

Unclassified**English - Or. English**

12 January 2023

**TRADE AND AGRICULTURE DIRECTORATE
COMMITTEE FOR AGRICULTURE****Working Party on Agricultural Policies and Markets****An assessment of the labour and skills shortages in agriculture and the food sector**Contact: Michael Ryan (michael.ryan@oecd.org).**JT03510638**

Note by the Secretariat

This paper is mandated under the 2021-22 PWB of the Committee for Agriculture (CoAg) under Expected Output Result (EOR) 3.2.1.2.1, “Policies to strengthen Human Capital and facilitate Structural Adjustment”. The first element in this EOR focuses on policies to address the human capital needs in the agro-food sector.

A scoping paper “Policies to address labour and skill shortages in agriculture and the agro-food sector” [TAD/CA/APM/WP(2021)19] was presented to the ad hoc meeting of the APM in July 2021. This was followed by a “Workshop on labour shortages and skills in the agro-food sector”, held on 22 November 2021.

A draft paper “An assessment of the labour and skills shortages in agriculture and the food sector” [TAD/CA/APM/WP(2022)12] was presented, for discussion, to the meeting of the APM on 17-19 May 2022. The comments received from delegations at the meeting and in writing have been addressed and are included in this revised version of the paper [TAD/CA/APM/WP(2022)12/REV1].

The revised document [TAD/CA/APM/WP(2022)12/REV2] takes into account the written comments from delegations up to 30 November.

This paper provides a stocktaking of the labour and skills shortages in agriculture and the food sector and discusses the factors and policies that drive the supply of labour in the sector. It also discusses the key challenges, constraints, and policies that many OECD countries are facing and their policy responses to addressing the labour and skills shortages in the sector.

The paper draws on two background review papers from external consultants, as well as work on labour markets and skills that has been carried out in several Directorates in OECD including the Directorate for Employment, Labour and Social Affairs (ELS), the Centre for Skills (SKC), the Directorate for Education and Skills (EDU), and the Directorate for Trade and Agriculture (TAD). In addition, this paper brings together the experience and discussion of six OECD countries in addressing these concerns that were presented at the Workshop on Labour and Skills in the Agro-food Sector in November 2021.

This revised paper “An assessment of the labour and skills shortages in agriculture and the food sector” [TAD/CA/APM/WP(2022)12/FINAL] was declassified on 16 December 2022.

Table of contents

| | |
|--|-----------|
| Executive Summary | 5 |
| 1. Introduction | 7 |
| 2. An assessment of the labour and skills gaps in the agricultural workforce | 8 |
| 2.1. Trends in the demand and supply of labour in the agro-food sector..... | 9 |
| 2.2. Labour market policies and the agro-food sector | 13 |
| 2.3. Labour skills in the agro-food sector | 14 |
| 2.4. Strengthening gender balance in agriculture and the food sector | 18 |
| 2.5. Education attainment and the workforce in the agro-food sector | 20 |
| 2.6. Role of the advisory services in addressing labour and skills shortages in the agro-food sector | 24 |
| 3. Sharing experience in addressing labour and skills shortages in the agro-food sector | 26 |
| 3.1. Japan..... | 27 |
| 3.2. New Zealand..... | 29 |
| 3.3. The Netherlands | 31 |
| 3.4. Ireland..... | 33 |
| 3.5. Spain..... | 35 |
| 3.6. The United States | 36 |
| 4. Conclusions | 38 |
| References | 42 |

Tables

| | |
|---|----|
| Table 2.1. Skills needs in agriculture, forestry and fishing across some OECD and non-OECD countries (2015) | 17 |
| Table 2.2. The diversity of farm advisory services | 25 |

Figures

| | |
|--|----|
| Figure 2.1. Workforce employed in agriculture and GDP per capita: Trends between 1991 and 2017 | 10 |
| Figure 2.2. Family and hired farmworkers on US farms, 1950-2000 | 11 |
| Figure 2.3. Temporary employment in agriculture compared to overall temporary employment, people aged 25-54, 2011-12 | 12 |
| Figure 2.4. Occupational shortage indicator for agriculture, forestry, and fishing | 16 |
| Figure 2.5. Educational attainment by industry of employment | 21 |
| Figure 2.6. Indicators of over and under-qualification by sector (OECD average) | 22 |
| Figure 2.7. Tertiary education enrolment in agriculture, forestry, fishing and veterinary, 2013 and 2018 | 23 |
| Figure 2.8. Percentage of students in tertiary education enrolled in agriculture programmes and the share of agricultural employment | 24 |
| Figure 4.1. A summary of the key issues and policy linkages in addressing the labour and skills shortages in the agro-food sector | 39 |

Key messages

- Employment in the agro-food sector continues its long-term downward trend, broadly in line with agriculture's declining share of GDP, in OECD countries. The demand for labour in agriculture is driven by the interaction of several factors: farm structural adjustment (increase in average farm size, change in ownership structure, demographics); technological advances (increased automation, robotics, drone technologies); and the changing demand of consumers for attributes such as animal welfare, environmental footprint, and food quality.
- The agricultural labour force is segmented with many categories of labour including family owner-operators, farm managers, hired labour, and seasonal workers (including foreign workers). The agricultural labour force is characterised by lower formal education and training.
- Managing complex biological and business enterprises requires greater diversity of skills for employees and employers. Most OECD governments support and incentivise greater inclusiveness in their workforce. While there are significant data gaps on the composition of labour and skills in the sector, there is growing evidence of a large mismatch between the needs of the sector and the supply of labour and skills, including in the face of technological change.
- Labour and skills shortages are being experienced in many economic sectors across OECD countries, and this is resulting in increased competition, especially for semi-skilled and skilled labour in the agro-food sector. Entry barriers to the sector are a concern and include high start-up costs, geographical isolation, fragmented rural infrastructure, relatively low remuneration, poor working conditions, and the negative perception of farming as a professional career.
- Despite the labour and skills shortages, agricultural production and productivity have continued to increase, albeit decelerating in the most recent decade. Emerging labour-saving technologies bring new opportunities to the sector to make it more attractive and responsive to new demands, but they raise important questions on the continuous need for upskilling of the labour force.
- Governments need to find the right mix of policies to address these complex challenges; including policies that oversee the labour market, education and training, social protection, immigration, and agricultural labour. In priority they should aim to:
 - Improve the image of agriculture as a sector capable of offering career opportunities, as the role of agriculture is evolving with increasing attention to food security, environmental goods, biodiversity, and social aspects.
 - Promote a more diverse agro-food workforce with a wider range of skills.
 - Ensure a better alignment of education and skills to the evolving needs of the agro-food sector, which is critical for the sector to be sustainable and competitive, including entrepreneurial and digital skills.
 - As part of agricultural policy reforms to improve sustainable productivity, and investments in Agricultural Innovation Systems, enhance the continuous education and training of the workforce to optimise the adoption of new technologies and digitalisation in the sector.
 - Strengthen and expand the capacity of national farm advisory services to meet the current and future needs of the agro-food sector.

Executive Summary

The role of agriculture is evolving, with increasing attention to food security, environmental goods, and social aspects. These evolving demands faced by the agro-food sector require new skills and human capital, including entrepreneurial and digital skills, to ensure a sustainable and competitive sector.

The demand for labour in agriculture is driven by the interaction of the following three elements: farm structural adjustment (increase in average farm size, change in ownership structure, demographics); technological advances (increased automation, robotics, drone technologies); and the changing demands of consumers for attributes such as animal welfare, environmental footprint, and food quality. Furthermore, the technological revolution means that farmers need to continue to develop and update their technical skills. As development and application of new technologies that enhance productivity such as robotics, automation and digital applications play an increasing role in agriculture. Moreover, they also need to increase their knowledge on financial, marketing, and regulatory aspects, as they relate to environmental compliance.

The characteristics of the sector workforce have changed substantially over the last 20 years, driven by factors such as a long-term reduction in the number of farms and an increase in farm size; increased automation; and changes in the composition of the workforce with a steady decline in family labour, and an increase in hired labour. For many OECD countries, the shortage of both low skilled labour in some sub-sectors and high skilled labour in others, create new challenges for policymakers. Across the agro-food sector, the demand for labour is highly segmented and dynamic with different categories of employees, including family owned-operators, managers, and employees receiving wages, casual, seasonal and temporary workers (including via migration). Moreover, there is the dual trend of falling total employment in the sector, while at the same time an increasing reliance on temporary and seasonal workers, many of whom are sourced via migration. In many countries, more than 50% of the farm workforce is hired labour including several forms of full time, part-time and contract labour. Other important characteristics of the sector are the growing concerns over the steadily ageing workforce, relatively low education levels, and the low attractiveness of careers in the sector for young, qualified people.

Over the last decade, there has been an increase in enrolment in agriculture specific education in many OECD countries, but the enrolment in agricultural tertiary education is still low relative to other sectors. On the other hand, farmers tend to have higher participation in informal learning and training courses, which are often offered by farm extension services, industry, and farmers' organisations. Targeted agricultural education programmes can make an important contribution to addressing the labour and skills imbalances in the sector and can also improve the attractiveness of the sector by adapting courses to meet the skills needed to meet the changing demands of the sector and providing lifelong training to all workers. In many countries, the national farm advisory services continue to have an important role in providing informal training to farmers and workers, especially in upskilling to meet the increasing technological and administrative demands of the sector.

The agriculture and food sector has the highest rate of skills misalignments (including over and under-qualification) across all economic sectors and these challenges are projected to amplify in the future. For example, the European Union has forecast that over the next decade employment in the sector is expected to fall by 13%, with the largest decline expected for low skilled workers. Moreover, the share of the agricultural workforce composed of seasonal and temporary workers, many of whom are foreign, is expected to

rise. At the same time, the demand for employees with higher level entrepreneurial and management skills, digital know-how, and business and marketing experience is expected to increase. In terms of skills gaps, the largest are currently experienced in social skills and teamwork, problem solving, quality control systems and equipment maintenance. Across OECD countries, the highest shortages of these skills are reported in Ireland, Greece, Switzerland, Belgium, and Poland, while surpluses are found in Italy and Estonia.

To address these complex challenges, a mix of policies are required, including on labour market, education and training, and immigration, combined with agriculture specific training policies. Agricultural policies that encourage investment in skills and human capital, strengthening the extension services, and the wider Agricultural Innovation Systems can contribute to resolving these challenges. These policies are better targeted than other forms of agricultural support to enhance dynamic innovations that can attract more and better skilled labour to the sector (OECD, 2022^[1])

At the OECD Workshop on “Addressing labour and skill shortages in agriculture and the food sector”, held on 22 November 2021, several OECD countries (Ireland, Japan, the Netherlands, New Zealand, Spain, and the United States) shared their experiences in addressing the labour and skills shortages in the agro-food sector:

- In Japan, the government introduced the “Smart Agriculture” initiative to encourage the adoption of new technologies such as robotics, artificial intelligence, and automation in the agricultural sector. In addition, in response to the ageing farm population, several programmes have been introduced to attract young entrants to the sector, including income support measures, and specialised agricultural training programmes. The government has also introduced financial incentives and training programmes to encourage the uptake of modern technologies in agriculture.
- In New Zealand, the government introduced several measures to attract and retain young, qualified people in the sector. This approach involves encouraging all stakeholders, across the private and public sectors, to attract well-educated and highly skilled young people to the sector, by improving wages, working conditions and career paths. There are also specific programmes aimed at increasing the participation of the Maori community in agriculture and the food industry.
- The Netherlands introduced a Strategy for Green Education (2016-2025), which emphasises developing human capital in the agro-food sector. The long-term reliance on temporary and seasonal migrants has created uncertainties in the food and agriculture supply chain and concerns over the need for greater social protection of immigrant workers in the sector. Research is ongoing to assess the nature and extent of current and future skills gaps and how these gaps can be successfully addressed in the future. Moreover, policy efforts are ongoing to better integrate migrant labour into the agro-food workforce through targeted educational and training programmes coordinated across the Ministries of Agriculture, Labour, and Education.
- In Ireland, the agriculture and food sector is facing a major challenge to attract suitably qualified workers. The relatively low wages, long working hours, and lack of career prospects are seen as major barriers to enticing young people to the sector. Several policy measures including support payments, and tax incentives have been introduced to improve the attractiveness of the sector for highly educated and skilled workers. While it is critical to target these policies, the statistical coverage of labour and skills gaps in the sector needs to be improved to better reflect part-time and temporary labour, as well as gender to facilitate policy targeting.

- In Spain, only 26% of the workforce in agriculture are women, while in the food industry it is estimated at about 41%. An increase in women's participation in the sector and to build a modern and dynamic agro-food sector is a key priority of the government. Experience shows that a range of policy tools are essential to overcome the traditional gender biases in the sector, and to achieve greater gender balance and diversity. For instance, changing the status of women in the sector is complex and requires several policy and legislative changes: creating formal farming ownership, increasing women's managerial capacities in agro-food co-operatives and providing specific training programmes.
- The agro-food sector in the United States relies heavily on migrant and transient workers for agricultural production and in food processing. A system of special visas has operated to facilitate temporary and seasonal migrant employment. Entry to the sector is relatively easy compared to other sectors in the economy due to low entry barriers and relatively low skills needs. The actual number of migrant workers in the sector is estimated to be substantially higher than reflected in the official statistics. With the growing shortage of low skilled and semi-skilled workers, wages have risen, creating difficulties for hiring, especially in the crop sector. Many crop producers are adopting new labour-saving technologies such as technological platforms, conveyers, and mechanical harvesters, or have switched to fewer intensive crops. In some cases, they have moved production outside of the United States.

1. Introduction

1. The agro-food sector is facing critical labour and skills shortages that may impede the sector's productivity growth, resilience, and sustainable development. The supply of educated and skilled labour to agriculture is impacted by policies that cross many different areas including education and training, labour markets, migration, regional and rural development policies. Labour and skills shortages are of particular concern in countries that have a relatively large agricultural sector with an ageing farm population, rapid technical change, and ongoing structural adjustment in the sector. This paper aims to provide evidence of the labour shortage and skills challenge and discusses some policies and programmes OECD countries are adopting to alleviate these shortages in the sector. The paper also discusses the important role of the public and private sectors in research, training, and advisory services. Over the last two years, the COVID-19 pandemic has made more visible structural weaknesses in the agricultural labour market the role of migrant labour to ensure the continued growth of the sector.

2. Labour, land, and capital are the key factors of production in agriculture and the food sector. For several decades, there have been concerns in many OECD countries over the labour supply and skills needed for the development of a resilient, innovative, and sustainable sector. One of the biggest challenges currently facing the agro-food sector is how to find the right balance of skills, talent, and adequate workers to manage the diverse needs and increasing complexity of the sector. In agriculture, labour is often seen as a "special case" because of its unique range of roles, technical, managerial, and social. Furthermore, the agricultural sector is becoming more and more dependent on migrant workers, which has created additional challenges for employers in the sector.

3. The evolving demand for labour in agriculture is driven by the interaction of the following three elements: farm structural adjustment (increase in average farm size, change in ownership structure, demographics); technological advances (increased automation, robotics, drone technologies); and the changing demands of consumers for attributes such

as animal welfare, environmental footprint, and food quality. Moreover, a technological revolution also means that farmers need to continue to develop and update their technical skills, but also their knowledge on financial, marketing, and regulatory aspects, in particular as they relate to environmental compliance. The development and application of new technologies that enhance productivity such as robotics, automation and digital applications will play an increasing role in agriculture. The adoption of these new technologies may have had a differential impact on the agricultural workforce and have been displacing more farm family labour than hired labour, according to (Nettle, 2015). In most OECD countries, family members still represent the most common form of labour in agriculture, but there is a steady increase in dependence on external labour, and this is likely to have an important impact on the type of future training needs of the sector.

4. Accompanying these major structural changes at farm level, there has also been significant consolidation in the upstream and downstream sectors; transport, and marketing of agricultural produce have also contributed to these adjustments at the farm level. Moreover, major changes in agriculture specific policies have also played a key role, not least of which are the implementation of policies linked to environmental compliance and sustainability in food production. Accompanying these fundamental structural changes, there has been a substantial reduction in the number of farms resulting in greater consolidation, and a steady decline in the overall size of the labour force employed in agriculture and the food sector (see [TAD/CA/APM/WP(2021)26/FINAL]).

5. Concerning the demographic changes in the sector, agriculture needs to continue to attract young people, to improve working conditions and to offer good career opportunities, for example, to women and Indigenous Peoples. The economic incentives for workers in agriculture are often significantly less attractive compared to other sectors in the economy due to the perception of the low education attainment and skills required and inflexible working conditions. Moreover, the demand for labour is increasingly of a temporary or seasonal nature, which often relates to less security for agricultural workers. Countries have adopted different approaches to overcoming these obstacles and improving the image of the sector as a career for young people.

