and water scarcity is exacerbating agricultural challenges under ongoing climate change across the NENA region. Climate change is already a serious constraint and is expected to worsen the challenges of water scarcity and sustainability of agriculture and the environment. There will be significant reductions in precipitation in many areas as well as increased uncertainty about the timing and frequency of rainfall events. The temperature in the region, already rising, is expected to continue to increase until the end of the century. Agriculture will experience higher temperatures during the growing season and more frequent and intense heat waves affecting one-third of the land area.

8. The region's vulnerability to climate change is essentially due to its geographical location that makes it prone to water scarcity, declining agricultural production, land degradation and desertification, flooding and rising sea levels. For the region, adaptation to climate change will be essential for any programme or policy on sustainable development. Implementation of climate adaptation and mitigation programmes will require a major transformation of the food, agriculture and energy sectors but also through economy-wide actions based on strategies and sectoral action plans designed, amongst others, for the following areas of intervention: agriculture, water, waste, forests, energy, industry and housing. Addressing the multiple challenges of climate change and water scarcity effects on smallholder agriculture requires comprehensive innovation policy frameworks to drive collective farmer action, which will enable farmers to access market opportunities and achieve scale while preserving natural resources.

9. Capacity development and access to agriculture knowledge constitutes a major limitation of smallholder agriculture. Traditional extension services offered by government agencies are often poorly funded and administered, leaving small-scale farmers to rely on other forms of technical advice, or none at all. In general, extension staff are insufficient; in several countries a majority of extension workers lack the adequate knowledge and capacity to deal with the complexity of current and emerging agri-food systems. Access to the right knowledge at the right time through the right means will make a positive impact on the livelihoods of smallholder farmers. Taking into consideration the regional challenges in agriculture extension and the opportunity of improving connectivity, and reach of digital technologies, the digitalization of agricultural extension to support the dwindling agriculture extension workers seems to be the way forward. The digitalization of agricultural extension knowledge would be the first step to setting this transformation in pace.

10. Access to finance and markets is a sine qua non requirement for agriculture and rural development in the region. Smallholder farmers do not easily access basic requirements such as finance to ensure access to inputs, transport and storage facilities, as well as to small machinery. Access to microloans and the right knowledge can benefit the smallholders and significantly improve their livelihoods. The proportion of total credit provided to agriculture has recently decreased in North Africa; which has generated some level of untapped demand for agriculture credit in the region, as informal credit could not fully make up the reduction of the formal one. A number of causes have been mentioned for this reduction, including: (i) the perception that agriculture is risky and the lack of risk mitigation mechanisms; (ii) lack of capacity of small producers to provide the required loan collateral; (iii) weak capacity of agriculture cooperatives to play a role in awarding loans and collecting repayments; (iv) lower chances of accessing informal credit from input providers, agribusinesses, and other buyers; (v) legislative framework that is not encouraging the emergence of a microfinance sub-sector; and (vi) lack of a strategy on how to serve the financial needs of smallholder farmers.

III. Status of digital agriculture in the NENA region

11. Different technologies offer varying value propositions and impacts within the agri-food system value chain. For the sake of clarity, one could group these technologies into the following: social networking-based digital solutions and mobile applications; remote sensing-driven solutions; big data, cloud, analytics and crop modelling; artificial intelligence (AI) applications; internet of things (IoT) and

digitally connected farming; robotics, drones and intelligent automation; and distributed ledger technologies such as blockchain[4].

12. The region is heterogeneous in terms of innovation capacity and infrastructure. For instance, the ranking of NENA countries in the Global Innovation Index[5] varies widely between 36th (the United Arab Emirates) and 129th (Yemen) amongst 130 countries in the 2019 ranking (Figure 1). In general, the Gulf Cooperation Council (GCC) countries have better rankings, followed by North Africa and the Mashreq regions.

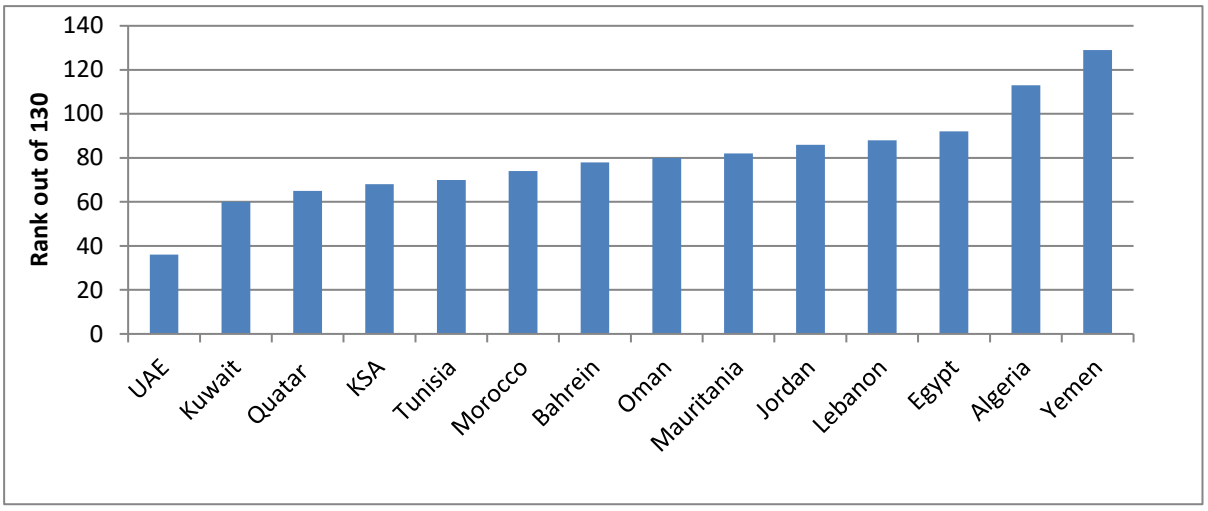

Figure 1: NENA Rankings in the Global Innovation Index, 2019

Source: WIPO. 2019. Global Innovation Index: Creating Healthy Lives — The Future of Medical Innovation. Geneva.

13. Promotion of promising technologies and innovations is crucial to avoid reinventing the wheel. The International Forum on Innovation in Agri-Food Systems to achieve the SDGs that was supposed to be held in Riyadh, Saudi Arabia, from 15 to 17 March 2020 but postponed due to COVID-19, aims to serve as a staging point to address issues that require solutions and to explore available opportunities based on innovation in agriculture and food systems. The event is designed as an interactive forum that brings together stakeholders from all sectors to share their expertise on innovation for sustainable agri-food systems and deepen their understanding of its importance and of the importance of promoting agricultural innovation. The new dates of the Forum will be set once international travel bans are lifted in light of the COVID-19 crisis.

