European Training Foundation

IDENTIFYING TECHNOLOGICAL CHANGES AND SKILLS NEEDS IN THE WESTERN BALKAN AGRI-FOOD SECTOR

COUNTRY REPORT: *North Macedonia*

THE EU AGENCY SUPPORTING COUNTRIES TO DEVELOP THROUGH LEARNING

European Training Foundation

The study is coordinated by **PPMI**

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INTRODUCTION

This report forms part of a broader study on the technological changes and skills needs of the Western Balkan agri-food sector, conducted by the European Training Foundation (ETF). The report focuses specifically on the North Macedonian agri-food sector and aims to identify the skills needs and technological changes that have taken place between 2017 and 2022, within three specific niches of the sector: digitalisation for agri-food, biochemical and microbial products for agri-food, and organic and functional foods.

To answer the research questions related to these niches, the report draws on both qualitative and quantitative research methods. Desk research was carried out, analysing sources such as EU and national government reports, donor reports, academic journal articles, project reports, and grey literature. In addition, nineteen interviews were conducted with representatives of the academia, businesses, public sector representatives, business intermediaries, such as employment organisations and civil society organisations.

In this context, the overall objective of this report is to identify current and emerging technological changes and skills needs in the specific niches of the agri-food sector in North Macedonia and shed light on innovativeness of the SMEs. The report also provides conclusion remarks and recommendations aimed at addressing the gaps in education offer, institutional set up, level of cooperation among business intermediaries, businesses and training providers.

OVERVIEW OF THE AGRI-FOOD SECTOR

Policy background and key stakeholders

The agri-food sector is one of the most important sectors in the North Macedonian economy, providing food and agricultural primary materials necessary for country's growth and development. Agri-food sector has been recognised as a crucial area in the development of the country's **Smart Specialisation Strategy 2021-2024**, which has not yet been adopted and is in the process of preparation from 2018.[1]

In 2021, the Joint Research Centre of the European Commission (JRC) conducted quality analysis of the economic, innovation and scientific potential of the country. The results of this assessment will inform the final Strategy. Four[2] preliminary domains were suggested by the JRC to be further elaborated in the Smart Specialisation Strategy, including sustainable food and beverage production and value chains. The proposal within this domain was to include two sub-areas which will focus on smart agriculture, and food processing with high added value.

According to the interviewed representatives from the public sector, the preparation of the Strategy is supported by the World Bank, Swiss funded project Increasing Market employability (IME),[3] and German Agency for International Cooperation (GIZ). It is coordinated by the Ministry of Education and

[1] Qualitative analysis of economic, innovation and scientific potential in North Macedonia (JRC Technical Report, 2021).
[2] Including Information and Communication Technologies (ICT), Smart/Sustainable buildings and materials; and Electrical.
[3] Available here.

Science (MoES), Ministry of Economy (MoE) and the Cabinet of the Prime-minister for Economic Affairs.[4]

Relevant public institutions and stakeholders which are involved in the functioning and development of the agri-food sector, SMEs, and research and innovation activities in the country are presented below.

- The **Ministry of Agriculture, Forestry and Water Economy** (MAFWE) is responsible for agriculture, forestry, water management, and fishery, including the use of land and water resources, monitoring and researching the conditions of the plants and soil and other activities set in the legislation. The MAFWE sets strategic goals, adopts policy documents, and monitors their implementation.

- The **Agency for Financial Support of the Agriculture and the Rural Development** (AFSARD) was founded in 2007 with the objective of improved implementation of the agricultural policies and the rural development policies in the country. The AFSARD is also an institutional body which enables efficient management of the financial resources both from the Central government budget and the funds from the European Union Pre-Accession Assistance for Rural Development (IPARD).

- **Ministry of Education and Science (MoES)** ensures the functioning of education and training in the country. MoES is also the focal point for innovation programmes and development of the research and science in the country. According to the Law on innovation activity, the MoEs through its Department for Innovation and Entrepreneurship prepares the Strategy for Innovation[5] which plays crucial role in the developing of the innovation landscape in the country, including in the agri-food sector.

- **Fund for Innovation and Technologic Development** (FIDT) is public institution that supports start-ups and innovative companies in the Republic of North Macedonia. FIDT was formed by the Law on innovation activity in 2013[6] and by 2021 has co-financed more than 680 projects with more than 86 million EUR. The FIDT prepares Annual working plan and executes its activities in accordance with the plan. In the Financial plan for 2022, FIDT foresees to spend nearly EUR 19.8 million of which nearly EUR 1.5 million goes for the three accelerators: X Factor (in Bitola), Seavus Accelerator (in Skopje) and Business-Technology Accelerator UKIM (in Skopje). FIDT, through its programme and operational plans, fosters the capacities of start-ups, micro sized and small companies and encourages digitalisation among businesses.

- **Macedonian Academy for Science and Arts** (MASA) is the highest scientific and artistic institution in the country, which organises basic, developmental and applied research. The Academy collaborates with universities, scientific and cultural institutions, scientific and artistic societies and other organisations in the field of sciences and arts in the country and abroad. MASA has eight research centres and has well-developed cooperation with universities, research centres and institutions. Centres that are relevant to the development of the market niches of digitalisation in agri-food and biochemical products for agri-food are the Research Center for Computer Sciences and Information Technologies and The Research Center for Genetic Engineering and Biotechnology. While the activities of these research centres are not focused on the agri-food sector, their work can be applicable for the development of the broader agri-food sector.

- **National Council for Higher Education and Research** (NCHER)[7] is body that was formed in June 2021, in accordance with the amended Law on Higher Education in 2018. The Council has 15 members elected in the Parliament whose mandate is evaluating, developing and improving the quality in higher education and scientific research activities in the Republic of North Macedonia. In October 2022, the Council brought a regulation on standards and normative on

[4] More information is available here.
[5] Innovation Strategy of the Republic of Macedonia 2012-2020, available here.
[6] Law on innovation activity (Official gazette 79/2013 and amended in the years 2014, 2015, 2016, 2018, 2021).
[7] National Council for Higher Education and Research Activities.

establishment of scientific institutes and activities for conducting scientific and research work. Although new in its functioning, NCHER would have important role in creating strategic goals and setting the reform pathway for overall educational and scientific landscape in the country.

The general regulatory and policy framework that exists in North Macedonia to support SMEs and innovation is presented in Annex 1. Policy framework for SME and innovation development.

Apart from the public bodies, various business intermediaries support the development of the agri-food sector and the specific niches, such as digitalisation in agriculture and food processing, biochemical and microbial products for agriculture and organic and functional foods (see the table below).

TABLE 1. BUSINESS INTERMEDIARY BODIES

Name of body	Form	Legal status
Association of Agriculture and food processing industry	Economic Chamber of North Macedonia	Economic chamber
Agro-business chamber	Macedonian Chambers of Commerce	Economic chamber
Association of Food Producers	Business Confederation Macedonia	Employers' organisation
ProAgro Farmers	Association of Farmers	Non-Government Organisation
Rural Development Network	Association	Non-Government Organisation
Regional Rural Development Standing Working Group	Working Group with members from the WB6 countries	Intergovernmental Organisation
Chamber of Organic Producers	Economic Chamber	Economic chamber
National Farmers Federation	Association	Non-Governmental Organisation
North Macedonia Organic Producers Federation	Association	Non-Governmental Organisation

Source: Desk research and field interviews.

Key business statistics

Agriculture

Agricultural sector is among the most relevant sectors in Macedonian economy in terms of GDP share and exports. In 2021, the sector employed about 11.5% of country's workforce[8] and added nearly 7.6% to the economy's GDP.[9] The share of GDP in 2021, was lower compared to the previous decade, and might be partially attributed to faster growth of manufacturing and service sectors. The economic slowdown in sector's development is also evident in other indicators, such as gross fixed capital formation,[10] decrease in the number of active companies, and growing trade deficit, which rose by 38% for the period 2017-2021 (see the table below). All these indicators show that in the past decade the sector has become less attractive for doing business, investments and employment.

TABLE 2. MAIN INDICATORS OF AGRICULTURE, FORESTRY AND FISHING SECTOR (NACE GROUP A)

Indicator	Units	2017	2018	2019	2020	2021
Gross Domestic Product						
Agriculture, forestry and fishing	% share of GDP	7.9	8.5	8.1	8.6	7.6*

[8] Makstat (n.d.). Available here.

[9] Makstat (n.d.). Gross Domestic Product by production approach, by NKD Rev.2, by quarters. Available here.

[10] Word Bank definition: Gross fixed capital formation includes land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings.

Indicator	Units	2017	2018	2019	2020	2021
Gross fixed capital formation in Agriculture	in million MK Denars (in brackets mln EUR)	2,909 (47.3)	3,798 (61.7)	4,067 (66.1)	3,266 (53.1)	/
Employment						
Total employed in MK**	thousands	740,648	759,054	797,651	794,909	795,087
Employed in Agriculture	thousands	120,311	119,337	111,033	95,545	91,506
Employment in Agriculture	% share of employed	16.2	15.7	13.9	12.0	11.5
Active businesses						
Active business entities NACE Rev. 2	number	2,603	2,546	2,605	2,414	2,363
International trade						
Export (total MKD)	mln EUR	5,018.6	5,872.5	6,433.3	5,781.9	6,922.6
Import (total MKD)	mln EUR	6,834.9	7,676.3	8,441	7,599.4	9,638.3
Export (01-24 from HS***)	mln EUR	529.9	541.3	621.6	590.2	625.1
Import (01-24 from HS***)	mln EUR	755.5	787.3	832.6	818.2	938.1
Trade deficit (agri-food)	mln EUR	-225.6	-246	-211	-228	-313
*for 2020 and 2021 data are preliminary and estimated respectively ** Labour Force Survey from State Statistical Office *** Two digit codes used from the Harmonised System of classifications (01-24) for agri-food products						

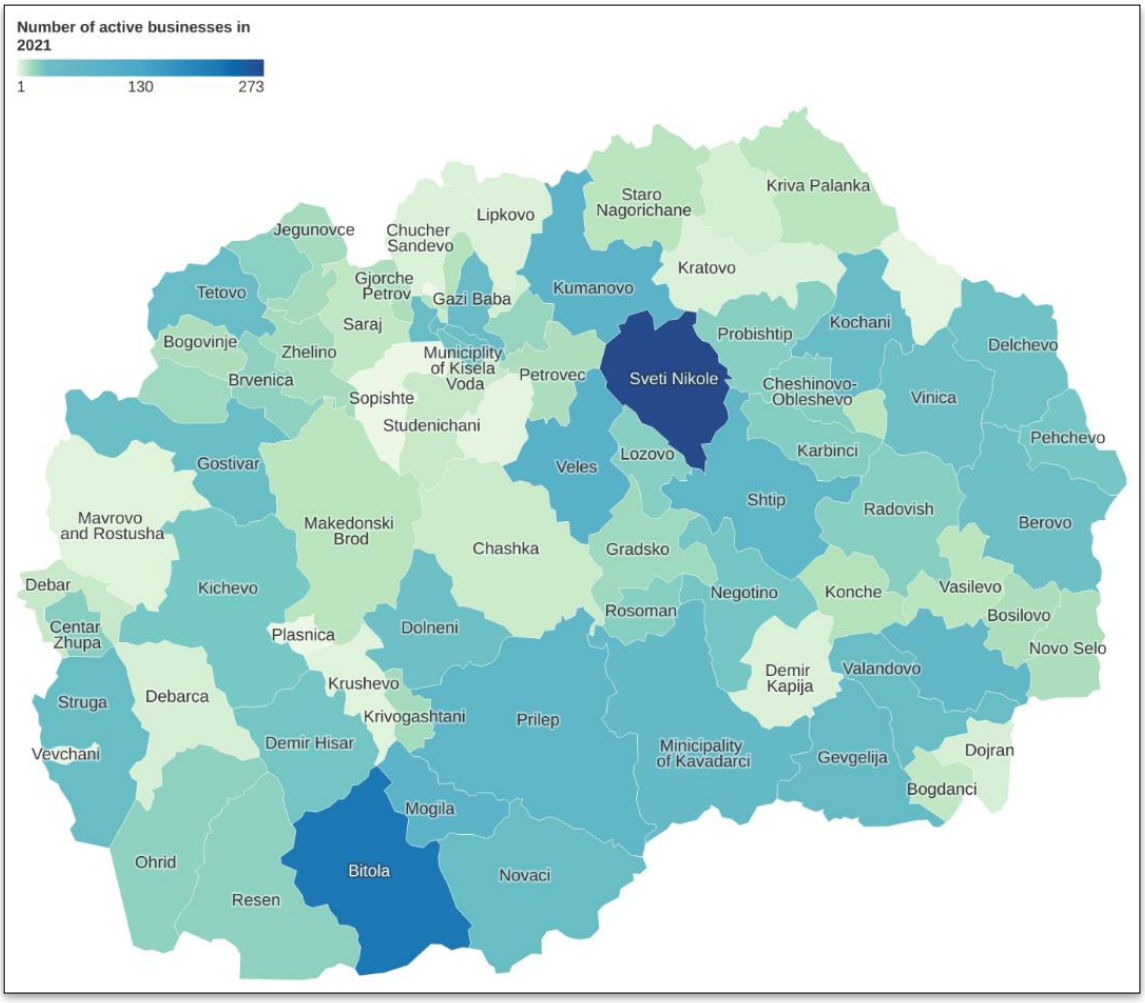
Source: State Statistical Office Makstat, author's calculations.

As illustrated above, the number of active businesses entities whose main activity is agriculture, forestry and fishing were 2,363 in 2021; this constituted 3.2% of all active businesses[11] and registered a decrease of about 250 businesses since the pre-pandemic year 2019. The sector features a high number of small businesses (around 89% of active businesses employ up to nine employees) of which a significant share is among the rural population. Hence the sector plays an important role in providing income and means of subsistence for those living in rural areas. The overall number of all active companies in North Macedonia in 2021 have decreased by 4.1% compared to 2019, while the agriculture sector recorded a 10% decrease of active businesses compared to 2019. Such developments warn that businesses in agriculture were disproportionally affected by the pandemic, and policy response might not have been sufficient to retain the businesses in the sector.

As the figure below demonstrates, at the end of 2021, a significant part of the registered businesses in agriculture was concentrated in two municipalities: Sveti Nikole and Bitola, which constitute 20% of all registered companies in the country.[12] This shows that some known agricultural centres, such as Tetovo and Strumica, feature with a large number of individual agricultural workers.

[11] Makstat (n.d.). Available here.
[12] Makstat (n.d.). Available here.

FIGURE 1. NUMBER OF ACTIVE BUSINESSES REGISTERED WHOSE MAIN ACTIVITY IS IN AGRICULTURE SECTOR, BY MUNICIPALITY, END OF 2021.



Source: State Statistical Office Makstat, map by the author.

The level of **foreign direct investments** (FDIs) is comparatively low in the country: North Macedonia, along with Bosnia and Herzegovina, attract the least FDIs as share of GDP among the Western Balkan countries.[13] For the period 2015-2020, on average, North Macedonia attracted FDI in value of about 3.5% as share of country's GDP, which is below region's average of 6%. However, when it comes to agriculture, forestry and fishing, the FDI inflow in this sector has started to attract more investments during the period 2019-2021 and constitutes bigger share out of all FDI's, which is interpreted as a good signal for investors and jobs creation.[14]

[13] The Word Bank (n.d.). Foreign direct investment, net inflows (% of GDP) - North Macedonia, Bosnia and Herzegovina, Serbia, Kosovo, Albania, Montenegro. Available here.

[14] During the interviewing process, it was pointed out that the high number of FDIs in the sector are result of investments in the production of Hemp and Cannabis Sativa for industrial and medical use, following the amendment of the Law on control of narcotics and psychotropic substances in 2016 (Official gazette 37/2016).

TABLE 3. FDI IN NORTH MACEDONIA IN AGRICULTURE, FORESTRY AND FISHING SECTOR AND TOTAL, FOR THE PERIOD 2012-2021, MILLIONS OF EUR

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Agriculture, Forestry and fishing	2.92	8.28	10.67	2.75	1.6	-2.93	4.7	31.79	20.77	36.28
TOTAL FDI	111.2	252.2	205.1	216.7	338.4	181.7	614	398.7	201.4	470.5
% of all	2.6	3.3	5.2	1.3	0.5	-1.6	0.8	8.0	10.3	7.7

Source: National Bank of the Republic of North Macedonia, author's calculations.

Food processing

According to the Structural Business Statistics from State Statistical Office,[15] 1,685 enterprises operated in manufacture of food products (NACE C10) sector in 2019, representing about 21% of all enterprises within the manufacturing sector (NACE C).

The detailed analysis of the subsectors presented in the table below shows that the sector is heavily dominated by manufacturing of bakery and farinaceous products, where 58% of the enterprises were registered.

TABLE 4. PERCENTAGE OF ENTERPRISES OPERATING IN MANUFACTURE OF FOOD PRODUCTS IN 2019, NACE REV.2

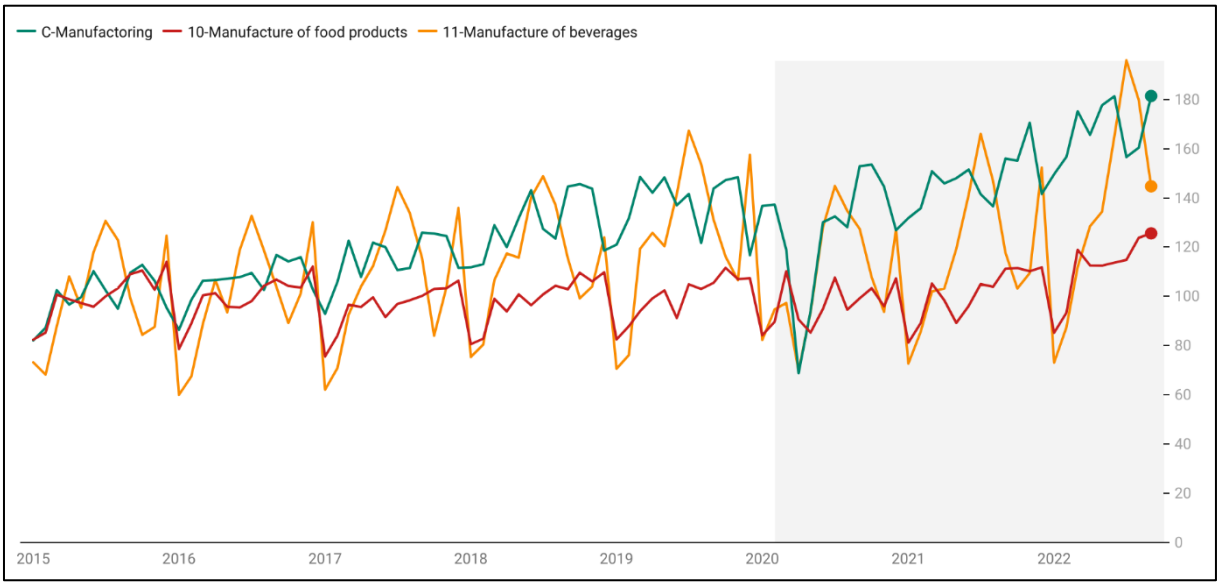
Activity (NACE rev2)	Percentage of enterprises by activity
C10.1 Processing and preserving of meat and production of meat products	3.68%
C10.2 Processing and preserving of fish, crustaceans and mollusks	0.00%
C10.3 Processing and preserving of fruit and vegetables	9.28%
C10.4 Manufacture of vegetable and animal oils and fats	0.00%
C10.5 Manufacture of dairy products	5.67%
C10.6 Manufacture of grain mill products, starches and starch products	3.50%
C10.7 Manufacture of bakery and farinaceous products	58.65%
C10.8 Manufacture of other food products	19.23%
C10.9 Manufacture of prepared animal feeds	0.00%

Source: State Statistical Office Makstat, author's calculation.