6. This paper attempts to flesh-out some of the different challenges posed by the shortage of labour and skills mismatch, takes stock of the specificities of the agriculture and food sector, and discusses policy approaches taken by a selection of countries. The rest of the paper is organised as follows. Section 2 provides an overview of the key characteristics of the agro-food labour force. Section 3 highlights the actual experiences and the policy responses of six OECD countries (Japan, New Zealand, Ireland, the Netherlands, Spain, and the United States).¹ Lastly, Section 4 provides a summary and brief conclusion to the paper and outlines some key messages from the work.

2. An assessment of the labour and skills gaps in the agricultural workforce

7. This section provides a short review of the characteristics of the agricultural workforce, and the factors that drive the supply and demand for labour and the type of skills increasingly needed in the sector. It draws on the ongoing work in OECD that has been developed under the work stream on innovation, agricultural productivity, and sustainability – the Directorate for Trade and Agriculture (TAD), as well as work on labour policies in the Directorate for Employment, Labour and Social Affairs (ELS), the

¹ These experiences were shared during the OECD Workshop on labour shortages and skills in the agro-food sector, held on 22 November 2021.

Directorate for Education and Skills (EDU), and the Centre for Skills (SKC) particularly on the findings of the national skills strategies. In addition, two reports on labour and skills shortages in the sector, prepared by external consultants also feed into this work (Nettle et al., 2021; Rose et al., 2021).

8. The enormous structural change in the agro-food sector over the last 20 years has resulted in major changes in demand and the type of skills required in the sector, as well as the supply of labour and skills to the sector. Labour demand is likely to continue to evolve driven by a combination of factors including the increased use of technologies, the ageing of the farm work force, the increase in the average size of farms, diversification in farm ownership, the increase in non-family agricultural labour, and the consolidation and integration along the food supply chain.

2.1. Trends in the demand and supply of labour in the agro-food sector

9. The agricultural sector across OECD countries faces specific issues compared to other sectors with a steady long-term decline in employment due to demographics, structural change, and technological change. While an ageing workforce is a common issue across many countries, attracting and retaining family and non-family members to jobs in rural areas presents unique challenges in all sectors. The national workforce employed in agriculture continues to decline, as well as family labour working in the sector, but hired labour has increased. Furthermore, there has been a rise in the proportion of the agricultural workforce in temporary and seasonal work, as well as a sharp increase in migrant labour. These trends are common across the agricultural sector in many OECD countries.

10. Traditionally, most farming systems were highly labour intensive, with family labour the predominant source of the workforce, and to a lesser extent, hired labour from local regions. However, the structural and technological changes have seen a rise in demand for highly skilled labour in agricultural production. Moreover, the different sub-sectors of agriculture have evolved at different rates, with divergent demand for skilled workers. For example, in many countries the size of livestock farms has increased, and family employment has fallen, while in other countries structural adjustment has resulted in more diversified family farms and an increase in employment (Contzen and Forney, 2017).

11. Demand for labour in agriculture is segmented with many different categories of employees ranging from family owner-operators, farm managers, to employees receiving wages, casual and secondary/temporary workforce (Nettle et al., 2021). For example, in some countries, over 50% of the farm workforce is hired workers either part-time, seasonal, or full time (Nettle et al., 2021). In Australia, for example, the total number of people working on farms declined by 5.5% between 2007 and 2018, with a decline of 20% of farm owner managers, and a net increase of 19% in employees (ABS, 2019).

12. The dual trend of declining overall demand for labour, but increasing reliance on hired labour (part-time, casual, seasonal) as a proportion of the farm workforce is common to many OECD countries. The demand for labour in the agro-food sector is highly segmented and dynamic. This growing trend provides an important context for understanding future skills and labour requirements of the agricultural sector in the coming decades. Moreover, some countries do not account for seasonal, temporary or contract workforces in their national agricultural employment statistics and do not distinguish part-time from casual workforce, or from permanent or full-time employment. The categories of work and the nature of shortages and surpluses in these categories are important to clarify when considering policy responses to future labour and skills needs in the sector.

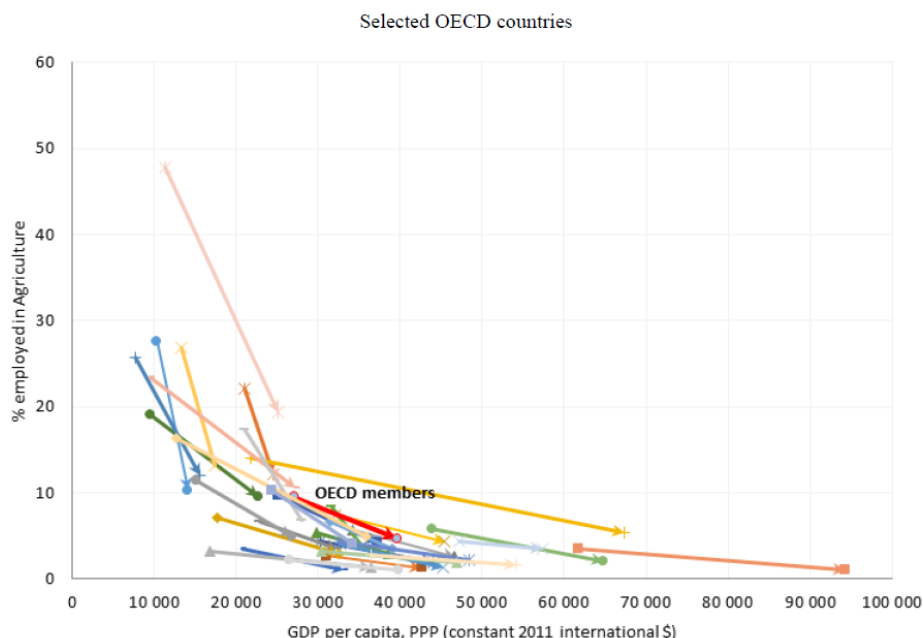
13. Another common trend across the agricultural sector in OECD countries is the steadily ageing workforce, and low number of new entrants to the sector. The OECD's

“Innovation, Agricultural Productivity and Sustainability” reviews (Japan (2019b), the United States (2016a), Australia (2015c), Latvia (2019c), the Netherlands (2015a), Canada (2015b), Korea (2018a), and Estonia (2018b)), highlight the problem of ageing as a key challenge facing the agricultural sector in nearly all countries. For example, the average age of a farmer (owner/manager) in the United Kingdom rose to 60 years in 2016, while 25% of Canadian farmers will be 65 or older by 2025. Kalantaryan et al. (2020) noted a “brain drain” of young talent from rural to urban areas, a trend that is replicated in many other regions and countries.

14. Recent data have shown that about 2.5 million workers have left the agricultural sector across the European Union over the last decade, with this fall being associated with a declining number of farms and larger farm holdings (Schuh et al., 2019). This report also forecast that the agricultural workforce will continue to decline by about 2% annually up to 2030. This steady downward trend in employment in the sector is broadly similar across many OECD countries. The US Bureau of Labor Statistics (2020) has predicted a 6% decline in farmers, ranchers, and other agricultural managers by 2029, and a 1% fall in agricultural workers. An Australian review (The Senate, 2012) also predicted a similar steady decline in employment in the sector over the next decade.

15. Figure 2.1 shows the trend in employment in agriculture and GDP per capita between 1991 and 2017. In overall terms, employment in agriculture has fallen to less than 10% of the agro-food labour force in OECD countries, with the food sector accounting for an increasing share of jobs. It should be noted that in farming, the largest decline has been in the non-salaried family labour input on farms.

Figure 2.1. Workforce employed in agriculture and GDP per capita: Trends between 1991 and 2017

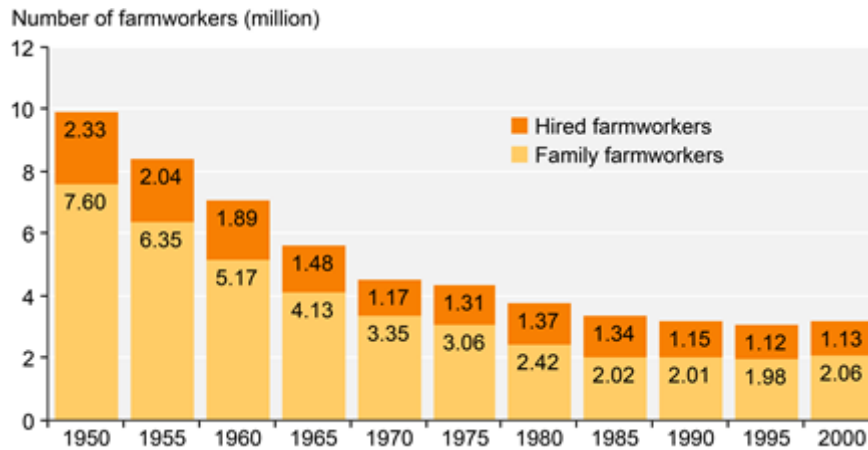


Note: The beginning of each arrow represents each country’s position in 1991; the arrowheads show where they were in 2017.
Source: The World Bank (<https://data.worldbank.org>).

16. This steady fall in agricultural employment can be clearly seen in Figure 2.2, which shows the evolution of the US farm workforce between 1950 and 2000 (USDA). This trend

has been accompanied by greater farm consolidation, increased mechanisation, and higher rates of informal labour migrant workers as seasonal and temporary workers.

Figure 2.2. Family and hired farmworkers on US farms, 1950-2000



Note: Family farmworkers include self-employed farmers and unpaid family members. Hired farmworkers include direct hires and agricultural service workers employed by farm labour contractors.

Source: USDA, Economic Research Service using data from USDA, National Agricultural Statistics Service, Farm Labor Survey (FLS). The FLS stopped estimating the number of family farmworkers beginning in 2001. As of 2012, the survey no longer counts contracted agricultural service workers.

17. There is increasing dependence on migrant and temporary workers for agricultural production, especially for seasonal labour in harvesting and processing in the fruit and vegetable sector, and for full time migrant labour in the meat-processing sector. For example, in the United States, it is estimated that more than half of the farm workforce were born outside the country (USDA, 2021). This trend is likely to have a significant impact on the nature of demand and type of skills needed for agriculture in the future. The greater use of hired labour may also require changes to the education system, as well as with informal learning opportunities.

18. For example, the Seasonal Agricultural Workers Program (SAWP), is a jointly regulated programme that has been successful in facilitating an orderly mobility of labour between Mexico and Canada. The SAWP highlights the strategic partnership between the two countries by filling the labour shortage gaps in Canadian agriculture, while at the same time allows Mexico to increase its capacity for international labour mobility. This programme covers a maximum of eight months in a calendar year, and Mexican workers are employed by more than 2 200 growers in primary agriculture. An interesting aspect of this programme is that all seasonal agricultural workers, while in Canada, are protected by Canadian law, and have life and medical insurance, and after several years are eligible for a pension.

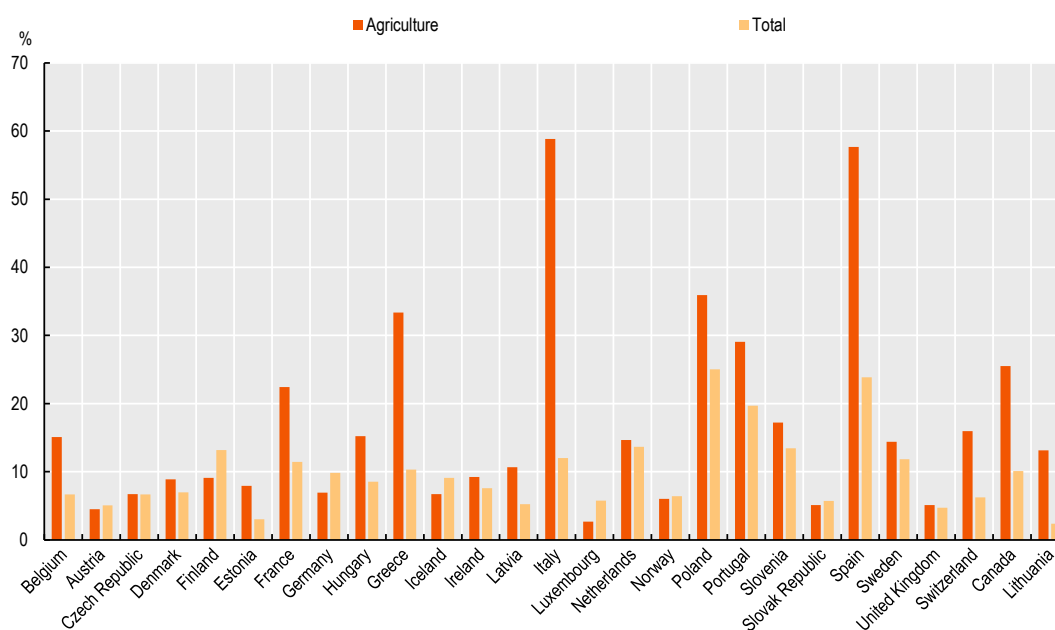
19. Ensuring an adequate supply of labour to the agro-food sector remains a high priority issue for labour policies in many developed countries. With the diverse farming systems across different countries, and varying reliance on migrant labour, the situation is very different in each country. Moreover, the loss of migrant labour due to COVID-19 is likely to impact those countries that rely heavily on migrant labour to perform manual tasks, such as in horticulture, field vegetables and sheep farming (Rose, 2021). However, the potential impacts may be minimal in more developed economies which have a greater capacity to invest in new technologies, there is a drive toward greater automation to fill these labour gaps, and an increasing demand for highly skilled labour.

20. Rotz et al. (2019) identified two key challenges facing the sector, namely, the growth forecast for agriculture due to the expanding global population, and the development and application of new technologies such as robotics, automation, and digital applications. The adoption of new technologies has had a differential impact on the agricultural labour force and has displaced more farm family labour than hired labour (Nettle, 2015). However, family labour still represents the most common form of labour in agriculture, but with the growing reliance on external labour, this is likely to have a fundamental impact on future training requirements in the sector. Balancing further automation and labour demand in the sector is likely to be challenging especially for those countries that want to create more jobs in rural areas.

21. In most OECD countries, the agricultural sector relies heavily on temporary jobs, compared to other sectors. For example, almost 60% of the agricultural workforce in Italy and Spain is temporary, compared to less than 25% for the whole economy (Figure 2.3).

Figure 2.3. Temporary employment in agriculture compared to overall temporary employment, people aged 25-54, 2011-12

Percentage of all employees in each industry



Source: OECD calculations based on European Union Labour Force Survey (EU-LFS) microdata and national labour force surveys (OECD Employment Outlook 2014).

22. The key trends in agricultural employment indicate a continuous decline in the proportion of the workforce in agriculture, a decline in family labour, and an increase in salaried workers. Another interesting trend is the high growing share of seasonal, temporary, and part-time employment in the sector. In many countries, this is often linked to the rapid rise in migrant labour, which is usually characterised by lower skilled manual labour in agriculture. Moreover, the agricultural workforce is ageing, while the number of new entrants to the sector is declining, and entry barriers to agriculture tend to be high in many countries. Lastly, the increased adoption of new technologies and greater automation in farming, is leading to an increase in demand for more highly educated and highly skilled workers in the sector.

2.2. Labour market policies and the agro-food sector

23. Labour market policies are important to ensure that labour markets are working efficiently and are sufficiently flexible to meet the needs of the different sectors in the economy. In addition to the cost of labour and conditions of employment, employment protection regulations also directly influence labour mobility and structural adjustment. Labour markets need to be sufficiently flexible (including social protection) to facilitate workers to move from one economic activity to another at low cost, and to allow wages to fluctuate in response to market forces. The broad labour policies affect the conditions and the cost of employment, as well as the production choices of businesses and their decisions to invest in new products and processes. The OECD indicators of employment protection legislation measure the procedures and costs involved in dismissing workers, and the regulations that apply to the use of fixed term or temporary work contracts (OECD Employment Protection Database, 2016). For example, the United States and Canada have some of the least restrictive employment protection legislation among OECD countries, including for temporary forms of employment. This is particularly important for the agro-food sector due to its high proportion of seasonal labour.

24. Many OECD countries have strengthened regulations on temporary forms of employment including Spain, Türkiye, France, and Luxembourg. According to the Global Competitiveness Report (2017-2018), Canada is amongst the top five OECD countries for labour market efficiency, on the other hand Korea ranks amongst the countries with the least efficient labour markets. Moreover, those sectors in the economy that are undergoing rapid technological change are likely to be particularly affected by labour market efficiency. The agro-food sector is one of these sectors, as it increasingly relies on innovations and new technologies, and attention must be paid to the regulations in order to satisfactorily address labour shortages and skills imbalances in the sector.

