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THE FUTURE OF SKILLS

A case study of the agri-tech sector in Israel

Summary note

THE EU AGENCY SUPPORTING COUNTRIES TO DEVELOP THROUGH LEARNING

INTRODUCTION

Countries world-wide are experiencing profound changes in all sectors due to technological advances. Very little is known, however, about the skills that will be needed to keep up with this evolution. Israel is no exception, and here, a summary of a recent study on future skill needs in the country's agri-tech sector is presented, which combined conventional methods of skills analysis with more experimental data science text mining. The research experience gained in Israel during the study will be applied to studies in other countries.

In Israel, a water-scarce country, over half the saline soil is arid or semi-arid, making it difficult to grow crops. For this reason, Israel has traditionally relied on technological progress and innovation in agriculture, which yields relatively high levels of productivity as a result of these advanced technological solutions.

Agri-tech is defined as the application of technology, such as advanced irrigation systems, biotechnology and genetics, robotics for planting or crop gathering, or analysis of big data and AI to research soil and growing conditions, sensors and other IoTs to monitor and assess plant health, in order to improve all elements of the growing process in agriculture, horticulture and aquaculture.

Data providing estimates of employment by occupation and qualification level in the agri-tech sector were not readily available as the sector involves different economic activities from agriculture to research and development and IT that does not fit into typical classification of economic activities (NACE). An approximate share of employment in relevant NACE sectors were used in order to provide these estimates for the agri-tech sector, resulting in an estimation that it accounts for 3% of total employment in Israel.

AN OVERVIEW OF THE AGRI-TECH SECTOR AND ITS ECOSYSTEM

Agri-tech in Israel brings together a number of actors from the public and private sector who are in turn supported by many public, private, research, and non-governmental organisations. Its economic strength comes from the combination of these public and private organisations which stimulate innovation and entrepreneurship. Israel's innovation ecosystem ranks 10th best in the world, at the same time, its traditional sectors which often depend on relatively low-skilled labour, are a burden on growth productivity.

In comparison with EU employment in the sector which is 4%, employment in the agriculture sector in Israel, which has been in decline over the long term, only accounted for about 1% of employment in 2018, with approximately 72 000 people directly employed in the sector. This figure includes around 21 000 foreign workers. An additional 170 000 people or so work in the production of agricultural inputs and the distribution of agricultural outputs. However, the sector is increasingly affected and supported by technological and research activities, which is the focus of this research.

Technical and vocational education and training (TVET) has made much progress and is well developed in Israel. There are vocational schools for young people, and TVET is present in academic

colleges, adult training centres, and on-the-job training. However, practical training for high school students in companies and on-the-job training programmes in workplaces could be created, as well as increasing cooperation with employers.

Despite the presence of a TVET network, a skills shortage could potentially arise in the agri-tech sector due to several factors. Over recent decades the number of people continuing in higher education has increased considerably – more than half of the working-age population are tertiary education graduates – and there is an increasing demand for highly skilled specialists (especially in ICT) in sectors other than agri-tech, even if the skills required by agri-tech are relatively high. Another factor is that many of the skilled workers who emigrated to Israel in the 1960s are of retirement age.

The increasing demand in the sector will require higher-level skills coming from other areas that relate to biotechnologies such as science, technology, engineering and mathematics (STEM) which are in high demand in all countries. But people with medium levels of skills will also be in higher demand because of technological changes, and they too, will be experiencing transformation in their area.

THE DRIVERS OF CHANGE IN THE SECTOR

A number of factors are driving change in the sector including trade, global value chains, new technology, digital tools, the greening of the economy and climate change. Because technology is the most important driving force for the agri-tech sector in Israel, the report extensively covers innovation and new technologies.

New technologies and their impact on the sector

Using text mining techniques, various data sources were analysed, resulting in the compilation of a list containing the most recent and active ongoing technologies in Israel. Patents issued both by the Israel Patent Office and from international sources such as the European Patent office database which contains over 120 million documents, were selected, retrieved, and analysed. Two of the largest databases for peer-reviewed papers were used to perform a study on around 70 million scientific papers.