Industrial production index (IPI) which measures the production output by sector, shows that the production output of food products and beverages was affected by the Covid-19 pandemic in 2020 and 2021, with a slow rebound in 2022 (see the figure below).[16]

[15] Makstat (2022). Basic structural business indicators by Activity (NACE Rev2), Variables and Year. Available here.
[16] Makstat (2022). Available here.

FIGURE 2. TURNOVER INDICES IN INDUSTRY WITH BASE 2015=100, BY MONTHS



Source: State Statistical Office Makstat, author's representation.

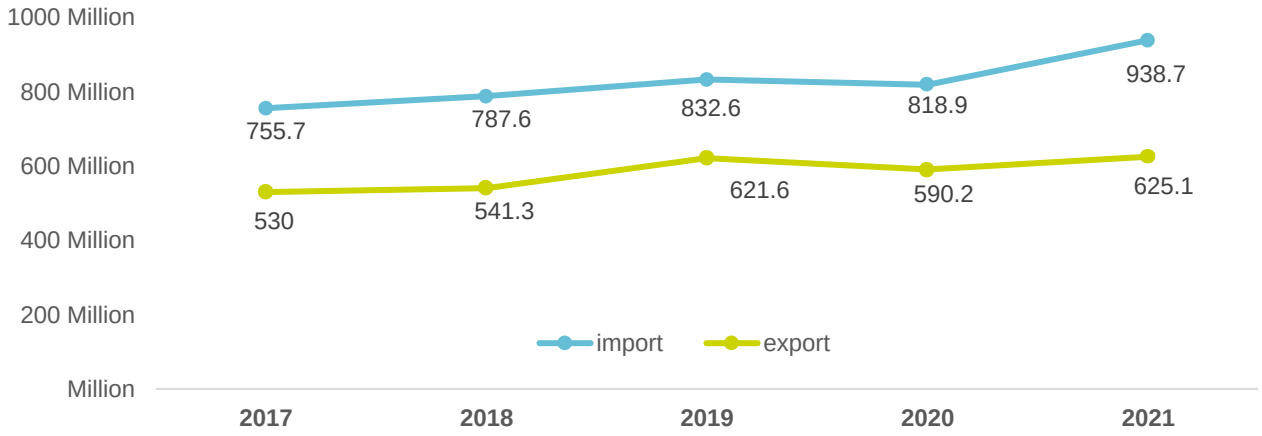
International agri-food trade

The international trade statistics are part of various national strategies and policy documents in the country. International trade dynamics provide not only the status of trade balance, but also measures the competitiveness of domestic goods and services on international markets. The agri-food sector takes a significant part of the country's international trade share of about 10% in 2021.[17]

During the 2017-2021 period, values of both export and import of agri-food products recovered after the decrease in 2020. Macedonia's export of agri-food products reached EUR 625 million in 2021, or about 9% of total exports of goods, while the import reached EUR 938.7 million or 9.8% of all imports of goods, thus registering about EUR 313 million trade deficit. Annual trade statistics for the agri-food sector for the period 2017-2021 demonstrate that the trade deficits in trade of agri-food goods have an increasing trend over the years (see the figure below). While in 2017 the trade deficit was EUR 225 million, in 2021 it rose to EUR 313 million.[18]

[17] For the trade statistics in year 2021, preliminary data from the State Statistical Office is used.
[18] Makstat (2022). Available here.

FIGURE 3. EXPORT AND IMPORT OF AGRIFOOD PRODUCTS FOR 2017-2021 IN MLN EUR (01-24 HS 2 DIGIT)



Source: State Statistical Office Makstat, author's calculations.

Most exported goods from the agri-food sector are tobacco,[19] vegetables and wine, where Western Balkan countries and the EU markets are the main trade partners, with nearly two-thirds of the goods exported. It is also worth mentioning that despite having low trade volume with Russia (about 1% in the 2019-2020 period), the country's export is highly dependent on Russian market for certain agricultural products, such as apricots, peaches and cherries, with more than 90% of such products sold only to Russian and Belarussian markets. Hence, current trade policies aligned with the EU[20] will force domestic producers to search for substitution of these markets and seek new markets.

A more analytical view of the agri-food statistics shows that the trade deficit is not attributed to all groups of products. While some groups of products are registering fast grow of trade deficits (dairy products, meat and edible meat, sugar and miscellaneous edible preparations), some sectors such as tobacco and manufactured tobacco products are showing trade surplus over the years. For example, groups of products under tobacco, live trees, edible vegetables and preparations of vegetables, fruits, nuts and similar products had a joint surplus of nearly 180 million EUR in 2021, as presented in the table below.

TABLE 5. EXPORT AND IMPORT OF AGRI-FOOD PRODUCTS, IN MILLION EUR

Chapters 2-digit level	Export		Import		Trade deficit	
	2017	2021	2017	2021	2017	2021
01 live animals	2.3	2	3.1	6.2	- 0.8	- 4.2
02 meat and edible meat	10.9	17.5	107.4	117.3	- 96.5	- 99.8
03 fish and crustaceans, mollusks and other aquatic invertebrates	2.4	7.1	12.4	18	- 10	- 10.8
04 dairy produce; birds' eggs; natural honey; edible products of animal origin, nes	9.5	7.1	45.9	65.4	- 36.4	- 58.4
05 products of animal origin, not elsewhere specified or included	0.2	0.5	1.9	1.5	- 1.8	- 1.1
06 live trees and other plants; bulbs, roots and the like; cut flowers and ornamental foliage	14.7	21.3	7.6	9	7.1	12.3
07 edible vegetables and certain roots and tubers	60	67.3	17.5	24	42.5	43.3

[19] Tobacco have been considered as strategic export-oriented products are the tobacco and manufactured tobacco products. The tobacco growing in the country has been valued from two aspects: providing jobs and income to rural population and providing foreign currency that maintains the trade balance.

[20] Republic of North Macedonia, Ministry of Foreign Affairs (2022). Press Release. Available here.

Chapters 2-digit level	Export		Import		Trade deficit	
	2017	2021	2017	2021	2017	2021
08 edible fruit and nuts; peel of citrus fruit or melons	42.6	47.8	42.2	50.7	0.4	- 2.9
09 coffee, tea, mata and spices	4	8.9	26.8	27.2	- 22.8	- 18.2
10 cereals	6.2	15.6	30.2	33.5	- 24	- 17.9
11 products of the milling industry; malt; starches; inulin; wheat gluten	0.8	1.7	21.2	22.6	- 20.3	- 20.9
12 oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal plants; straw and fodder	4.1	2.9	18.1	21	- 14.	- 18.
13 lac; gums, resins and other vegetable saps and extracts	0.3	0.4	2	2.7	- 1.6	- 2.2
14 vegetable plaiting materials; vegetable products not elsewhere specified or included	0	0	0	0	0	0
15 animal or vegetable fats and oils and their cleavage products; prepared edible fats; animal or vegetable waxes	6.3	16	50.2	72.9	- 43.9	- 56.9
16 preparations of meat, of fish or of crustaceans, mollusks or other aquatic invertebrates	11	15.5	34.3	40.6	- 23.3	- 25.1
17 sugars and sugar confectionery	7.9	8.4	45.7	46.3	- 37.8	- 38
18 cocoa and cocoa preparations	10.8	14.6	42.2	49.8	- 31.4	- 35.2
19 preparations of cereals, flour, starch or milk; pastrycooks' products	66.2	71	47.1	66.5	19.1	4.5
20 preparations of vegetables, fruit, nuts or other parts of plants	47.8	67.6	31.4	37.6	16.3	30
21 miscellaneous edible preparations	22.8	34.1	67.7	96.3	- 44.9	- 62.2
22 beverages, spirits and vinegar	59.3	67.9	38.3	60.2	21	7.8
23 residues and waste from the food industries; prepared animal fodder	0.8	1.7	24.9	37.9	- 24.1	- 36.2
24 tobacco and manufactured tobacco substitutes	139.2	128.1	37.6	31.3	101.6	96.8
Total	530	625.1	755.7	938.7	- 225.8	- 313.6

Source: State Statistical Office Makstat, author's calculations.

The European Union (EU-27) is the largest trade bloc for agri-food products for North Macedonia. In 2021, about EUR 761 million or 49% out of EUR 1.5 billion agri-food trade volume were traded with the EU countries, mainly Germany (EUR 102 million), Greece (EUR 96.6 million), Italy (EUR 81.5 million), Bulgaria (EUR 76 million), Croatia (EUR 72 million) and Poland (EUR 70.1 million). In 2017-2021, on average 50% of North Macedonian agri-food exports went to the EU-27 market.[21]

Western Balkan countries[22] (also part of CEFTA[23] trade bloc) constitute the second biggest trade market for agri-food products. Trade with CEFTA has continuously expanded North Macedonia's trade volume in the agri-food sector, reaching EUR 488 million (30% of all agri-food trade) with trade deficit of EUR 88 million. Serbia is the country's main trade partner for agri-food products, with nearly EUR 300 million trade volume in 2021, of which EUR 150 million constituted a trade deficit for North Macedonia.[24]

Employment in the agri-food sector

Starting from 2015 the number of people employed in the agriculture, forestry and fishing sector is decreasing. For example, the Labour Force Survey (LFS) data shows that in 2014 18.6% of all

[21] Makstat (n.d.), available here, and author's calculations.
[22] Albania, Bosnia and Herzegovina, Montenegro, Kosovo and Serbia.
[23] Central European Free Trade Agreement.
[24] Makstat (n.d.), available here, and author's calculations.

employed were employed in agriculture, forestry and fishery sector (127,000), while in 2021 nearly 11.5% (around 91,000) of all employed were employed in this sector.[25]

The agriculture sector is composed of a high number of individual households working in agriculture, and is characterised by a large share of informal employment compared to other sectors.[26] The estimations by the State Statistical Office show that in the first quarter of 2022 nearly 52% of all informal workers in North Macedonia were agriculture sector workers, mostly working as unpaid family workers and self-employed.

Administrative data from the Public Revenue Office show that the number of people who have reported income from their own agricultural production was 55,943 at the end of 2021 (whereas in 2019 there were 60,585).[27] Overall, this means that the sector is fragmented among big number of producers, with small plots of land. Such situation poses difficulties for individual producers to scale up their operations or access certain resources like investments in infrastructure, access to modern equipment and technology, attracting professionals etc. Gaining access to domestic wholesalers and export markets is also limited due to constrained production capacities, therefore a great part of the production is sold on open green markets.

The LFS data demonstrate that the number of workers in agriculture, forestry and fishing is decreasing, while the number of workers in the manufacturing sector has an upward trend (see the table below). This can be interpreted as a process where workers switch workplace from agriculture to manufacture and other more propulsive sectors, such as sales (employment data for other sectors is presented in Table 17 in Annex 3).

TABLE 6. THE NUMBER OF EMPLOYED IN MANUFACTURING AND AGRICULTURE, FORESTRY AND FISHING SECTORS

Sectors of activity	2017	2019	2021
Manufacturing	143,253	157,831	157,563
Agriculture, forestry and fishing	120,311	111,033	91,506

Source: LFS from the State Statistical Office, own calculation.

When it comes to the **occupational structure** of the agriculture, forestry and fishing sector (NACE A), it is dominated by skilled agricultural and fishery workers (see the table below). The significant number of the employed in the sector are in elementary occupations.

TABLE 7. EMPLOYED IN AGRICULTURE, FORESTRY AND FISHING BY OCCUPATION

	2017	2019	2021
Managers	533	903	947
Professionals	1,270	950	1,554
Technicians and associate professionals	1,144	1,180	2,157
Clerks	992	640	543
Service workers and shop and market sales workers	1,220	919	1,313
Craft and related trades workers	2,508	1,752	812
Plant and machine operators and assemblers	1,590	1,258	1,127
Skilled agricultural and fishery workers	42,312	63,987	56,553
Elementary occupations	68,742	39,444	26,499
Total	120,311	111,033	91,505

[25] Labour Force Survey of the State Statistical Office, available here.
[26] MakStat database (n.d.). Available here.
[27] Public Revenue Office. Data requested through the Law on Free Access to Public Information.

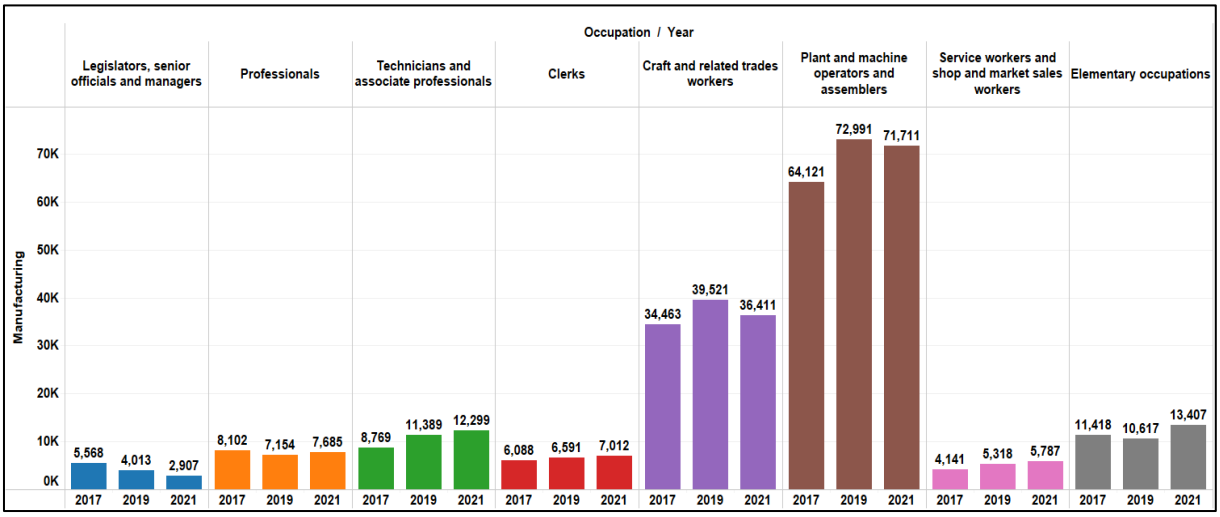
Source: State Statistical Office Makstat, author's representation.

One of the biggest concerns mentioned during the interviews was that many agricultural workers from the rural places see the opportunity to work as agricultural seasonal workers in Western European countries (mostly Italy, Germany and Croatia), and earn more money in up to three months, rather than working around the year in North Macedonia. Data from Eurostat also show that at the end of 2021, around 33,000 citizens of North Macedonia held a residence permit for employment reasons, issued by the EU-27 countries and EFTA countries,[28] illustrating the scope of migration to the EU. Emigration from rural places poses negative impact on the future of the sector's developments and a lack of workforce which also affects the production outputs.

When it comes to **food processing**, in 2020, the number of employed in the sectors manufacture of food products (C10) and manufacture of beverages (C11), was 19,308 and 2,674 respectively, which represents about 16% of all employed in the manufacturing sector.[29]

In absence of disaggregated data by NACE Rev.2 divisions by ISCO groups, i.e. number of workers in manufacture of food products sector by ISCO occupation, the figure below shows main **occupational groups** in manufacturing sector as a whole.

FIGURE 4. OCCUPATIONS IN MANUFACTURING SECTOR AND NUMBER OF EMPLOYED BY ISCO



Source: LFS data from State Statistical Office Makstat, author's representation.

Data on **wages** are published by the State Statistical Office[30] and are represented as average paid gross wage and net wage, by NACE rev.2 sector. The statistics on wages are published only as averages across sectors on NACE Rev.2 two-digit level, without having wages published by other disaggregation, such as median, age groups, regions/municipalities and gender. Net wages in the manufacture of food products sector recorded slower than average growth for the period 2018-2021:

[28] Eurostat (n.d.). Available here.

[29] Republic of North Macedonia (2022). Statistical Yearbook 2022, available here. The data also shows that from 2019 there is a break of series. The primary source of this data is administrative and comes from the Public Revenue Office and Employment Service Agency. Another source of data used is the Labour Force Survey, which uses sampling method and have higher figures for number of employees.

[30] The data is collected from administrative sources Public Revenue Office and Employment Service Agency.

in the compared period, average wage grew by 12% which is lower than the country's average wage growth (15%) and the wage growth in the manufacture sector (17%).

TABLE 8. AVERAGE NET WAGE PAID BY NACE SECTOR AND DIVISION

NACE Code	Year	2018	2019	2020	2021
All	Country average EUR*	395	410	442	467
A1	Crop and animal production, hunting	299 (75.7%**)	319 (77.8%)	354 (80.1%)	372 (79.7%)
A3	Fishing and aquaculture	218 (55.2%)	250 (61%)	285 (64.5%)	342 (73.2%)
C	Manufacturing sector	326 (82.5%)	344 (83.9%)	373 (84.4%)	394 (84.4%)
C10	Manufacture of food products	327 (82.8%)	325 (79.3%)	360 (81.4%)	371 (79.4%)
C11	Manufacture of beverages	480 (121.5%)	496 (121%)	516 (116.7%)	555 (118.8%)

Source: Statistical Yearbook of Republic of North Macedonia, 2022.
Note: Exchange rate 61.5 MKD for 1 EUR. ** Percent of country average wage.

Skills Needs Analysis (SNA) is a report prepared annually by the Employment Service Agency (ESA) and serves as one of the fundamental documents for preparing the Operational Plan for active employment programmes and measures and services on the labour market.[31] Latest SNA was prepared in October-November 2021, and assesses the skills and occupations needs in the upcoming 6 to 12 months disaggregated by region and ISCO classification. The SNE, in combination with other sources, such as local labour market projections, surveys done by the employer's organisations and chambers of commerce, serves as an underpinning document for assessment and plan for the trainings demanded on the labour market.

Based on the 2022 projections, the total number of employed in all sectors demanded would be 11,476 of which 30% were among elementary occupations (see the figure below). The demand for skilled agricultural, forestry and fishery workers constituted the lowest share among all occupational groups.

FIGURE 5. NUMBER OF WORKERS BY ISCO MAJOR GROUPS (SNE 2022)

Source: Employment Service Agency, author's representation

[31] Employment Service Agency.

When we look at the regional level, Skopje region demands most of the occupations among professionals and service and sales workers, while other regions are mostly demanding elementary and craft related workers.

TABLE 9. PERCENTAGE OF EMPLOYEES DEMANDED IN THE SNE BY ISCO GROUP AND REGION IN 2022

	Eastern	North-east	Pela-gonia	Polog	Skopje	South-eastern	South-western	Vardar
Professionals	2.5%	2.7%	4.9%	11.4%	27.3%	4.7%	7.9%	6.4%
Technicians and Associate Professionals	4.3%	9.4%	16.1%	8.9%	14.6%	7.2%	7.0%	3.9%
Clerical Support Workers	8.1%	1.2%	4.6%	7.1%	5.4%	4.4%	13.9%	3.2%
Services And Sales Workers	3.9%	20.4%	4.7%	25.0%	21.1%	16.5%	43.1%	10.0%
Skilled Agricultural, Forestry and Fishery Workers	2.0%		0.2%			0.3%		0.2%
Craft and Related Trades Workers	38.5%	43.9%	12.4%	15.7%	10.2%	23.3%	11.9%	21.9%
Plant and Machine Operators and Assemblers	7.7%	12.9%	4.7%	12.9%	4.3%	11.5%	5.2%	16.1%
Elementary Occupations	32.9%	9.6%	52.5%	18.9%	17.1%	32.0%	10.9%	38.3%
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Employment Service Agency, author's representation.

During the interview process, the main concern shared by the companies was the increased emigration flows from regions other than Skopje, which they believed would greatly affect production process in agriculture. They shared the expectation that due to migration it would be especially hard to find seasonal workers for crop gathering in the future. Meanwhile, engineers and technicians in agronomics are increasingly difficult to recruit as their numbers of enrolment and graduation had fallen significantly over the years.