25. Globally, there are four mega-trends that are driving changes in skill requirements at work over the past decades: 1) technological change, 2) climate change and the green transition, 3) demographic developments, and 4) the globalisation of value chains (Nettle et al., 2021). The green transition is likely to bring about substantial structural change in business operations and up to 25% of jobs are dependent on consumers in foreign markets. The COVID-19 pandemic has accelerated the adoption of new technologies, increased the risks of displacement, reduced migration, and caused stresses and changes to global value chains. Agriculture and the food sector, in particular, are substantially affected by the climate emergency and the “green” recovery measures in most countries. Many jobs in the agricultural sector are more vulnerable to these megatrends than jobs in other sectors of the economy.

26. Assessing skills and labour needs by standard measures (e.g. hours worked, wages paid, and types of tasks undertaken), can allow a comparative analysis of relative conditions and trends in labour across different sectors of the economy and across different countries. Rose et al. (2021) argue that there are significant skills shortages in the farm sector, especially in high quality social skills and technical knowledge. This pattern is not unique to agriculture but occurs across many sectors. While the labour and skills shortages in agriculture are of concern, the share of jobs at high or significant risk of automation in the sector is high across OECD countries. The agricultural labour force generally engages less on training than most other sectors, and this is partly related to the fact that the labour force is much older, on average, than other sectors in the economy.

27. The aggregate trends suggest that a labour surplus is emerging in the agricultural sector in some OECD countries (Figure 2.1). However, behind these aggregate figures, there is evidence of an increase in demand for more highly educated and highly skilled

workers, and a decrease in demand for low skilled workers. Across OECD countries, on average, these trends are less marked in agriculture than in other sectors. This increasing mismatch between the workforce skills available and those needed in the sector is a cause of growing concern for policymakers. The agricultural workforce is also skewed towards groups that tend to face greater barriers to participation in further training than workers in other sectors.

28. To ensure a sufficient supply of labour and skills to the agro-food sector, as well as other sectors in the economy, active labour market policies are important, and include young people, women, and migrants, for the sustainable development of agriculture and the food sector.

2.3. Labour skills in the agro-food sector

29. The nature and intensity of skills required in agriculture can vary substantially across OECD countries depending on each country's level of technology employed in the agricultural sector. For example, when the agricultural sector is technology intensive there is a high demand for highly skilled workers who can operate these technologies. Conversely, when the demand for labour is linked to more traditional production technologies in the sector, demand for medium skilled workers may be prevalent as production is concentrated in sectors with relatively low value added, and obsolete productive technologies.

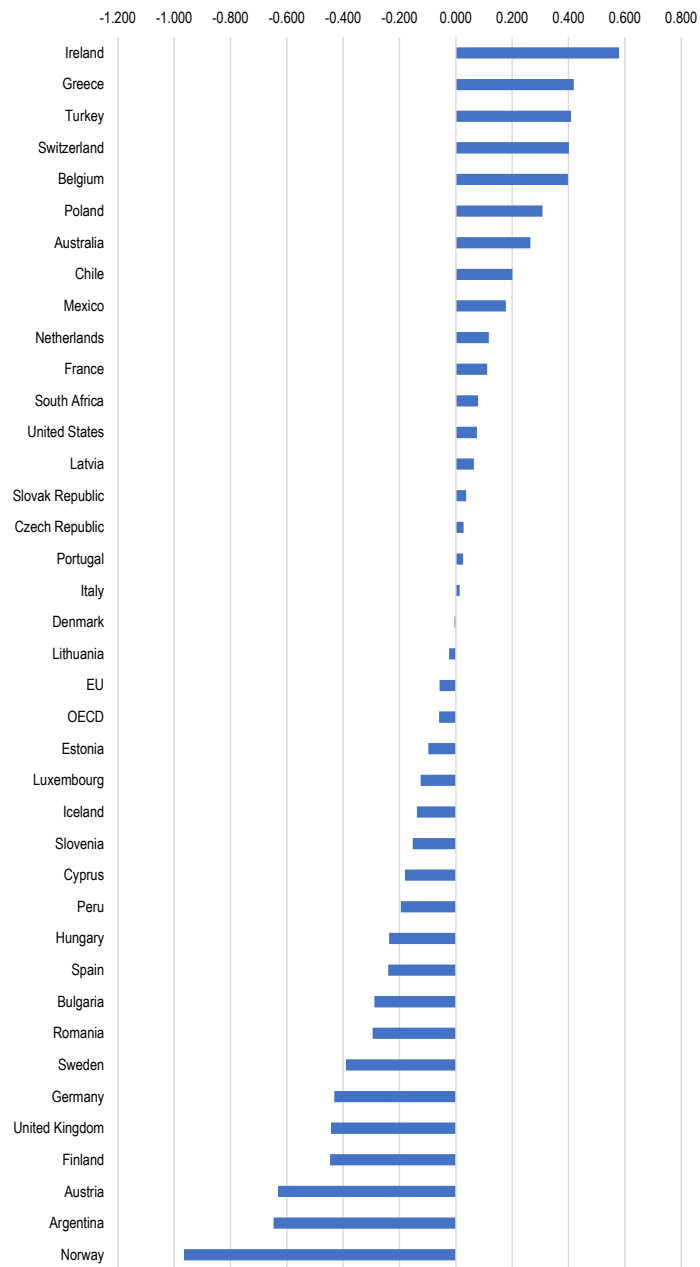
30. The agricultural sector across OECD countries faces unique challenges in meeting the skill needs compared to other sectors. The labour and skills shortages and mismatches across OECD countries suggest that there are major challenges to be overcome, particularly, given the increase in demand for food and other agricultural products. The OECD reports on "Getting Skills Right" make an assessment and address the skills imbalances in the different sectors of the economy. Several recent reviews have been completed for OECD countries including Australia, Chile, France, Italy, Sweden, and the United Kingdom. These reports provide an assessment and make projections on the changing skill needs, good practices, future adult learning systems, financial incentives for education and training, and updates on automation, skills use and training by sector. Despite the rapid mechanisation in agricultural production, many OECD countries still depend on temporary and seasonal workers in the different sub-sectors.

31. Some degree of skill mismatches is inevitable in the economy, and in the sector, as rapid technological change requires constant skill development that can only be achieved with some time lags. However, persistent mismatches may indicate that labour markets are not functioning at their optimal level. More specifically, the evidence shows how some countries are more efficient in reacting to skills challenges and matching the supply and demand of workers' skills in the labour market. According to the OECD's Skills for Jobs database, amongst the skills needed in agriculture, forestry and fishing sector, the greatest skills shortages are related to social skills and teamwork, problem solving, learning, planning, and job specific skills. The data also suggest that the occupational shortages for agriculture, forestry, and fishing are greatest in Ireland, Greece, Switzerland, Poland, Türkiye, and Belgium, while Norway, Austria, and Finland have surpluses of these critical skills (Figure 2.4). Having the appropriate matching of skills with the needs of the job is critical to optimising sustainable productivity in the sector.

32. As labour markets evolve, many countries are refocussing on improving the foundation skills in their workforce. Developing these skills is important to facilitate the introduction of productivity-enhancing technologies and innovations to boost economic growth. In agriculture, the occupational shortages may also be linked to the ability of

countries to develop technology-relevant skills. However, there are major challenges to addressing the low level of digital skills in agriculture, which can have an adverse effect on the adoption of new technologies and productivity. The findings of the OECD Skills for Jobs database illustrate the relationship between occupational shortages and cross-country productivity in agriculture. These findings suggest that, on average, countries that experience more occupational shortages also show lower agricultural productivity levels (Nettle et al., 2021).

33. The skill shortages in the agriculture, forestry and fishing sector differ significantly from the skill shortages for the overall population in each country (see Table 2.1). More specifically, while general skills shortages are concentrated among content skills (reading comprehension, writing, speaking), process skills (critical thinking and active learning), and problem-solving and social skills (instructing, social perceptiveness). In the case of agriculture, the findings suggest that greater efforts need to focus on improving teamwork, management, and operational skills, as well as the importance role of an efficient and effective farm advisory service.

Figure 2.4. Occupational shortage indicator for agriculture, forestry, and fishing

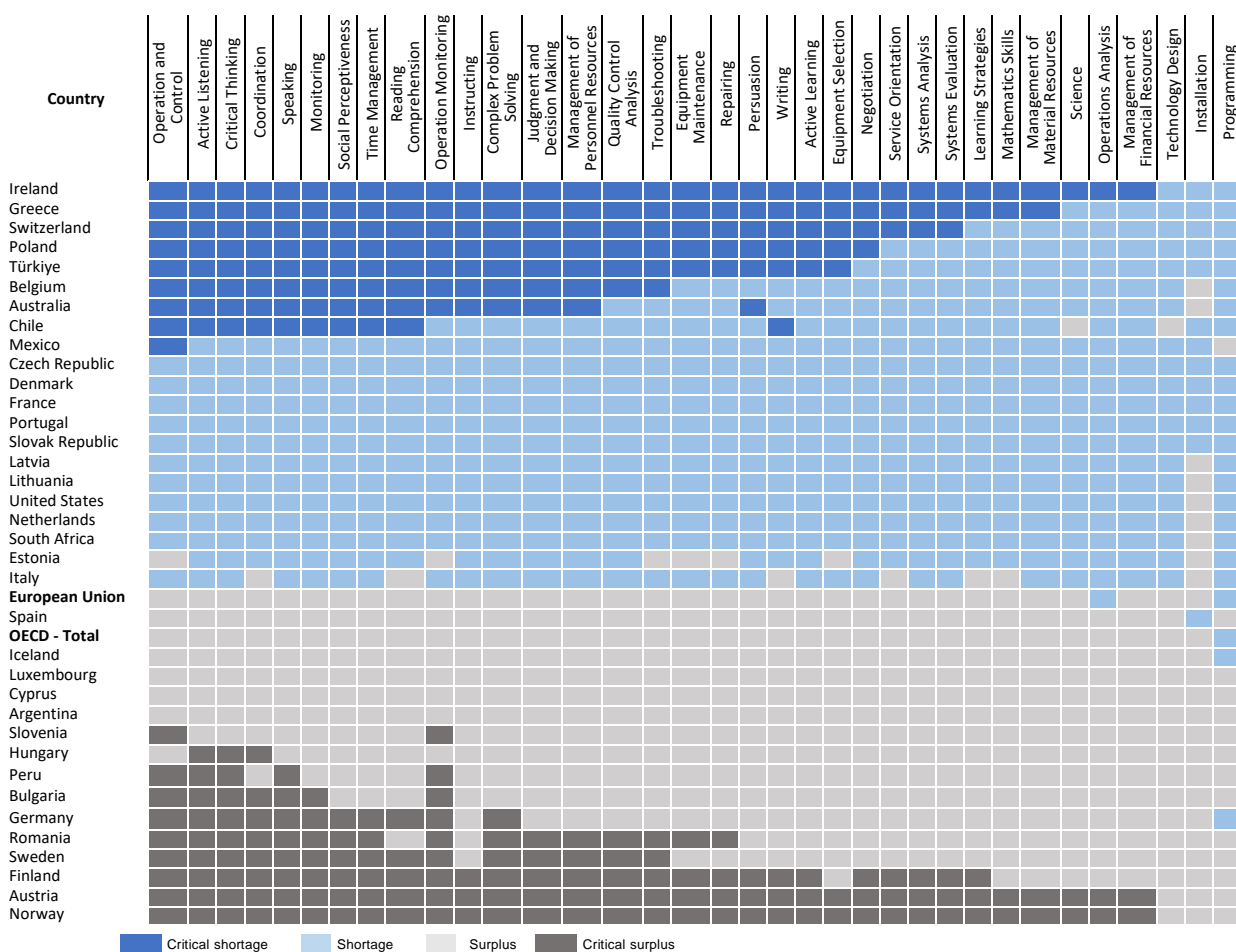
Note: Results are presented on a scale that ranges between -1 and +1. The maximum value reflects the strongest shortage observed across OECD (31) Countries in agriculture.

Note by Türkiye: The information in this document with reference to “Cyprus” relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Türkiye recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Türkiye shall preserve its position concerning the “Cyprus issue”.

Note by all the European Union Member States of the OECD and the European Union: The Republic of Cyprus is recognised by all members of the United Nations with the exception of Türkiye. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

Source: OECD Skills for Jobs database, 2017.

Table 2.1. Skills needs in agriculture, forestry and fishing across some OECD and non-OECD countries (2015)



Note: Critical shortage (darker blue) is defined as the observations in the top quartile of the positive skill imbalance values across countries and skills. Critical surplus (darker grey) is defined as the observations in the bottom quartile of the negative values. Source: OECD Skills for Jobs Database.

34. Drawing from the wider OECD work on labour and skills, the elements of a strategy to meet the needs of the sector should cover four important areas. The first relates to improving formal education by strengthening career information and guidance in schools and encouraging work-based learning opportunities and training. The second area includes aligning adult learning courses with labour market needs and designing targeted programmes for adults whose skills are obsolete. The third area involves making better use of available skills, for example, providing healthy work-life balance options, and creating temporary worker programmes and remuneration incentives for seasonal workers. The final area relates to better governance, improving co-operation and collaboration across the whole of government and stakeholders in the agro-food sector.

35. The OECD Skills Strategy, Assessment and Recommendations (diagnostic report prior to 2017) also recognised the changing nature of most workplaces. These reports cover several OECD countries including Austria, Ireland, Italy, Latvia, Mexico, the Netherlands, Norway, Poland, and Spain, and highlight the rapid transformation of the workplace and the necessity for new skills to be learned for workers to adjust to the new environment, and to be better able to adopt innovations. One of the key recommendations was to promote

lifelong learning so that skills are regularly updated. According to these reports more than 40% of adults participated in some form of further education or training over the previous 12 months, but the rate appears to be lower in the agricultural sector.

36. The changing nature of work in all sectors has been the focus of many foresight reports in the last five years as we prepare for the so-called “fourth industrial revolution”. The World Economic Forum (2016) estimated that 65% of children starting primary school today will end up in professions that do not currently exist, illustrating the radical technology-related changes expected in the workplace in the next decades. The introduction of new technologies into the workplace will have a profound impact on the nature and type of future skills demanded by the economy. A report for the EU Commission by Block et al. (2020) on “Farmers of the Future” predicted that tech-savvy, hyper connected millennials will comprise 75% of the workforce by 2030. The so-called “fourth agricultural revolution” (Agriculture 4.0) is also changing employment and skills needs in agriculture with the adoption of technologies such as artificial intelligence, robotics, gene editing, drones, hydroponics, and cellular agriculture present possible solutions to social, environmental, and economic challenges (Rose and Chivers, 2018). The current trend towards a technology-oriented agriculture is likely to accelerate and thus result in increasing demand for highly skilled labour in the sector.

37. A Canadian review of emerging skills in agriculture identified four key attributes for future farmers including innovative, highly skilled, and diverse and data driven. The report also called on the Canadian Government to rethink its approach to education in agriculture and to invest in the key skills to attract younger, technically skilled people to the sector. Through the Canadian Partnership, Agriculture and Agri-Food Canada invests in Agriculture in the Classroom Canada (AITC-C), a national organisation that aims to increase agriculture awareness and education by targeting students from kindergarten to grade 12 to learn about Canada’s agriculture and food through its activities and teaching tools that are delivered by its 10 provincial member organisations. This initiative can help to increase Canada’s agriculture sector’s workforce capacity and future sector engagement.

2.4. Strengthening gender balance in agriculture and the food sector

38. Improving gender balance in agriculture and the food sector is a high priority across OECD countries, as the number of women officially employed in the sector is relatively low compared to other sectors in the economy (OECD’s PIAAC survey). Also, there is low participation rate of women in agriculture (if measured by gender of the principal farmer) due to several factors including, the lack of affordable and reliable childcare support, lack of time-off for childcare responsibilities, lack of access to finance, and the complex health work-life balance. A study by Kalantaryan et al. (2020) found that only 28% of farm managers across EU Member States are women, and that there has been no significant improvement in recent years. Under the new Common Agricultural Policy (2023), however, additional incentives are being proposed with the aim of increasing the participation of women in the sector.

39. Türkiye introduced several targeted programmes that are focussed on more vulnerable rural groups, including rural women, and young people, to address the issue of labour force shortages in agriculture (OECD, 2016b). The project “Supporting Women Entrepreneurship in Rural Areas” aims to enhance knowledge and skills for entrepreneurship, and thus improve the employment prospects for rural women by helping them to establish agricultural related businesses. For example, women receive special training and support in learning how to brand and market local products. This programme has been initiated by the Active Employment Market Programs’ Project, the Turkish Labour Agency, and the Turkish Agricultural Chamber Association through a special

protocol – “Cooperation for Active Employment Market Programmes”. As part of this programme there are also incentive measures to encourage more young people to become active in agriculture and the food sector.