From this analysis it was found that more than 60% of agri-tech patents in Israel can be divided into four groups which include: new varieties of plants; horticulture, viticulture and floriculture; irrigation systems; and pesticides. The following are just some of the most recent technologies that have been introduced or are in the process of being so:

- Irrigation systems and devices: it should be noted that drip irrigation has contributed to a 1 600% increase in the value of products grown over the last 65 years.
- Water treatment technologies: 86% of Israeli wastewater is recycled and used to provide more than fifty percent of the water for irrigation. This is of vital importance in Israel's strategy to overcome water scarcity and sustain agriculture in arid regions.
- Big data analytics software and methodologies are a fast-growing trend.
- Vehicle guidance and image processing systems are being impacted by machine learning and deep learning algorithms which are providing a number of imaging techniques that can solve problems in multiple fields of agriculture, such as image analysis to detect nutrient deficiencies in plants, assist pest detection, and inspect fruit quality.

- Fungicides as related to pesticides are being developed with new molecules to act against insects, part of an increasing development related to trying to solve the problem of disproportionate use of pesticides in Israeli agriculture.
- Computer vision, control systems and sensors are developing quickly and are transversal, they can be applied to almost all sectors in innovation.

As far as disruptive technologies are concerned, the following have been identified as gamechangers:

- AI/machine learning applied to predictions or simulations of real cases allowing for improved, more efficient production of results. It can benefit many areas, from precision agriculture to genetics, to bioinformatics.
- CRISPR, a genome-editing technique that allows greater precision compared to other approaches.
- Vertical/indoor growing will allow plant cultivation to be controlled, applying factory-like methods to agriculture, reducing the issues of plant protection and water consumption.
- Improved resolution of satellite imaging will allow parameters such as plant or soil condition to be monitored without the need for sensors in the fields.
- Robots and mechatronics will reduce the need for manual labour and increase productivity.
- Molecular delivery systems which transport a beneficial compound into a biological system in an efficient and localised way will reduce the use of active molecules.
- The introduction of new materials such as nanotechnology, biosensors, or electro-optics could potentially reshape nearly any aspect of agriculture.

These technologies are already transforming the agri-tech sector, but artificial intelligence and vertical/indoor growing, in particular, will disrupt and change the production and business models in the sector. Existing technologies already in place could further transform the sector towards **precision agriculture** if more farms adopt them.

Most interesting developments come from **transversal** or **cross-sectoral technologies** using multi-disciplines, for example, IT and agriculture or agriculture and medicine, which indicates the need for skills covering a variety of disciplines and technologies. A **complex set of skills will be needed as these new technologies and multi-disciplinary interventions are introduced** alongside older technologies. Besides changing the task content of existing occupations, such as agronomists, increased exports of products, services and technologies are also creating new jobs. As a result, many occupations, both technological and non-technological, are affected by the changes, as are their skills set requirements. It can be noted that compared to the rest of the world, the rate of innovation in agri-tech in Israel is slowing down as can be seen in the lower number of patents filed over the past ten years.

Evolution of jobs and skills demand

Research shows that because of the changes being introduced into agri-tech, employers are increasingly looking for two skill sets: technical or technology-related occupations, and business services and related occupations. Many of the newly created jobs require highly skilled workers, medium-skilled workers, tradespeople and machine operators, and plant and machine operators and assemblers, which can be broken down into three categories, namely:

- engineers and technicians in fields such as automation, robotics, electronics, electricity, mechanics, agricultural equipment, irrigation, water and drainage;

- computer scientists/software developers and various types of data scientists which include bioinformatics;
- a new generation of agricultural professionals with new skills that permit them to use new technologies such as agronomists, biochemists, and plant and soil specialists.

The research also revealed that digitalisation is not the only technological area that has a significant impact on skills. A variety of specialisations will be in demand, from biotechnologies to engineering, plus a demand for those occupations traditionally associated with agriculture such as agronomists. Companies, however, are now seeking a new type of agronomist, one with a wider range of knowledge that includes precision agriculture techniques, such as sensor deployment and management, and data interpretation.

Nearly all of the technology-related occupations need highly skilled or at least medium-skilled profiles. How, then, to train the required professionals for very specific competences? Two trends seem to be apparent: there is a tendency to be specialised in a specific technology but have the capacity to apply it transversally over different jobs; and other trend is merging more than one occupational profile, or at least of the related competences, into one individual profession.

Technology-related profiles that are in high demand include software engineers, data scientists, engineers in various branches, agronomists, breeders, chemists, plant pathologists and physiologists, toxicologists, and statisticians.

Other job profiles sought are only indirectly related to technology and include industrial processes specialists, quality assurance officers, project managers, production managers and lean production specialists.