14. The Selected Innovation Success Stories in the NENA region to be showcased in the Forum include 13 cases from 10 countries across the region. A summary table of the success stories is included in Annex 1.

15. While internet penetration is increasing worldwide, the digital gender divide is also growing fast in developing countries. Figure 2 depicts the internet penetration rate for men and women in 2019 according to the International Telecommunication Union (ITU). This will have a huge implication for developing and sustaining digital services for agriculture as the role of women in agriculture is well

[4] The relevance and importance of these technologies to different segments of the agriculture value chain is reviewed in the background papers of the International Forum on Innovation in Agri-Food Systems to achieve the SDGs.

[5]. Every year, the Global Innovation Index (GII) ranks the innovation performance of nearly 130 economies around the world. The Innovation Input Sub-Index is comprised of five input pillars that capture elements of the national economy that enable innovative activities: (1) Institutions; (2) Human capital and research; (3) Infrastructure; (4) Market sophistication; and (5) Business sophistication. The Innovation Output Sub-Index provides information about outputs that are the results of innovative activities within the economy.

documented. In the Arab states, 91 percent of the population is covered by a 3G or higher network nevertheless, coverage does not ensure equal access to information and services for women.

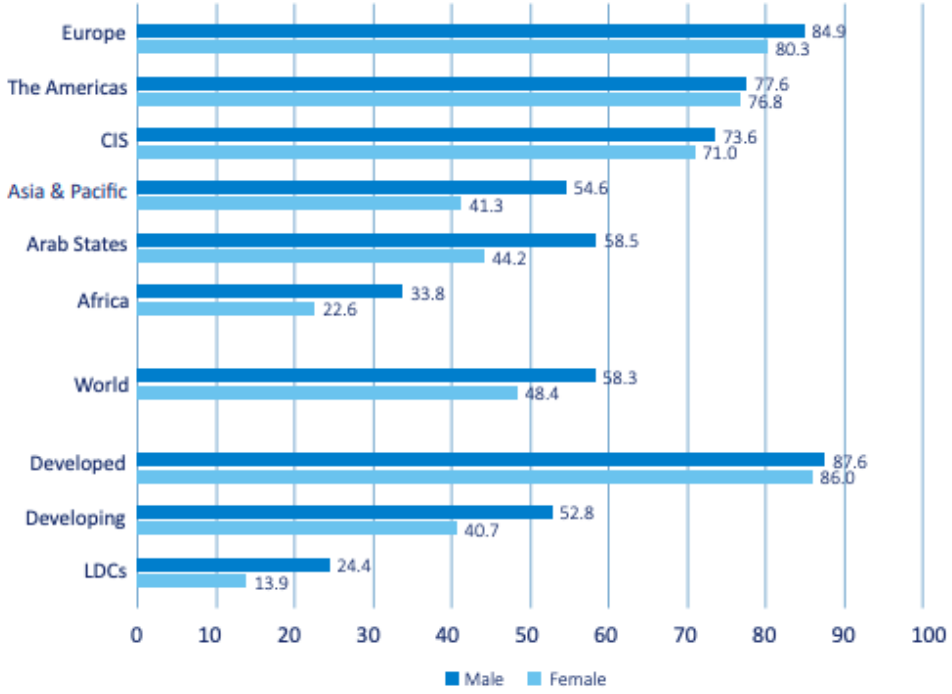

Figure 2: Internet penetration rate for men and women, 2019

Source: ITU. 2019. Facts and Figures. Geneva.

a) Status of digital agriculture in North Africa

16. The following sections give specific examples of innovative digital agriculture initiatives in North African countries, namely Egypt, Morocco and Tunisia.

Precision agriculture

17. In **Egypt,** initiatives of precision agriculture are present in the irrigation, livestock and fishery sectors. These come from both private sector (mostly start-up companies) and public interventions. Tomatiki is a start-up that is promoting a smart irrigation solution. Solarise developed a smart aeroponics system to be deployed in local farms, using IoT technology, embedded controllers and sensors to control the Aeroponic system. The system aims at enhancing and maintaining the farm by monitoring the plants growth and needs and taking the suitable necessary actions and adjustments automatically. Similarly, AbuErdan ensures chicken value chain management using IoT, artificial intelligence, cloud and blockchain. This start-up's services include a full traceability system; measuring and predicting performance for hatchery, breeder and adult chicken stages; and slaughterhouse management. In the fishery sector, an Egyptian start-up called Innovation produces large-scale automated fish feeders.

18. In **Morocco**, the branches of Microsoft and CISCO provide platforms and cloud services for start-ups to develop digital products including for precision agriculture. Among existing start-ups, AGROAM is providing an integrated system including (i) data collection through an IoT network including weather station, sensors and water treatment mini-plant; (ii) cloud-based data processing; and (iii) an application for farm management (accessible through smartphone, web and industrial enterprise resource planning or ERP).

19. Although still in the initial stage in **Tunisia,** precision agriculture technology has been promoted and used by a small number of start-ups such as Ifarming, Seabex, Ezzayra and MooMe. It also includes a drone-based initiative managed by the *Société Nationale de Protection des Végétaux* (SONAPROV). I-FARMING, a start-up created in 2015 and that in 2019 took part in an accelerator programme in France, known as Station F, is presently in discussions to receive international venture capital.

Agriculture extension and knowledge dissemination

20. FAO is conducting a pilot initiative in **Egypt**, for deploying an agriculture mobile application under the "Inclusive rural information and communication services for agricultural innovation and resilient family farming in the NENA region" initiative. Currently, Egyptian rural advisory and extension services lack both effectiveness and outreach due to the insufficient number and capacity of extension agents. In addition, although women are heavily engaged in farming operations, they are less likely to access these services. Hence digital technologies such as mobile-based advisories can be extremely beneficial in these situations.

21. In **Morocco**, the main provider of agricultural extension services through mobile phone is AGRIDATA. This firm is developing new digital products, trying to adapt to the needs of small producers and represents a resource actor in digital agriculture in Morocco. FERTIMAP is a joint initiative by the Ministry of Agriculture, Fisheries, Rural Development, Water and Forests and the Group Office *Chérifien des Phosphates* (OCP) aiming at providing (i) knowledge related to soil fertility; and (ii) ad hoc cost-effective fertilizing recommendations based on soil fertility map and soil sampling. The initiative runs on a geographic information systems (GIS) platform accessible online. In the future, it could be made available through a smartphone application.

22. Plantix is a mobile-based crop advisory services. Implemented by the *Deutsche Gesellschaft für Internationale Zusammenarbeit* (GIZ) in **Tunisia**, this mobile app can diagnose plant diseases, pests and nutrient deficiencies affecting crops. This initiative was set up through a public-private partnership between GIZ and two start-ups (Progressive Environmental and Agricultural Technologies or PEAT from Germany and Royal Green Technologies or RGT from Tunisia). PlantMed, a network of young male and female plant doctors, has recently been established (with strong participation of women plant doctors in the steering committee) including the creation of an exchange forum in Arabic with over 8 000 downloads.