40. In Switzerland, a comprehensive, national study about women in Swiss agriculture was finalised and published at the end of October 2022. As with the “Women in Agriculture” studies from 2002 and 2012, the study combined both a quantitative and qualitative analysis of the situation. More specifically, in the first step, data (social and geographical origin, education, professional career, tasks in family, farm, etc., changes in family, farm, etc., women's views, view of the future, social and legal security, state of mind, etc.) were collected via an online survey. The second step involved a deepening of the results through four discussion groups in different parts of the country. The final report recommends several actions to empower women in agriculture. Some of the key highlights of the study include:

- The role model and self-image of women in agriculture are changing.
- The economic importance of women is increasing – with farm management, work on the farm or off-farm activities.
- Most women surveyed contribute more than half of the farm income.
- Social security has improved significantly over the last ten years.
- Despite higher workloads, women are more optimistic about the future.

41. A recent OECD study on strengthening gender equality in agriculture entrepreneurship in the Association of Southeast Asian Nations (ASEAN) countries raised several interesting issues. In Southeast Asia ageing is not necessarily an issue, but strong internal migration pressures suggest that “retaining” people in agriculture is an issue; and there is concern over the lack of gender equality in the sector. Moreover, ASEAN countries have a high proportion (45%) of women of working age in rural areas, and a high proportion (28%) of young people in the rural female population. The approach to tackling labour and skills issues has been primarily dialogue-driven. Furthermore, co-ordination and management skills are also in increasing demand in the agro-food sector.

42. Moreover, the OECD is developing an inclusive policy framework for women’s entrepreneurship in ASEAN rural areas, as well as stepwise implementation measures. A draft background document was prepared using available data and information and was discussed with policymakers in the relevant countries. The OECD was invited to produce high-level guidelines, recently endorsed by the ASEAN countries, for implementing the relevant policy in rural areas. The central issue of “inclusiveness” also involves focussing on policy complementarities and trade-offs. Across many countries in the region, it is challenging to ensure that young men and women in rural areas have equal access to entrepreneurial training and skills development. A pre-requisite of training programmes is that they are designed so that men and women train towards entrepreneurial activities that are in high demand, e.g. smart farming. After completing the training, it is important that both women and men have equal rights to property and the use of land, and that the mechanisms and tools are in place to safeguard these rights. Having a network to engage with other women entrepreneurs (e.g. offering mentoring and role models), and expanding access to finance through micro-credits and collective approaches at local levels (e.g. village savings, loans associations, and social collateral) are also important aspects of gender policies.

43. The draft principles submitted by OECD to ASEAN countries for their approval include the following five themes, strengthening access to information, knowledge, and

training, reducing time spent on unpaid work, providing effective support to unlock entrepreneurial potential, ensuring equal access to credit and financial services, and implementing the policy guidelines. In summary, inclusivity is key to strengthening the attractiveness of rural areas to disadvantaged groups, and skills development is an essential part of any employment and entrepreneurship strategy. The design and implementation of inclusive policies to attract people from specific groups to participate in the agricultural work force may require a multidimensional approach, involving different public and private actors and tailored to the specific characteristics and circumstances of the country. A preliminary assessment of systemic strengths and weaknesses can also be helpful to identify and understand the key priorities and avoid duplication. Good policy dialogue is an important element involving a combination of peer learning and the sharing of best practices in identifying new solutions to common problems in the agro-food sector.

2.5. Education attainment and the workforce in the agro-food sector

44. An important characteristic of the agricultural labour force is the relatively low interest and investment in formal education, with a strong preference for informal and experimental pathways to acquiring skills via learning on the job and within the environment of the family farm. However, over the last two decades there is evidence that this situation is changing driven by the changing demands of the sector for more highly educated and higher skilled employees. With the increasing complexity of tasks involved in the agro-food sector, new entrants to the sector also need to have higher formal education to cope with these tasks. The application of modern technologies requires new skill sets, as well as changes in working practices that will have long term implications for the agricultural workforce. An Australian study (KPMG and Skills Impact, 2019) estimated by 2030 about one-third of all new jobs created in the industry will be technology related, mostly navigation and process automation technologies. As reported by many researchers, there needs to be a paradigm shift in thinking about the long-term nature of the agriculture workforce in terms of creating better careers and remuneration, and not simply about short-term concerns on filling labour gaps (Nettle, 2015).

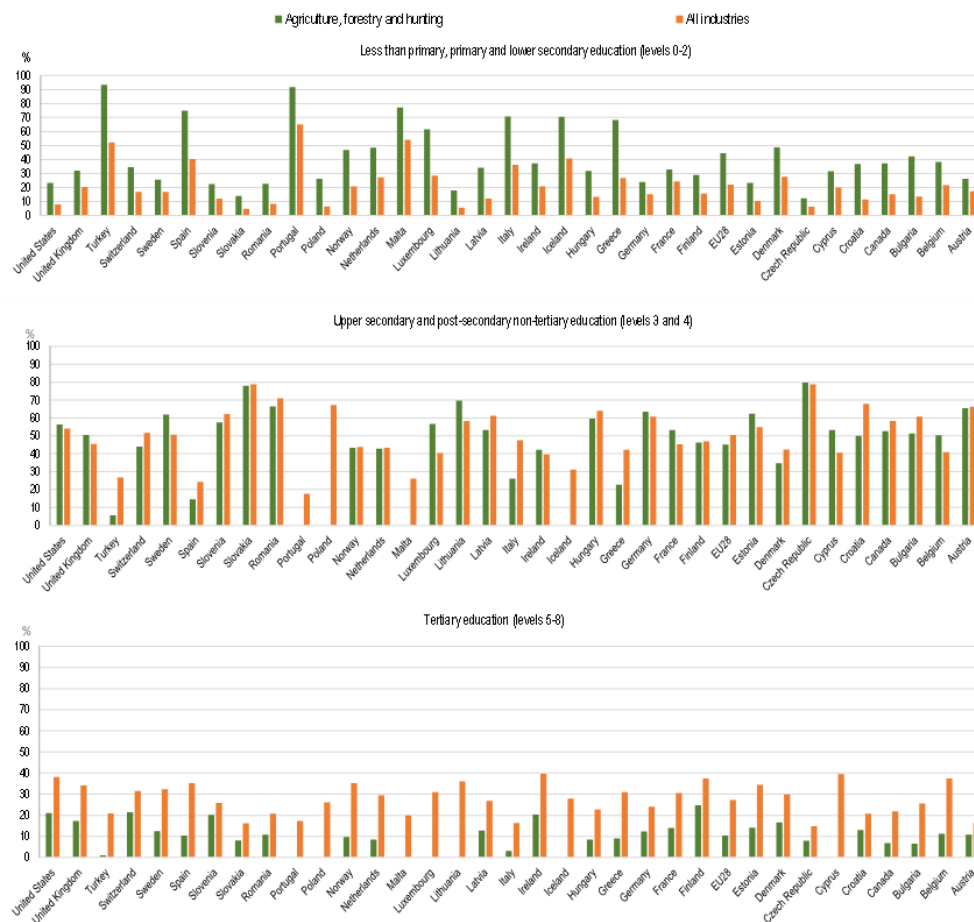
45. Figure 2.5 compares the educational attainment for OECD country's labour force with the labour force employed in the agricultural sector. The figure shows that the educational attainment is lower among agricultural workers, compared to other sectors in the economy. More specifically, the agricultural workforce is more likely to have less than primary and lower secondary education with fewer employees having completed a tertiary education degree. While there are differences in educational attainment across OECD countries, most countries show that educational attainment of agricultural workers is, on average, lower when compared to the rest of the economy. Similarly, educational attainment in rural areas, where agricultural labour is often recruited, is lower than that in urban areas. In addition, the largest share of qualification mismatches is in the agricultural sector.

46. An OECD (2015c) review of Australia found that 47% of people employed in agriculture had a post-secondary qualification, compared to 69% across the whole economy. In Canada, the agricultural sector has a higher proportion of workers without a high school diploma (37%) than the overall labour force (15%). In Japan and Korea, for example, (OECD reviews 2019b, 2018a), the emphasis is on tertiary over vocational education and the provision of adequate training for those in agriculture. The OECD review (2016b) for Türkiye found that over 75% of people employed in agriculture have only primary or secondary school education, while 15% are illiterate. In some countries, the trends are changing with a rise in the number of farm managers with higher levels of formal education. For example, in Ireland between 1990 and 2015, there was a 40% decline in the

share of farm managers relying on practical experience due to greater emphasis on educational efforts (Kalantaryan et al., 2020). Furthermore, the educational attainment has also increased significantly amongst the farming population. In Canada (OECD, 2015b), almost half of the agricultural workforce under 40 have a post-secondary educational qualification, with a significant in those with only a secondary education or an apprenticeship.

Figure 2.5. Educational attainment by industry of employment

Selected countries



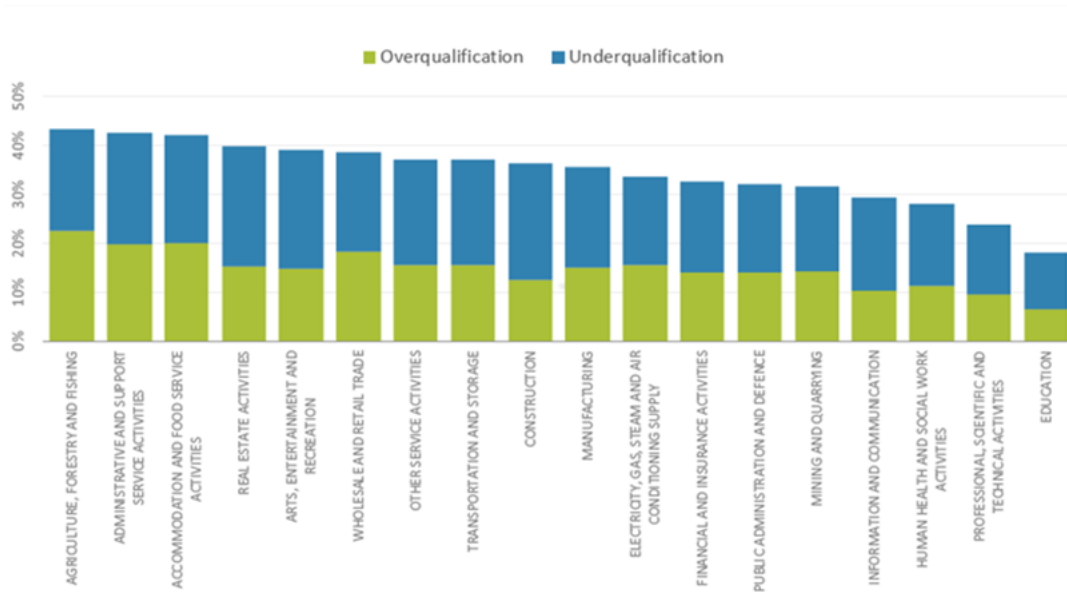
Note: Information from the USA comes from USDA, 2015. For Canada, data are from *Statistics Canada* Census of Population, 2006. For EU countries, data are from 2008, except for Luxembourg, Poland, Slovenia, Sweden which are from 2007.

Source: USDA, National Agricultural Statistical Services for USA, Statistics Canada for Canada, and Eurostat for European Union countries

47. The OECD Skills for Jobs database also provides interesting information on the misalignment between the quantity and quality of education credentials of workers and those required by their jobs. For example, overqualified workers have higher qualifications than those required in the job, while under-qualified workers have lower qualification than those required in the job. Figure 2.6 shows the extent of qualification mismatches across the different sectors in OECD countries. The largest share of mismatches occurs in the agriculture, forestry, and fishing sector, where over 40% of workers are considered as mismatched based on the level of their qualifications. These indicators suggest that there is

an urgent need to improve the alignment (right qualifications) between education qualifications and the jobs requirements.

Figure 2.6. Indicators of over and under-qualification by sector (OECD average)



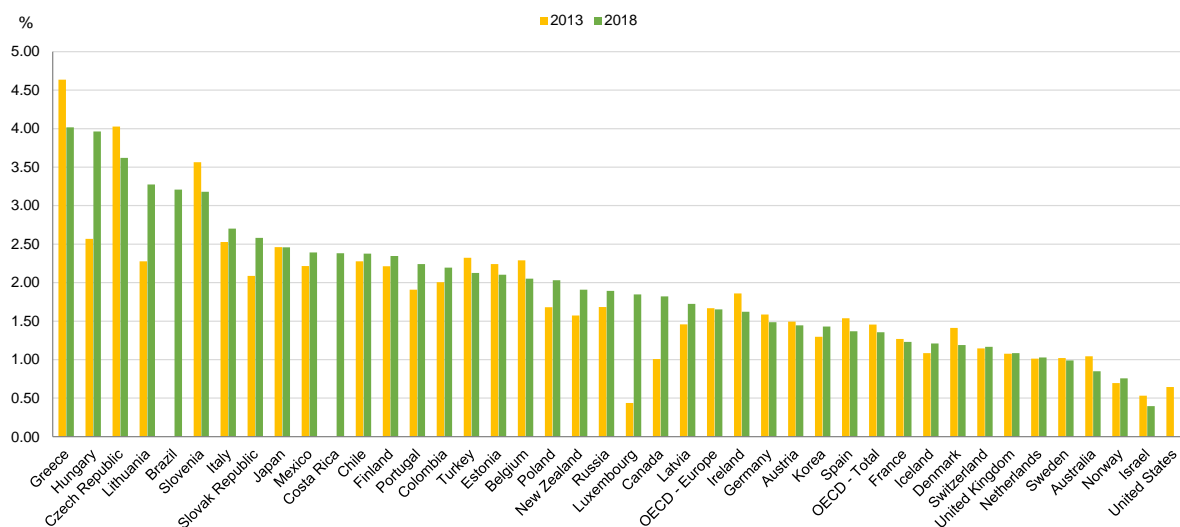
Source: OECD Skills for Jobs, 2018 – Insights.

48. Given the demographic challenges facing agriculture and the need to encourage younger highly qualified workers to the sector, the education system has a critical role to play in meeting these challenges. In 2017, OECD countries expenditure on educational institutions, from primary to tertiary levels, was estimated at 4.9% of their gross domestic product (GDP) (OECD Education at a Glance, 2020). However, there is a wide variation across OECD countries. Furthermore, the share of national resources devoted to non-tertiary education (primary, secondary, and post-secondary non-tertiary levels), was 3.5% of GDP (on average), and much larger than the share devoted to tertiary education at 1.4% of GDP. Moreover, private sources also play a role in financing tertiary education, and accounts for about one-third (on average) of expenditure on educational institutions. Over the period 2012 to 2017, expenditure on primary to tertiary educational institutions as a share of GDP decreased by more than two-thirds across OECD countries.

49. In agriculture, much of the vocational education/training tends to focus on improving production skills and this is particularly important in helping farmers adapt in a rapidly changing sector. In the European Union, vocational education development is a key strategic area in the development of the agro-food sector workforce. For example, EUROPEA is a network that promotes the future development of vocational education and training (VET) in the green sector in Europe. This sector covers a wide range of professions including agriculture, horticulture, forestry, etc. In Switzerland, for example, the objectives and requirements for basic education and training must be reviewed at least every five years to ensure that they are up to date. Currently, a total revision of basic agricultural education in Switzerland is underway. This is intended to teach learners the basics of sustainable agriculture and enable them to meet the major challenges facing agriculture (digitalisation, specialisation, climate change, etc.).

50. Figure 2.7 shows the upward trend in enrolment in tertiary education in agriculture, forestry, fishing and veterinary over the period 2013 to 2018 for most OECD countries. However, there are some exceptions to this trend, for example, Greece, the Czech Republic, Slovenia, Türkiye, Estonia, and Belgium. Having completed a primary degree, short-cycle tertiary programmes are the next most common route into tertiary education. In overall terms, men are more likely than women to enter short-cycle tertiary programmes in countries where science, technology, engineering, and mathematics (STEM) are more prevalent at this level. On the other hand, the share of women at this level is higher where health and education fields are more prevalent.