The role of transversal technologies and soft skills

Because many technologies are interrelated, it is becoming increasingly apparent that transversal technologies are needed in a number of sectors or subsectors and there will be a **greater demand for skills covering a variety of technologies** and related competences. Some technologies are transversal – meaning that they are used by different occupations – and the demand for related knowledge and skills for their application is increasing. Knowledge of computer vision, for example, is expected to be in high demand as it is needed for different occupations, from disease prevention to harvesting. The skill sets needed to operate transversal technologies in a practical context might be even greater because of the potential need **to interact with a variety of professionals**, from truck drivers to satellite scientists. Other skill sets that are mentioned with increasing frequency are wind-related profiles such as wind turbine service technicians, water resource specialists, water and wastewater treatment plant and system operators, and solar energy engineers.

Technology will shape the skills content of jobs, but non-technical jobs related to management, marketing and sales, or export and trade will also be needed. In this fast-developing area soft skills are also constantly evolving and their importance increasing as much as technical skills. The soft skills most sought after are teamwork, communication, empathy, collaboration, open-mindedness, flexibility, curiosity, entrepreneurship, responsibility and persistence among others.

From analysis taken from data mining and interviews, significant changes are taking place and will continue to evolve due to technological changes – job definitions are more fluid and in constant evolution, like the sector. A greenhouse installer or plant inspector could be required to operate sophisticated machines, know some English, basic coding, or even mechatronics.

A visible trend is the **adoption of a multidisciplinary approach**, combining agricultural sciences with medicine, computer science or other fields. In academic environments, multidisciplinary research labs are becoming more common, in which scientists from different disciplines interact. Data scientists employed by companies won't be mere 'number-crunchers' but will need to understand the agricultural value of information, and in order to make decisions, breeders and agronomists must understand data science. Another similar trend is the integration of functions across the value chain; with technicians, for example, also working in business development, customer care, sales, and dealing with suppliers, therefore needing soft skills as well. **Workers will have to not only be proficient in one discipline but will need to have a deep knowledge of another.**

There will be a decrease in demand for low-skilled, manual workers; only highly trained manual workers won't be able to be substituted by automation. However highly skilled technicians are also at risk of being replaced, for example Geographic Information Systems (GIS) technicians could be replaced by methods using image analysis. As AI progresses, there may be a need for fewer experts.

The future worker will require a wider range of skills and competences, the ability to mediate and adapt to new situations and roles and be able to work across disciplines.

Many current agri-tech jobs will continue to exist, but the requirements of these jobs will evolve as a result of technological changes. There will be a mix of technical and soft skills. And finally, **the concept itself of being a farmer may be changing**. In certain areas of Israel, people with smallholdings also have other jobs and they rely on a variety of technologies which allow them to combine their jobs. It's possible that in the future these 'part-time' farmers will grow thanks to the new technologies leading to a complete change in employment in the sector.

REFLECTIONS AND SUGGESTIONS FOR FUTURE POLICIES AND PRACTICES

Once the needs of the sector have been identified, it is necessary to develop policies and practices to ensure that emerging skills needs are met. Research has found that the primary limiting growth factor for most companies is due to the shortage of skilled workers. The people who possess the necessary skills often find the sector less attractive, moreover there are global shortages in some of these professions to begin with, for example IT specialists in the growing Israeli IT sector.

Companies are therefore widening their recruitment strategies and training their existing workforce. But several avenues could be improved, such as links with universities and TVET systems. There is only one dedicated Agriculture Faculty in the country and no 'agri-tech track' in Israeli technical colleges, so academic courses are not up to date with the actual needs of the sector and TVET tracks could be reviewed and updated. A closer dialogue and cooperation between companies, academia and the TVET system will allow better training programmes to be designed that are matched to the future needs of the labour market.

It was also found that many companies do not take advantage of the courses provided through the national formal education and training institutions because the bureaucracy involved is considered too demanding.

The researchers who carried out the report hope their findings will raise awareness among policymakers and practitioners about the changing skills needs in the agri-tech sector. They suggest that the following actions might be helpful:

- developing learning modules for upskilling/reskilling professionals in the field;
- identifying gaps in the existing curricula;
- developing new qualifications in partnership with the universities, TVET providers and companies in the sector;
- better career guidance and information about emerging job and career opportunities, and most important skills to acquire;
- instituting existing good practices in the acquisition of newly needed skills;
- establishing a system of collaboration between enterprises and education providers.