Financial services

23. E-Finance is the most prominent public sector initiative using digital solutions for economic development in **Egypt.** This publicly-owned company was founded in 2005 as the first fin-tech company in Egypt to build and operate and manage the government financial payment hub, Payment & Collection, and to automate all government accounting units under a unified platform known as Treasury Single Accounts (TSA). In the agriculture sector, E-Finance established AgriMisr, an online platform connecting farmers, banks and agro-input dealers for delivering subsidized inputs to farmers. E-Finance and the Agriculture Bank of Egypt have collaborated to establish a farmer digital smart card that will store information including farmer's name, identification number and agricultural land holdings. This card is used for (i) distribution of subsidized agricultural inputs; and (ii) gathering data on land holdings and types of cultivated crops, which will help agricultural planning and investment design.

24. **Morocco** has a leading financial sector in the African continent. Seventy-five percent of the population holds a bank account (although in some rural areas, this rate is only 20 percent). The *Crédit Agricole du Maroc* (CAM) has been working on a digital agenda since 2011. It has produced a smartphone application allowing clients to carry out online bank operations such as checking bank account, money transfer and payments. It has also established the "*relais digitaux*" in remote rural areas to deliver financial services as well as advisory services on savings, health and life insurance using a screen visual connection between the financial advisor and the client. CAM is presently the most dynamic financial institution in Morocco and is showing a strong interest in digital solutions including

an interoperable e-payment system; and the use of big data for crop loan associated with weather index-based insurance schemes.

25. Digital financial services for the agriculture sector are limited in **Tunisia**. However, one important initiative implemented by Enda/Tamweel is providing loans on a digital platform and intends to fund precision agriculture and livestock. There are presently no digital technologies being used for improving credit profiling and de-risking agriculture lending in Tunisia.

Market access

26. In **Egypt**, Freshsource is a start-up that has established an e-commerce business-to-business (B2B) platform linking farmers to vendors in Cairo for fresh horticulture produces (see success stories summary table). Freshfarm is another ag-tech start-up that works as an intermediary between farmers and urban consumers, aiming at incentivizing consumers towards buying straight from the farm thus contributing to both higher income for farmers and more reasonable prices for consumers. It will also help combat low quality food through guidance and education to farmers. Verumcode is promoting the use of blockchain and Quick Response (QR) codes to fight counterfeit products. VerumCode has developed an algorithm that creates unique codes to help identify fraudulent products. The start-up is promoting this concept for food traceability and safety. The service can be used for better linking producers and consumers as well as real-time reporting, tracking the product and its delivery and forecasting time needed.

27. E-commerce of agricultural products is nearly non-existent but has some potential to grow in **Morocco.** Actors present in the e-commerce sector and willing to expand in e-agriculture include Jumia and Hmizate.

28. In **Tunisia,** Herundo provides e-commerce services to the National Olive Oil Exporter Association. It will establish a dedicated business-to-consumer (B2C) platform for expansion in the markets of Canada, China, the European Union and the Russian Federation. According to their market analysis, the price of Tunisian olive oil on e-marketplace could reach EUR 20-40 per litre in European Union countries and EUR 18-38 per litre in Russia. According to Herundo, the main benefits of a dedicated e-marketplace include reduced intermediation cost, economies of scale, branding and increased customer number and margins.

b) Status of digital agriculture in the Mashreq Region

29. Digital transformation of the agriculture sector in the three focus countries – Iraq, Jordan, and Lebanon – has the potential to increase agricultural productivity and sustainability, as well as to improve environmental outcomes including mitigation of and adaptation to climate change. A selection of applications as they are in practice today are highlighted in the following sections, extracted from the 2020 background paper "Revitalization of the Agri-Food Sector in Mashreq: Focus on Iraq, Jordan, and Lebanon" developed by American University in Beirut (AUB), the World Bank, FAO, United Nations Economic and Social Commission for Western Asia (ESCWA) and Center for Mediterranean Integration (CMI).

Precision Agriculture

30. In **Iraq**, there is evidence of the adoption of precision agriculture, though the concurrent application of digital technologies is unclear. Examples of applied techniques include digital applications to support the adoption of zero tillage and conservation cropping systems in the drylands of northern Iraq, and sub-surface drip irrigation for vegetable crops. Field inspection of the production of seeds for strategic crops has included the application of digital technologies, through the issuance of electronic certificates. The use of digital images or drones in Iraq's agriculture sector is restricted due to security concerns and the current regulatory environment which requires legal permissions to use drones.

31. Digital technologies are already present in **Jordan's** agriculture sector, particularly in the export value chains. Remote sensing technologies are used to estimate evapotranspiration for the purposes of monitoring agricultural water use. The largest uptake of digital technologies in Jordan's agriculture sector is the application of irrigation-related technologies by large, export-oriented farms. The specific technologies, including sensors and pumps, are typically imported from outside of the country. The focus on irrigation is reasonable, given the scarcity of water and the relatively high cost of water. Digital technologies play a part in the many initiatives to develop soilless agriculture being led by Jordan's Ministry of Agriculture. Electronic components have been designed to control irrigation, fertilization, temperature, and humidity. Such projects are being implemented at various locations across the country.

32. In **Lebanon**, precision agriculture technologies are currently in use by a very small share of Lebanese farmers, which either operate at large scale or produce high value products that justify the cost of a large investment and subsequent operational costs. The wine industry is among the most promising sub-sector for sales of precision agriculture equipment, for use in vineyard production. This may be due to the sub-sector's higher profits and export orientation. Vineyards and wineries are actively using digitally-enhanced precision agriculture including drone-and sensor-based IoT technologies to assess growing conditions and vine performance. For example, wineries are using drone technology to relay high-definition imagery for the monitoring of water stress and wood diseases. Large-scale potato producers oriented to food processing and export have also invested in advanced precision agriculture technology. Several private sector vendors are currently offering digitally-enhanced precision agriculture technologies to the market in Lebanon.

Agriculture Extension and Knowledge Dissemination

33. **Iraq**'s Directorate of Agricultural Extension and Training has implemented a project using mobile applications to communicate with farmers. Fifteen extension centres across the country provide information to farmers related to the main farming activities within that governorate. The application provides information regarding recommended dates for different agricultural practices, the use of herbicides and insecticides, and other techniques to improve productivity. Application information can also support farmers to anticipate and respond to pest attacks, crop failures, and climatic changes through timely weather-based agro-advisory messages. Price information is also provided to farmers to reduce market distortions and help them to plan production processes. Iraq's Directorate of Veterinary Services is implementing a separate project to develop a geospatial surveillance and monitoring system.