Figure 2.7. Tertiary education enrolment in agriculture, forestry, fishing and veterinary, 2013 and 2018

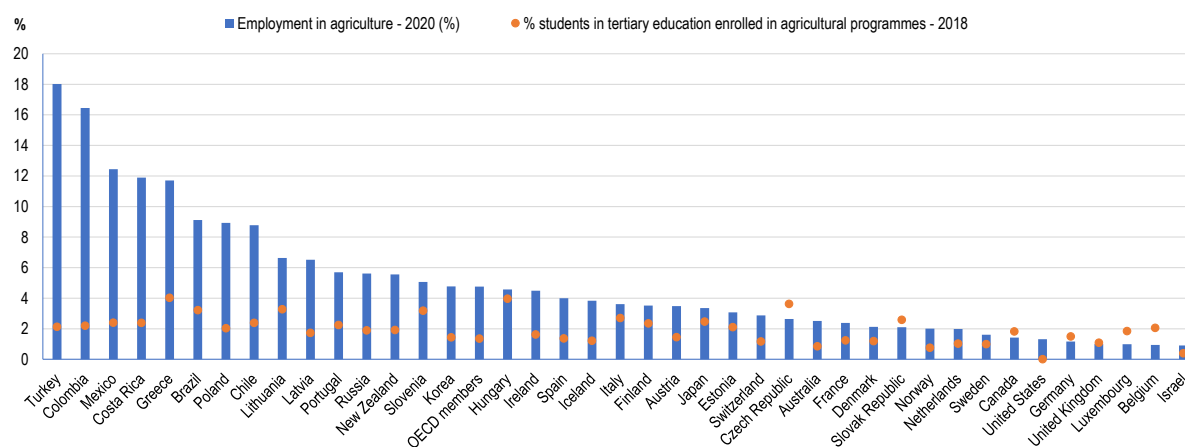


Note: The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem, and Israeli settlements in the West Bank under the terms of international law.

Source: Education at a glance, 2020.

51. Across OECD countries, the demand for agricultural courses at university has been steadily falling over the last 20 years (OECD, Education at a Glance, 2020). More specifically, between 1998 and 2012 the share of university students who have enrolled in agriculture fell by almost 50%, largely in line with the decline in employment opportunities in the sector. Figure 2.8 shows the share of students enrolled in tertiary agricultural courses relative to employment in the sector. It is interesting to note that despite a declining share of employment in agriculture, the share of agricultural enrolments in higher education was stable or rising in several OECD countries including Finland, Japan, and Switzerland.

Figure 2.8. Percentage of students in tertiary education enrolled in agriculture programmes and the share of agricultural employment



Source: <https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS> (for employment in agriculture)

https://stats.oecd.org/Index.aspx?DataSetCode=EAG_ENRL_SHARE_INST (for % students in tertiary education enrolled in agricultural programmes). The missing information on Brazil, Costa Rica and the United States is due to the lack of data rather than the lack of activity.

2.6. Role of the advisory services in addressing labour and skills shortages in the agro-food sector

52. The agricultural extension and advisory services play an important role in the transfer and adoption of innovations on farms, and in providing informal learning opportunities for farmers and farm employees. In addition, the advisory systems also provide contract services for management advice, and the demand for these services are expected to increase with the rise in digitalisation in the sector. Table 2.1 shows the diversity of advisory systems across OECD countries including public and private organisations, farm associations, and specialist consultants. In Japan and Korea, for example, the government is the main funder of farm advisory services, while in other countries, such as Estonia, funding is based on a type of co-funding involving both the public and private sectors. Furthermore, in some countries farmers' organisations also play an important role in providing advice to farmers, who pay collectively for these services. In the Netherlands, the national advisory system was privatised and replaced by a diversity of private providers who provide these services to farmers.

53. In some countries, specialised farm consulting services have emerged, and these provide specialised advice in areas such as management, technical information, and communication technologies. In other countries, farmers can also receive technical and marketing advice from input suppliers, downstream industries and from farmer co-operatives.

Table 2.2. The diversity of farm advisory services

| | Main institutions | Source of funds | Countries |
|------------------------|--|--|--|
| State run | Public organisations at regional and national level | Wholly financed from public funds | Brazil for smaller farms, Colombia, Japan, Korea, Sweden, Türkiye, United States |
| Public-Private service | Increasingly provided by private consultant businesses | Farmers partly or wholly pay for services; centralised and decentralised | Canada, China, Estonia, Australia, United States |
| Farmers' organisations | Farmers' organisations | Membership fees and payments by farmers | Australia, Canada, Colombia, Japan, United States |
| Commercial | Commercial businesses or private individuals | Payment through project implementation or grants | Netherlands, commercial farms in Brazil, Türkiye, United States |

Note: Several systems co-exist in some countries.

Source: OECD (2019b), Innovation, Productivity and Sustainability in Food and Agriculture: Main Findings from Country Reviews and Policy Lessons, OECD Food and Agricultural Reviews, OECD Publishing, Paris, <https://doi.org/10.1787/c9c4ec1d-en>. Adapted from OECD (2013), Agricultural Innovation Systems: A Framework for Analysing the Role of the Government, <https://dx.doi.org/10.1787/9789264200593-en> and OECD (2015e), Fostering Green Growth in Agriculture: The Role of Training, Advisory Services and Extension Initiatives, <https://dx.doi.org/10.1787/9789264232198-en>.

54. In recent years there has been increased interest in strengthening farmers' advisory services, evaluating these services and the governance of pluralistic advisory systems, as well as access to advice for farmers, and the accreditation of advisers (EU SCAR, 2017). At this juncture, the farm advisory services are in a state of transition in many countries due to the changing nature of farmers' demands arising from more sophisticated farming systems. Some of the major trends include:

- To provide advice on a range of subject areas (technology, management, policy, etc.) in an ever increasingly complex sector.
- To advice on compliance (cross-compliance) with regulations and policy requirements.
- To transfer knowledge and information (Information Communication technologies), especially on public goods aspects, policies, and environmental aspects.
- To reduce costs and enhance sustainable productivity growth.
- To provide guidance on farm performance based on benchmarking with other farms in the sector.

55. The advisory services are continuing to adapt and evolve to meet the challenges that are facing farmers and the industry across OECD countries. For example, the advisory services in Latvia (see Box 1).

Box 1. The Advisory Services in Latvia

- Agricultural advisory services provide a range of services, including technological, management, bookkeeping, taxes, and legal advice to farmers.
- The agricultural advisory services are decentralised and include public, private and third sector organisations, with insufficient co-ordination between the different institutions.
- Most of the advisory services are supported by public funding, but increasingly cost recovery is being introduced through fees on farmer users.
- The dominant provider of agricultural advisory services has introduced mandatory certification of the professional qualifications of advisors, and these are supplemented by annual training programmes and knowledge test on production technologies and EU and Latvian regulations.
- In public support measures on the provision of advisory services the quality proofing ex ante exist to create a list of eligible advisory service providers.
- Increasing costs is resulting in the advisory services switching from individual farmer to more digital and group communications.
- There is growing awareness of the need to broaden the range of advisory services, and to include farm workers as well as farm owners.

Source: (Report for the AKIS inventory of the i2connect project, 2021^[2]), [The IPPC ePhyto Solution - International Plant Protection Convention](#).

56. In addition to the technical guidance provided by farm advisors, there is growing awareness of the need for advisers also to have a core set of “soft skills and competencies”, to help farmers navigate the challenges facing the sector (Atkinson, 2010). These may include the core social and emotional skills, trusted rapport, ability to work collaboratively, as well as the ability to manage conflicts. Furthermore, the transition towards digitalisation also brings new responsibilities for advisors and the need to develop new skills (Eastwood et al., 2019). It is well recognised that the advisory services make an important contribution to alleviating the labour and skills shortages in the sector by providing advice and guidance on adaptation to farmers, and through formal and informal education and training programmes.

3. Sharing experience in addressing labour and skills shortages in the agro-food sector

57. This section provides a summary of the presentations and discussions at the Workshop on labour and skills shortages in the agro-food sector, which was held on 22 November 2021. Experts from six OECD countries presented their country’s experience in dealing with the labour and skills challenges in agriculture and the food sector. The Workshop was aimed at identifying and assessing labour and skills mismatches, and the policy approaches taken to addressing these challenges in primary agriculture and in the agro-food sector. The discussions explored the current understanding of the nature and extent of these mismatches and sharing of practices and experiences on possible solutions.

3.1. Japan

58. The shortage of labour and skills in agriculture has been a major challenge for Japanese policy makers for several decades, with the ageing of the farm population and the low number of new entrants to farming. The average age of farmers in Japan is amongst the highest in OECD countries, with the average age increasing from 66 years in 2010 to 68 years in 2020. Over the last two decades, the retirement rate of older farmers has been increasing and this has created some opportunities for young people to enter the sector, and for existing farmers to expand their operations. However, the sector is still characterised by many labour-intensive tasks, as well as tasks that require higher skills. At the same time, agriculture is being driven by competitive pressures to reduce production costs, and this has seen some farmers leaving the industry. Some of the workers who leave are in the younger age cohort and find alternative employment outside of farming. While a large part of agriculture continues to be labour-intensive with many activities still involving a high level of physical risk, and often requiring expert skills and know-how.

59. The structure of farming is also steadily changing with larger corporate farms increasing their share of agricultural production, including in rice farming. Accompanying these changes has been a steady decline in the number of farmers from 11.8 million in 1960 to about 1.4 million in 2020. Unlike traditional family farms, the management of corporate farms often separates the day-to-day agricultural production operations from farm management decisions such as marketing and financial matters. Moreover, with the rapidly changing economic, technological, and social conditions in agriculture, the skills and qualifications of farm managers also need to evolve to meet the current and future farming needs. For example, with the development of modern agricultural value chains, farm managers are increasingly required to acquire entrepreneurial and digital skills in order to develop integrated business plans beyond the farm gate.

60. The capacity of the agriculture and food sector to innovate is closely linked to its ability to attract skilled labour, which in turn depends on improving the remuneration and working conditions in the sector. Despite the increase in mechanisation in some sectors, the agricultural sector is still heavily dependent on seasonal labour to fill the labour shortage gaps, especially in the crop sector. However, the mismatch between the supply and demand of certain skills tends to limit the pace of development and the capacity to adopt innovations. In response to the evolving needs for skilled labour in the sector, agricultural education and training programmes are being reviewed, upgraded, and developed to meet the future needs of the sector.

61. Agricultural education in Japan is based on a system of agricultural colleges that are established at the prefectural level and can be relatively slow to respond to the increasingly diversified and specialised needs of the sector. However, there is a growing awareness of the need to make agricultural education and training more attractive and relevant in order to attract younger skilled workers to agriculture and to help resolve the mismatch of supply and demand for specialised skills. In addition, the focus on continuous learning in the sector is a priority to enable farmers to keep up to date on new technologies. To achieve this requires good collaboration and interaction amongst the key stakeholders to better identify the key skills needed in agriculture, and to help improve the education and training programmes for farmers. In addition, this would help agricultural colleagues to expand their capacity and meet the high skilled labour needs of the sector.

62. Japanese agriculture also faces a challenge related to the shortage of seasonal labour through market and immigration policies, and many farmers are responding by adopting labour saving technologies in agriculture. The government has introduced several programmes to encourage more young farmers to enter the sector. One such programme

provides income support payments for young farmers for up to five years after they enter farming. The provision of more opportunities for learning and training that combines both lectures and internships in advanced farming methods is seen as important in acquiring the skills to become a viable farmer. Japan's agricultural extension system is evolving towards more demand-driven advisory systems that combine both public and private services. The public extension service has an important role in promoting sustainable production practices, supporting disadvantaged producers, co-ordinating government policy, and supporting continuous education and training for farmers.

63. The government's "Smart Agriculture Demonstration Project" promotes "Smart Agriculture". The Japanese Ministry of Agriculture, Forestry and Fisheries (MAFF) defines this as "agriculture that is using advanced technologies such as robotics, artificial intelligence (AI), and information technology". An increase in automated operation such as self-driving tractors (robotics) would enable farmers to reduce their dependence on on-farm labour. For skills succession, the use of ICT technology enables the passing-on of accumulated agricultural know-how and skills to new entrants to agriculture. Lastly, data utilisation enables a farmer to achieve advanced agricultural management through more accurate predictions of growth and analysing remote sensing data for the more efficient use of fertilisers and chemicals.

64. The government set up the Demonstration Project to promote "Smart Agriculture", which introduces advanced technologies to on-farm production. In almost all cases where these technologies (e.g. autonomous tractors, pesticide spraying drones, water management systems, etc.) were introduced, there was a clear reduction in the number of hours worked on the farm. As regards the costs of these technologies, the expensive smart agricultural machines are only installed in a limited area, and this increases the cost of the technology and reduces the potential profits. However, in the case of protected horticulture (e.g. growing green peppers under cover), despite the increase in new technology and other input costs, profits have increased due to higher yields from these integrated environmental control systems.

65. There are three main policy challenges to supporting the adoption of "Smart Agriculture's technology: high initial introductory costs, insufficient infrastructure development, and insufficient learning opportunities amongst farmers. To overcome these challenges, the government launched a policy package and includes the demonstration of techniques and research analyses, setting up a dedicated advisory/extension support service, identifying a pilot village to take it forward and providing learning opportunities to students of agriculture in Japan and abroad. Furthermore, a support service has been introduced to promote Smart Agriculture in schools and training colleges, as well as for a small number of farmers. Training has been offered nationally to extension agents and services including designing a national training programme in 2021, which encourages local training via MAFF offices.

66. Since 2019, the government has funded the Smart Agriculture demonstrations project. As farmers require new skills and knowledge, including AI and new kinds of technology, an IT platform has been developed to promote IT technology – including management controls, the use of autonomous machines, the use of drones, GIS mapping for precision agriculture and reducing chemical and fertiliser inputs. While these new technologies have generally high set-up costs and coupled with poor infrastructure and weak learning opportunities for farmers, these barriers present a challenge to a more market-led adoption of these technologies. However, intervention by the government has helped to reduce these barriers and to encourage greater adoption of these modern technologies.

67. In Japan, the government has scaled-up income support payments to young farmers for up to seven years to encourage more young people to enter the sector. In addition, the information and training package offers demonstrations and performance analysis, advice, and support, making new data available to farmers and offering education in how to make the most efficient use of the various options available. Also, interested students are given information videos, teacher training, and lists of ‘visiting lecturers’ who can be called upon to present these specialist skills to students. These different options are promoted through the advisory networks and through a range of short courses at agricultural colleges. This programme has only been in operation for two years, and as such it is too early to be able to measure the full impacts of the demonstration initiative and broader policy provision for Smart Agriculture. To-date the uptake of this programme amongst students has been promising.

3.2. New Zealand

68. New Zealand’s agriculture faces significant labour and skill shortages which have been exacerbated by COVID-19 and the accompanying lockdowns and border restrictions. Agriculture, like other sectors in the economy, is undergoing a major transformation and this is resulting in a change in the demand for labour, as well as for the skills required. For policymakers to address these issues, they need timely and reliable information and data on the situation in the agro-food sector. This gives rise to a major data challenge including the need for timely and inclusive data, especially in relation to gender participation in the agricultural labour force, as well as the need to monitor the major trends in demand for new skills. The current workforce composition can be identified by its role and character, i.e. whether labour is permanent, part-time, seasonal, etc. However, the evolving demand for specific agricultural skills is more difficult to measure, and robust forecasts are needed to identify future labour demand in the sector, as well as the skills required. For policymakers to make good decisions on the future workforce, it is critical to have good forecasts of future demand for labour and specific skills in the agro-food sector and this requires having reliable and comprehensive information and data on the situation.

69. In New Zealand, attracting and keeping young people and new entrants in farming is a major challenge, with the need to inspire and attract a more diverse workforce. Here the central focus is on education and training to ensure that people have the right skills and knowledge to have a successful career in agriculture and the food sector. Having good employment conditions are critical to enable people to thrive in workplaces with good practices and work conditions. To achieve these goals several elements are required including good collaboration between the public and private sectors, enhancing the reliability and coverage of the data on the agricultural workforce, careful attention to workforce planning, sound forecasting of future scenarios, and making pragmatic transition plans. In New Zealand, the Primary Industry Capability Alliance (PICA, 2020) was founded in 2014 and includes industry, educators and government working together to attract and grow a diverse range of talented people to the food and fibre sector. Building on this initiative, New Zealand’s agricultural industries and government collaborated to develop the Food and Fibre Skills Action Plan 2019-2022. This plan contains basically four broad activities:

- **Knowledge:** generating accurate information on skills and labour needs.
- **Attraction:** changing perceptions to attract people with the right skills into food and fibre careers to support a high quality, adaptable and innovative workforce.
- **Education:** celebrating the food and fibre sectors with students, teachers, and other stakeholders.

- **Employment:** creating workplace conditions to attract and retain talented employees.

70. In the early years, the implementation of the plan was led by the Primary Industries Skills Leaders Working Group 2019, a group of industry, employee and employer representatives, Maori leadership bodies and government agencies. The agro-food sector is also examining ways to improve the attractiveness of agricultural jobs and the nature of farm work (Eastwood et al., 2018).