In order to meet the needs for skilled workforce, several companies in the country have founded their own training centres in confectionary industry[32] and wine market,[33] and some of the interviewed companies had plans about creating their own training centre where specific non-formal short-term courses and modules would be delivered to employees in order to address the skills gaps.

In the SNA, number of demanded occupations related to agri-food sector were around 420 for the year 2022, of which major part were crop farm laborers, bakers and confectionary makers, food preparers and agricultural and industrial machinery mechanics and repairers. The detailed numbers by ISCO occupations are shown in the table below.

[32] One of the biggest agri-food companies in the country in partnership with the European Bank for Reconstruction and Development (EBRD) have formed a training center "Progressive Academy" where new employed can attend courses in operating with confectionary equipment and produce of chocolate products.

[33] Winery Kamnik opened the training center for the "Wine advisor" which is certified by the Adult Education Center.

TABLE 10. VACANCIES RELATED TO THE AGRI-FOOD SECTOR, SNA

ISCO code	Name	Number demanded
2132	Farming, Forestry and Fisheries Advisers	10
3116	Chemical Engineering Technicians	21
6111	Field Crop and Vegetable Growers	30
6112	Tree and Shrub Crop Growers	3
6114	Mixed Crop Growers	1
6121	Livestock and Dairy Producers	5
6221	Aquaculture Workers	1
7233	Agricultural and Industrial Machinery Mechanics and Repairers	49
7422	Information and Communications Technology Installers and Servicers	10
7511	Butchers, Fishmongers and Related Food Preparers	54
7512	Bakers, Pastry-cooks and Confectionery Makers	68
7513	Dairy Products Makers	1
7514	Fruit, Vegetable and Related Preservers	17
8160	Food and Related Products Machine Operators	31
8341	Mobile Farm and Forestry Plant Operators	5
9211	Crop Farm Labourers	65
9212	Livestock Farm Labourers	1
9216	Fishery and Aquaculture Labourers	2

Source: Employment Service Agency.

Education in the agri-food sector

VET in the agri-food sector

In the call for enrolment in public schools for 2022/2023 from the MoES, vocational education in agriculture, veterinary medicine, and food processing can be realised in 19 public high schools. The table below presents the profiles offered by school and town.

TABLE 11. EDUCATIONAL PROFILES OFFERED BY VET SCHOOL AND TOWN

Number	Name of school	Town	Profiles
1	SOZU “Kuzman Shapkarev”	Bitola	Agrotechnician, Technician in agromanagement, Technician in phytomedicine
2	SOU “Gotce Delchev”	Valandovo	Technician in phytomedicine, Agrotechnician
3	SSOU “Dimitrija Chupovski”	Veles	Baker, Meat cutter
4	SOU “Vancho Prke”	Vinica	Food technician
5	SOU “Metodija Mitevski-Brico”	Delchevo	
6	SU of the City of Skopje “Dimitar Vlahov”	Skopje	
7	SOU “Niko Nestor”	Struga	
8	SOU “Mitko Pendzukliski”	Kratovo	
9	SOU “Gjoce Stojcheski”	Tetovo	
10	SOZSU “Gjorche Petrov”	Kavadarci	Technician in phytomedicine, Agrotechnician/ agromanagement
11	OSU “Drita”	Kichevo	Baker
12	DSU and Regional Center for vocational education “Kiro Burnaz”	Kumanovo	Technician in phytomedicine, Agrotechnician/ agromanagement, Technician in veterinary medicine, Food technician, Baker
13	DSU and Regional Center for vocational education “Vanco Pitosheski”	Ohrid	Baker, Meat cutter
14	SOU “Orde Chopela”	Prilep	Agrotechnician/ agromanagement, Technician in veterinary medicine, Technician in phytomedicine, Food technician
15	SOU “Tzar Samoil”	Resen	Agrotechnician, Technician in phytomedicine
16	SOU “Kocho Racin”	Sveti Nikole	Agrotechnician/ agromanagement
17	SUGS “Brakja Miladinovci”	Skopje	Technician in veterinary medicine, Agrotechnician, Technician in phytomedicine, Technician in agromanagement
18	SOU “Dimitar Vlahov”	Strumica	Agrotechnician, Technician in agromanagement, Technician in phytomedicine, Crop producer, Technician in veterinary medicine, Food technician, Baker
19	SOSU “Mosha Pijade”	Tetovo	Technician in veterinary medicine /Technician in phytomedicine, Agrotechnician

Source: MOeS, Estimates from the call for enrolment by the author.

However, the interest in agri-food profiles in VET education is decreasing over the years. The number of students who graduated from educational programmes in agriculture, veterinary medicine, veterinary and food processing in school year 2020/2021 was 363 (116 of them women) or 1.8% of all graduates. The concern over low levels of graduation from VET schools in the agri-food sector was shared by most of the interviewed and several reasons were shared for such situation: many see agriculture as side work, i.e. for additional income and do not want to work in the sector that offers wages less than the average, and the sector is lagging in use of modern technologies, machinery and tools.

TABLE 12. STUDENTS WHO FINISHED SECONDARY SCHOOL IN AGRI-FOOD SECTOR, BY SCHOOL YEAR, EDUCATIONAL PROGRAMME AND SEX

School year	Sex	Agriculture	Agriculture and veterinary medicine	Food production	Veterinary
2017/2018	Female	8	116	10	10
2017/2018	Male	15	250	19	21
2017/2018	**Total**	**23**	**366**	**29**	**31**
2018/2019	Female	0	97	4	0
2018/2019	Male	0	258	7	0
2018/2019	**Total**	**0**	**355**	**11**	**0**
2019/2020	Female	3	70	1	0
2019/2020	Male	0	195	0	0
2019/2020	**Total**	**3**	**265**	**1**	**0**
2020/2021	Female	3	112	1	0
2020/2021	Male	3	243	1	0
2020/2021	**Total**	**6**	**355**	**2**	**0**

Source: State Statistical Office Makstat, author's representation.

The dual system of education which means combined practical experience in the workplace with academic study provided in the classroom, started as test programme in 2018. In this phase, most interest for this type of education was shown by the companies which operate in Technologic Industrial Zones and need specific set of qualifications and skills. The preparations for amendments in the current Law on VET are well advanced and dual education is expected to be formally introduced in the educational system. It can be estimated that around 200 classes existed during 2022/2023 school year, however as there are no official statistics on the number of graduated students and programmes.

Apart from the dual training, one of the focus points of VET Reform in North Macedonia is the establishment of Regional VET Centres (RVETCs).[34] It is planned that RVETCs will eventually emerge as regional centres of excellence and innovation hubs with strong collaboration with industry. Currently, there are three schools with this status (Ohrid, Kumanovo and Tetovo), and two more re yet to be selected. The EU's Instrument for Pre-accession Assistance (IPA) actions support the works on their physical infrastructure and development of new functions.

To raise the interest for dual education, in September 2022, Ministry of Education and Science (MoES)[35] published a call for 1,500 stipends worth of MKD 3,500 (EUR~57) monthly, for duration of nine months for the students who will enrol VET schools which offer practical work.

To regulate the occupations and qualifications, the Ministry of Education and Science jointly with the Ministry of Labour and Social Policy (MLSP) are the responsible institutions for development and implementing of the National Qualifications Framework (NQF). Both ministries can provide recommendations on development of the **qualification** standards, while the MLSP is approving the **occupational** standards.[36]

[34] More information is available here.
[35] Ministry of Education and Science (n.d.). Available here.
[36] Aleksov, B. (2022). Guideline on the process of verification of new qualification. Available here.

At the end of 2022, in the register[37] of adopted qualification standards, there were 106 standards, of which 10 were in the field of agriculture, fishing and veterinary medicine and 9 in chemistry and technology, of which 6 are related to food production and food processing. The list of relevant qualification standards, as well as more background information for qualification and occupational standards is presented in the Annex 3. Macedonian Qualifications framework and standards.

Higher education in the agri-food sector

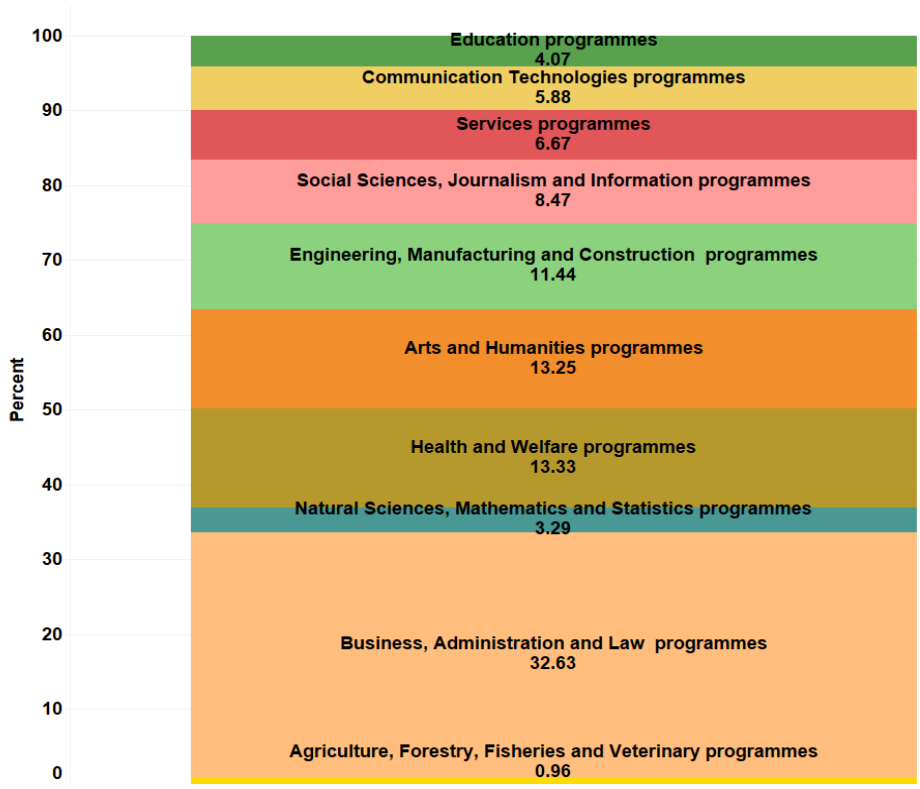
University education related to agriculture, food technology, nutrition, biotechnology, and food safety and quality is held in public institutions and offered through various study programs within seven public faculties and one institute. Faculties that enrolled undergraduate students in the academic year 2020/2021 were:

- Faculty of Agriculture- University Goce Delchev - Shtip,
- Faculty of Technology and Metallurgy- University Ss. Cyril and Methodius-Skopje,
- Faculty of Technology and Technical Sciences- University St. Kliment Ohridski-Bitola,
- Faculty of Biotechnological Sciences- University St. Kliment Ohridski-Bitola,
- Faculty of Agricultural Sciences- University Ss Cyril and Methodius-Skopje and
- Faculty of Food Technology- University Goce Delchev - Shtip,
- Faculty of Food Technology and Nutrition- State University-Tetovo
- Institute of Agriculture (postgraduate studies)

Statistics on graduation from tertiary education by field of study show that less than 1% of graduates in the country come from the educational fields of agriculture, forestry, fisheries and veterinary studies. Such small number of graduates was also a concern shared among interviewed stakeholders who believed that the agri-food sector would face serious shortages in skills and qualifications in the near future. The reasons for low enrolment rates relate to the fact that the sector does not offer well paid jobs and career options.

[37] Register of the qualifications standards adopted, available here.

FIGURE 6. PERCENT OF GRADUATES FROM TERTIARY EDUCATION, BY FIELD OF STUDY IN 2020



Source: UNESCO, author's representation.

Estimations based on the data from the State Statistical Office show a downward trend in numbers of graduated from the seven faculties jointly which offer courses in agri-food related sectors, from 320 students graduated in 2017, to 220 graduated in 2021.

Another higher educational institution which offers scientific and educational courses (postgraduate studies) is the Institute of Agriculture – Skopje within the Ss. Cyril and Methodius University in Skopje. The Institute of Agriculture offers postgraduate studies in organic production with 10 places available per year, in a duration of two semesters.

Non-formal education in the agri-food sector

Open Civic Universities

Open Civic Universities (OCU) were founded by the Law on Open Civic Universities and lifelong learning (Official gazette 36/2011) and amended in the years 2014, 2015, 2016 and 2018. OCU's are successors of the Workers Universities and can offer formal and non-formal educational programmes.

With the enactment of the Law on OCU, the property of the workers and people's universities which belonged to the state was transferred to the governance of municipalities. During the interviews, it was pointed out that due to poor management and financial difficulties, only few OCU's are currently functioning in the country and those operating are offering training courses in accordance with the occupations demanded by the companies. The courses offered were mostly in food processing sector such as butchers, confectionary workers, and similar.

Although there is no data available on trainings and programmes offered by the OCUs, some OCUs have verified programmes related to food processing occupations at the Adult Education Center.

Adult education centre

Adult Education Center (AEC) is a public institution established in 2008 in accordance with the Law on Adult Education (Official gazette 7/2008) and amended in the years 2011, 2012, 2014, 2015, 2016 and 2018. Currently AEC holds a register of 1,099 educational programmes (379 not verified), offered by 259 training institutions. There are only 19 educational programmes in agriculture, which shows that the interest from the training providers to offer programmes in this field is very low.

Participation in adult education programmes is difficult to estimate as AEC does not have an obligation to register and publish statistics on the number of students who attended course. Data from other certified trainers or institutions that provide education and training in the sector are also not publicly available.

Lifelong learning offered by universities

In accordance with the article 141 of the Law on Higher education (Official gazette 82/2018) amended in 2019 and 2021, universities can establish centres for lifelong learning and offer continual professional development and non-formal training courses. However, the system of organising the study programmes, curricula development, duration and certification is prescribed within university internal acts. There are no available structural statistics on such training delivered by the universities by field of study, credits, students (for example published by the State Statistical Office). Currently, professional development courses and non-formal courses are not mandatory in the professions within the agri-food sector and there is little interest in attending the courses in the area. However, it is expected that some professions in agri-food sector receive the status of regulated profession (phytomedicine engineer and agronomy engineers) and continual professional development would be mandatory.

Business chambers and other business intermediary bodies also offer various types of educational programmes and non-formal educational courses in the area of marketing, management, sales, e-commerce:

- **The Association of Macedonian Chambers of Commerce** is an umbrella economic chamber especially active in the field of continuous learning. The Association is certified through the Macedonian Centre for Science, Research and Education to provide adult education.[87] The Economic Chamber of North Macedonia, a member of the umbrella association, have founded the Education and Human Resources Development Centre to help develop the supply of professional education in the country. The centre's goal is to help business stakeholders develop on-the-job skills for their employees. They focus on organising seminars, workshops, presentations, and conferences to develop human resources.
- **The Chamber of Commerce for ICT (MASIT)** is an ICT association that promotes and represents enterprises active in the ICT sector in North Macedonia. It focuses on providing its members access to information, education, legal advice, cooperation, networking and promotion at various levels. They cooperate regionally and internationally and are a member of the Balkan and Black Sea Cluster Network and the World Information Technology and Services Alliance. In 2019, MASIT launched the 2nd cycle Pre-qualification project. The project carried out pre-qualification training for interested candidates for ICT occupational profiles. The sample of candidates was made of unemployed persons who were not older than 35 and who wished to gain knowledge and practical skills in IT with the view of being employed by ICT companies. The programme developed by the project lasted for three months. Though there is no specific description of skills developed by the programme, mainly being referred to as ICT skills, MASIT's website suggests that front-end development was a very important component.

- **The Fund for Innovations and Technology Development (FITD)** of North Macedonia is another important BIB. They have launched a programme for supporting skills development and innovation.[88] The programme offers grants for the establishment of business technology accelerators and includes support in the form of consulting, training, and mentoring. The programme is supported by the World Bank.

- **Chamber of Organic Producers**[89] is a non-governmental professional organisation that works to encourage the development and competitiveness of the organic sector in North Macedonia. One of its goals is to set up determined rules for organic production in the country and support business with continuous education opportunities, networking events and access to funds. In addition, they encourage the flow of information on organic production by providing access to various guides and literature. As of yet, they have no training and education projects advertised on their website.

- **National Farmers Federation (NFF)**[90] is a non-profit organisation that supports farmers in the rural areas of North Macedonia. They mainly support farmers by developing activities in the areas of networking, organisational support, education, and gender equality. They have a strong portfolio of collaboration with international partners, such as We Effect.[91] In 2022, the NFF ran a training on **agrotechnical measures and irrigation** of wheat with farmers as part of the project on "Organisational development of NFF and improvement of market connections for small farmers and food producers from rural areas in order to increasing their income." The project was supported by the Swedish International Cooperation and Development Agency (SIDA). The training provided skills development in **feeding** and **watering** of **crops**, and exposed participants to methods of **soil analysis** provided by experts in the field of agricultural sciences and food production.

- **Business Confederation of Macedonia (BCM)**[92] is an association of employers established in 2001. It focuses on improving and developing the business environment in North Macedonia. BCM has a dedicated sector for training through which it provides training in the field of human resources management, health and safety at work, business development, risk management, innovation, and digitalisation. Some of the completed projects focused on equipping single mothers with skills in **professional communication**, **teamwork** and **time management**, while others targeted people with autism spectrum disorders to help increase their work productivity.

In line with the results obtained from the State Statistical Office publication on Continuing vocational training in enterprises for 2015[38], combined with the responses from the interviewed stakeholders, the following barriers were mentioned for provision of CVT:

- Financial provisions (expensive trainings);
- Not mandatory (professionalism in the sector is low compared to other professions, CVT is voluntary and not certified);
- Training obtained through CVT is not supervised by certification bodies;
- Lack of suitable courses on the market;
- Difficulties to assess the need for courses.

[38] State Statistical Office (n.d.), available here.

DIGITALISATION IN AGRICULTURE AND FOOD PROCESSING

The niche of developing and producing digital solutions for the agri-food industry has been centred on the input level of the agri-food value chain. Through the implementation of digital technologies, the agri-food production process can be improved in terms of efficiency, productivity, and economic viability. This developing niche in the agri-food sector has seen the increasing use of technologies like drones, e-commerce, crop pattern monitoring, and robotics across the globe.

The analysis of niche of digitalisation in agri-food focuses on the businesses developing and producing the digital innovations for agri-food. They fall under the following NACE sectors:

- Manufacture of agricultural and forestry machinery (C28.3);
- Manufacture of machinery for food, beverage, and tobacco processing (C28.9.3);
- Computer programming, consultancy and related activities (J62);
- Information and service activities (J63);
- Research and experimental development on natural sciences and engineering (M72.1).

This chapter provides an overview of the market niche for digitalisation in agri-food in North Macedonia, highlighting its key economic indicators. It also discusses the demand and supply for skills in the niche and matching the niche's demand and supply.

The profile of the market niche and the stakeholder ecosystem

General overview

In the absence of disaggregated data from the State Statistical Office, to estimate the subsectors relevant for the digitalisation of agrifood sector, administrative data from the Central registry are used in this report. We start from the broader sectors, under which the enterprises developing and producing digital innovations for agri-food operate (among enterprises serving other purposes than agrifood). The table below presents the main administrative indicators of North Macedonian companies operating in these sectors.

TABLE 13. ADMINISTRATIVE DATA ON NUMBER OF COMPANIES, TURNOVER AND EMPLOYEES- DIGITAL

Year	Number of employees	Income in MKD	Income in EUR (exchange rate 61.5)	Number of companies
M72.1 Research and experimental development on natural sciences and engineering				
2019	209	346,075,000	5.6 million	51
2020	190	308,885,000	5 million	54
2021	183	351,104,000	5.7 million	53
J63 Information service activities				
2019	1,742	2,746,194,000	44.6 million	345
2020	1,895	2,993,961,000	48.7 million	377
2021	2,854	4,306,128,000	70 million	405
J62 Computer programming, consultancy and related activities				

2019	7,888	15,116,107,844	245.8 million	1,311
2020	8,801	17,729,417,485	288.3 million	1,429
2021	10,273	22,377,103,304	363.9 million	1,635
C28.3 Manufacture of agricultural and forestry machinery				
2019	92	75,392,510	1.2 million	8
2020	97	98,314,694	1.6 million	7
2021	95	91,241,894	1.5 million	10
C28.9.3 Manufacture of machinery for food, beverage and tobacco processing				
2019	138	233,794,328	3.8 million	15
2020	132	238,619,476	3.9 million	15
2021	137	295,297,954	4.8 million	16

Source: Central Registry of the Republic of North Macedonia.