34. In **Jordan**, digital platforms for knowledge dissemination could usefully target animal diseases and pest control, which remains a problematic issue for producers of fresh fruits and vegetables. Currently, the private sector dominates the provision of information on pest control and advocates spraying as a preferred control method. Farmers have insufficient information on the safe handling and application of pesticides, and tend to over-apply as a result. Moving forward, information could be shared with farmers to track where pests are found, particularly on an early warning basis, and to inform them of optimal techniques for their handling and treatment. Improvements in pest control, if matched with traceability and auditing, could also improve food safety and consumer confidence.

35. **Lebanon**'s National Center for Remote Sensing runs several ICT activities that generate publicly-accessible data that may be relevant to the agricultural sector, though the extent to which the information is used by agriculture stakeholders is unknown. **Lebanese** farmers have only recently begun to adopt digital technologies to access weather forecasts and inform their production plans such as planting, pest treatments, and fertilization. Since 2017, the Lebanese Agriculture Research Institute has disseminated Arabic-language weather information and alerts via its website, an SMS broadcast system, and a smart phone application to reach farmers. Elsewhere, the AgVisor digital application that was launched in 2019 by the Chamber of Commerce for Industry and Agriculture in Zahle includes notifications for farmers on interventions to combat crop pests and diseases.

Financial Services and Risk Management

36. A minority of Iraqis aged 15 or older and living in rural areas made use of digital technologies related to financial services or digital payments as of 2017, indicating that there is significant room for growth in this area. Financial services for Iraqi farmers could potentially build on an existing system of digitally-based cash distribution that was established for the distribution of social assistance, salaries and pensions.

37. In **Jordan**, farmers may access credit through multiple sources including commercial banks and input suppliers. The private sector – including agricultural input suppliers and wholesalers – also provide loans to farmers on the basis of deferred sales methods, which can translate into high interest rates. Several digital payment mechanisms are currently in place and widely used in Jordan, though they are not restricted to actors or applications in the agriculture sector. Making Cents International and BanQu have formed a partnership using blockchain technology to deliver digital economic identities to refugees, migrants, and undocumented and remote populations as a means of delivering social, financial, and health services.

38. **Lebanon** generally lags in the digital provision of financial services, despite the large size and relative sophistication of the financial sector. Nevertheless, a small but rising share of rural Lebanese aged 15 or older were making use of digital technologies related to financial services or digital payments, which could serve as a basis to extend credit and insurance services to Lebanese farmers. Like Jordan, Making Cents International and BanQu have expanded to Lebanon the use of blockchain technology to deliver digital economic identities to marginalized groups to facilitate delivery of social services.

Market Access

39. In **Jordan,** several web-based applications have been introduced to support marketing by producers by sharing information on fresh fruits and vegetable prices, and these have proven very popular. The Wholesale and Vegetable Market of the Greater Amman Municipality maintains a website that displays the quantities of local and imported fruits and vegetables and the prices traded in the market (highest, lowest and majority). The Jordanian Exporters and Producers Association for Vegetables and Fruits also operates a website containing price data including the local prices in the country of origin and market prices in the countries importing fruits and vegetables; as well as detailed information and standards required by exporters.

40. The AgVisor digital application was launched in **Lebanon** in 2019 with the aim of allowing farmers to compare prices across different crops and markets. The platform also offers a directory of actors in agriculture value chains. AgVisor faces challenges particularly related to the collection and updating of its data and to its long-term financial sustainability. Moreover, while it appears that AgVisor has been successful in disseminating price information so far, evidence is not yet available to determine whether farmers can effectively use that information to obtain higher market prices.

c) Status of digital agriculture in the GCC region

41. Agriculture extension service is the common theme among the few digital agriculture solutions that are currently available in the GCC region. Most of these apps are developed by public-agencies. For example, the Ministry of Environment, Water and Agriculture in Saudi Arabia has a simple mobile or web application that enables advisories and requests for approval and transactions. Although this application is not in itself an innovation in the sector it paves the way for change. Similarly, the Ministry of Agriculture and Fisheries in Oman has an app that serves the same needs for Omani farmers. The Government of the State of Qatar provides web-based solutions for certification of health of veterinary animals, inspection of agricultural products and other farmer-government transactions.

42. Oman Agriculture is an example of an agricultural extension application developed by a private company. This provides static information to Omani farmers about farming requirements such as irrigation, seed details, pesticides, fertilization needs and harvesting protocols for five major crops –

tomato, banana, watermelon, sweet melon and wheat. However, to date, usage of the application has been limited.

43. Date palm is one of the oldest fruit trees in the GCC countries and has played a key role in the lives of the region's people. The date fruit is marketed all over the world as a high-value product, and it remains an important subsistence crop in most of the desert areas in the GCC region. Management of plantation crops through satellite imagery and crop modelling is an important aspect for the future of the date palm industry in the GCC region. With climate change becoming a key issue, date palm plantations face an uncertain future. The problems in date palm cultivation experienced in the GCC countries are non-optimal farm management, pest and disease prevention and irrigation management. Digital solutions can thus play an important role. The International Center for Agricultural Research in the Dry Areas (ICARDA) has developed digital technologies to assist the farmers in precision management of date palm. GeoAgro is a good example of the potential of satellite imagery application. While the solution is effective from the standpoint of scientific capability, the probability of acceptance by farmers is still relatively low because it is not optimized for user experience.

44. Currently, solutions developed in the GCC countries for farmers seem to suggest the following: (i) insufficient awareness of the potential of digital solutions among the farmers; (ii) inefficient and inflexible design of digital solutions that does not connect with the farmer; (iii) absence of professional and financial motivation for private players to be involved; and (iv) a lack of enthusiasm among farmers to embrace a digital future, possibly because of various economic, gender and societal pressures.

Protected Agriculture

45. In **Bahrain**, protected agriculture was introduced at the Ministry of Commerce and Agriculture Research Station in *Budiya* in the late 1970s, with about 60 hectares of farmland. The Arabian Peninsula Regional Program (APRP), launched by ICARDA, incorporated protected agriculture into its mandate. This expansion has improved the assimilation of protected agriculture into mainstream practice, but also helped in research, development and validation of improvements such as Integrated Production and Protection Management (IPPM), soilless culture, improved greenhouse designs, higher-efficiency cooling systems and reduction of pesticide and fertilizer usage. Greenhouse production is tailor-made for Bahrain. Farmers are benefiting with higher yields. By producing in greenhouses, farmers have been able to save at least 50 percent of irrigation water compared to open-field production. Almost half of Bahrain's farmers produce in more than 4 000 greenhouses, with a total area of 85 hectares. The commercial viability of protected agriculture has resulted in commercial greenhouse growers establishing their farms in the country.