71. For agriculture, policies have focused on attracting new entrants, widening the labour force net, upskilling, providing better employment conditions, alongside more general policy reforms including in vocational education and immigration rebalancing. New Zealand's Primary Industry Advisory Services (PIAS) promotes PIAS Work stream Initiatives; including a Certification Scheme for Farm Environment Plan Advisers, and funding Research Projects – developed through producer and system and workforce co-design processes, to ensure that the sector knowledge is incorporated. The planned research and outreach programme for agriculture includes cultural competency workshops, and regional education support via the use of seminars and workshops. To attract more young people into the sector, promotional videos have been used, and a new internship programme is planned, as well as work with career development advisors. The PIAS has about 750 advisors, with about 500 skilled in Farm Environmental Plans. Almost 50% of advisors are over 50 years of age and many are expected to retire in the next decade.

72. The New Zealand Government has developed specific strategies for New Zealand's primary industry sector to accelerate economic growth over the next decade. The "Fit for a better World" aims to add NZD 44 billion in export earnings over the next decade. The activities cover four areas: **New Zealanders in Jobs**, which provides incentives to attract young people to work in the agro-food sector and the advisory services, **Safe and healthy food**, **Connect rural New Zealanders**, aimed at supporting innovations, digital infrastructure, best practices and well-being, and **thriving rural communities**. The impact of COVID-19 has had a major disruptive effect on the agricultural workforce over the last two years, but the full impact on training and enrolment in agricultural education, and changes to the structure of the workforce are being explored.

73. The indigenous Māori community is strongly engaged in the agro-food sector. The labour-related policies for the Māori community focus on three key issues: Māori participation in the workforce and Māori representation throughout the workforce – especially in highly skilled, well remunerated roles, ensuring that Māori agribusinesses have the labour and skills to succeed, and Māori participation more broadly in the sector. A project to examine Māori workers' control of agricultural land is ongoing. Overall, Māori make up 18% of the agro-food workforce, and 16.5% of the New Zealand population. Among Māori-owned assets, natural-resource based sectors dominate the Māori-owned asset base, with assets in agriculture, fishing, and forestry totalling NZD 23.4 billion, including: NZD 8.6 billion in sheep and beef farming; NZD 4.9 billion in dairy farming; NZD 4.3 billion in forestry; NZD 2.9 billion in fishing and aquaculture; and NZD 2.6 billion in other agriculture (including horticulture). Māori are also responsible for 65% of fishing quota, 30% of sheep and beef production, 10% dairy and 10% kiwifruit production.

74. For the Māori community, the objective is to increase the number of Māori landowners and agribusinesses and to enable them to achieve confident, well-informed change to achieve their aspirations through their primary sector assets. The MPI has several funds to help this goal:

- Māori Agribusiness Pathway to Improving Productivity – focused on individual Māori land managers.

- Māori Agribusiness Extension programme – supporting Māori agribusiness clusters.
- Sustainable Food Fibre Futures Fund – realising Māori agribusiness innovation.

75. In summary, New Zealand’s agro-food sector is changing rapidly, and this will change the future demand for labour and skills in the sector. One notable change is the growth of non-traditional skills needs in the agro-food sector, which requires training both of employees and their employers. The government is promoting more collective action programmes to help address these skills gaps, and to prepare the sector for future shocks and challenges.

3.3. The Netherlands

76. The Dutch agro-food industry has faced a major challenge in attracting skilled workers to meet the sector’s needs. In 2015, the sector projected a shortage of 1 600 technically qualified workers per year up to 2022 (Taskforce Human Capital Agenda Food & Feed, 2015). In responding to this challenge and to maintain the Netherlands’ international competitiveness, the government, businesses, and education sectors came together to develop a Strategy for Green Education 2016-2025, covering agriculture, nature, and the food sectors. The objective behind this “Human Capital Agenda” has been to increase the involvement and responsibility of food and feed businesses in education and the development of skills, and to attract students to ensure an adequate supply of qualified employees. The strategy has five goals and three related activities.

- Increase the capability of the green education sector to meet labour market needs.
- Increase the speed of renewal of education and training materials and strengthen contribution of innovation in green businesses.
- Increase the responsiveness of the education system to labour market requirements.
- Increase the impact of the education system across its full continuum, focusing on three areas:
 - strengthen international orientation of the green knowledge and education system
 - strengthen and renewing education and linkages to other disciplines
 - strengthen life-long learning and innovation culture
- Develop a positive image for the sector as being a relevant, innovative, and attractive sector in which to study and work.

77. While migration is an important source of labour, especially temporary labour, for the agro-food sector, it has created many challenges for the Dutch agricultural workforce. It is estimated that more than 532 000 labour migrants from European Union countries are currently employed across all sectors in the Netherlands (Taskforce on the Protection of Labour Migrants 2021). Migrants participate in many aspects of the agro-food system in the Netherlands, with about 19% of migrant labour working in horticulture, in addition to those employed in food processing and downstream activities. The COVID-19 impact on labour in the sector has been small and relatively short-lived and has tended to mask longer-term structural issues to ensuring an adequate supply of migrant labour to the sector. In the broader context labour immigration is also a sensitive issue in the Netherlands. Policies for the migrant workforce aim to have better farm inspections to ensure adequate standards for migrant labour, as well as the wider sourcing of migrants from countries outside the European Union. Even with the significant inflow of migrant workers, there continues to be a significant shortage of technical skills in agriculture and the food sector.

78. The vacancy rate in the Dutch agricultural sector (number of open vacancies per 1 000 jobs), shows that there has been a large increase in the overall vacancy rate since the end of the financial crisis in 2014. Moreover, the onset of COVID-19 pandemic caused a temporary dip in the number of vacancies, but it has risen again. A further trend has seen an increase in the share of labour migrants among regular employees in agriculture. For example, the share of labour migrants among temporary agency workers is around 90%, while the share of temporary agency workers in agriculture is around 40%. Overall, these shares have shown little change because of COVID-19, with the share of migrant workers among regular employees in the agricultural sector only declined during the first lockdown in 2020 but was back to “normal” levels by the end of 2020.

79. With growing public concern over the conditions of migrant labour, the Dutch Government set up a Task Force on Protection of Labour Migrants to review the conditions of low-skilled workers in the Netherlands. The recent statistics show that around 532 660 EU citizens are currently working in the Netherlands. The supply of labour in the long run is also a concern, as most of the migrant labour is low skilled, while the demand for highly skilled workers is increasing in line with technological developments in the sector. At the same time, the debate is ongoing with respect to environmental issues, leading to some re-examination of the whole rationale of Dutch agricultural production, which has been relatively intensive and agro-industrial in the past. In addition, the continual decline of family farms in the sector is also a concern for policy makers.

80. Generally, labour migrants often face discrimination from issues such as language, complex legislation, weak social networks, poor bargaining position and are very dependent on employers (for their work, housing and even insurance). The recommendations of the Task Force are for the authorities, employers and other stakeholders involved in the agricultural sector labour market. The main short-term recommendations of the Taskforce include improve the social protection for migrant labour, including temporary and seasonal workers, closer monitoring of work agencies and contractors, improving the housing for migrant workers, and improving the safety and working conditions of temporary migrant labour. The Taskforce also found that less favourable conditions are more prevalent among labour migrants in agriculture compared to other sectors in the economy. The Report also recommended that greater efforts are needed to integrate migrant labour into the Dutch workforce through more targeted educational programmes, and especially language programmes.

81. In the Netherlands, the Green Table was created in 2014 to enhance collaboration amongst educational institutions on areas of common interest including: negotiations with the government, linkages between education and the labour market, and the maintenance of a good knowledge structure across the economy. Some progress has been made in making agriculture-related education more attractive and responsive to the changing skills needs in the labour market and students’ choices, by emphasising job opportunities and societal values. The share of higher educated workers in agriculture is relatively low, largely due to the high share of low educated migrant workers in the sector. Moreover, many technological developments are being initiated to enable the sector to become less dependent on migrant workers in the future. On the other hand, technological developments are also increasing the demand for highly skilled workers, as is the case for other sectors in the economy. The continued adoption of new technologies has increased labour productivity in the agricultural sector at almost the same rate as the average increase across other sectors in the Netherlands.

82. The share of women workers in the agricultural sector is lower on average than in other sectors, and the situation has not changed much in recent years. Overall, there is a general shortage of labour and skills in the agricultural sector, and the increase in demand

for specific skills is not matched by an increase in the supply of workers with these skills. For most Dutch students, studies and potential careers in the agro-food sector is not popular due to many factors: including the general negative social perceptions of agriculture as a career choice. Much work is ongoing to assess the skills gaps, improving the attractiveness of agriculture, assessing the current and future demand for skills, assessing the inflow of workers, and assessing the working population flows such as labour mobility, ageing population, etc.

83. The Netherlands has had a long-term reliance on migrant labour for the agro-food sector, and one of the biggest challenges is how to overcome the negative views of the sector among the new generations of potential domestic workers who could find rewarding jobs and careers in a modern and progressive agricultural sector. A central focus of policies is on life-long learning as a key to meeting the future complex needs of the sector. However, the main concerns are on the future supply of skilled labour to agriculture, labour migration and social issues surrounding labour migration, as well as identifying the future skills gaps and how to make the sector more attractive to new and non-traditional highly skilled entrants. Furthermore, greater efforts are needed to improve co-ordination among Ministries, especially Labour, Agriculture and Education, as well as at local, regional, and sectoral level. Improving co-ordination is critical to integrate migrant labour into the workforce and to ensure a more stable long-term supply of labour to the sector. Lastly, the Netherlands also faces strong competition for low and skilled labour on European labour markets, as many European countries are also experiencing labour and skill shortages not only in agriculture and the food sector, but in many other sectors of their economies.

3.4. Ireland

84. Agriculture and the food industry remain an important sector in the Irish economy in terms of their contribution to GDP, trade, and employment. Despite the long-term decline in total employment in the sector, nevertheless, the sector is facing a significant shortage of labour and skills. The shortages are most severe in the following areas: general farm operatives and butchers in meat processing, farm labour in horticulture (and dairy), and general operatives in food processing.

85. Almost 38% of current vacancies exist in these areas so attracting, retaining, and developing talent is a high priority for the sector. More specifically, Ireland has significant labour shortages in meat processing and in horticulture where it has traditionally relied on migrant labour, which is becoming more problematic. Almost 40% of farm businesses indicate that recruiting and retaining suitable staff is difficult. In agro-food, substantial skills shortages exist in sales, senior management, marketing, R&D, languages, and digital knowledge. With the transformation of the economy, especially in relation to digitalisation, agriculture and the food sector are increasingly seeking more highly educated and highly skilled workers.

86. Over the last two decades, net inward migration from EU15 (accession) Member States to Ireland has been relatively low since the Global Financial Crisis. Moreover, the limited availability of labour for agriculture is facing increased competition with other economic sectors (especially construction), where wages are usually substantially higher. In agriculture, the wages for hired labour tend to hover around the minimum wage level, except for dairy farms, and this is not competitive with other sectors. Despite the excess demand for labour in the sector, wages have not tended to rise due to the general low level of profitability.

87. Farm labour in Ireland, like many countries, faces a reputational problem based on outdated perceptions of the work, education and skills requirements, and its lack of

attractiveness as a long-term career. As the industry modernises and changes, the type of demand for labour is also changing resulting in an increase in demand for more highly educated and skilled personnel. Improving the attractiveness of agriculture as a career is fundamental to improving the skills of those in farming. For example, if talented and educated young people are not attracted to the sector, then upskilling becomes more difficult in this digital age. There are several initiatives ongoing to boost the image of agriculture, and one such initiative is the “People in Dairy Action Plan”, which began in 2018. This scheme aims to boost the attractiveness of the dairy industry, to build long term skills, and to attract 6 000 new workers to the industry by 2025.

88. Several policy instruments have been adopted to encourage and support young farmers to improve their formal education qualifications and skills. In 2015, an EU report highlighted that 10 Member States had included additional qualification criteria for support payments to young farmers under 40 years of age. The “Young Farmer Payment Scheme”, a compulsory scheme for all Member States to implement, allows countries to add additional eligibility criteria to the scheme. For example, in Ireland, to qualify for the payment, a farmer must have successfully completed a recognised course of education in agriculture and have achieved a FETAC level 6 or its equivalent by a set date to qualify for any additional support payments.

89. As regards the current policies to address the imbalances and skills mismatches in the sector, the Irish local and European employment services have had limited success with recruitment to the sector. In the coming year, the government is expected to introduce new employment permits for seasonal migrant workers to help relieve the situation. However, the issuing of such permits is politically sensitive, and they will be quite restrictive and seen as an option of last resort. The Department of Social protection are involved in helping employers recruit from the domestic and European labour market. The sectors also need to have appropriate labour attraction and retention policies in place. Moreover, greater automation in the industry will continue and possibly accelerate, thus reducing the demand for labour. In the short-term automation has some potential to fill the skills gaps, however, the costs and the required scale of application can cause some problems on the small and medium sized family farms.

90. Greater consideration is also being given to increasing apprenticeships, more targeted education initiatives, and new more ambitious and specially tailored training courses to improve education, skills, talent attraction and retention strategy for the sector. Employers also have an important role to play in making the employment more attractive in farming and the food sector by enhancing wages and salaries, working conditions, and investing in appropriate training for workers. In Ireland, future policies plan to encompass the following core aspects; reviewing education and training needs, more responsive and flexible labour migration policies, better promotion of careers in the sector, more investment in research and development, support to spread automation across the sector, and measures to improve gender balance and diversity in farming.

91. Improving the attractiveness of the agro-food sector for new entrants is paramount, especially given the diversity of job types, and there is a need to promote career opportunities in the sector.

92. Finding the appropriate solutions to filling the labour and skills gaps is specific to each country and, possibly each sector, but the sharing of experiences between countries is critical in helping to find these solutions. The available official statistics on labour and skills gaps in agriculture and the food sector are limited, as they often do not include part-time labour such as seasonal/casual labour, student labour, and information on gender employment in the sector. Additional data on these aspects would be helpful in finding sustainable solutions to the labour and skills shortages.

3.5. Spain

93. The characteristics of the labour force in the agro-food sector have changed considerably over the last several decades, due to a reduction in the total number of farms, an increase in farm size, and changes in the contribution of family and non-family labour to the labour force. According to the official statistics women account for only 26% of employment in “Agriculture, hunting and related activities”. However, in the case of the food industry the situation changes significantly, and women represent about 41% of total employment in the sector. In Spain, studies have suggested that the official statistics understate the gender and diversity of the agricultural work force by as much as 60 000. For example, the official statistics understate the number of women working in agriculture, as many farmers’ wives work on farms, but are not registered as formal workers or as waged/salaried employees. In Spain, as in other EU countries, women make a vital contribution to the success of family farm businesses.

94. Moreover, about 32% of farm owners are women, however, in terms of owners who are also managers of holdings this number falls to about 26%. Concerning the agro-food cooperatives only 7% of the managerial positions are held by women. In the Spanish farming statistics, it is evident that women-led farms tend to be much smaller, on average, than those owned by men, and this characteristic tends to be similar in many European countries. Moreover, the standard output of farms owned by women is 40% lower than the average in Spain. In summary, women are significantly under-represented in the agro-food sector.

95. There are many issues and complexities in seeking to change the status of women in agriculture and to empower women in the sector. This development is being increasingly recognised as an important element of modernisation and enhancement of the sector for the future. The Spanish Government has recognised this fact and has introduced several programmes to enhancing the role of women in the sector. Furthermore, Strategic Objective 8 in the new CAP 2023-2027 Regulation aims to “promote employment growth, gender equality, social inclusion and local development in rural areas, including bio-economy and sustainable forestry”. Under this context, Spain has programmed relevant interventions under its CAP Strategic Plan for improving gender equality under the EAGF and EAFRD support. There are many examples of policies and initiatives along these lines in some Spanish regions, and often funded via the LEADER programme.

96. To increase the participation of women in agriculture, several approaches and programmes are being implemented. For example, creating formal farming partnerships is being promoted as a specific model of farm ownership and management that can allow women to have a more equal status alongside their husbands in the farm business. This model generally appeals to older farm couples, for whom the family set-up remains traditional, with the man as the titular head of household. By contrast, younger people generally would expect women to have stronger representation and status than this model would imply, so initiatives that enable women to become principal farmers and set up in farm businesses are more popular among younger age groups. The main goals of these initiatives include increasing women’s access to supports aimed at the agricultural sector, enhancing economic size and profitability of women farms, foster women presence in decision-making bodies within the agricultural sector, ending the invisible work of women in agriculture, and improving the availability of sex-disaggregated statistical data of the sector.