Data from the Central Registry show that subsectors J62 and J63 related to ICT service activities, programming and consulting, have experienced fast growth in the observed period 2019-2021, both in terms of company creation and turnover. Nevertheless, the sector generates most of the income from abroad, through outsourcing services and to a lesser extent from domestic market.

TABLE 14. AVERAGE PAID NET WAGE PER EMPLOYEE, BY SECTORS OF ACTIVITY, BY NKD REV.2, IN OCTOBER

Sector	October, 2020	October, 2021	October, 2022
Average monthly net wage, paid in MKD (EUR)	27,899 (454) *	29,145 (474)	33,104 (538)
(A) Agriculture, forestry and fishing	22,118 (360)	22,996 (374)	26,239 (427)
(C) Manufacturing	24,120 (392)	24,657 (401)	29,003 (472)
(J) Information and communication	50,418 (820)	55,488 (902)	63,414 (1031)

Source: State Statistical Office Makstat.
Note: Numbers in brackets are in EUR, 1 EUR = 61.5 MKD. Available here.

Talking about the application of digital products and services by agri-food companies, it has been low despite introduction of the digitalisation in agriculture as a policy direction. A survey on the use of ICT tools in the sector of Herbs and Spice run by the UNDP in 2020[39] found that about 50% of agricultural producers were using basic digital tools such as social media/ platforms/ applications for general exchange of information, weather forecast applications, general information on trends in the sector and, to a lesser extent, for commercial services (online promotion and e-shops).

BOX 1. DIGITALISATION IN AGRICULTURE

In March 2021, FITD jointly with the Ministry of Agriculture, Forestry and Water Economy (MAFWE) and the Program for Increasing Market Employability (IME) have launched a call for Digitalisation of Agriculture. The total budget of the call was 100,000 EUR of which the project can be co-financed with 90%, and each competitor must provide 10% of the project budget for co-financing the project.

Based on the competition rules, the companies were requested to submit their proposals in following categories:

- Smart Farming
- Precise Agriculture
- Robotics and Automation

[39] Herbs & Spices (2020). Socio-economic impact of the Covid-19 crisis in Agriculture. UNDP. Available here.

- Biotech
- Databases and Artificial Intelligence
- Digitalisation of Post-Harvest Activities and Processing
- Drones and Satellites
- Internet of Things – IoT

The call resulted with selection of four companies which provided solutions in drone mapping and monitoring (DronOps), a platform for integrating applications and sensory data (8tek), innovation of service "Center for digital agriculture" where education, consulting and use of drones would be offered to the producers (Agfutura Technologies) and controller for remote control of the temperature of the reservoirs for milk storage (Agrodiadem).

Source: FITD.

During the interviews, there was a consensus among interviewees that the digitalisation in the agri-food sector in the country is among most the underdeveloped processes. Desk research resulted with little literature on the topic, and the most important policy document that addresses digitalisation of the agri-food sector in the country is the Strategy for Agricultural and Rural Development 2021-2027, where precision agriculture, education and training for agricultural workers, decrease of administrative burden with use of digital solutions are among the topics and approaches elaborated on how to tackle in the envisaged period of implementation of the Strategy.

The Strategy for Agricultural and Rural Development spot several weaknesses such as the low level of digitalisation in the agriculture sector, low educational attainment of the agricultural workers, weak awareness of the agricultural workers about the digitalisation and aging and emigration of the rural population.

The small size of farms is one of the barriers for adopting digitalisation. The interviewed business intermediaries pointed out that while there is the large number of farmers and agricultural workers, horizontal cooperatives are almost non-existent. Attempts to revive horizontal cooperation among individual agricultural workers and small farms across the country started during Yugoslav times and did not yield significant results. In the past, several laws on cooperatives have been superseded with newer in order to foster and support cooperatives. The current Law on Agricultural Cooperatives which was enacted in 2013, had little impact on the creation of cooperatives and did not revive the horizontal cooperation among farmers and agricultural workers.[40] With use of modern technology, such as software for tracking and managing supply chains, the creation of cooperatives could aid the process of cooperation among large number of small agricultural workers through more transparent and cost-efficient management. This, in turn, can increase the demand for digital solutions. However, in order to successfully implement such systems, digitalisation of the sector and upskilling of the workers cooperants should take place first.

Key stakeholders

Generally, the key stakeholders in the digitalisation in agriculture and food processing market niche are similar to the stakeholders described in the Overview chapter above, including relevant ministries for agriculture and scientific and research development.

National bodies that are responsible for digitalisation in North Macedonia include the Ministry of Information Society and Administration, national Broadband Competence Office, and the National ICT

[40] Official gazette 23/2013. Available here.

Council, however, their focus is primarily on development of information society and electronic governance. The Fund for Innovations and Technology Development is another relevant body, which was created in order to encourage innovations by providing additional sources of funding. The fund supports innovative enterprises and contributes to the development of regulatory framework – for instance, it currently works on the development of the National Strategy for Artificial Intelligence.

Furthermore, the National Strategy for Innovation 2012-2020 envisaged the creation of Agency for Technological Innovations which would act as focal point for companies and institutions and would act as an intermediary in building on capacities with other counterpart institutions from the region, the EU or advanced economies.

International donors are active in supporting the niche development. Donor support is especially welcomed among stakeholders in the agri-food sector, because support from the state for purchase of equipment is small. Currently, active donor projects in the digitalisation of agriculture are the IME project[41] and UNDP[42], which have calls and provide trainings to the workers in the sector, participation to international fairs, purchase of equipment and similar small scale infrastructure co-funding investments.

Moreover, USAID[43] through its Agriculture Development Credit Authorities enables access to finance for the growth of micro, small and medium enterprises. The programme started in 2015 and provided support to more than 850 loans which were used for purchase of farming and storage equipment and used as working capital.

Companies representing the niche

The companies included in the interviews to represent the niche were micro and small companies whose ownership is domestic. All were limited liability companies owned by men. We interviewed the representatives of DronOps, Vision Dynamixm and an anonymous innovative company whose work was related in different sub-sectors of digitalisation, such as drone construction which can be used in agricultural works, agribusiness services and consulting, agri-food marketing, and software development for 3D mapping solutions. While DronOps ais a newly established company and at the time of the interview offered services on domestic market only, other two companies had export experience in the region and international markets. The companies used modern technology in their work in order to keep pace with the technological advancement and competition.

The representatives of companies saw the North Macedonian market as a small and limited place for business operation. They were therefore looking for internationalisation of their products and services. As barriers to enable business expansion, the interviewed companies reported insufficient support from the institutions, legislation that is not aligned with the EU regulations which impedes export to EU markets, undereducated workers whose education level does not correspond to the job position,[44] and the lack of staff with multidisciplinary background (i.e. sales persons with background in IT). For example, a company representative mentioned that North Macedonia is not compliant with the EU

[41] Increasing Market Employability project, available here.

[42] Skills4future, available here.

[43] Agriculture Development Credit Authority (DCA), available here.

[44] During the interviews, company representatives indicated the cases where applicants hold a degree, but are lacking certain level of knowledge and skills. For example, good English language skills needed for sales on international markets, knowledge on usage of modern equipment and technologies and so on.

Regulations which set rules and procedures for drone operation and barely can find domestic experts in the area.[45]

Regarding the plans to invest in the medium term, the interviewed stakeholders planned to invest mainly in equipment (sensors and modern hardware), training of personnel and software licences. The main challenges of the companies included in the interviews were the lack of adequate financial support for purchase of equipment, undereducated personnel which required longer time of training and insufficient institutional support in setting regulatory framework for operations.

The interviewed companies did not have representative bodies or membership organisations where they could communicate to the other stakeholders the benefits and use of digital solutions in the sector. Occasionally, some organisations like Macedonian ICT Chamber of Commerce-MASIT[46] with assistance of USAID support have prepared guidelines on digitalisation in agriculture, mainly to raise public awareness.

Skills demand

Most of the interviewed companies which operate in the digitalisation in agriculture niche rely on domestic workers with tertiary education in the fields related to computer science, software development, agriculture and economics. Their teams were composed of a small core team who were dealing with financial and administrative tasks, and teams of experts with full time employment. In order to meet the needs of the clients, the interviewed companies often used local external experts, and to a lesser extent, experts from abroad, to solve tasks that needed high level of specialisation which was not available in the country.

The companies were not looking for new employees at the time of interviews. The energy crisis had constrained the demand for new workers and investments in the sector, where most of the interviewed companies responded that they were going to refrain from investments and employment in 2023. Nevertheless, based on the profiles of their current employees, as well as the products they develop, a number of ESCO occupations could be identified as relevant for the niche, as presented in the table below.

BOX 2. TECHNICAL OCCUPATIONS RELEVANT FOR THE DIGITALISATION IN AGRI-FOOD BASED ON COMPANIES' SKILLS NEEDS

Digital technologies	
• Software developers (2512) • agricultural equipment design engineer (ESCO 2144.1.2.1) • mechatronics engineer (2144.1.11)	• mechatronics engineering technician (3115.1.11) • mechatronics assembler (8211.3) • electronic equipment assembler (8212.3) • electronics engineer (2152.1)
Agronomy, agriculture and food processing	
• agricultural scientist (ESCO 2132.1) • agronomist (2132.2)	• agricultural technician (3142.1)

Besides the skills needed for the development of digital solutions for agriculture, it is important to note that the users of digital innovations in agricultural holdings that apply digital solutions also require particular skills profiles. Digital skills in agri-food sector refer to the use of technology and digital tools

[45] EASA (2022). Easy Access Rules for Unmanned Aircraft Systems (Regulations (EU) 2019/947 and 2019/945). Available here.
[46] Available here.

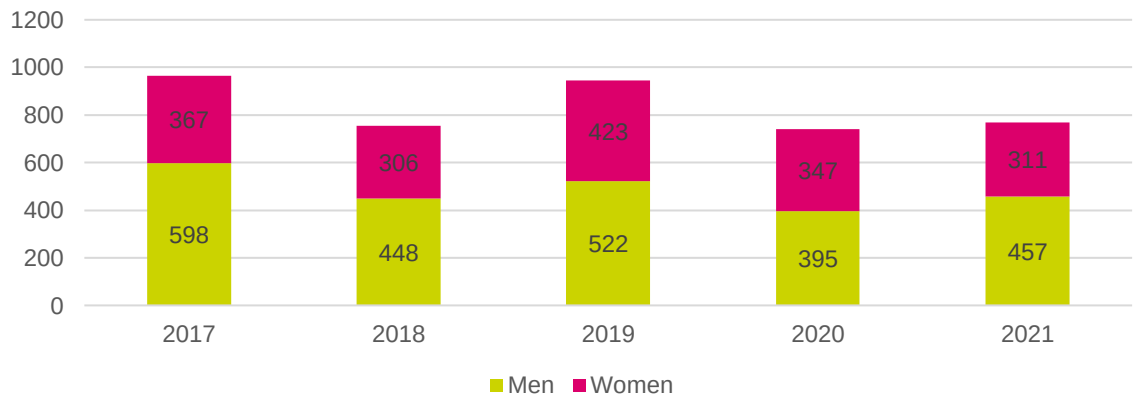
which can improve various aspects of farming in agriculture and food production. They are an important precondition for the demand and application of digital solutions produced by the interviewed companies in food production. Based on the evidence gathered from the interviews with the representatives of the companies, academia and business intermediary bodies, the digital skills and competences that would be relevant in the agri-food businesses nowadays are:

- **Data analysis and management**: Applying tools like spreadsheets and specialised software (electronic diaries, calendar and similar) to collect, analyse and manage data related to farming operations, such as soil analysis, crop yields, and irrigation schedules. Introducing digital solutions and upskilling of the farmers would replace use of paper-based diaries, which is common among Macedonian farmers, the farming operations, like soiling, applying pesticides and other operations are entered in digital calendars on a tablet.
- **Precision agriculture**: Applying technology like GPS and sensors to gather data on soil conditions, weather patterns, crop growth, and using this data to optimise farming practices, such as applying fertilisers and pesticides more efficiently. These skills would add to the productiveness in the farming operations. During the field interviews, it was shared the concern that farmers are using their mobile applications for weather forecast and make decisions on whether there is a need to be applied pesticides or fertilisers in a given period of time. Hence, their estimations are based on experience and consultations with peer farmers, rather than using precise sensory data on atmospheric conditions, soil conditions and parameters which can optimise the processes.
- **Drone technologies**: Operating drones equipped with cameras and sensors to gather data on crops, soil, and other characteristics of farming operations. This data can be used to make better and timely decisions about irrigation, fertilisation, pest control, harvesting and farming operations.
- **Online marketing and e-commerce**: Using the internet and e-commerce services to market and sell agricultural products to consumers, or through online marketplaces. During the period of pandemic 2020-2021, the agricultural sector was affected disproportionally compared to other sectors in terms of companies' closures. While many companies in retail, wholesale, pharmacy and HoReCa sectors used the advantage of modern digital solutions, such as online sales and deliveries of their products to the customers, agricultural companies and farmers did very little in use of online sales channels and e-commerce. Hence, it is important to modernise and revive the agrifood market by use of technological solutions such as e-commerce and supply chains.
- **Crop monitoring and prediction**: Using data analysis and machine learning techniques to predict crop yields and optimise farming practices based on weather patterns and other factors that can affect the growing processes.

Skills supply

The number of **university graduates** in computer sciences, ICT and engineering offered at 15 faculties in the country varies through the years. In 2021, around 8% of all students graduated from these faculties. As shown on the figure below, men represent almost two thirds of the graduated.

FIGURE 7. THE NUMBER OF GRADUATES FROM FACULTIES OF COMPUTER SCIENCE, ENGINEERING AND ICT, BY SEX[47]



Source: State Statistical Office Makstat, own representation.

Faculties of electronics, software engineering and informatics in the country have more advanced trainings in terms of digital training curricula, such as Artificial Intelligence, Machine Learning, IoT, programming/coding and design of digital tools, however, there is little evidence that those are engaged in agri-food sector. Agricultural faculties, in their turn, have curricula for building digital skills capacities of their students but assume that the skills and training in specific area are acquired through the mandatory practical work between the academic years of schooling.

When it comes to cooperation between universities and other stakeholders, it is mainly based on commercial basis, where universities or research labs provide services to the companies related to calibration, measurement and certification of their products. Cooperation with the scientific and research centres is occasional and project based, where most of the funds are coming from donor funds, such as Horizon 2020, Erasmus+ and similar programmes.

VET education in the field is usually provided by technical vocational schools within electrical engineering and similar fields. For instance, the secondary electrical engineering school of the City of Skopje "Mihajlo Pupin" offers programmes in computer engineering and automation, as well as in electronics and telecommunications.[48]

The link between companies in the sector and VET schools in agri-food is ad-hoc, i.e. company representatives in cooperation with the schools may provide trainings on the use of drones, software for high precision aerial 3D maps, robots for applying pesticides and similar modern technological solutions to the high school students, while there are not yet specific curricula that can offer continual and updated usage of such products and services. In the interview with the VET representative, it was shared that possibilities to hear about modern technologies were enabled through Erasmus project

[47] The involved faculties are: Faculty of Information and Communication Technologies- UKLO, Faculty of Electrical Engineering and Information Technologies- UKIM, Faculty of Computer Science and Engineering- UKIM, Faculty of Electrical Engineering- UGD, Faculty of Computer Sciences- UGD, Faculty of Computer Science and Engineering- UIST, Faculty of Communication Networks and Security- UIST, Faculty of Applied Information Technology- Mechanical Intelligence and Robotics- UIST, Faculty of Information Sciences- MTU, Faculty of Informatics- European University, Faculty of Informatics- FON, Faculty of Computer Science and IT- UACS,
Faculty of Contemporary Sciences and Technologies- SEE, Faculty of Computer Science- UTM, Faculty of Informatics- ISU.

[48] See, for example, here.

when NGO representatives visited the school and presented novel equipment and tools. There is also almost no support from the central government to purchase modern equipment for training purposes.

In order to support continuity in the process and introduce new techniques and technologies, two enabling factors were mentioned: the need to train and educate the VET professors with the subjects related to use of digital technologies; and equip laboratories and workshops where novelty technologies might be taught.

Business accelerators and other intermediary bodies rarely have trainings and educational support for digitalisation in the agri-food sector specifically. However, some examples of business intermediary bodies in ICT skills supply exist. For instance, the Chamber of Commerce for ICT (MASIT) is an ICT association that promotes and represents enterprises active in the ICT sector in North Macedonia. In 2019, MASIT launched the second cycle Pre-qualification project. The project carried out pre-qualification training for interested candidates for ICT occupational profiles. The sample of candidates was made of unemployed people not older than 35 and who wished to gain knowledge and practical skills in IT with the view of being employed by ICT companies. The programme developed by the project lasted for three months.[49]

When it comes to **in-company training**, the interviewed companies used different models. Some of the companies were training their staff in-house, where more experienced and senior employees transferred the knowledge to the new employees; this process usually lasted around three to six months. Other companies relied on online courses and subscriptions offered by vendors. This was especially common for the staff working in software engineering and programming businesses.

Matching the demand and supply

While the country has seen a fast increase in the number of companies and employees in the digital sectors such as computer programming and ICT, cooperation between the ICT sector and the agri-food sector in the country is not common. Given that the wages in the ICT sector are almost two times higher than the national average (represented in table above), interviewed companies in the sector indicated that the domestic agri-food sector has lower than country's average wage, which in turn is less likely to attract workforce with ICT educational background or personnel with high level of ICT skills. Such situation delays introduction of digital solutions in the sector which can facilitate know how transfer and work on development of ICT solutions for the domestic companies. Hence, only big companies and those companies with higher value added of their products, can afford introduction of digitalisation in the processes, and attract high skilled personnel.

Small companies which sell equipment and services on international markets in order to follow technological changes shared that they faced skills shortages. Hence, they provided in-house training for their employees which was necessary for keeping the employees competent in the area, or outsourced expertise.

While no obvious gaps exist in the provision of ICT skills, workers with advanced ICT skills are looking after job opportunities in foreign companies or domestic companies within sectors where wages are well paid, such as fintech and insurance, automotive and energy sector. Furthermore, the multidisciplinarity desired by the SMEs (e.g. digital skills and competences with focus on agri-food

[49] Though there is no specific description of skills developed by the programme, mainly being referred to as ICT skills, MASIT's website suggests that FrontEnd development was a very important component.

sector, ICT profiles combined with business management or sales skills, etc.) is lacking from the skills profiles of recent graduates.

One step towards matching the demand and supply of qualified workforce in the agri-food sector is to introduce multidisciplinary programmes where faculties of agriculture jointly with the faculties of business, engineering and ICT can form new class of professionals able to adopt and transfer the know-how from more advanced economies to the domestic companies.

BIOCHEMICAL AND MICROBIAL PRODUCTS FOR AGRI-FOOD

The area of biochemical and microbial products in the agri-food industry pertains to the input level of the agri-food value chain. It plays a crucial role in growing essential crops and driving innovation in food production. This area includes the manufacturing of fertilisers, nitrogen compounds, pesticides, and other agrochemical products, as well as research and experimental development in biotechnology. These sectors are classified under NACE codes:

- Manufacture of fertilisers and nitrogen compounds (C20.1.5);
- Manufacture of pesticides and other agrochemical products (C20.2);
- Research and experimental development on biotechnology (M72.1.1).