46. In **Kuwait**, protected agriculture is adopted rapidly and greenhouse production has been accepted as the way forward by the Government and farmers. The Public Authority of Agriculture Affairs and Fish Resources (PAAFR) has targeted to bring at least 20 percent of the total area under cultivation under greenhouse management. The steps taken by the Government include push actions such as subsidies and pull actions such as farmer training, seminars and other educational activities. Farmers in Kuwait are currently using greenhouses predominantly to produce fruits, leafy vegetables, tubers and pulse.

47. In **Oman**, protected agriculture was introduced in the 1980s by the private sector to fill the gap in vegetable production. Since then, greenhouse production has been accepted as an effective method to grow high-value crops, such as cucumbers, capsicums and tomatoes. The wide acceptance is shown by the fact that less than half of all greenhouses in Oman are unsubsidized. Another interesting aspect of protected cultivation in Oman is the growth of soilless technologies such as hydroponics. The Ministry of Agriculture and Fisheries introduced and evaluated the performance of soilless production, in collaboration with ICARDA. After a successful pilot and the adaptation of the technology to local requirements, more than 200 soilless-growing greenhouses have been introduced into the country. Commercial soilless production was started in the year 2014 for the production of tomatoes and capsicum. The facility is built over 13 000 hectares and uses state-of-the-art high-technology greenhouses.

48. **Qatar**'s Vision 2030 showcases a great interest in the agriculture sector and envisions to achieve a high degree of self-sufficiency in food. In light of this goal, the Ministry of Municipality and Environment has listed the production of vegetable crops using protected agriculture as one of its goals. Currently, the area under protected agriculture does not exceed 2.25 percent of the total cultivated area in the country. Among this, cucumbers occupy close to half of the area followed by tomatoes. The blockade of 2017 had a positive effect on the greenhouses in Qatar. The number of greenhouses increased by more than 20 percent during the following season.

49. **Saudi Arabia** leads the GCC countries with an output of more than 70 percent of the total GCC food production. In the past decade, domestic crop production in Saudi Arabia has been replaced with imports. Large-scale production of crops has been limited to cereals, vegetables, potatoes and dates. This is largely due to the Government's sensitivity to the lack of water sources and fertile soils in the country. Protected agriculture has been positioned to support the growing of high-value crops because of their ability to provide high yields with much less water usage. Since 1960s, many greenhouse projects have been set up around the country. It was estimated that greenhouses occupied as much as 8 000 hectares producing around 670 000 tonnes of food. Saudi Arabia has also been active in R&D activities of protected agriculture. The Government established the Sustainable Agriculture Research Centre. The purpose of the centre is to conduct applied research on innovative techniques for greenhouse design, suitable to the local conditions (including water use efficiency) and on the application of integrated pest management (IPM) for food quality and safety in protected cultivation.

50. The **United Arab Emirates** relies on protected agriculture to assist in meeting the demands of food as well as present the country as a progressive, forward-looking nation. In the United Arab Emirates, protected agriculture offers an opportunity for vertical farming, generating high yields with impressive water use efficiencies. Vertical farming has become popular in the United Arab Emirates with commercial ventures being established in the country to grow leafy vegetables, cucumbers, and tomatoes among other produce. Vertical farming has proven to be highly productive; an example is the vertical hydroponic farms of tomato which save 120 cubic metres of water for every tonne of tomatoes harvested compared to conventional soil systems. The interest shown in protected agriculture by the United Arab Emirates has attracted investments from around the world as well as proposals for exploring bilateral collaborations with countries such as the Netherlands – evidence of the potency of protected agriculture for future growth.

IV. Digital solutions for Agriculture 4.0 in the NENA region

51. Digital technologies are penetrating the agriculture sector of the NENA region at an increasing pace. The momentum of this development is linked to the private sector dynamism associated with a strong demand pull from all strata of urban and rural societies and a pervasive push from technological advancement. Increased adoption and scaling-up of digital agriculture technologies in the region will undoubtedly be driven by private investments on a commercial basis but will also require public interventions in terms of adequate policies and regulatory framework as well as provision of public and semi-public goods.

52. The main digital solutions that are likely to be relevant in the agriculture in the region in the short-medium term relate to the challenges described in the first section which include climate change adaptation and water management, as well as access to agriculture knowledge, finance and market. These solutions are presented in Figure 3 below and described in the section below for the whole region.