97. To help address the gender imbalance, the Spanish Law of “Farms Shared Ownership” (Law 35/2011) is being relaunched and reinforced to encourage greater women participation in agriculture. This is being achieved through several actions including,

providing a more advantageous tax regime, giving priority access to some public aids, new assistance to help smaller holdings to pay the second social security contribution, and new actions on information dissemination across the country.

98. Concerning the agro-food sector, several measures have been taken to encourage greater participation by women in agro-food co-operatives. At the National Level, an agreement between the Spanish Ministry of Agriculture and Spanish Agri-food Cooperatives Organisation (2018) provides specific actions related to gender equality. More specifically, to develop plans to enhance women's involvement in co-operatives, to publish a compilation of "best practices" regarding gender equality in co-operatives and incorporating gender equality in their training programmes. At the Regional Level, a specific framework for supporting rural women in Castilla La Mancha (Law 6/2019 of Rural Women) should be highlighted, within which a set of measures focussed on rural women are laid down. Furthermore, legislation on regional co-operatives (Law 9/2018 of cooperatives from Extremadura is aimed at increasing parity in representation – "The governing council, in its composition, will tend towards parity and there will be, at least, a number of women members proportional to the number of members that the co-operative society has".

99. Recently, the Spanish Government supported an enquiry into the role of women in agriculture, which found that there were few women representatives in senior roles within agricultural co-operatives. As a result, there is now a National Law that requires these co-ops – which are significant entities in Spain's agro-food sector – to achieve gender parity in their leadership and workforce over a period. In addition, the government is also encouraging women in agriculture to act as role models for others. Also, a special fund has been established for an awards programme for women in farming, which is intended to raise the profile of women in the sector. Early feedback from this programme suggests that these awards have transformed the visibility and status of women in the sector.

100. In sum, greater attention needs to be given to improving the labour force statistics as it relates to labour and skills shortages, the diversity of the workforce, and the special training programmes that are aimed at increasing women participation in the sector. In Spain, the policy experience on improving gender balance in agriculture and the food sector requires a range of tools to overcome traditional biases and to achieving greater gender balance, with different sub-sectors and circumstances requiring a different mix of policy tools.

3.6. The United States

101. The agro-food sector in the United States relies heavily on immigrant and transient workers for agricultural production. The US agricultural workforce has long been a mixture of two groups of workers: 1) self-employed farm operators and their family members, and 2) hired workers (ERS, Farm Labor). Undocumented immigrants have been the backbone of the agricultural labour force for decades and access to this source of labour is increasingly the focus of debate at State and National levels. The National Agricultural Workers Survey suggests a majority of hired US farm workers are foreign born (68%), and 36% lack legal work authorisation (Gold et al., 2022).

102. Foreign guest workers brought in on temporary work visas (H-2A) are a growing share of hired workers in US agriculture. Some estimate the share of H-2A among crop workers as high as 10% (Costa and Margin, 2020). The COVID-19 pandemic increased the visibility of the agricultural sector's reliance on this source of agricultural labour. Moreover, the pandemic has also increased the visibility of "low skilled" foreign workers, who have been reclassified as "essential" in some States. In 2020, foreign guest workers

traveling into the United States with H-2A visas were classified as “essential”, but this is no longer the case. Immigrant workers, however, travel to multiple locations, H-2A workers are only allowed to work in a specific location for a specific employer.

103. The share of the US population employed (self-employed and family labour) in agriculture has been steadily declining (Farm Labor Surveys, USDA). Estimates of the size of the hired US agricultural workforce vary from 1.5 to 2.5 million depending on whether one counts for average fulltime equivalent jobs or the number of individuals employed for wages on US farms at sometime during the year (Martin, Philip 2020). The average employment of hired workers in US agriculture is about 1.5 million, and there are 2.5 million individuals employed for wages on US farms during a typical year. The crop and livestock sectors continue to rely on low skilled labour, much of it foreign born. Despite the fall in the total share of employment, there has been growing evidence of worker shortages in the agricultural sector over the last decade, as evidenced by the dramatic growth of guest worker programmes (2010-2019). In 2020, employment in agriculture, food and related industries accounted for 19.7 million jobs or 10.3% of US employment. However, over half of these jobs are in food services, eating and drinking establishments.

104. A recent USDA Economic Research Service report (ERS, 2022) on “Farm Labor, Human Capital, and Agricultural Productivity in the United States” showed that agricultural employment and total hours worked fell over the last 70 years, while agricultural output tripled over the same time. Along with the reduction in labour employed in the sector, the US farm workforce experienced major changes in demographic characteristics, especially the educational attainment of the workforce. The report estimates that, after adjusting for the changes in the quality of human capital, labour productivity increased by about 12-fold between 1948 and 2017.

105. The Bureau of Labor Statistics has projected strong growth in jobs for agriculture and the upstream industries, including a 19% growth for food preparation and serving, agricultural support industries (30%), equipment operators (12.9%), and farm managers/supervisors (8.7%). Since 1948, agricultural productivity has more than doubled, and total factor productivity has grown at an annual rate of 1.4%. Furthermore, the entry of younger people to the sector has resulted in greater adoption of new technologies, which, in turn, has dampened the demand for low skilled farm workers.

106. In the United States, significant investment is made in agricultural education with training beginning in secondary schools involving a combination of in-class activities and experimental hands-on learning outside of the classroom. The USDA National Institute for Food and Agriculture (NIFA) implements an education and workforce development programme with three key goals: workforce development through grants for scholarships and fellowships, enhancing the research, teaching and extension capacity at Minority Serving Institutions, and fostering learning and engagement in the food and agricultural sciences through programmes and opportunities at secondary and post-secondary institutions. These programmes fund projects that develop curriculum and instructional materials and support teacher training to strengthen student’s critical thinking, communications, and leadership skills. The focus of these programmes is on the public goods aspects, policies, and environmental aspects.

107. According to the National Agricultural Statistics Service (NASS), the US agricultural workforce has seen a long-term decline in both types of employment, self-employed and hired labour, with the largest reduction noted in the self-employed and family labour category. Overall, the workforce is relatively low skilled as 48% of farm labourers, 24% of farm managers, and 20% of other occupations in agriculture, lack a high school diploma compared with just 9% of all US private wage and salary workers. The agricultural sector is characterised by workers having a lower level of formal education

and, consequently, lower wages. Moreover, studies have shown that the average agricultural income in the United States is less than half the income, on average, of non-agricultural workers.

108. In the United States, special visas are required by immigrant workers who wish to work in agriculture (H-2A visas) and the agro-food sector (H-2B visas). The issue of visas for workers under H-2A and H-2B periodically enters the public debate and has been considered in proposed legislation – most recently, the Farm Workforce Modernization Act of 2021. The administration of the H-2A Program (for agricultural workers) is complex, and jointly administered by the US Department of Labor, Department of State, and the Citizenship and Immigration Services. The rules on H-2A guest workers are very strict, especially for seasonal workers, in relation to housing, transportation and wage rates.

109. According to the USDA, Economic Research Service report (2021), “Examining the Growth in Seasonal Agricultural H-2A Labor”, the speciality crop industries remain highly labour intensive and largely dependent on immigrant H-2A labour. But the demand for semi-skilled farm labour has been rising in recent years partly linked to the growth in farm mechanisation. The demand for H-2A visas has more than doubled in recent years driven by increasing demand from the vegetables, fruit and tree nuts, and melon producers. In terms of geographical distribution most of these workers are employed in the intensive crop producing States, in particular California and Florida. The share of farm labour contractors has also increased and now accounts for most H-2A certifications in the vegetables and melon sectors, estimated at about 42% of total certifications issued (2019). As regards wage levels, the average wages for these workers have risen by about 31% between 2010 and 2019, while the average contract length has fallen from 6.7 to 5.3 months. The demand for H-2A visas increased 266% between 2010 and 2019, with the majority issued to workers from Mexico.

110. The growing shortage of low skilled and semi-skilled workers has resulted in higher wages in the sector. Many crop producers have responded to these wage increases by adopting alternative approaches to solving the labour and skills shortages in their sector. More specifically, producers are adopting new laboursaving technologies such as technological platforms, conveyers, and mechanical harvesters, switching to less labour-intensive crops and, in some sub-sectors, moving production outside of the United States.

111. The official statistics underestimate the share of the migrant workforce in agriculture for several reasons including the lack of data, the low entry barriers to the sector compared to other sectors, and the relative informality of the sector. The Bureau of Labor Statistics (2020) has predicted a 6% decline in farmers, ranchers, and other agricultural managers by 2029, but only a 1% fall in the number of agricultural workers in the sector.

4. Conclusions

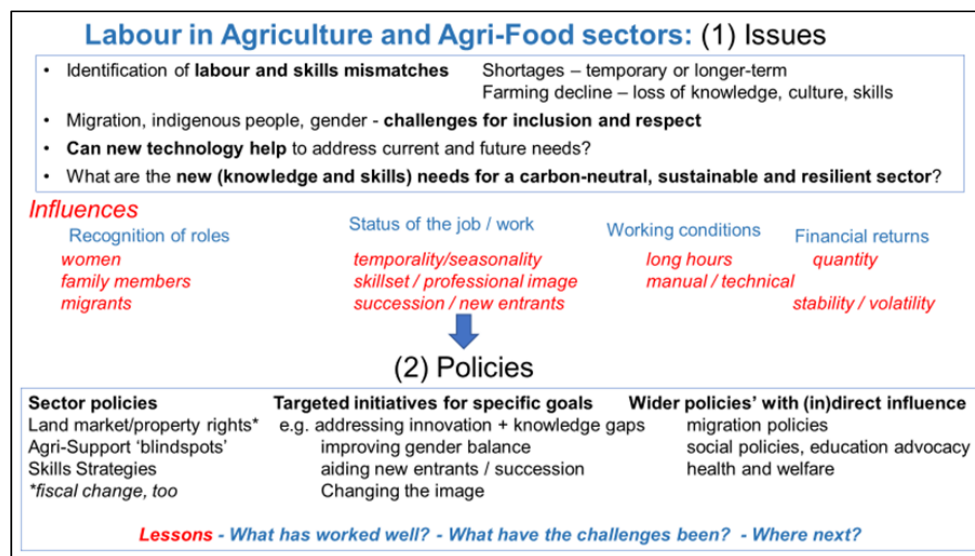
112. The shortage of labour and skills is a major challenge to further growth in the agro-food sector across OECD countries. This challenge is compounded by the relatively small contribution of agriculture to GDP, and the negative perception of the sector with low wages and limited career prospects. While many of the solutions to addressing this issue lie outside the sector, nevertheless, any solutions will involve a mix of policies such as general labour market policies, migration policies, as well as education and training policies for the sector. The agricultural sector also has an important role to play in contributing to finding the best solutions to addressing these shortages in the sector. Some of the elements include improving the working conditions, providing better career prospects, and raising investment in agricultural education and training of young people to enter the sector. In

many countries, the farm advisory services and vocational training courses are also important in building the skilled human capital workforce to meet the future needs of the sector.

113. The characteristics of the sector workforce have changed substantially over the last 20 years, driven by factors such as a long-term reduction in the number of farms and an increase in farm size, increased automation, and changes in the composition of the workforce with a steady decline in family labour, and an increase in hired labour. For many OECD countries, the shortage of both low skilled labour in some sub-sectors and high skilled labour in others, create new challenges for policy makers. Across the agro-food sector, the demand for labour is highly segmented and dynamic with different categories of employees, including family owned-operators, managers, and employees receiving wages, casual, seasonal, and temporary workers. Moreover, there is the dual trend of falling total employment in the sector, while at the same time an increasing reliance on temporary and seasonal workers, most of which is sourced via migration. In many countries, more than 50% of the farm workforce is hired labour including several forms of full time, part-time and contract labour. Other important characteristics of the sector are the growing concerns over the steadily ageing workforce, relatively low education levels, and the low attractiveness of careers in the sector for young, qualified people.

114. Figure 4.1 gives an overview of the complexity of the labour and skills shortage issue and policy interlinkages in the agro-food sector. Many policies are interlinked due to the underlying need to transform the agriculture and the food sector in response to the global megatrends of greening, demographics, digitalisation, and technological developments such as artificial intelligence, automation of production, and robotics. Moreover, the skills shortages facing the sector are complex due to the degree of skill mismatches, migration, and technological change, as well as a variety of influences linked to public perceptions with respect to the role of women and Indigenous Communities, family members and migrants in the sector. In addition, the perceived status of the employment, working conditions and remuneration also influence recruitment into the sector. These “soft” influences have become more and more a focus for a range of existing and potential new policy approaches across OECD member countries.

Figure 4.1. A summary of the key issues and policy linkages in addressing the labour and skills shortages in the agro-food sector



115. Countries are making progress in addressing these challenges, and six OECD countries shared their experiences at a recent Workshop on “Policies to address labour and skill shortages in agriculture and the agro-food sector” on 22 November 2021. The Workshop highlighted the urgent need to do more in terms of inclusiveness, upskilling, and building a resilient workforce for a future agriculture and food sector. More specifically, identifying good practices in measuring and understanding the issues, and in identifying policies can help to address these concerns in a more cost-efficient way. In many countries, the key priorities include a greater engagement of women, young people, Indigenous Peoples, and migrants in the sector, as part of their active market employment policies in agriculture. Furthermore, additional efforts are required to collect the right data and to apply in-depth analyses is critical for a better understanding of the issues and their interlinkages and, thus, to identifying and target potential solutions that are sustainable in a dynamic and fast-moving sector.

116. There are differences between countries with respect to these trends, and therefore a different mix of policies are needed to address these concerns across the sector. The demand for labour and skills differs across the different sub-sectors, and often depends on the labour costs, and the configurations of the family and non-family workforces. For example, in many OECD countries livestock farming has been characterised by an increase in size of enterprise and more automation, while family participation on these farms continues to decline. This trend is closely linked to increased labour productivity resulting from the substitution of labour by capital.

117. The increasing dependence on, and access to, migrant and transient labour in agriculture is a focus of debate in many OECD countries. The COVID-19 pandemic has heightened the visibility of low skilled migrant workers and their critical contribution to the sector, and in some countries has prompted a re-evaluation of the legal status of migrant workers, especially seasonal workers. On the other hand, migrant labour can also be seen as part of a more flexible strategy by farmers to cope with the peaks and troughs in demand needed during the production cycle. Moreover, this flexibility can also be important in dealing with climate challenges, and growing competition for similar skilled labour from other sectors in the economy.

118. Agriculture and the food sector can draw useful lessons from the labour and skills experiences and policy developments in other sectors across the economy. Policies that provide flexibility in hiring and firing enhances the dynamics of the sector and the creation of new jobs, while improving the gender balance in the workforce is likely to increase the attractiveness of the sector to young-qualified entrants. In many countries, greater engagement of women, young people and migrants in the sector is a priority as part of the active market employment policies in the agriculture.

119. Furthermore, inclusivity is a key element to strengthening the attractiveness of rural areas to disadvantaged groups, and the development of skills is an essential part of employment and entrepreneurship strategies. However, inclusive policies need to be designed to be supportive of their needs and attract people from diverse groups to participate in the agricultural work force. This approach often requires close collaboration between the different public and private stakeholders and needs to be designed to the specific characteristics and circumstances of the country. A critical aspect is to have good policy dialogue and a combination of peer learning and sharing of best practices in identifying new solutions to a common challenge across the agro-food sector.

120. The agricultural advisory services make an important contribution to alleviating the labour and skills shortages in the sector by providing advice and guidance to farmers, and through formal and informal education and training programmes. The advisory services play an important role in many countries by providing technical production advice,

management advice, financial and marketing advice, as well as informal training on new techniques and technologies. In addition to the technical guidance, there is growing awareness of the need for advisers also to have a core set of “soft skills and competencies”, to help farmers navigate the challenges facing the sector. These may include the core social and emotional skills, trusted rapport, ability to work collaboratively, as well as the ability to manage conflicts. Moreover, the transition towards digitalisation in agriculture also brings new and more challenging responsibilities for advisors, and the need for life-long learning and the acquisition of new skills.