This chapter commences with an overview of the overall profile of the biochemical and microbial products niche for agri-food in North Macedonia. We then examine the demand and supply of skills in this niche and matching the demand and supply.

The profile of the market niche and the stakeholder ecosystem

General overview

This market niche is represented by small number of micro sized companies. All three sectors had less than 20 active companies combined in North Macedonia in 2021, as well as a very small number of full-time employees (see the table below).

Production of fertilisers, nitrogen compounds, pesticides and agrochemical products took place in North Macedonia until early 2000s. Two companies OHIS[50] and Chemical Industry Veles (HIV-Hemiska Industrija Veles)[51] used to produce and export agrochemical products across the region.

Currently, there is only one producer of fertilisers in the country, Alkaloid-Skopje, whose main economic activity is in manufacture of pharmaceutical products. The company mainly produces chemical products such as liquid mineral fertilisers, bio-stimulants, soil conditioners and mineral fertilisers with annual sales of EUR 5.4 million in 2021.

[50] OHIS was a Skopje based state run chemical company build in 1960 and operated until the beginning of 2000's. The company had 5 factories for produce of pesticides, fertilisers and cosmetics.

[51] Chemical Industry Veles was a state owned large industrial capacity with more than 400 employees and produced fertilisers until 2003.

TABLE 15. ADMINISTRATIVE DATA ON NUMBER OF COMPANIES, TURNOVER AND EMPLOYEES- BIOCHEMICAL

Year	Number of employees	Number of companies	Income in MKD	Income in EUR (exchange rate 61.5)
C20.1.5 Manufacture of fertilisers and nitrogen compounds				
2019	8	8	24,312,169	395,320
2020	8	8	33,422,060	543,448
2021	8	8	29,196,760	474,744
C20.2 Manufacture of pesticides and other agrochemical products				
2021	5	4	1,691,000	27,496
M72.1.1 Research and experimental development on biotechnology				
2019	9	5	5,098,588	82,904
2020	10	5	5,677,306	92,314
2021	3	7	3,998,472	65,016

Source: Central Registry of the Republic of North Macedonia.

The value of fertilisers and nitrogen compounds imported to North Macedonia in 2021 was nearly EUR 24 million. Major shares of were imported from Russia (EUR 5.7 million), Bulgaria (EUR 5.1 million), Greece (EUR 3.4 million) and Croatia (EUR 2.5 million).[52] Most of the fertilisers are imported in bulk and packed locally in consultation with the farmers and their needs.

Biofertilisers are an eco-friendly alternative to chemical fertilisers and can help increase crop yields and reduce the need for synthetic chemicals, and are becoming popular among small family-run agricultural businesses and individual farmers, as shared in the interviews. During the interviews, it was also indicated that biofertilisers are mostly used also in so-called micro-organic farms which produce and sell organic products door-to-door and some restaurants.

Production of biofertilisers in North Macedonia is still marginal in terms of quantity produced and companies operating. While there is only one large enterprise that engages on production of chemical fertilisers and similar products, there are several small producers of innovative biochemical and microbial products. Several companies[53] are producing biofertilisers with small quantities exported to the countries in the region, while the use is not monitored and registered.

Several companies are working in the field of **biotechnology** whose main activity is the analysis and testing of quality of water, food, soil and air, and to less extent performing research and development of new products, such as biopesticides and enzymes for winemaking.[54] These products are now under testing, and their development and commercialisation is expected to take place within the next three years. Research and experimental development in biotechnology is present among small number of domestically owned private companies and one public company. During the interview process, it was pointed out that the sector received very limited support from the public funding and most of the operations are implemented through foreign funded donations.

[52] Available here.

[53] Organika Nova is a small family run company that produces organic microbiological fertilisers, biostimulators and soil improver, produced from manure processed by the Californian red worms.

[54] Bioengineering is a domestically owned company which in 2022 received co-funding from the FITD for commercialisation and sale of Macedonian indigenous yeasts for production of geo-local wine.

Production of premixes for animal feed is also present in the country, with small number of domestically owned companies which are offering domestically produced and imported products. Premixes for animal feed are tailored to meet the specific nutritional requirements of different types of animals, such as poultry, pigs, cattle, bees, goats, sheep, pets etc. Premixes are usually added to a base feed material, for example grain, to create a finished feed product that is nutritionally enhanced for the animals. Currently there are no officially available data on quantities produced and imported.

A small number of local companies also produce biofuels. Data from the SSO on importation of biofuels show that in the past years, the value of imported biofuels was around EUR 0.5 million annually, while there are no significant exports registered. In absence of national legislation, and alignment of the legislation with the EU Regulations, the sector remains likely underestimated, with unused potentials for economic development.

Key stakeholders

The main stakeholders in this niche are the general agri-food ecosystem stakeholders outlined in the Overview chapter, as well as agencies such as Food and Veterinary Agency. Several scientific institutions could be mentioned, such as the Research Centre for Genetic Engineering and Biotechnology within the Macedonian Academy of Sciences and Art, and associations such as the Macedonian Society for Medical Biochemistry and Laboratory Medicine. It is important to note though, that although these organisations conduct research in biotechnology, they are more focused on medicine, and only individual research projects are directly linked to the agri-food sector (e.g., the Research Centre for Genetic Engineering and Biotechnology has worked DNA markers in cultivated varieties of tobacco and conducts analysis of GMOs[55]). There is a lack of business intermediary bodies whose activities would be focused on the biochemical and microbial products.

Companies representing the niche

The companies included in the interview process were micro and small enterprises with domestic ownership. All companies were limited liability companies, of which two were owned by men and one by a woman. We interviewed the representatives of Bioengineering, Greenagro and Ferthem-Tim whose work is related in different sub-sectors, such as research and development of biopesticides and enzymes for winemaking (Bioengineering), forage mixtures and components for animal feed (Greenagro), and preparation of mixtures for fertilisers (Fertem-Tim[56]). All companies had existed in the market for more than 15 years. Except Ferthem-Tim, the companies had export experience in the Western Balkan region. The company Bioengineering used modern technology in its operations in order to keep in pace with the technological advancement and to perform state of the art research.

Regarding the plans to invest in the medium term, two of the interviewed stakeholders (Bioengineering and Greeagro) planned to invest in equipment, including laboratory equipment and modern hardware, and training of personnel, while Ferthem-Tim had challenges which occurred with the supply of resources chains and were going to refrain from investments in the next period.

The companies have small teams of engineers and technicians with educational background in chemistry, agriculture and economics. Along with the preparation of fertilisers, their secondary activity

[55] See more information here.

[56] Ferthem-Tim was founded after the closure of the factory Chemical Industry Veles in the beginning of 2000s, when several experienced engineers and technicians, ex-factory employees, founded a company which prepare mixes for fertilisers and nitrogen compounds. Similar business models were replicated by several other employers.

is related to counselling and advising the individual farmers on how to improve the soil fertility and prepare specific mixtures of fertilisers in accordance with soil conditions.

The activities of the interviewed companies are focused on local market only at the time of the interviews. Disruptions in the global supply chains[57] in the aftermath of the pandemic 2020, complemented with the energy crisis that emerged in the beginning of 2022 were preventing most of the companies in the niche to plan new employments and investments in the next one-year period.

Skills demand

None of the interviewed companies were actively hiring or looking for new employees. However, some insights on the skills required in the niche could be made based on their current staff profiles. Most of the current employees of the interviewed companies have higher education in agriculture, veterinary science, genetics, biology, chemical engineering, and other natural sciences, while some have secondary education. The corresponding occupations in terms of ESCO include the following:

- 2144.1.2 - agricultural engineers, 2132.1 - agricultural scientists, 2132.2 – agronomists, 2133.11 - soil scientists, 3142.1 - agricultural technicians
- 2250 - veterinarians, 3240 - veterinary technicians and assistants
- 2131 - biologists, botanists, zoologists and related professionals, particularly 2131.4.8 – geneticists, and 2131.4.10 - microbiologists
- 2145.1 - chemical engineers, 2131.4.2 – biochemists, 2145.1.1 - biochemical engineers

Although the current employees of the interviewed companies are generally highly skilled, experienced and specialised in production, many of the employee's skills in the niche are obsolete: modern technologies are not used in the production processes, while modern marketing strategies and channels are not utilised for sales promotion. This is one of the reasons why the sales and operations are limited to the domestic market and companies do not internationalise. This also indicates the skills needs for occupations that will be in increasing demand in the future:

- Genetics engineers, microbiologists and biochemical engineers whose skills needs to be updated frequently because rapid advancement of technology renders their skills obsolete.
- Experienced project coordinators needed to coordinate multiannual research programmes among several partners from different countries (ESCO 1219.6 - project managers).
- Salespersons with skills needed to commercialise the products abroad (e.g., ESCO 1324.3.2 - import export manager, 3331.2.1 – import export specialist, 2433.6 and 3322.1 – sales representatives).

Based on field interviews, the premixes for animal feed segment of the biochemicals market niche had seen increased labour demand in recent years. The distinctiveness of this segment of the market niche is that along with the products sales, counselling and advising services are offered, which can include preparation of recipes, dosage of the premixes and providing guidelines for farm management. Skills demanded in the niche include knowledge of animal nutrition, expertise and experience in preparing recipes for mixtures, quality control of the materials used, and excellent communications skills and customer care.

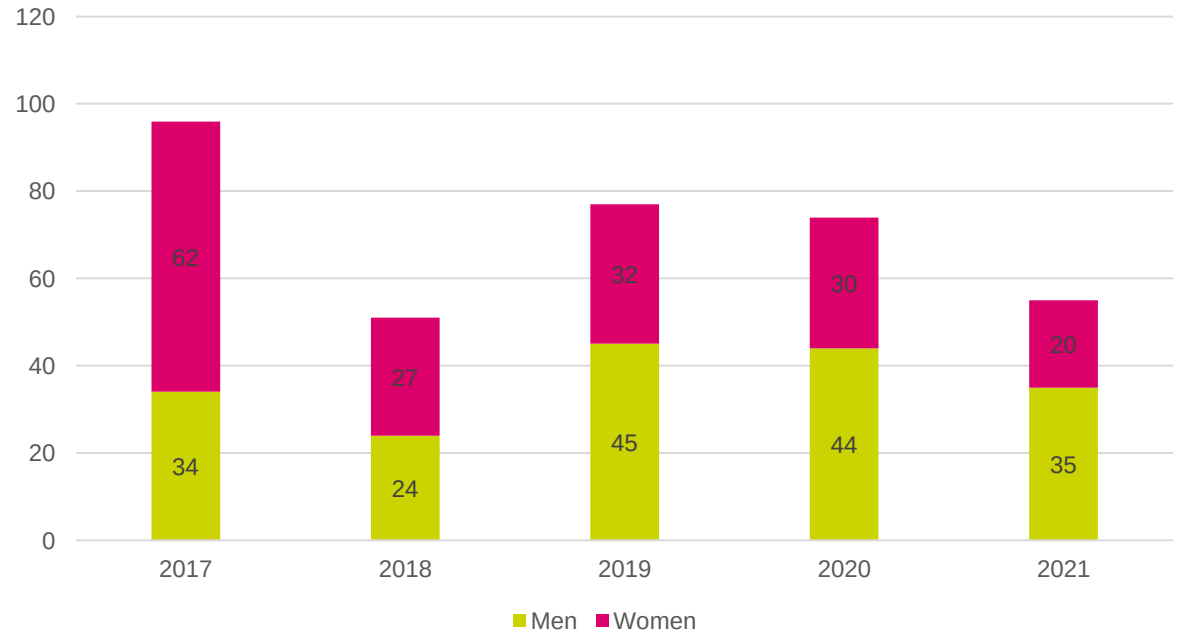
[57] During the interviews it was shared that the sanctions introduced by North Macedonia on Russia have forced companies to purchase compounds for fertilisers from Turkey and Greece which would decrease their price competitiveness in the future.

The interviewees also pointed out the need to strengthen research cooperation with research centres from more advanced economies in the field, especially in postgraduate studies, because domestic universities do not offer the necessary educational and training set of skills for the positions companies plan to employ or outsource.

Skills supply

University level education in biotechnical sciences, food technology and veterinary medicine which is relevant to the sector niche can be obtained at five faculties[58] in the country. However, the trends show that interest in the sector has decreased over the last period and only 55 students graduated in 2021 from all five faculties combined.

FIGURE 8. NUMBER OF GRADUATES FROM FACULTIES OF BIOTECHNICAL SCIENCES, FOOD TECHNOLOGY AND VETERINARY MEDICINE, BY SEX



Source: State Statistical Office Makstat, own representation. Available here.

Supply of workers in the biochemical and microbial sectors is characterised by severe deficit, as those sectors are less present in the country and the profiles offered by educational providers is limited to several profiles and small number of graduates. SNA, for example, estimates a need of 150 positions for chemical engineers, biologists and veterinarians, which is three times more than the number of graduates in 2021.

Profiles in VET schools which have curricula related to production and application of fertilisers, pesticides and nutrition products for animal feed are Agrotechnicians, Technicians in phytomedicine and Technicians in veterinary medicine. However, during the interview process, company representatives have expressed the concern that the curricula do not offer the right set of skills needed in their companies and there is a need of on-the-job training which takes 6-12 months. Skills

[58] Faculty of Biotechnical Sciences-UKLO, Faculty of Veterinary Medicine- UKLO, Faculty of Veterinary Medicine- UKIM, Faculty of Food Technology – UT, Faculty of Agricultural and Biotechnical Sciences – UT.

shortages were reported related to increased automation of the processes, need for use of IT tools, use of e-commerce, use of sensory components and reading the results etc.

Due to the lack of qualified area experts in the country, companies often lean on expertise from abroad. The know-how transfer is done also through short training visits in more advanced countries such as Israel, Italy, Netherlands and Germany. Most of the products present in the market (e.g., fertilisers, pesticides, biofuels, enzymes for food production, premixes for animal feed etc.) are imported from abroad, and usual practice is that the sellers provide training to the local resellers on how to use and sell the products.

Companies in the field of biotechnology encounter shortages of highly specialised staff which is hard to find on local labour market. Hence, cooperation with research centres (e.g., MASA) and universities partially solves the issue, as companies engage researchers from research and education institutions on a project base. Such occupations are genetics engineers, microbiologists and biochemical engineers. The company representative from one of the interviewed businesses also mentioned that they value graduates and researchers who have obtained a degree from Western countries.

Matching the demand and supply

Matching the demand and supply of skills is challenging in the biochemical and microbial products market niche. Skills demanded by employers change rapidly, and the available workforce skills are generally not ready to meet the demand.

Estimations based on administrative data from ESA show that the number of unemployed with a university degree in agriculture and forestry at the end of November 2022 was about 200-250 persons and outnumbers the demand for such profiles.[59]

Most of the interviewed companies are members of the chambers of commerce, from where they receive notifications and information on opportunities for cooperation within the country or from abroad. However, chambers and other representative bodies fail to notice the sector niche and consider it as small in value and businesses. Hence, they remain reluctant to broaden the support to the businesses in the niche.

Companies solve the issues of skills shortages in various ways, such as in-house and on-the-job training, supporting the employees to attend courses in the country and abroad and providing on-line course subscriptions.

There are also examples where companies like Bioengineering, which have signed memorandum of cooperation with the universities, specifically with the Faculty of Natural Sciences and Mathematics, on hiring new graduates with particular accent in the field of molecular biology. Such practice allows students to train on equipment and instruments owned by the companies (bioreactors, testing equipment, instruments for DNA sequencing and similar) and which is non-existent or outdated at faculty's laboratories.

[59] ESA. Available here.

ORGANIC AND FUNCTIONAL FOODS

Organic farming is an agricultural method that aims to produce food using natural substances and processes. This means that organic farming tends to have a limited environmental impact as it encourages:

- responsible use of energy and natural resources,
- maintenance of biodiversity,
- preservation of regional ecological balances,
- enhancement of soil fertility,
- maintenance of water quality.[60]

Functional foods are foods that have been developed or modified to provide additional health benefits beyond basic nutrition. These foods are typically fortified with specific nutrients or bioactive compounds, such as vitamins, minerals, probiotics and antioxidant that are deficient in the diet. The production and commerce of such products is regulated by the Food and Veterinary Agency (FVA) which holds three registers on the products which fulfill the criteria for food safety:

- Register of products which fulfils safety criteria on use of food additives;
- Register of products which fulfils safety criteria on food for nutritive use;
- Register of products which fulfils safety criteria on food enriched with vitamins, minerals and other substances.

For the purpose of this study the organic and functional foods market niche was analysed through four broader NACE classification groups:

- crop and animal production, hunting and related service activities (A1)
- fishing and aquacultures (A3)
- manufacture of food products (C10)
- and manufacture of beverages (C11)

This chapter provides an overview of the niche's profile in North Macedonia and discusses the skills demand and supply for the niche, as well as matching demand and supply in the niche.

The profile of the market niche and the stakeholder ecosystem

General overview

There is a lack of data on the functional foods segment of the market niche, therefore, the findings presented in this section mainly refer to organic food. In the skills demand section, however, some insights from the interviewed functional food companies are presented.

In North Macedonia, organic production was firstly introduced by a law in 2004, which was replaced in 2009 with the current Law on organic production (Official gazette 146/2009, amended in 2011, 2015,

[60] European Commission (n.d.). Organics at a glance. Available here.

2016 and 2021) and a set of bylaws which regulate the production, distribution, processing, and trading of organic products, as well as financial support.

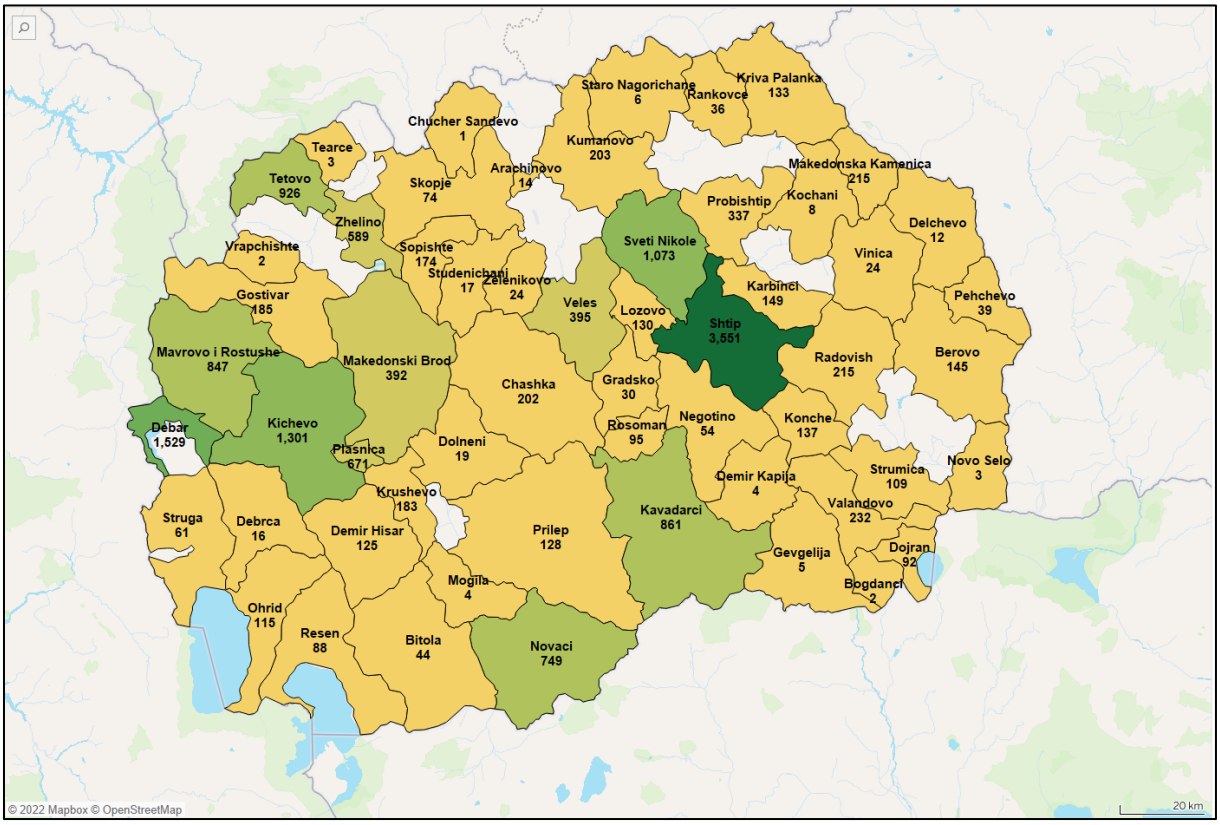
In the initial years of introducing and promoting organic farming it attracted huge interest among individual farmers and companies. The two main drivers for such interest were detected: first, it was perceived as something new that can add to the value of the products sold and increase the possibility for selling on foreign markets and second, it was announced by policy makers a generous subsidy schemes for organic production which also attracted interest for boosted production at the beginning of 2010's. Over the years, it became notable that expectations were not met, and many producers turned in to non-organic production which requires less effort, work practices to be followed and provides cheaper products. Such decrease is also notable from the statistics on land use under organic production.