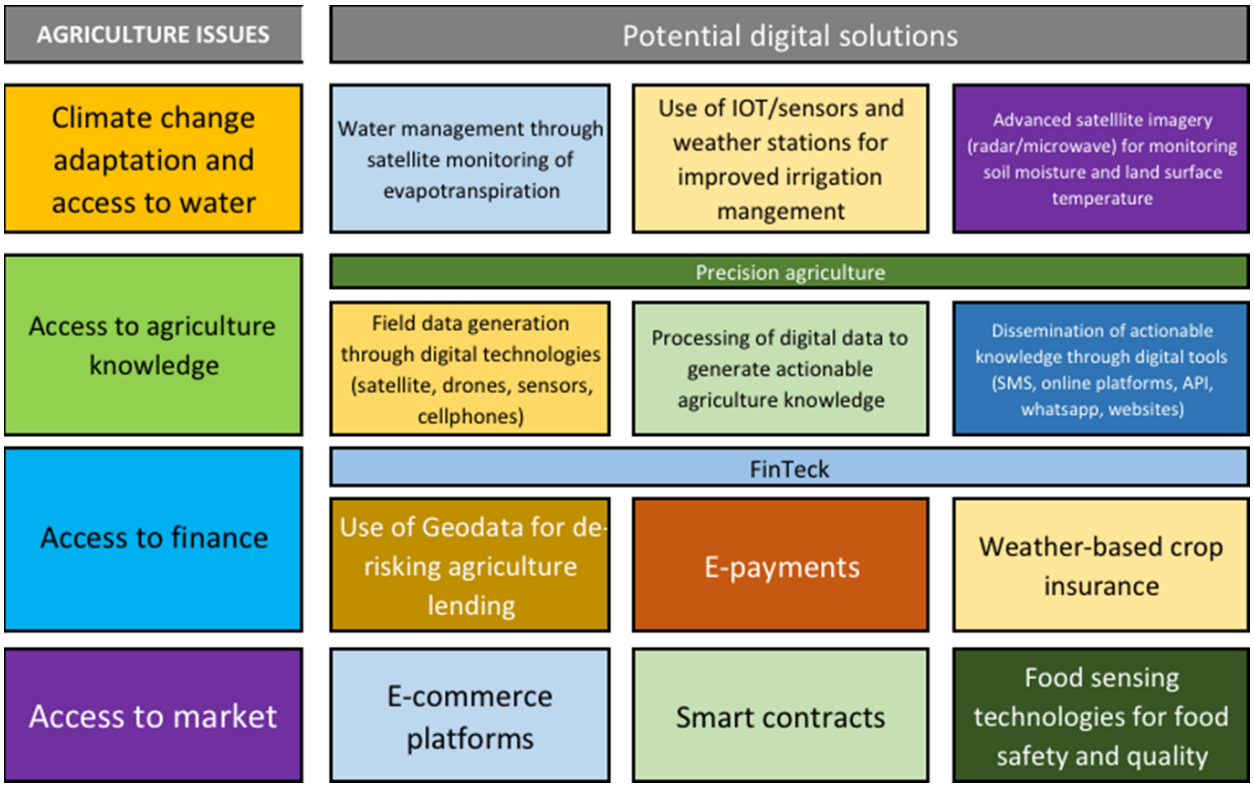

Figure 3: Relevant Digital Solutions in the NENA Region

Implementation challenges

53. ***Demand side obstacles.*** On the demand side, the usual causes of limited new technology adoption apply to digital solutions. These include (i) lack of awareness and familiarity with digital technology among aging small-scale farmers; (ii) lack of demonstrated financial viability; (iii) high initial cost of the technology; (iv) lack of access to suited financial products; and (v) lack of incentive framework for rural users.

54. ***Sound data analysis.*** Data must be actionable to create impact. The hard data collected from sensors is important, but for this data to create a positive impact for the smallholder farm sector, farmers must have the capacity to effectively understand how to act on this data – whether by analysing the data themselves or receiving actionable advice from others within their networks or working within their value chains. Data analysis must translate to actionable instructions that are relevant for specific crops, in specific geographies, and delivered at a level of sophistication upon which smallholders can act. While there are some global best practices, much of this translation and localization will have to be done locally and according to specific contexts. Integrating multiple sensors can improve the breadth and comprehensiveness of data, but this must be balanced with simplicity to create insights that are "good enough" to inform action.

55. ***Access to extension.*** Extension systems should develop new programmes with new objectives and focus on: (i) technical programmes targeting extension agents and specialists oriented to raise awareness on data-driven decision support systems and digital tools that can be used to support their work; (ii) new training strategies used by extension agents when engaging farmers on the use of data-driven solutions; and (iii) designing and evaluating the impact of new methods of farmers' advisory services (e.g. data-driven advisory services) and consider using social media for advice and information exchange. Extension could promote the entrepreneurial intention of young people towards digital solutions by playing a dual role: it could (i) train stakeholders to become entrepreneurs (how and why to be entrepreneurs using digital solutions); and (ii) serve as the bridge between farmers (needs, knowledge and skills) and the service providers developing digital solutions.

56. ***Access to agriculture finance.*** The use of digital technologies for improving financial performance relies on a combination of financial services and technology (FinTech), with potential for addressing the constraints in accessing credit and inputs. For example, Agri-Wallet is a lending and payment platform that uses blockchain to ensure transparency and security of transactions for all actors in a value chain (farmers, financial institutions, input providers and commercial buyers). In Agri-Wallet, typical transactions include purchase of agricultural inputs by farmers and purchase of harvested crops by processors and aggregators.

57. ***E-commerce platforms for food and agriculture*.** E-Commerce is broadly defined as commercial transactions facilitated through a digital platform. For the purposes of smallholder agriculture, e-commerce has been touted as a way to deliver B2C services by linking smallholder farmers to input or output providers further up the value chain. While this concept has had some success in agricultural markets in China and India, E-commerce as defined above in the NENA region has not yet scaled. Examples of dedicated E-commerce platforms for food and agriculture products include Twiga. The *Twiga* Foods platform uses mobile phone technology to match supply and demand, aggregating market participants and finding buyers for farmers' produce in Africa's large, but highly fragmented fruit and vegetable market. Since it launched operations in 2014, Twiga has grown to work with over 13 000 farmers and 6 000 vendors in Kenya. It is proving that smart use of technology and innovative business models can vastly improve large and inefficient African markets such as the agricultural supply chains.

58. ***Distributed ledger technology (DLTs) for traceability*.** Traceability will play a key role in re-shaping food systems around the world by (i) providing comprehensive and consistent data collection along the supply chain; (ii) adopting new technologies that allows for easy sharing, aggregating and analysing of data; and (iii) creating low-cost, commercially viable and comprehensive food testing and monitoring solutions. In food traceability, blockchain technology is increasingly acquiring a central role. One implementation of DLTs is blockchain, a digital ledger, which brings in decentralization, immutability, a high level of security, transparency and trust .Blockchain-based traceability systems are being piloted in many agriculture value chains.

59. ***Food sensing technologies for food quality and safety*.** Non-invasive and non-destructive food sensing approaches such as hyperspectral imaging and spectroscopy can improve food quality and safety. These technologies identify information related to the structure of a product (for example, near-infrared spectrometers use spot measurements to assess specific wavelengths to rapidly analyse moisture, protein and fat content). This information is then uploaded to the cloud and analysed through machine learning and image processing algorithms. Examples on the use of these technologies include use of hyperspectral imaging in fish meat quality tests, including salmon, trout, cod, halibut and sea bass.

60. ***Blockchain for smart contracts***. These contracts are special protocols intended to contribute, verify or implement the negotiation or performance of the contract. Smart contracts use blockchain and are designed to self-execute once a number of predetermined conditions are met. In a smart contract, the clauses that rule the exchange of goods or services are embedded in coding, and actions (such as payment) are triggered automatically once conditions are met (such as the delivery of products). They are traceable and irreversible.

V. Way forward: digital innovation for agri-food systems transformation

a) Potential benefits and risks

61. Digital technologies have the potential to address the main challenges that the NENA region agriculture will face in the coming decades. These include per capita food production gaps, climate change adaptation and resilience, a shrinking base of natural resources especially related to water and soil and the predominance of high risk-low returns in small-scale agriculture. Digital technologies will likely contribute to the overall improvement of the NENA agriculture by delivering a range of economic,

institutional, environmental and social benefits that are summarized in Figure 4 below and potential impacts according to efficiency, environment and equity are described in detail[6]