References

- ABARES (2020), *Labour Use in Australian Agriculture*, Australian Bureau of Agricultural Resource Economics and Sciences, Canberra, Australia.
- ABS (2019), Australian Bureau of Statistics, The demand for farm workers.
- ABS (2020), Farm Management and Demographics, Australia – 2018-19 Dataset downloadable as part of data release for Agricultural Commodities, Australia, 2018-19. ABS Catalogue No. 7121.0. Australian Bureau of Statistics, Canberra.
- AgAmerica (2020), Speciality crop farmers and the growing farm labour shortage, accessed 29 October 2020. Agrifood Skills Australia (2014), Submission to the Agricultural Competiveness White Paper, Canberra: Agrifood Skills Australia.
- Alvarez-Cuadrado, F. and M. Poschke (2011), “Structural change out of agriculture: labor push versus labor pull”, *American Economic Journal: Macroeconomics*, Vol. 3, 127–158, <https://doi.org/10.1257/mac.3.3.127>.
- Akyazi, T., Goti, A., Ovarbide, A., Alberdi, E., and Bayon, F. (2020). A Guide for the Food Industry. To Meet the Future: Skills Requirements Emerging with Industry 4.0. *Foods*, Vol. 9.
- Atkinson, O. (2010). Communication in farm animal practice 1. Farmer-vet relationships. *In Practice*, Vol. 32, pp.114-117.
- Baptista, R.D. (2012), “Technological transition and the new skills required by the agribusiness sector”, *Int. Food Agribus. Manag. Rev.*, Vol. 15, N°6.
- Barr, N. & Kancans, R. (2020), Trends in the Australian Agricultural Workforce: What can data from the Census of Population and Housing tell us about changes in agricultural employment? *ABARES Research Report 20.19*, Canberra, November, DOI: <https://doi.org/10.25814/F8QC-DY41> CC BY 4.0
- Barr, N. (2014), New Entrants to Australian Agricultural Industries: Where are the young farmers?, Rural Industries Research and Development Corporation, Publication No. 14/003, Canberra, DOI: 10.13140/RG.2.1.1100.8160.
- Burton, R. and Fisher, H. (2015), The Succession Crisis in European Agriculture. *Sociologia Ruralis*, Vol 55, Number 2, 155-166.
- Birner, R., Davis, K., Pender, J., Nkonya, E., Anandajayasekeram, P., Ekboir, J., Mbabu, A., Spielman, D.J., Horna, D., Benin, S., Cohen, M. (2009), From best practice to best fit: a framework for designing and analyzing pluralistic agricultural advisory services worldwide. *Journal of Agricultural Education and Extension*. Vol 15 (4), 341–355.
- Botwright Acuna, T., Monckton, D. and Boersma, M. (2019), Design and Delivery of a Masterclass in Horticultural Business, *Int J Innov Sci Math Ed*, 27(4):88–96, 2019.
- Contzen, S. and J. Forney (2017), “Family farming and gendered division of labour on the move: a typology of farming-family configurations”, *Agriculture and Human Values*, 34. <https://doi.org/10.1007/s10460-016-9687-2>.
- Costa, D., and P. Martin (2020)., “Coronavirus and Farmworkers Farm Employment, Safety Issues, and the H-2A Guestworker Program”, Economic Policy Institute.
- Eastwood, C.R., Greer, J., Schmidt, D., et al. (2018), Identifying current challenges and research priorities to guide the design of more attractive dairy-farm workplaces in New Zealand. *Anim. Prod. Sci.* <https://doi.org/10.1071/AN18568>.
- European Commission (2017), *EU agricultural outlook: For the agricultural markets and income 2017-2030*, Directorate-General for Agriculture and Rural Development and the Joint Research Centre

- (JRC), Brussels, https://ec.europa.eu/agriculture/sites/agriculture/files/markets-and-prices/medium-term-outlook/2017/2017-fullrep_en.pdf.
- EU SCAR (2017), *SWG SCAR-AKIS Policy Brief on the Future of Advisory Services*, Strategic Working Group (SWG) of the Standing Committee of Agricultural Research (SCAR) on Agricultural Knowledge and Innovation Systems (SWG SCAR AKIS4), Brussels, https://scar-europe.org/images/AKIS/Documents/Policy_Brief_Future_Advisory_Services.pdf
- European Commission (2017), *EU Agricultural Outlook: For the agricultural markets and income 2017-2030*, Directorate-General for Agriculture and Rural Development and the Joint Research Centre (JRC), Brussels, https://ec.europa.eu/agriculture/sites/agriculture/files/markets-and-prices/medium-term-outlook/2017/2017-fullrep_en.pdf.
- Gold, A., Fung, W., Gabbard, S., and Carroll, D. (January 2022). Findings from the National Agricultural Workers Survey (NAWS) 2019-2020.
- Ingram, J., Chiswell, H., Mills, J., Debruyne, L., Cooreman, H., et al. (2018), “Enabling Learning in Demonstration Farms: A Literature Review”, *International Journal of Agricultural Extension*, 29-42. 13th European International Farming Systems Association (IFSA) Symposium, Greece.
- Kalantaryan, S., Mazza, J. and M. Scipioni (2020), *Meeting labour demand in agriculture in times of COVID 19 pandemic*, Publications Office of the European Union, Luxembourg, EUR 30235 EN, ISBN 978-92-76-19174-2, DOI: <https://doi.org/10.2760/686549>, JRC120800.
- Knierim, A., Labarthe, P., Laurent, C., Prager, K., Kania, J., Madureira, L. and H. Ndah (2017), “Pluralism of agricultural advisory service providers – Facts and insights from Europe”, *Journal of Rural Studies*. 55:45-58. DOI: <https://doi.org/10.1016/j.jrurstud.2017.07.018>.
- International Labour Organization (2016), *Migrant workers in commercial agriculture*, International Labour Office, Sectoral Policies Department, Conditions of Work and Equality Department, Geneva, Switzerland.
- International Labour Organization (2012), *International standard classification of occupations structure, group definitions and correspondence tables: ISC-08 Volume 1*, Geneva, Switzerland.
- KPMG and Skills Impact (2019), *Agricultural workforce digital capability framework*, Cotton Research and Development Corporation, Narrabr, available at: <http://hdl.voced.edu.au/10707/545993>.
- Latruffe, L. (2010), “Competitiveness, Productivity and Efficiency in the Agricultural and Agri-Food Sectors”, *OECD Food, Agriculture and Fisheries Papers*, No. 30, OECD Publishing, Paris, <https://doi.org/10.1787/5km91nkdt6d6-en>.
- McElwee, G. and G. Bosworth (2010), “Exploring the Strategic Skills of Farmers Across a Typology of Farm Diversification Approaches”, *Journal of Farm Management*, 13(12), 819-838.
- Marshall A. Dezuanni M., Burgess J. Thomas J, Wilson, C.K. (2020), “Australian farmers left behind in the digital economy – Insights from the Australian Digital Inclusion Index”, *Journal of Rural Studies* 80 (2020) 195–210.
- Martin, P.L. (2016a), *Migrant workers in commercial agriculture*. International Labour Office, Sectoral Policies Department, Conditions of Work and Equality Department. – Geneva: ILO. ISBN 978-92-2-128885-5 (print) ISBN 978-92-2-128886-2 (web pdf).
- Martin, Phillip (June 24, 2020), U.S. Farm Employment and Farm Workers. Wilson Center. *Farm Labor and Rural Migration News Blogs*.
- McGowan, A., Andrews, M. and Millot, V. (2017), ‘The Walking Dead? Zombie Businesses and Productivity Performance in OECD Countries’, OECD Economics Department Working Papers, No. 1372, OECD, <http://dx.doi.org/10.1787/18151973>.

- Ministry of Social Affairs and Employment, Netherlands (2020), Geen tweederangs burgers, Aanbevelingen om misstanden bij arbeidsmigranten in Nederland tegen te gaan, [Geen tweederangsburgers. Aanbevelingen om misstanden bij arbeidsmigranten in Nederland tegen te gaan | Rapport | Rijksoverheid.nl](#).
- Ministry of Social Affairs and Employment, Netherlands (2020), Eerste aanbevelingen Aanjaagteam bescherming arbeidsmigranten, [Eerste aanbevelingen Aanjaagteam bescherming arbeidsmigranten | Rapport | Rijksoverheid.nl](#)
- Nettle, R. (2015), “More Than Workforce Shortages: How Farm Human Resources Management Strategies Will Shape Australia’s Agricultural Future”, *Farm Policy Journal* 12(2): 17-27 (Winter quarter).
- Nettle, R. and E. Vera-Toscano, (2021), “Skills and labour needs in food and agriculture”, Background report on shaping the agri-food workforce for sustainable growth, prepared for the OECD Secretariat, Unpublished, University of Melbourne, Australia.
- Nettle, R., A. Crawford, P. Brightling (2018a), How private-sector farm advisors change their practices: An Australian case study. *Journal of Rural Studies*, Volume 58, February 2018, Pages 20–27 <https://doi.org/10.1016/j.jrurstud.2017.12.02734>.
- Nettle, R., Kuehne, G., Lee, K. and D. Armstrong (2018), “A new framework to analyse workforce contribution to Australian cotton farm adaptability”, *Agron. Sustain. Dev.* 38, 38. <https://doi.org/10.1007/s13593-018-0514-6>.
- Nettle, R. Klerkx, L., Faure G., and Koutsouris, A. (2017), Governance dynamics and the quest for coordination in pluralistic agricultural advisory systems, *Journal of Agricultural Education and Extension* 23:3, 189-195, DOI: 10.1080/1389224X.2017.1320638
- Nettle, J.M. Morton, N. McDonald, M. Suryana, D. Birch, K. Nyengo, M. Mbuli, M. Ayre, B. King, J.-A. Paschen, N. Reichelt. (2021), Factors associated with farmers’ use of fee-for-service advisors in a privatized agricultural extension system, *Land Use Policy*, No. 104.
- OECD (2022), *Agricultural Policy Monitoring and Evaluation 2022*, OECD Publishing, Paris, <https://doi.org/10.1787/2d810e01-en>.
- OECD (2020), *Agricultural Policy Monitoring and Evaluation 2020*, Organisation for Economic Cooperation and Development Publishing, Paris, DOI: <https://doi.org/10.1787/928181a8-en>.
- OECD (2020), *Education at a Glance 2020: OECD Indicators*, OECD Publishing, Paris, <https://doi.org/10.1787/69096873-en>.
- OECD (2019a), *Innovation, Productivity and Sustainability in Food and Agriculture: Main Findings from Country Reviews and Policy Lessons*, OECD Food and Agricultural Reviews, OECD Publishing, Paris, <https://dx.doi.org/10.1787/c9c4ec1d-en>.
- OECD (2019), *OECD Skills Outlook 2019: Thriving in a Digital World*, OECD Publishing, Paris, <https://dx.doi.org/10.1787/df80bc12-en>.
- OECD (2019b), *Innovation, Agricultural Productivity and Sustainability in Japan*, OECD Food and Agricultural Reviews, OECD Publishing, Paris, <https://doi.org/10.1787/92b8dff7-en>.
- OECD (2019), PISA 2018 Results (Volume I): What Students Know and Can Do, PISA, OECD Publishing, Paris, <https://doi.org/10.1787/5f07c754-en>.
- OECD (2019), Survey of Adult Skills (PIAAC) (2012, 2015) in *OECD Employment Outlook 2019: The Future of Work*, OECD Publishing, Paris, <https://doi.org/10.1787/9ee00155-en>.
- OECD (2019c), *Innovation, Agricultural Productivity and Sustainability in Latvia*, OECD Food and Agricultural Reviews, OECD Publishing, Paris, <https://doi.org/10.1787/>.

- OECD (2018a), *Innovation, Agricultural Productivity and Sustainability in Korea*, OECD Food and Agricultural Reviews, OECD Publishing, Paris, <https://doi.org/10.1787/>.
- OECD (2018b), *Innovation, Agricultural Productivity and Sustainability in Estonia*, OECD Food and Agricultural Reviews, OECD Publishing, Paris, <https://doi.org/10.1787/>.
- OECD (2018), *Good Jobs for All in a Changing World of Work: The OECD Jobs Strategy*, OECD Publishing, Paris, <https://doi.org/10.1787/9789264308817-en>.
- OECD (2017), *Getting Skills Right: Skills for Jobs Indicators*, OECD Publishing, Paris. DOI: <http://dx.doi.org/10.1787/9789264277878-en>.
- OECD (2016), *Employment Protection Database*, www.oecd.org/employment/protection.
- OECD (2016), *Skills Matter: Further Results from the Survey of Adult Skills*, OECD Skills Studies, OECD Publishing, Paris. <http://dx.doi.org/10.1787/9789264258051-en>.
- OECD (2016a), *Innovation, Agricultural Productivity and Sustainability in the United States*, OECD Food and Agricultural Reviews, OECD Publishing, Paris, <https://doi.org/10.1787/9789264264120-en>.
- OECD (2016b), *Innovation, Agricultural Productivity and Sustainability in Turkey*, OECD Food and Agricultural Reviews, OECD Publishing, Paris, <https://doi.org/10.1787/>.
- OECD (2015a), *Innovation, Agricultural Productivity and Sustainability in the Netherlands*, OECD Food and Agricultural Reviews, OECD Publishing, Paris, <https://doi.org/10.1787/9789264238473-en>.
- OECD (2015b), *Innovation, Agricultural Productivity and Sustainability in Canada*, OECD Food and Agricultural Reviews, OECD Publishing, Paris, <https://doi.org/10.1787/>.
- OECD (2015c), *Innovation, Agricultural Productivity and Sustainability in Australia*, OECD Food and Agricultural Reviews, OECD Publishing, Paris, <https://doi.org/10.1787/>.
- OECD (2014), *OECD Employment Outlook 2014*, OECD Publishing, Paris, DOI: https://doi.org/10.1787/empl_outlook-2014-en.
- OECD (2014), “Analysing Policies to improve agricultural productivity growth, sustainably: Revised framework”, <http://www.oecd.org/tad/agricultural-policies/Analysing-policiesimprove-agricultural-productivity-growth-sustainably-december-2014.pdf>.
- OECD-FAO (2020), *OECD-FAO Agricultural Outlook 2020-2029*, OECD Publishing, Paris/FAO, Rome, <https://doi.org/10.1787/1112c23b-en>.
- Preibisch K. (2010), “Pick-Your-Own Labor: Migrant Workers and Flexibility in Canadian Agriculture”, *International Migration Review*. 2010; Vol.44(2), pp.404-441. doi: <http://dx.doi.org/10.1111/j.1747-7379.2010.00811.x>.
- Quintini, G. (2011), “Right for the Job: Over-Qualified or Under-Skilled?”, *OECD Social, Employment and Migration Working Papers*, No. 120, OECD Publishing, Paris, <https://doi.org/10.1787/5kg59fcz3tkd-en>.
- Rose, D.C. and E. Creak (2021), “What skills are needed in farming and how can they be learned”, Background report prepared for the OECD Secretariat, Unpublished, University of Reading, United Kingdom.
- Royal Bank of Canada (RBC) (2019), “Farmer 4.0: How the coming skills revolution can transform agriculture”, Royal Bank of Canada, Toronto.
- Rotz, S., Gravelly, E., Mosby, I., et al., (2019). Automated pastures and the digital divide: how agricultural technologies are shaping labour and rural communities. *J. Rural Stud.* DOI: <https://doi.org/10.1016/j.jrurstud.2019.01.023>.

- Seymour, E. and Barr, N. (2014), *Farmer preferences for formal learning: a review of current data and literature*, State Government of Victoria Department of Environment and Primary Industries, Melbourne, DOI: <http://dx.doi.org/10.13140/RG.2.1.3197.9684>.
- Statistics Canada, (2020), “COVID-19 Disruptions and Agriculture: Temporary Foreign Workers”, accessed 20 October 2020.
- Statistics Canada, (2019), *Canadian Agriculture at a Glance: The educational advancement of Canadian farm operators*, Authors: Kevin Tran and Matthew Shumsky. Release date: 21 March 2019;
- Taskforce Human Capital Agenda Food & Feed (2015), “Ontwikkelagenda groen onderwijs 2016-2025”, *Topsector Agri & Food*, Wageningen, The Netherlands, accessed 1 September 2020.
- USDA (2015) US Department of Agriculture Economic Research Service, ‘Farm Labour’(National Agricultural Statistics Service, Farm Labour Survey (FLS): available at <https://www.ers.usda.gov/topics/farm-economy/farm-labour/>).
- USDA, Economic Research Service (2022), “Farm Labor, Human Capital and Agricultural Productivity in the United States”, *Economic Research Report* Number 302, February 2022.
- USDA, Economic Research Service (2021), “Examining the Growth in Seasonal Agricultural H-2A Labor”, *Economic Information Bulletin* Number 226, August 2021.
- USDA, Economic Research Service (2021), “Farm Labor,” <https://www.ers.usda.gov/topics/farm-economy/farm-labor/>.
- Wolbers, M. (2013), Job Mismatches and their Labour-Market Effects among School-Leavers in Europe. *European Sociological Review*. DOI: <https://doi.org/10.1093/esr/19.3.249>.
- World Bank, (2019), *Employment in Agriculture*, <https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS?contextual=employment-by-sector&end=2017&start=1991&view=chart>.
- World Bank, (2007), World Development Report 2008: Agriculture for Development. World Bank. <https://openknowledge.worldbank.org/handle/10986/5990>.