Still, organic food is becoming more popular as more people are becoming aware of the benefits of food that is grown without the use of synthetic pesticides and fertilisers. Many local farmers and small businesses offer organic products, including fruits, vegetables, grains, honey, meat, and dairy products. The processing companies operating in the production of organic food are export-oriented because of the size of the domestic market and the opportunity to sell for higher prices on foreign markets. A few stores in the country, as well as online retailers, specialise in selling organic products. Some restaurants and cafes in the bigger towns also offer organic options on their menus. Functional food segment is also present on the North Macedonian market, exemplified by the two of the interviewed companies that produce functional drinks from chia seeds and protein snacks.

Estimates from the database find that the municipality of Shtip has largest areas of organic certified and under conversion land under plants or crops production. Other maps related to production of organic food are available in Annex 5. Organic production by municipality.

Overall, the availability of organic food in North Macedonia is increasing, but the range of products and availability on retail market is still small compared to EU countries. With growing demand and support from organisations and institutions, it is likely that the availability and variety of organic food will continue to expand in the future.

FIGURE 9. ORGANIC AREA OF CROPS (CERTIFIED AND UNDER CONVERSION), BY MUNICIPALITY IN 2021 (IN HECTARES)



Source: Ministry of agriculture, forestry and water economy, author's representation.

The share of area under organic farming (fully converted and under conversion) in 2020 was 0.3%, compared to EU-27 average of 9.08%.[61] Back in 2013, the share of area under organic production in the country was 0.8% and aimed to reach 4% by 2020. Yet, the latest data show a decrease of organic area as percent of total cultivated area. In 2021, however, according to Eurostat data on organic farming, the organic crop area has almost doubled in North Macedonia in comparison to 2020, reversing the negative trend.[62]

The government aims to support the organic segment of the market niche by granting more financing to organic farms. Thus, the National Programme for Agriculture and Rural Development 2018-2022 has projected higher financial assistance for organic production than that for conventional agriculture.[63]

Key stakeholders

In line with the EU recommendations, the Law on organic production envisages introduction of control and enforcement mechanisms and bodies which can audit and inspect the process. Currently there are two certification bodies responsible for certification of organic production: Balkan Biocert and Procert which are accredited by the Institute of Accreditation and authorised by the Ministry of

[61] Eurostat (n.d.), available here.
[62] Eurostat (n.d.), available here.
[63] See here.

agriculture, forestry and water economy (MAWFE).[64] As of end of 2022, there is not publicly available list of certified exporters who are licenced by the certification bodies, and a recent study[65] found that in 2020 there were 26 companies registered.

MAWFE is responsible for the evidence and databases of subjects who produce, process and trade organic products. Data from the MAWFE are exchanged with the State Statistical Office which publishes statistics on organic production. At the end of 2021, the database consisted of 929 subjects of which about 700 producers, and the remaining are organic food processors and traders.

In order to reach the goals set, and incentivise organic production, the government adopts Annual programme for financial support of organic production which is implemented by the Agency for Financial Support of the Agriculture and the Rural Development (AFSARD). The annual programme for 2022 envisages financial support of about EUR 2 million for producers of organic products, but the realisation of the programme cannot be tracked because the reporting is done jointly with same programme code as the code for financial support for agriculture.[66]

The National agency for supporting the agriculture production (NASAP) is a state agency founded in 1998. The NASAP has around 220 employees[67] and offices in 30 towns and dispersed offices in 44 rural places across the country. The mission of the NASAP is to provide counselling services to the agricultural producers, as well as training, transfer of know-how, tutoring, introducing and establishing information systems in the agriculture to improve the traceability of agricultural activities and exchange of information with stakeholders in the agro-complex, providing mentorship in production and other type of professional and information support related to agricultural production. NASAP has around 85 professionals who are providing counselling services related to soiling, fertilisation, applying pesticides and other farming operations to the agricultural producers, upon their request. However, profile of the professionals and area of specialty in which counselling and training modules are provided to the interested farmers are unknown. Certification and regulation of the profession counselling and training in agriculture, was suggested among interviewed stakeholders.

Several business intermediaries, such as civil society organisations and a business chamber (Chamber of Organic Producers KOP[68]), are active among the producers of organic food. However, companies which **process organic food** currently do not have registered business association and according to the interviewed representatives, the process to form an association is ongoing.

The IME is multiannual donor supported programme funded by the Swiss government.[69] One of the targets of the programme are support, education, and certification of agricultural producers on organic production. Over the years, the programme had provided co-funding for start-ups with the FIDT, non-formal educational training to farmers, supported the participation of organic producers on international fairs and purchased equipment for micro-sized companies producers of organic food. Currently, the IME programme is engaged in training of several producers of organic food to make

[64] Собрание на Република Македонија Парламентарен Институт (2017). Органско производство во Република македонија (семе, саден материјал и ѓубрива): тематска анализа, available .

[65] EkoConnect (2022). Report on the Status of Organic Agriculture and Industry in North Macedonia.

[66] Programme for financial support of the agriculture in 2022 and Programme for financial support of organic production 2022 use same subprogramme code 20, division 464 -other transfers, which is difficult to estimate the realisation of transfers for organic production.

[67] Budget for 2022 of the Republic of North Macedonia, available here.

[68] KOP was founded in 2019 with the support of 60 producers and associations, that operate in agri-food sector.

[69] IME. Sustainable agribusiness. Available here.

their way to the Swiss market by obtaining Bio Suisse – organic certification and adding their products to the Swiss supply chains.

Companies representing the niche

The companies included in the interview belong to both, the functional food (two companies) and organic food (one company) segments of the niche. All of them were micro and small companies with domestic ownership, registered as limited liability companies. Two of the companies were owned by women and one by man. We interviewed the representatives of ChiaDia, Pro-Fit Vis and Organauts, whose activities focus on production of non-alcoholic functional drinks based on chia seeds, protein crackers with reduced carbohydrates, and local traditional organic food. All three interviewed companies were newly formed companies in the past three years. Only Organauts has export experience in the Balkan region.

Regarding the plans to invest in the medium term, two of the interviewed stakeholders (ChiaDia and Pro-Fit Vis) planned to invest mainly in equipment (new production lines and vehicles for logistics), while Organauts is focused on investing in marketing and acquiring new markets. At the time of data collection, their focus was on developing local sales network and promotion of the products on regional Western Balkan markets.

Skills demand

The interviewed companies involved in the production of organic and functional foods all had only one employee each, and did not have clear workforce needs for the future. The reason for that was that they were mainly preoccupied with finding equipment and financial resources; some were not sure about their company's future existence. The insights on the skills demand for the niche, therefore, are based on the theoretical considerations of the interviewees rather than current skills needs.

In respect to employment outlook for the future, the companies' expectations about future hard-to-find professions included nutritionists (ESCO 2265.1), sales managers (1221.3.2.1), as well as international marketing and sales managers (1221).

In the future, the demand for skilled labour force in organic production is also expected to increase, as the awareness about organic food is rising domestically and globally. Nevertheless, main pull factors for increased employment opportunities in the niche of organic and functional foods would be the access and participation to the markets in wealthier countries, as well as access to subsidies for incentivising the production. Some of the skills in high demand in organic farming include both lower and higher level skills and related occupations:

- **Knowledge of organic growing practices,** which includes understanding how to fertilise, pest control, and crop without the use of synthetic chemicals. In terms of ESCO occupations, these skills are covered by the following occupational profiles (yet requiring specific focus on organic production):
    - High-skilled: agricultural scientist (ESCO 2132.1), agronomists (2132.2), ecologists (2133.5), agricultural engineers (2144.1.2), agricultural technicians (3142.1)
    - Lower-skilled: farm managers (ESCO 6130.1), crop production managers (6114.1), horticulture production managers (6113.2), field crop and vegetable growers (6111), mixed farmers (6130).

  The SMEs also expect that the people taking up these occupations have the necessary **business skills**. Organic farmers need to have strong understanding how to budget, manage finances and prepare plans in order to succeed.

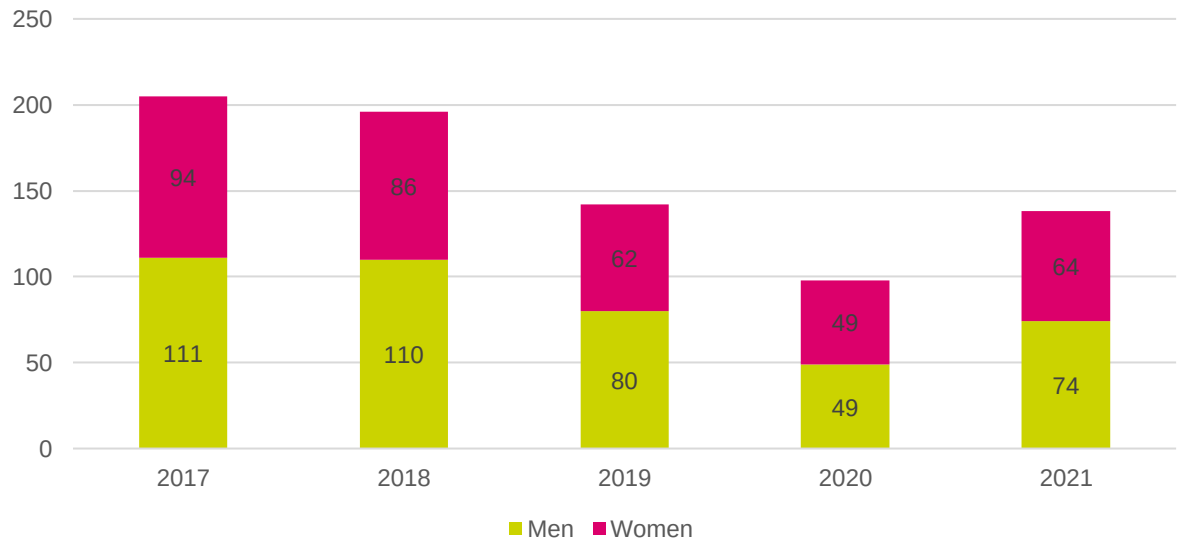
- **Knowledge of soil conditions** relates to the knowledge of the organic farmers to have a good understanding of soil condition and how to maintain it through sustainable practices such as cover cropping and composting. The corresponding ESCO occupation is soil scientist (2133.11).
- **Marketing and sales skills**. Organic farmers need to be able to sell their produce and sell products to consumers, markets, open green markets and restaurants. This includes understanding how to price and package their products, as well as how to effectively market them. In terms of ESCO occupations, these skills are covered by the following occupational profiles:
    - import export managers (1324.3.2), import export specialist (3331.2.1), sales representatives (2433.6 and 3322.1).
    - digital marketing managers (1221.5), marketing consultants (2431.10), marketing assistants (2431.10.3), market research analysts (2431.11), advertising specialist (2431.3).

As some of the most important horizontal skills for all occupations, **communications skills** were emphasised. Organic farmers often work closely with other farmers, customers, and organisations in their localities. Strong communication skills are essential in order to effectively collaborate and build trust and relationships.

Skills supply

University level education which is relevant to the organic and functional food niche can be obtained at three faculties in the country.[70] However, the graduation trends demonstrate that the interest in the sector has decreased over the last period and only 138 students graduated in 2021 from all three faculties combined. The disinterest to study in the area can be related to limited job opportunities and lower than average salaries in the sector.

FIGURE 10. NUMBER OF GRADUATES FROM FACULTIES OF AGRICULTURE AND FOOD TECHNOLOGY, BY SEX



Source: State Statistical Office Makstat, own representation. Available here.

[70] Faculty of Agricultural Sciences and Food-UKIM, Faculty of Agriculture- UGD, Faculty of Food Technology – UT; Faculty of Technology and Metallurgy-UKIM, Skopje also offers studies in food technology and wasn't included in the metrics.

The statistical bulletin issued by the biggest university in the country, University of Ss Cyril and Methodious-Skopje, shows that the number of enrolled students at the Faculty of Agriculture for the academic year 2021/2022 in the department of organic agriculture was only three students out of 76 enrolled at the faculty in total.[71] Such small enrolment numbers show that the interest in the field is weak and the supply of agricultural specialists in the area of organic farming will encounter sharp deficits in near future.

Data on research in the field of organic and functional production and food processing is scarce. Based on the interview data, some organic and functional food processors use the labs at the Faculty of Technology and Metallurgy in order to examine the compounds and contents of the food products, while there are no joint projects with the companies which can lead to product improvements and commercialisation. The weakness was spotted at the organisational level of universities, where there is not sufficiently dedicated staff and budgets for cooperation with donors and companies. Hence, the university employees (administrative and scientific) are less interested to spend time on projects' implementation and cooperation on international donor funded projects which can transfer know-how and best practices from countries more advanced in organic farming and processing and functional food production.

Largest skills shortages detected by the company representatives were directed towards educational programmes at the domestic universities. Namely, new graduates have only "qualification title" and "graduated title" while are lacking skills needed for use of modern technology, communication skills, teamwork skills and English language skills which are necessary for sales, learning from foreign literature, participation on international fairs and presenting the products to international markets.

When it comes to **VET education**, organic production is offered as optional subject in two VET profiles within the approved qualification standards Technician in phytomedicine (the subject Technology of organic production is optional) and Agrotechnician (the subject on organic production is optional). The number of places offered for 2022/2023 enrolments for these two profiles are estimated at around 200 places in the country. However, there is no available data on actual enrolment.

The number of VET graduates in organic production is even smaller than those graduating in agriculture and veterinary, and according to the representative from the VET school in Skopje, about 60 students graduated in 2022 with topics and subjects which have links to organic production.

Introduction of dual education (presented in the general VET in the agri-food sector section above) is expected to create stronger partnerships on the local level among stakeholders involved (companies, VET schools, municipalities) and adapt the workforce to the qualifications and skills demanded on the labour market. However, the dual education in agriculture faces some barriers. Agricultural VET schools used to have dual education system in Yugoslav times, as there was enough land available for practicing farming, mechanisation, vehicles and system to conduct practical trainings in large agri-combinates. Nowadays, agricultural VET schools face difficulties to bring the students to the crop fields, because there are no means for such activities. Currently there are not enough companies within Skopje region where students can be placed for practice. Students also do not receive reimbursement for traveling to distant farms and farmlands which is an additional problem for those coming from socially disadvantaged families.

[71] Available here.

When it comes to career guidance, a career centre used to function at the agricultural school Brakja Miladinovci-Skopje in the pre-pandemic period, but is currently non-functional due to the lack of funds for personnel.

On the side of **non-formal training**, training and knowledge dissemination in organic production is done mainly through non-formal educational courses offered by the associations in organic producers,[72] and to some extend by the adult education centre (AEC) programmes. In the database of AEC, there are six programmes related to training in organic production. However, there is no data on how many students have attended such courses. There was no information found on training relevant for the functional food.

Business intermediary bodies outside of the country also offer irregular training initiatives. For instance, in the late 2010s, the Research Institute of Organic Agriculture - FiBL, organised free courses on organic production to the professors at the VET school Brakja Miladinovci-Skopje, which helped them to learn more on organic production. In the post-pandemic period, however, access to such courses diminished.

Matching the demand and supply

The market niche of organic and functional food production, as represented by the interviewed companies, is characterised by low hiring needs, still affected by the global economic disruptions. At the same time, however, the supply of skill that the companies would need for their growth, modernisation and expansion to foreign markets, is limited.

The interest in agriculture study programmes has been steadily decreasing for a number of years, both at the university and VET levels. The graduates are also said to be lacking skills needed for use of modern technology, communication skills, teamwork skills and English language skills which are necessary for sales, learning from foreign literature, participation on international fairs and presenting the products to international markets.

No efforts were made to establish a system that can match the skills and occupations demanded and supplied on the sectors of economic activity that cover the organic and functional food production niche. Hence, risks for growth of this niche have high potential to exacerbate current situation and damage the striving sector in longer term. Such risks can be that the educational providers cannot produce the skills demanded by the companies either in numbers or quality. Nonexistence of system that can track the skills supply and demand, can lead to unnecessary attendance of trainings by unemployed who risk investing in unnecessary education, while for companies, hard to find the right skills needed.

Business intermediaries in the sector have difficulties to properly cooperate and promote their activities as there is little funding available from the central budget and only ad-hoc short-term projects funded by donors are disponible for a large number of small producers.

[72] Such are usually donor funded projects whose main activities are seminars, info sessions, workshops and similar types of events where participants can learn and gain insights about organic products, possibilities for organic production, commercialisation of organic products and similar topics.

CONCLUSIONS

The Macedonian agri-food sector is characterised with low productivity rate, low price competitiveness with CEFTA countries and a low level of modern technology use.

The role of the sector remains important for several reasons. Nearly 11% of the workforce is employed in the agriculture sector. Further development of food processing industry should be aimed at being able to process a great share of the agricultural products and contribute to higher added value of the products, decrease deficits in trade balance and add to economic growth, create new jobs, and increase productivity through investments in new technologies and well-educated workforce.

Most of the statistical data is limited to aggregated statistics, i.e. food processing industry data on employment, educational attainment from Labour Force Survey is aggregated within manufacturing and structural business statistics are not available after 2019.

Existing employment and occupation anticipating models (such as the Job vacancies and Skills Needs Analysis[73]) publish aggregate data, where food processing industry is included within manufacturing, while agriculture is not included in the Job vacancies survey which creates considerable gap in the policy creation processes.

There are weak linkages among educational providers, institutions and companies operating in the agri-food sector. Enhancing cooperation among these groups would increase confidence in educational programmes and induce reform of the educational programmes in favour of all participating parties. Links between employers and non-formal training providers (e.g., Open Civic Universities, Training Centres) should also be strengthened with involvement of relevant institutions (MAFWE, AEC, MoES) in order to secure sustainability of the educational and training processes.

Digitalisation in the agri-food sector is among the most underdeveloped processes in the country, however, notable examples of innovative companies that develop technological solutions for the sector exist, exemplified by the interviewed companies.

The educational offer in the sector is focused on several branches and updating of curricula at educational establishments needs to be prioritised. Outdated educational curricula in the agri-food sector combined with lower than country's average wages (22% less than country average in April 2022) adds to disinterest of young population in the agri-food sector, despite incentives offered by the government. Graduates in IT specialisations are less likely to be interested in working in the agri-food sector, as the salaries that the sector can offer are much lower.

The lack of training and education on digital skills in the VET schools along with the rapid advancement in technology has rendered certain profiles obsolete. Current curricula in agricultural VET schools offer programmes with skills that are generally relevant, but are not up to date with the latest technologies and best practices in the field.

Meanwhile, the production of biochemical and microbial products for agri-food sector in the country is in the early stage of development. While there is some limited support offered by the institutions in form of co-funding and granting for innovative projects, overall infrastructure is less developed and impedes significant growth in the sector in near future.