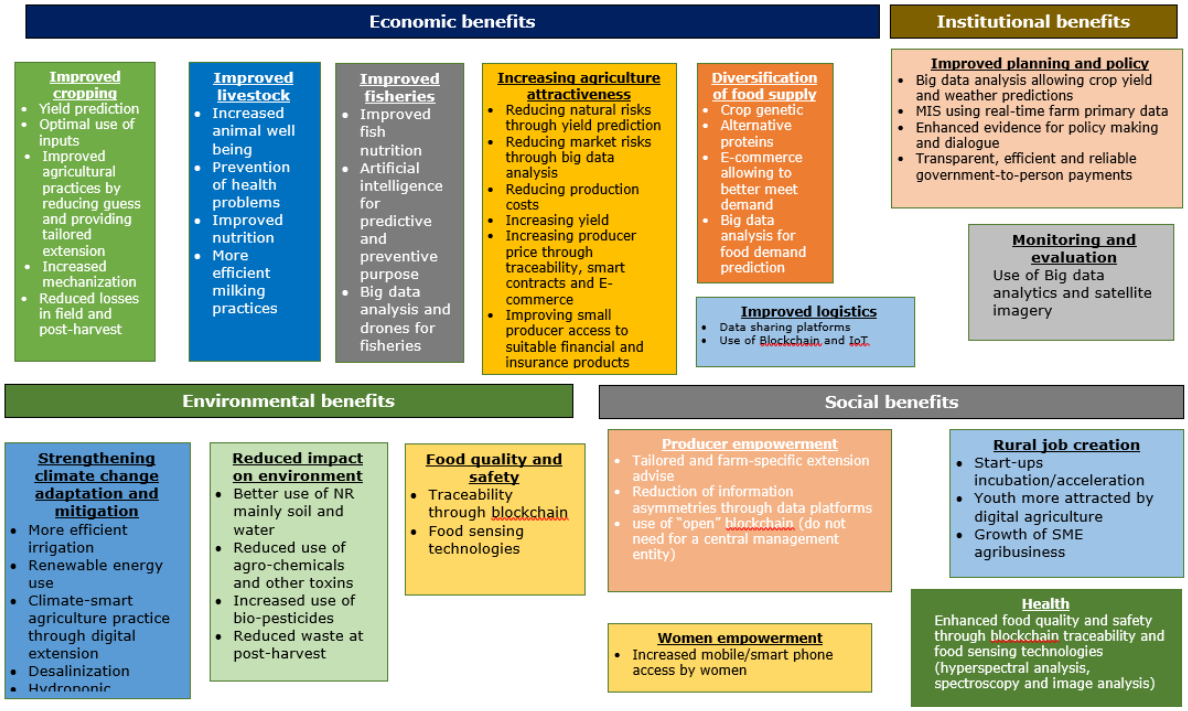

Figure 4. Potential benefits associated with digital technologies in agriculture

62. The main risks associated with digital transformation of agriculture are:

- Not addressing the digital divide in an effective manner and not being able to prevent a negative impact for small farmers;
- Missed opportunity in terms of addressing global equity, social and environment problems;
- Excess of market concentration among (large) private sector providers resulting in standardized and not sufficiently differentiated digital solutions;
- Impact on employment. Digital technologies are generally perceived as "labour replacing" while in practice most of these technologies are labour-enhancing but demonstration and piloting/testing are needed for changing this perception. Labour displacement effects should also be counter-balanced by skills upgrade resulting in labour reinstatement effects;[7]
- Insufficient collaboration and partnerships between governments and private sector on digital technologies for agriculture;
- Insufficient efforts for promoting public research, awareness and demonstrations for tailored smallholder solutions in digital agriculture, thus not countering the standardization that large agribusiness could promote;
- Despite increasing efforts, there is a risk of insufficient coordination of actions related to data access, management, property and privacy that could slow down the digital transformation of agriculture.

[6] How digital technologies are changing agriculture in the Maghreb Region (FAO, 2020)
[7] Acemoglu, 2018 https://www.nber.org/papers/w24196

b) Public interventions for harnessing digital innovation

63. Digital technologies are being mainly developed and disseminated by the private sector for a commercial purpose. This entails that commercial digital service providers will first pursue the low-hanging fruits from a marketing point of view which generally is represented by the large and medium farmers worldwide. When it comes to innovation, smallholders are less attractive clients for commercial firms as they are limited by a range of aforementioned constraints that require public intervention in order to be relieved. These interventions aim at establishing a conducive environment for both supply and demand of digital technologies for agriculture.

64. The public interventions likely to be needed to promote the digital transformation of agriculture have been described in detail for the North Africa region. Nevertheless, most of these actions may also apply for other countries in the NENA region. These public interventions can take the form of push and pull actions, which can be summarized as follows:

- Push actions for digital agriculture could include promoting a more conducive business environment through (i) policy dialogue on digital tools development for agriculture which can be conducted at sectoral level (whole agriculture sector), national/provincial/agricultural basin level; value chain level; specific technology level (mobile phone platforms, IoT, satellite imagery, blockchain); (ii) providing an incentive framework for start-up venturing in digital agriculture including start-up promotion through knowledge and innovation challenges, incubators and accelerators and innovation cluster approach; (iii) improved access to suitable financial products (debt, equity, quasi-equity, crowd-funding) for producer organizations, small and medium-sized enterprises (SMEs) and start-ups that want to venture into digital investments; (iv) improved and regulated access to data and information necessary to conduct big data machine learning in digital agriculture; (v) improving E-commerce regulatory framework; (vi) addressing public research bottlenecks; and (vii) harmonizing interventions with the digital economy agendas (where available).
- Pull actions for digital agriculture could include (i) awareness and promotion campaigns for potential clients and consumers on all main digital solutions for agriculture; (ii) demonstration activities of digital solutions at different stages of food systems and on various types of technologies; (iii) training at different levels of the food system and on different digital technologies; (iv) establishing an incentive framework for the use and consumption of digital products relying on subsidies, voucher systems and tax deductions; (v) promoting public-private partnerships with technology suppliers; and (vi) strengthening the technical capacity and market linkages of suppliers to better respond to market demand.

Annex 1. Selected NENA Innovation Success Stories for the International Forum on Innovation in Agri-Food Systems to achieve the SDGs