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[73] Employment Service Agency.

The lack of regulatory framework hinders entrepreneurship in the sector niche, though many enthusiasts seek to embrace the benefits, like producing biofertilisers from compost and biowaste in the times of price uncertainty of mineral fertilisers. With institutional help and dissemination, such products might be commercialised and partially absorb the shock caused by uncertainty in global supply chains.

Unsatisfied skills demand which exists in the sector can be overcome through cooperation among academia, companies and research establishments. Research cooperation among academia and companies needs to be fostered by public institutions where joint research projects that bring together the expertise and resources of both parties shall be prioritised. The process can be enhanced if partners from more advanced economies are involved, especially where domestic expertise can be complemented by foreign experts.

Talent exchange as a form of cooperation should be supported where companies can hire academic researchers to work on specific projects, and company employees can be allowed to work in research institutes for a certain period. This can help both parties learn from each other and build on connections that can lead to further cooperation.

Moreover, to address skills shortages, more active involvement from the side of the policy makers is needed to support unemployed university graduates in the agricultural field who are looking to transition to roles related to biochemical and microbial production, through initiatives such as job placement services, career counselling and retraining programmes.

When it comes to the organic and functional foods market niche, very scarce data exists on the functional foods segment of the niche. Overall, the availability of organic food in North Macedonia is increasing, but the range of products and availability on retail market is still small compared to EU countries. With growing demand and support from organisations and institutions, it is likely that the availability and variety of organic food will continue to expand in the future.

Current databases and registries are not digitalised and poorly structured, which results in the lack of statistics related to organic producers, fertilisers and pesticides used, geolocation and mapping of parcels, financial means disbursed for organic producers, trainer providers and programmes offered in agri-food sector and so on. During the interviews with the stakeholders, it was noted that farmers are using free applications for obtaining information on weather, prices, offers and demand for products and services. Addressing the low level of digital solutions available to the farmers and supported by the institutions (software, tools, equipment, education) also need to be prioritised along with the campaigns for raising the digital awareness.

Considerable effort should be made to establish a system that tracks and measures skills needs in the organic and functional food production. This can be done by introducing a regular survey by the business intermediaries who can be more responsive to the demand and supply of skills and competences needed in the sector.

From the skills supply perspective, there is a trend of disinterest among students to attend food production profiles in secondary schools, and agri-food profiles at tertiary level. There is an expectation that dual education will reverse the negative trend in VET. The process is still under development and its effectiveness cannot yet be assessed. Hence, establishing solid monitoring and evaluation indicators is important for measuring the learning effectiveness and matching the education and businesses in the sector.

The National agency for supporting the agriculture production (NASAP) is well established and institutionalised body which can provide trainings and raise the awareness about organic production and the digitalisation in agriculture. NASAP employees have close contacts with local farmers and producers, and can have more proactive role, such as organising local workshops, events and trainings which can also be enriched in the topics related to entrepreneurship, sales, communication, community cooperation and use of modern technologies in the organic farming and use of digital solutions.

One of the structural challenges in the niche is the big number of organised individual farmers who possess small parcels of land, which results in difficulties to purchase modern equipment and scale-up production. One way how this can be overcome is by reviving cooperatives. With the use of modern technology, such as software for tracking and managing supply chains, it could revitalise the process of cooperation among large number of small agricultural workers through transparent and cost-efficient management.

THE LIST OF INTERVIEWEES

Name	Company/Organisation	Title	Type	Date of the interview
Mr Ivan Kungulovski	Bioengineering	Owner/Researcher	Company	22 November, 2022
	An anonymous company in digitalisation in agri-food	Operations manager	Company	16 December, 2022
Mr Angel Ajkoski	Vision Dynamix	Employee/Software developer	Company	30 November, 2022
Ms Tanja Kotevska	Greenagro dooel	Owner	Company	5 December, 2022
Mr Vancho Navrov	Dron Ops LLC Shtip	Owner	Company	1 December, 2022
Ms Nadica Gorgieva	ChiaDía (Kinado)	Owner	Company	25 November, 2022
Mr Gorgi Gorgievski	Organauts (Organic Sailors)	Owner	Company	12 December, 2022
Ms Ivona Trajanovska	Pro-Fit Vis	Owner	Company	25 November, 2022
Ms Gabriela Micevska	Increasing Market Employability -IME	Project Specialist	Business intermediary	25 November, 2022
Mr Mile Boshkov	Business Confederation of Macedonia	President	Business intermediary	6 December, 2022
Mr Zlatko Edelinski	Business Confederation of Macedonia	Food Processing association representative	Business intermediary	7 December, 2022
Ms Irena Gjorgjievska	Fund for Innovation and Technological Development (FITR)	Head of sector for implementation of programs	Public institution	1 December, 2022
Mr Dragan Ivanovski	Ferthem-Tim Veles	Owner	Company	14 December, 2022
Ms Biljana Delovska	Employment Service Agency	Head of Research and Analysis	Public institution	Phone interview and email (7-16 December, 2022)
Mr Konstantin Hristovski	Adult Education Center	Head of department	Public institution	29 November, 2022
Ms Jana Klopchevska	Faculty of Technology and Metallurgy-Skopje	Professor	Education	29 November, 2022
Ms Fidanka Trajkova	University Gotse Delchev-Faculty of Agriculture in Shtip	Professor	Education	23 November, 2022

Mr Dejan Zlatkovski	UNDP	Project Coordinator	Business intermediary	6 December, 2022
Ms Elizabeta Bogomil	VET school Brakja Miladinovci-Skopje	School Director	Education	6 March, 2023

ANNEX 1. POLICY FRAMEWORK FOR SME AND INNOVATION DEVELOPMENT

The Ministry of Economy (MoE) is responsible for implementing of the **National Strategy for SME's 2018-2023.**[74] The SME's Strategy has three pillars, with programmes as shown in table below:

TABLE 16. THREE MAIN PILLARS OF THE SME'S STRATEGY

Business environment	Increasing and improving the possibilities for SME's growth	Dynamic entrepreneurial ecosystem and innovations
Enhance policymaking and coordination.	Improve business development services	Expand entrepreneurship in education and training
Simplify the legal and regulatory environment	Improve access to finance	Enhance Science, Technology and Innovation in SME development
Strengthen and Institutionalise Social Dialogue	Facilitate Internationalisation	Establish Science and Technology Parks and Innovation Incubators
Enhance the Coordination of SME Data Gathering and Use and SME Monitoring and Evaluation	Support Value Chain Development	
Improve SME Voice–A National SME Association		

Source: Ministry of Economy.

The SME's Strategy is accompanied by the Action Plan 2018-2020, which follows the implementation of the Strategy by pillar and programme. As the Action Plan 2018-2020 expired, the MoE notified the government that the preparation of new Action Plan 2022-2023 is under development. The document is expected to include the realisation of the remaining programmes which were postponed during the Covid-19 pandemic. The execution of the SME's Strategy may face challenges in implementation because the Committee on Innovation and Entrepreneurship (CIE) is not operational.

An important document for the innovation environment is the Strategy for Innovation 2012-2020.[75] The Strategy for Innovation is a document that sets four strategic goals:

- Strengthening of the business sector preparedness to introduce innovations,
- Strengthening of the human resources for innovation,
- Enabling regulatory environment for support of the innovations, and
- Increasing the knowledge transfer among stakeholders in innovations.

For implementing the Strategy's goals, following documents are taken into account: National Program for Scientific Research and Development 2012-2016, Program for enabling and supporting the technological development 2012-2015, Industrial Policy 2009-2020 (amended with Industrial Strategy 2018-2027) and various Action Plans which run on yearly basis.

Strategy for Innovation also suggests the need for foundation of "Agency for Technological Innovations" which will act as focal point for companies, institutions and will act as intermediary in building on capacities with other counterpart institutions from the region, the EU or other advanced

[74] Република Македонија, Министерство за економија (2018). Национална стратегија за мали и средни претпријатија (2018-2023), available here.

[75] Република Македонија (2012). Стратегија за Иновации на Република Македонија на 2012-2020. Available here.

economies. Such agency will also have a coordinating role in the development of the national policies for innovations. Whilst the first Strategy expired, the consultative processes for the new Strategy have not started by the end of 2022.

Various non-government actors and business intermediaries are also involved in the process of implementation of the Strategy for Innovation. Such include Chambers of Commerce, CSO's and other stakeholders which may also finance activities for innovation such as the Agency for Promotion of Entrepreneurship.[76]

In accordance with the Law on scientific and research activities,[77] article 6 envisages an enactment of a four-year National programme for higher education and scientific research, which should be prepared by the National Council for Higher Education, Science and Technology (NCHEST),[78] MASA and the Interuniversity Conference[79] and proposed to the government for consent which then passes for approval to the Parliament. In accordance with article 8 of the Law, MoES is responsible for the realisation of the National programme.

The National programme is envisaged to be implemented through yearly plans and should determine the development directions and priorities for funding scientific and research activities. It further should coordinate and manage implementation for the necessary research infrastructure, the methods for financing scientific-research activities, projections for the needs of personnel for science and indicators for monitoring the efficiency of scientific research activities, international cooperation, connection with the businesses and with the institutional networks. By the end of 2022, the National programme was not prepared, and the National Council for Higher Education, Science and Technology (NCHEST) was not formed.

[76] Available here.

[77] Службен Вестник на Република Македонија (2008), available here. amended in years 2011,2012,2013,2014,2015,2016 and 2020).

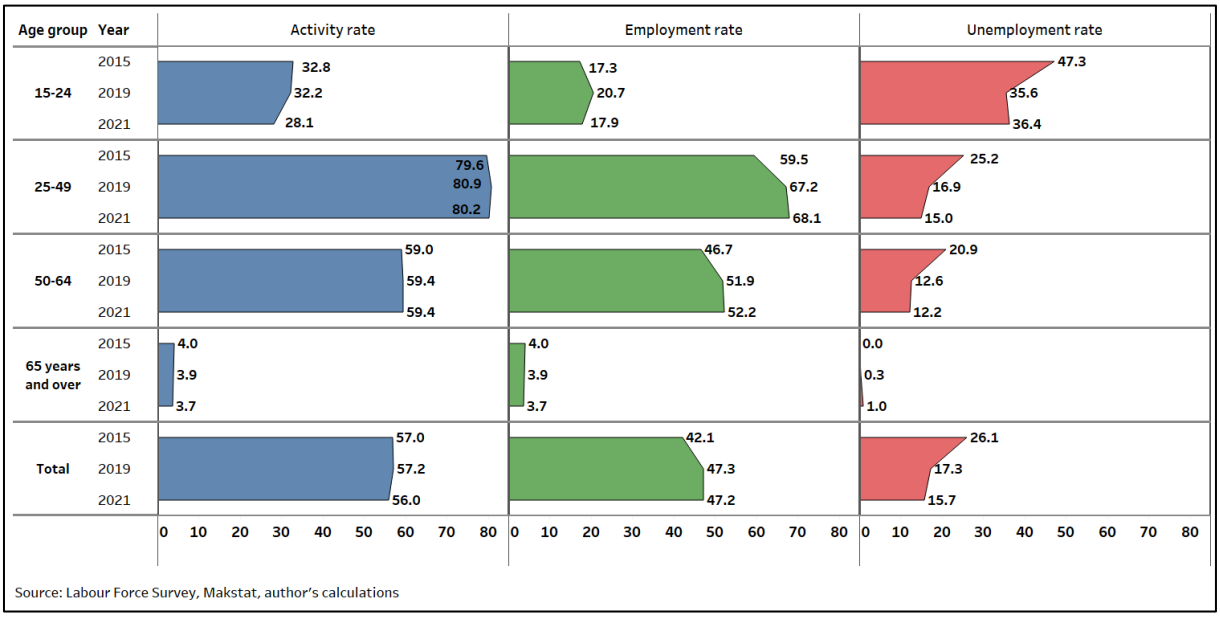
[78] During the interviewing process, the National Council for Higher Education, Science and Technology was not formed.

[79] Interuniversity Conference is a public body composed by the university rectors, presidents of the students unions, representatives from teaching and scientific employees and representatives from private universities.

ANNEX 2. EMPLOYMENT DATA

According to the Labour Force Survey in 2021, working age population in North Macedonia (aged 15 years and over) was 1,69 million persons, of which 943,000 (56%) were active and participating in the labour market. Among the active population in 2021, 80.2% were aged 25-49 years old. Inactive population represents 44% of the working age population, of which highest age group is amongst persons aged 50 years or more.

FIGURE 11. ACTIVITY RATES OF THE POPULATION AGED 15 YEARS AND OVER BY GENDER AND AGE GROUP, 2021



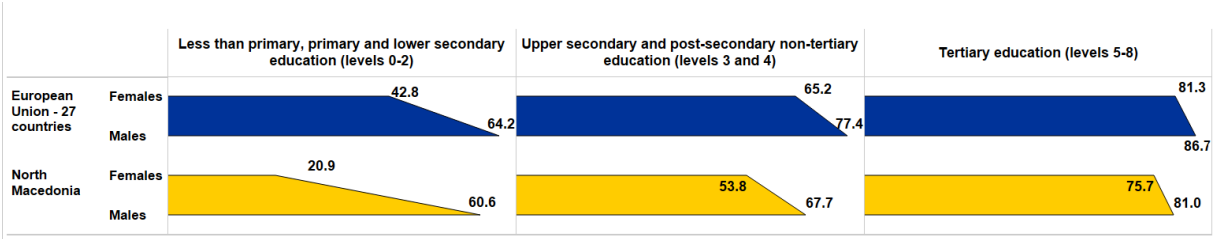
Source: Labour Force Survey, State Statistical Office, 2021.

Economic growth over the past decade boosted the demand for the workforce. The number of employed people (aged 15+) led to increase of the employment rate from 42% to 47% in the period 2015-2021. This increase, however, did not close the gender gap, and the activity rate of women (aged 15-64) remains low (45.3%) compared to EU 27 countries (62%) for 2020[80].

Women with low level of educational attainment in North Macedonia are less likely to be employed. Comparison data from Eurostat show that employment rates of females (aged 15-64) with less than lower secondary education are two times lower than those from the EU 27 countries average, and almost three times lower compared to males in the country.

[80] Eurostat (n.d.). Available here.

FIGURE 12. EMPLOYMENT BY EDUCATIONAL ATTAINMENT LEVEL



Source: Eurostat, author's representation. Available .

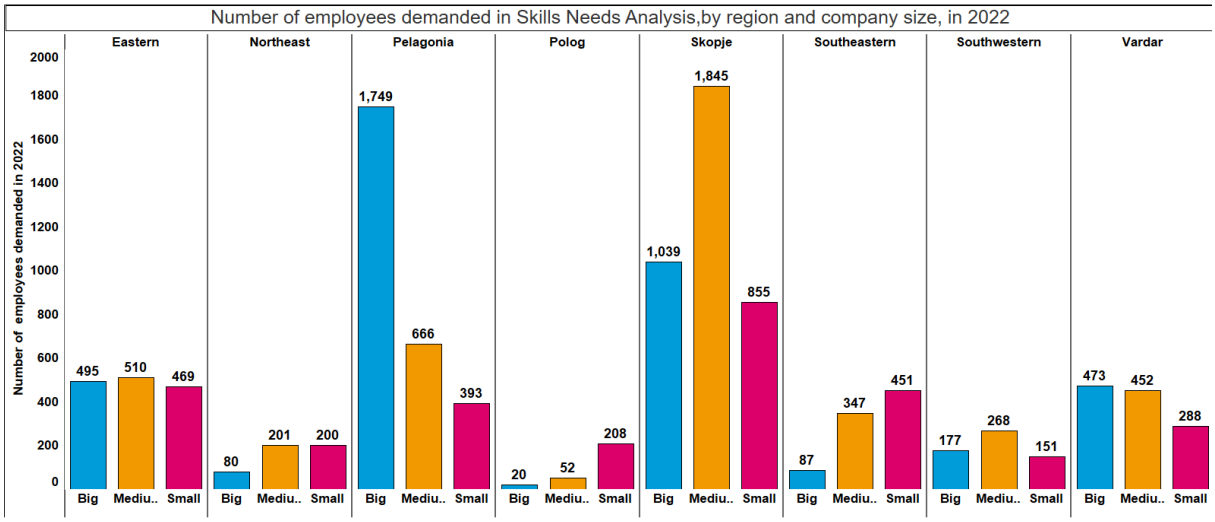
TABLE 17. NUMBER OF EMPLOYED BY NACE SECTORS IN VARIOUS YEARS

Sectors of activity	2017	2019	2021
Manufacturing	143,253	157,831	157,563
Wholesale and retail trade, repair of motor vehicles and motorcycles	108,869	112,624	122,626
Agriculture, forestry and fishing	120,311	111,033	91,506
Public administration and defense, compulsory social security	53,143	53,425	59,125
Construction	53,391	56,036	54,380
Human health and social work activities	40,807	45,279	53,598
Education	43,973	46,186	49,871
Transportation and storage	37,769	44,410	41,080
Accommodation and food service activities	28,569	34,333	28,775
Information and communication	13,587	15,348	20,659
Professional, scientific and technical activities	13,350	18,480	20,148
Administrative and support service activities	13,928	20,651	18,886
Water supply, sewerage, waste management and remediation activities	12,651	17,214	16,706
Arts, entertainment and recreation	13,262	17,773	15,999
Other service activities	12,604	14,875	14,708
Financial and insurance activities	10,817	10,627	10,190
Electricity, gas, steam and air conditioning supply	10,407	10,610	8,250
Mining and quarrying	6,576	6,587	7,655
Real estate activities	1,702	2,093	2,177

Source: LFS from the State Statistical Office, own calculation.

Data on demand for employees in statistical regions shows that 57% is demanded from Skopje and Pelagonia regions alone. As shown on figure below, medium-sized companies are the ones which were most in need of employees.

FIGURE 13. THE NUMBER OF EMPLOYEES DEMANDED IN SNA BY REGION AND COMPANY SIZE, IN 2022



Source: Employment Service Agency, author's representation

ANNEX 3. MACEDONIAN QUALIFICATIONS FRAMEWORK AND STANDARDS

Madedonian Qualifications Framework

According to available statistics from the Ministry of finance, in 2019, general government expenditure by function (COFOG) show that 3.9% of the GDP were spent on education[81] which is below EU-27 average (4.7%)[82] and is within the range of the countries from the Western Balkan region.

Macedonian Qualifications Framework (MQF) is a mandatory national standard that regulates the acquisition and use of qualifications in the country and a tool for establishing a system of qualifications acquired in the country. MQF has 8 levels and 6 sub levels.

TABLE 18. MACEDONIAN QUALIFICATION FRAMEWORK

NQF levels		Educational qualifications	Vocational qualifications*	EQF
8		Doctorate diploma	NVQ	8
7	A	Second cycle Master of Science diploma (from 60 to 120 ECTS)	NVQ	7
	B	Second cycle diploma for specialist studies (60 ECTS)	NVQ	
6	A	■ First cycle university diploma (240 ECTS) ■ First cycle vocational diploma (240 ECTS)	NVQ	6
	B	■ First cycle university diploma (180 ECTS) ■ First cycle vocational diploma (180 ECTS)	NVQ	
5	A	■ Short cycle higher education (vocational) diploma	NVQ	5
	B	■ Post-secondary diploma for specialist education	NVQ	

[81] Ministry of Finance (2019). Economic Reform Programme. 2019-2021. Available here.
[82] Eurostat (n.d.). General government expenditure by function. Available here.

NQF levels		Educational qualifications	Vocational qualifications*	EQF
		■ Craftsman diploma		
4		■ Upper secondary general education diploma ■ Upper secondary technical diploma ■ Upper secondary arts diploma	NVQ	4
3		Vocational diploma (three years)	NVQ	3
2		Vocational certificate (two years)	NVQ	2
1.1		Certificate of primary education	NVQ	

Source: Illustration from the ETF, adopted from the MoES.
Note: According to the law on the NQF, vocational/occupational qualifications can be acquired for part of a formal education programme (modules, courses), by completing a special programme in adult education, or through validation of non-formal learning.

Qualification and occupational standards in agri-food

Qualification standards are proposed by the Sector Commissions (16 in total), in accordance with the field of educational programme:

1. Geology, Mining and Metallurgy
2. Civil Engineering and Geodesy
3. Graphic Industry
4. Economy, Law and Trade
5. Electrical Engineering
6. Healthcare and Social Protection
7. Agriculture, Fishing and Veterinary Medicine
8. Personal Services
9. Mechanical Engineering
10. Traffic, Transport and Storage
11. Textile, Leather and Similar Products
12. Food Service Industry and Tourism
13. Chemistry and Technology
14. Forestry and Wood Processing
15. Sport and Recreation
16. Arts

Qualification standards are developed on the national level for the levels 1 to 5-B from the NQF by the VET Center, Adult Education Center and Bureau for Development of Education.

At the end of 2022, in the register[83] of adopted qualification standards, there were 106 standards, of which 10 were in the field of agriculture, fishing and veterinary medicine and 9 in chemistry and technology, of which 6 are related to food production and food processing.

TABLE 19. QUALIFICATION STANDARDS IN AGRICULTURE, VETERINARY MEDICINE AND FOOD PROCESSING

Sector	Name of qualification	NQF Level
Agriculture, fishing and veterinary medicine	Technician for phytomedicine	4
	Agrotechnician	4
	Technician in veterinary medicine	4
	Technician in agro-management	4
	Wine specialist	5
	Winegrower	3
	Florist	3

[83] Register of the qualifications standards adopted, available here.

Sector	Name of qualification	NQF Level
	Herder	3
	Gardener	2
	Crop producer	3
Chemistry and Technology	Producer of milk products	3
	Producer of meat products	3
	Baker	3
	Meat cutter	2
	Master Baker	5
	Food technician	4

Source: Register of the qualification standards.

Development and approval of **occupational standards** is regulated in article 7 of the Law on VET[84] (Official gazette 71/2006), amended in years (2008, 2009, 2011, 2013, 2014, 2015, 2016, 2018 and 2019). The need for preparation of specific occupational standards is proposed by the Ministry of Labour and Social Policy with prior positive opinion from the VET Council.[85] Subsequently, the VET Center develops the requested occupational standards and submits to the MLSP for approval and publication in the Official gazette.

Occupational standards groups and fields follow the groups of qualification standards, i.e same 16 sectors as mentioned above. At the end of 2022, 49 occupational standards are being developed and approved in the agri-food sector.[86]

ANNEX 4. INNOVATIVENESS IN COMPANIES STATISTICS

State Statistical Office within the publication Education and Science[87], publishes data on innovativeness of companies by main NACE rev2 groups and company size. Most recent data show that 48.2% of the companies have reported that have introduced innovation in 2018-2020, compared to share of 53% in EU 27 countries.[88]

Statistics on the innovativeness of companies show that large companies (250+ employees) are more likely to have introduced innovations in their work rather than medium sized (50-249) and small companies (10-49) for 2018-2020.

[84] Службен Вестник на Република Македонија (2006). Available here.

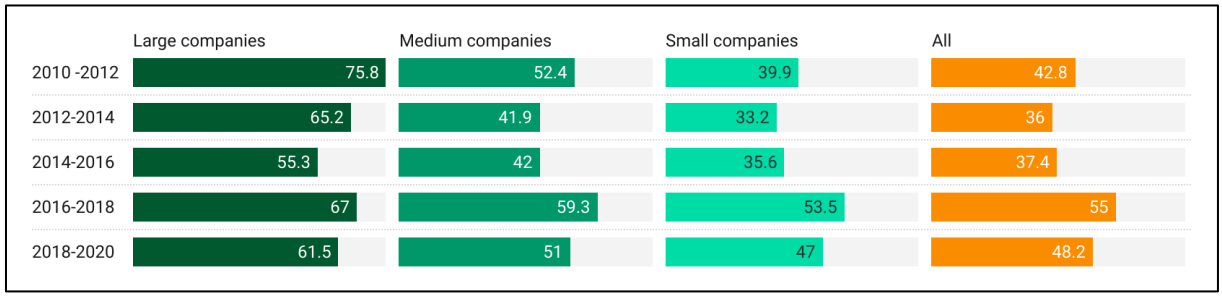
[85] VET Council is composed of 11 members, of which 5 are from the MoES, MLSP, Ministry of finance and Ministry of economy. The remaining 6 are members of the Bureau for development of the education, Employment service agency, social partners and the Association of the units of local self -government (ZELS).

[86] Center for Vocational Education and Training (n.d.). Available here.

[87] State Statistical Office (2022). Business entities by innovations in the period 2018-2020.

[88] Eurostat (n.d.).

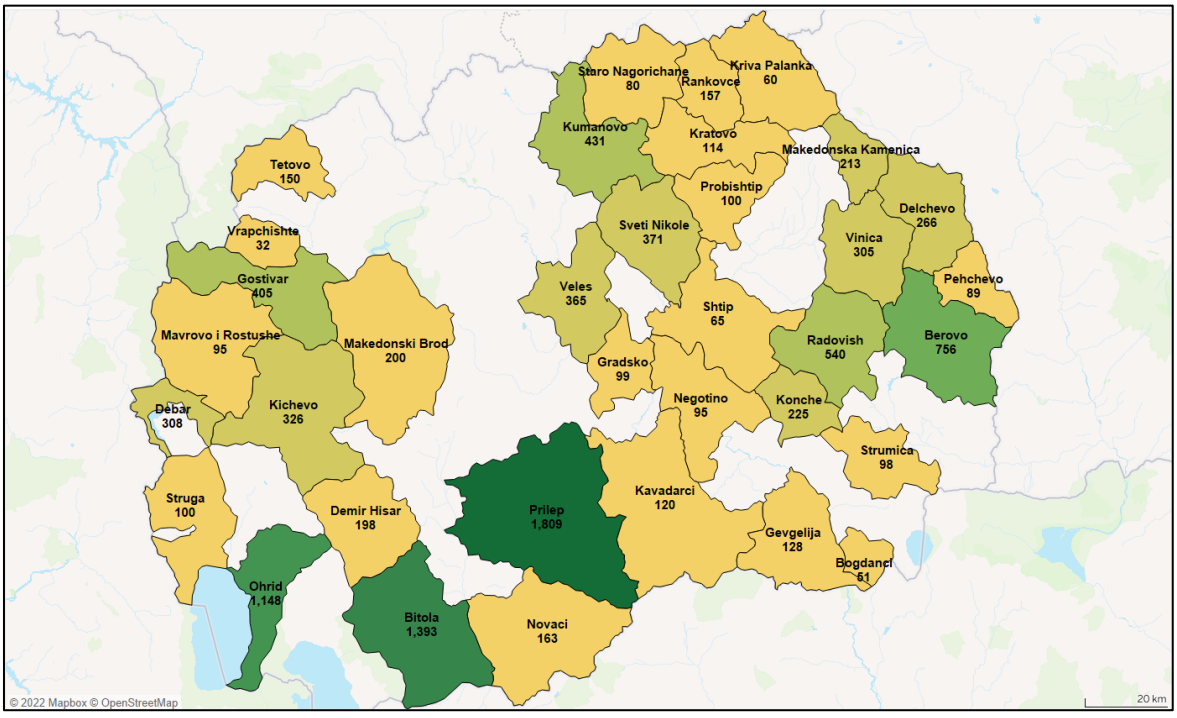
FIGURE 14. SHARE OF COMPANIES THAT INTRODUCED INNOVATION ACTIVITY, BY YEAR AND SIZE



Source: State Statistical Office Makstat, author's representation. Available here.

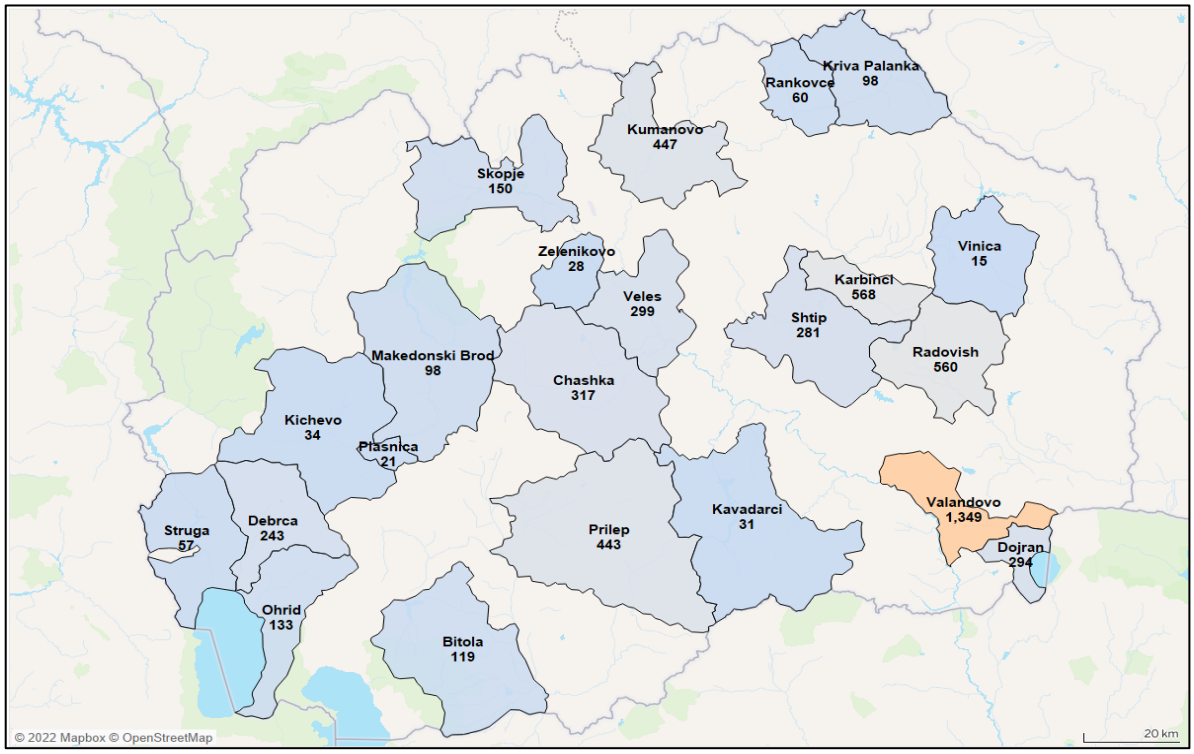
ANNEX 5. ORGANIC PRODUCTION BY MUNICIPALITY

FIGURE 15. ESTIMATED NUMBER OF CERTIFIED ORGANIC BEEHIVES, BY MUNICIPALITY IN 2021



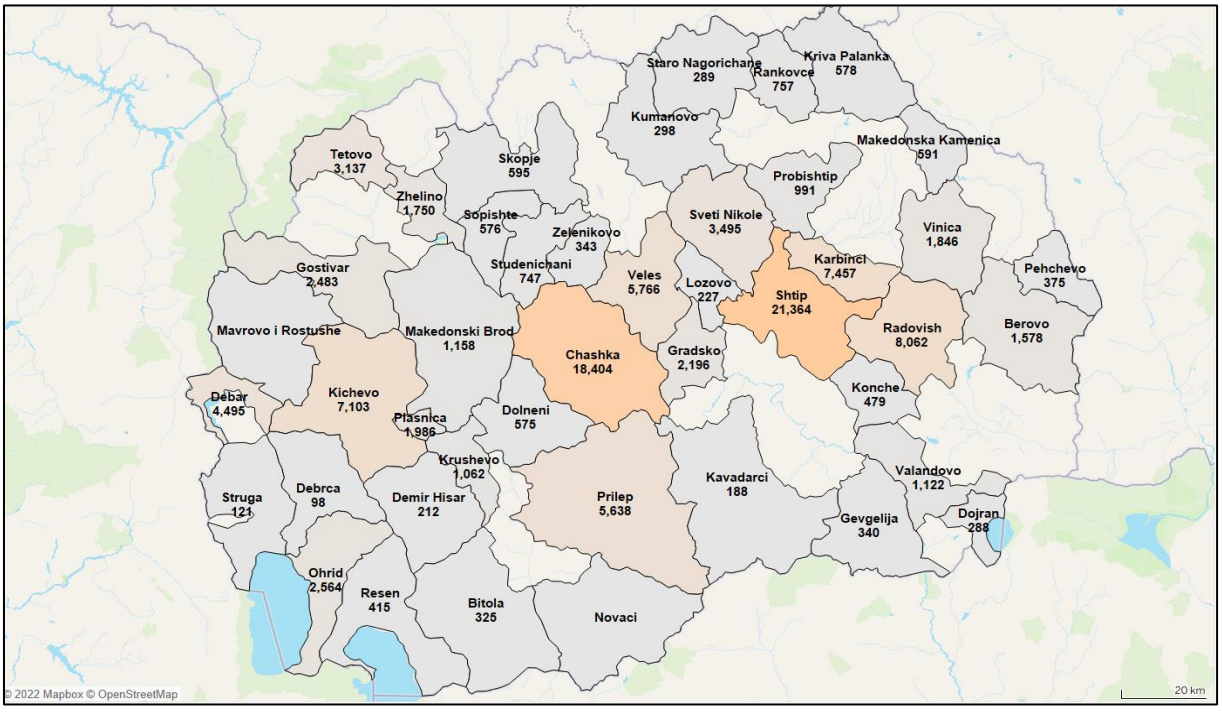
Source: Ministry of agriculture, forestry and water economy, author's representation.

FIGURE 16. ESTIMATED NUMBER OF CERTIFIED ORGANIC GOATS, BY MUNICIPALITY, IN 2021



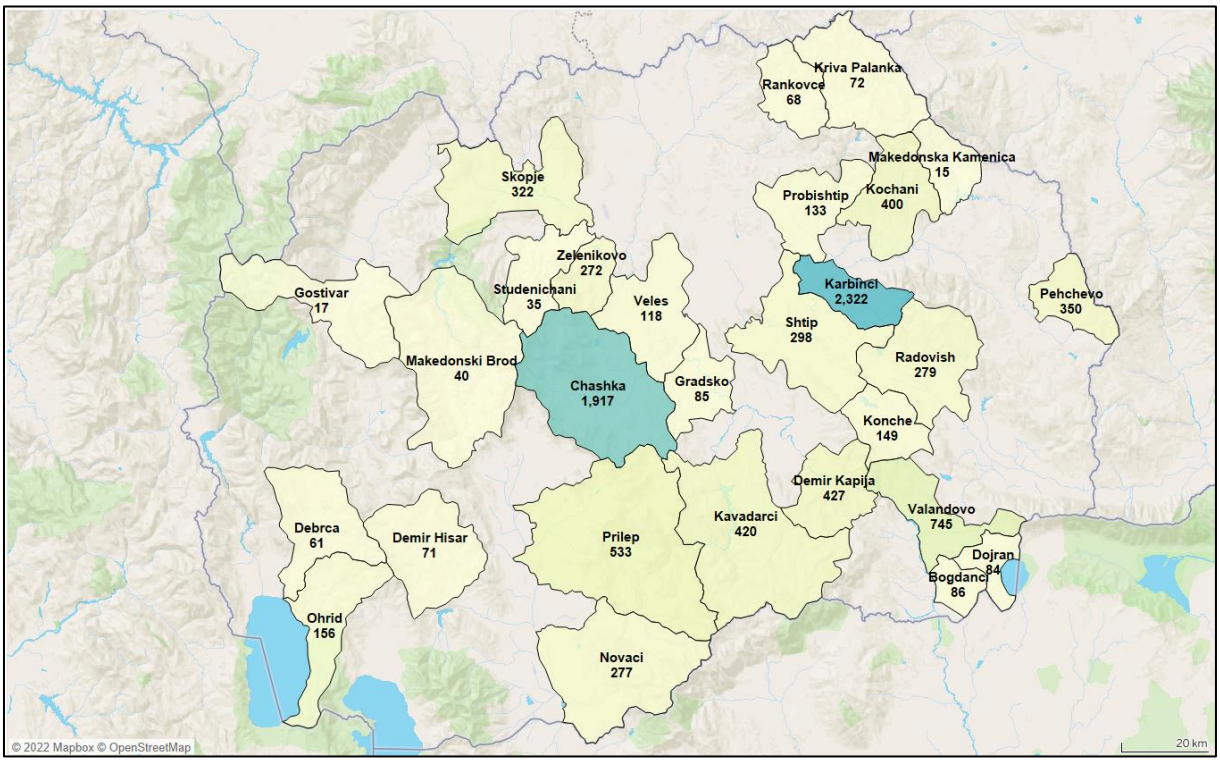
Source: Ministry of agriculture, forestry and water economy, author's representation.

FIGURE 17. ESTIMATED NUMBER OF CERTIFIED ORGANIC SHEEP, BY MUNICIPALITY, IN 2021



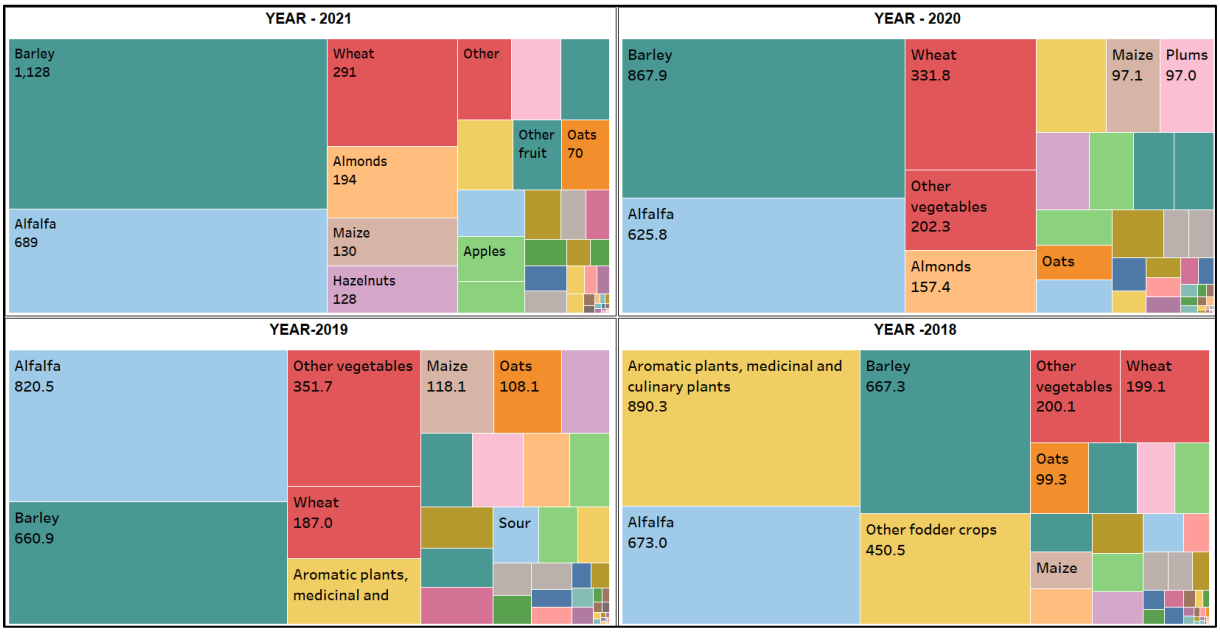
Source: Ministry of agriculture, forestry and water economy, author's representation.

FIGURE 18. ESTIMATED NUMBER OF CERTIFIED ORGANIC BEEF, BY MUNICIPALITY, IN 2021



Source: Ministry of agriculture, forestry and water economy, author's representation.

FIGURE 19. ORGANIC AREAS WITH ORGANIC CROPS, BY YEAR, IN HECTARES



Source: State Statistical Office Makstat.