#	Institution	Innovation description (impact, scale etc.)
1	Fresh Source (Egypt)	*FreshSource* is the region's first B2B platform for agri-goods, connecting farms to businesses and providing last mile solutions. The platform is bridging gaps in food security, tackling food loss and empowering farmers by connecting them to modern markets. Since January 2019 they have impacted the lives of 1 500 smallholder farmers and agri-vendors and the company has generated USD 120K in revenue. Farmers have increased income by 20percent. The company reduces food loss, through cold chain systems.
2	Knowledge Economy Foundation (Egypt)	Bashaier is an agribusiness Knowledge and Marketing Systems Platform combining ICT and inclusive business approaches. The Bashaier model focuses on the value chains with the highest potential for agribusiness, SMEs and small farmers, with specific networks for each value chain, Inclusive business approach supported by ICT tools, Market buyers linkages customized to their supply needs, Partnerships with state agencies for extension services on mobile and Leverage synergies for agribusiness SMEs through setting-up agribusiness virtual BDS/incubator center: Agrirowad. The digital platform links farmers to markets and a range of extension services. (https://www.bashaier.net/aboutUs)
3	WorldFish (Egypt)	WorldFish provided the Ninth Generation (G9) broodstock of the GIANT to 11 Broodstock Multiplication Centers (BMCs) in five governorates; these centres then disseminated improved mixed-sex fry to 160 tilapia hatcheries which supplied all-male fry to 1 500 fish farms in 2017. The results of an impact assessment of the G9 of GIANT in 83 of these fish farms in four Egyptian governorates indicate that the use of GIANT in all governorates achieved significantly higher fish yields (12.3percent–26.4percent higher) and 15.7 percent lower feed conversion ratio (FCR). Fish farmers who stocked GIANT had significantly higher average fish sales (USD 5 567/ha) than those who stocked non-improved commercial strains (USD 5 192/ha) in all governorates. Meanwhile, the in-pond raceway system (IPRS), increases the productivity of aquaculture in existing pond units by culturing fish in aerated raceways and removing solid wastes. The circular system captures nutrients for use as a crop fertilizer and requires minimal use of drugs and chemicals to ensure food safety.
4	JICA - (Japan, Egypt, Palestine)	JICA has implemented technical cooperation projects, which support small-scale farmers in Egypt and Palestine. Both projects have introduced SHEP Approach, which considered farmers' motivation. In SHEP Approach, farmers visit adjacent market physically and conduct market survey by themselves. Then, farmers made crop calendar or business plan according to market needs. Target farmers improved their farming after understanding market needs such as required quality, timing and volume. Farmers have changed their mindset on marketing from "Grow and Sell" to "Grow to Sell". Target farmers have realized "Farming as Business" and as a result, their livelihoods were much improved.
5	Methods for Irrigation and Agriculture (MIRRA) (Jordan)	The low-pressure "Drippers" improve the performance of irrigation systems in the water-poor country of Jordan, where about half of the country's water supply is used in irrigation, according to Jordan's Ministry of Water and Irrigation's 2016 report "National Water Strategy of Jordan 2016-2025". As the project progresses, gaining an understanding of the types of crops used across the Near East and North Africa region is to aid in creating a generalized technology to save energy, ensure less clogging regardless of the type of water used (surface water, treated wastewater, etc.), and standardize quality. The project started in 2011 in two governorates (marginalized areas) in Jordan. The project resulted in establishment of small community businesses.
6	Douda Vermiculture Solutions (Lebanon)	Douda offers a sustainable solution for an odourless, fast and simple way to treat organic waste at the source. It strives to expand the practice of vermicomposting and promote the use of vermicompost (end product organic fertilizer) in farming to reduce the application of chemical fertilizers. Douda solutions provide the needed tools and methods that allow people to apply vermicomposting in their backyard, apartment, school and workplace enabling them to get rid of the organic waste and produce their fertilizer at home. Thirty-six households participated to test the process; participants were pleased with the outcomes.
7	Aggregator "COSUMAR	The Attaissir platform designed by COSUMAR, is a solution devised for accelerating performance and simplifying the daily work of farmers. Composed of a digital on-line management system, Attaissir monitors agricultural operations from sowing to transportation of the plants to sugar refineries in real time by using agricultural machines connected by GPS. Agricultural partners are equipped with cards enabling them to access the information relating to them in real

	GROUP" (Morocco)	time and therefore facilitating all operations previously carried out manually. In December 2018, the system was deployed for the 80 000 farmers in the five sugar producing areas of Morocco, the distributers and service providers.
8	Edama Organic Solutions, KAUST (Saudi Arabia)	Edama Organic Solutions was born from a circular economy approach to solving sustainability challenges. By working with nature and taking a holistic approach to problem solving, Edama is working towards creating a Saudi Arabia where all organic waste goes back into the earth. Edama's *flagship product, Desert Compost, is an organic soil improver specifically designed to make sandy soils as fertile as they can be*. It increases water holding capacity, supplies organic matter and nutrients, improves soil structure, stabilizes pH and salinity, nurtures beneficial soil microorganisms and maximizes plant performance using as little water as possible.
9	Butana Integrated Rural Development Project (IFAD/ the Sudan)	The overall project goal is to improve the livelihoods of poor rural households in the target area and strengthen communities' resilience in the face of drought. The project targets smallholder pastoralist households in the sand dunes and clay plains of the region, households engaged in irrigated farming and smallholders who migrate seasonally with their herds. The project also helps develop crop production, and small off-farm enterprises, especially dairy processing. The project was introduced in 2011 in two communities as a pilot. Up to 2019, 313 communities were involved. Area covered by gaur is nearly 14 000 ha for nearly 7 000 farmers.
10	AHMINI (Tunisia)	AHMINI aims to facilitate the process of rural women's inclusion in the social coverage system by enabling them to register remotely via a mobile phone without the need to collect the amount of the cash subscription or incurring the hardship of moving to the fund's regional interests in order to pay the enrolment fee. Privileges of participating in AHMINI include coverage against the danger of work accidents, health coverage / treatment and retirement pension. Since May 2019, 8 000 women are registered under the AHMINI Programme.
11	ICARDA – (APRP-United Arab Emirates	In 2017, more than 1 020 and 350 greenhouses were converted to soilless system in the United Arab Emirates and Oman respectively. Soilless culture techniques offer: (a) supply of water and nutrients optimum for plant growth, (b) minimal water loss by evaporation, due to the narrow width of the growing channels, and (c) elimination of drainage water loss, since water is returned to the tank for recycling (closed system). Regarding the Net house technology, it protects crops from the harsh environment, while providing them with good ventilation, and the additional benefits of protection against pests and diseases. The records show that net houses saved about 77percent of water with a 10 percent increase of profitability compared to the cooled greenhouse.
12	ICBA (United Arab Emirates)	Quinoa is a revenue-generating crop, well suited for addressing income and environmental challenges faced by smallholder farmers in marginal areas. The demand for quinoa in Morocco is growing and many farmers have taken the initiative to grow quinoa in various regions across the country. However, yield and production have been highly variable and inconsistent, averaging only 0.3-0.5 t/ha, while the maximum attainable yield can be up to 1.0 t/ha. ICBA introduced best-performing quinoa genotypes developed after years of research by ICBA scientists and propagated the best management practices to get optimum yields under marginal growing conditions. Began in 2017, with 200 farmers involved in the pilot stage and about 1 000 farmers in the scaling-up phase.
13	FAO-Yemen	FAO's innovative idea of supporting a more prominent role for women, by exposing the women first to comprehensive conflict resolution capacity development programme to actually have women participate in the overall conflict resolution process and mediation. Also, the role of women in raising local community awareness was instrumental in mobilizing the community members to unite behind finding a solution to the conflict. The project succeeded in removing the tension and establishing communal peace. The project has generated immediate cash for work opportunities for both women and youth. It saves 170,000 m3 of much-needed water for irrigation and livestock drinking needs. As a result, FAO successfully resolved conflicts for over thirty sites around the country.