European Training Foundation

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

COUNTRY REPORT: *Montenegro*

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 Montenegrin 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: development and production of digitalisation solutions for agri-food, production of biochemical and microbial products for agri-food, and production of 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 Montenegrin government reports, donor reports, academic journal articles, project reports, and grey literature. In addition, 20 interviews were conducted with various stakeholders, including business representatives from the three niches, public sector representatives, business intermediary bodies, and education and training providers in Montenegro.

The report first provides a general overview of the agri-food sector in Montenegro, including information on employment levels, education and training opportunities, and support for small and medium-sized enterprises (SMEs). The three niches are then discussed in detail. The relevant skills demand and supply trends are discussed, along with the capacity to match these demands. The report concludes with general remarks and specific recommendations aimed at addressing gaps in funding, education, and upskilling in the agri-food sector in Montenegro.

OVERVIEW OF THE AGRI-FOOD SECTOR

Structural business statistics

Most Montenegrin agri-food companies participate in a simple **value chain** with input supply, production, collection, processing, transport/storage, and wholesale/retailing. This was confirmed through our analysis and interviews with relevant companies. Very often, one actor is involved in multiple levels of the value chain. Small farms and smallholders provide inputs (e.g., seeds, fertilisers) to second-tier actors (production). The second level of the value chain is mainly made up of medium- and large-scale farmers, but small-holder farmers can also be involved if they have enough production capacity. These actors produce fruits, vegetables, livestock, and by-products (e.g. eggs, milk, and leather). On the food processing level, medium- and large-sized companies dominate, processing raw materials supplied by previous-level actors. Shipping and warehousing companies are middlemen between processors and retailers, and the wholesale and retail facilities (supermarkets, restaurants, hotels, airlines, schools, kindergartens, animal feed suppliers, etc.) place the finished product.[1]

Agriculture's significance in the economy has diminished slightly over time as production has shifted towards construction and services, with tourism driving the trend. Primary agriculture's contribution to gross domestic product (GDP) reduced from 7.7% of GDP in 2010 to 6.31% in 2021. Employment in

[1] "Analysis of Value Chains in the Western Balkan Economies - Enriching the Potential for Regional Cooperation in Priority Areas", Joint Research Centre (JRC), European Commission, 2022. Available here.

primary agriculture has slightly increased over the same time period, from 6.2% in 2010 to 6.4% in 2021, but remains low compared with other Western Balkan countries at similar levels of agricultural contribution to GDP. Despite this, agriculture remains a significant source of income for nearly one-quarter of the nation's population, particularly in rural areas. Around 37% of the Montenegrin population lives in rural areas. It is estimated that around 70%[2] of the income of the rural population is coming from agriculture. In the past decade, efforts in modernising basic agricultural production and processing, improving rural infrastructure, and diversifying rural economic activities have advanced Montenegrin agriculture.

Despite having potential, agri-food development in Montenegro is facing many **barriers** such as a high percentage of small capacity agriculture holdings, low level of use of modern technologies in primary production and food processing, weak price competition, low level of organisation and links between small agriculture holdings in agri-food production and processing as well as poor infrastructure in rural areas.[3] Small and dispersed farms and insufficient food safety requirements pose further obstacles.[4]

In 2010, MONSTAT conducted a Census on Agricultural holdings in Montenegro.[5] According to the census, there were almost 49,000 **agricultural holdings**. Similar data are produced through Farm Structure Survey (FSS) in 2016, though with lower numbers (see the table below).

TABLE 1. THE NUMBER OF AGRICULTURAL HOLDINGS IN MONTENEGRO

	Survey on the structure of agricultural holdings (FSS 2016)	Agricultural census (AC 2010)
Number of agricultural holdings	43,791	48,870

Source: MONSTAT, 2010 and FSS, 2016.

By the beginning of 2021, about 13,900[6] agricultural holdings have been registered in the Register of Agricultural Holdings and could apply for the support of the Ministry of Agriculture, Forestry and Water Management through measures to support the Agri-Budget. Registration is necessary to receive support from Government, as holdings that are not in the Register of Agricultural Holdings, do not have the access to national subsidies; they produce mostly for their own consumption.

The total 43,791 agricultural holdings possessed 255,845.8 ha of total utilised agricultural land (5.84 ha on average). This is a rather high indicator in the regional context. According to official statistics average farm size in Western Balkan countries varies from 1.1 ha in Albania to 5.6ha in Serbia.

[2] MONSTAT, Agriculture Census, Structure of the Agriculture households, 2010.

[3] Operative Program for Implementation of S3 in Montenegro (2021-2024), Ministry of Science of Montenegro, p. 17.

[4] "Montenegro Institutional Development and Agriculture Strengthening Project (MIDAS)" World Bank, Dec 2021, available at: https://ieg.worldbankgroup.org/sites/default/files/Data/reports/ppar_montenegroinstitutionaldev.pdf.

[5] An agricultural holding is defined as a single unit of agricultural production under a single management, which has one or more parcels of land used wholly or partly for agricultural purposes. The agricultural holdings included in the census can be owned or rented and can be operated by individuals, households, or legal entities. They can produce crops, livestock, or both, and can engage in other activities related to agriculture, such as horticulture, apiculture, and forestry.

[6] Programme for Development of Agriculture and Rural Areas in Montenegro under IPARD IIII 2021-2027, Ministry of Agriculture, Forestry and Water Management, 2022.

The **food processing sector** is also an important sector of the Montenegrin economy; however, it is relatively small. According to the Statistical Office of Montenegro, this sector is showing positive development, particularly in 2021, when the sector grew by more than 9% compared to 2020.

TABLE 2. FOOD AND BEVERAGE PROCESSING FIGURES

INDICES OF PRODUCTION (previous year 100)	2019	2020	2021
Manufacturing	90.0	99.5	109.1
Manufacture of food products	106.2	94.7	109.4
Manufacture of beverages	103.2	70.2	116.7
Production in tonnes (t)	**2019**	**2020**	**2021**
Manufacture of food products	299	264	335
Manufacture of beverages	599	529	670

Source: MONSTAT, 2022.

Overall, Montenegro relies heavily on imports for its food supply and has a very low level of food export. Agri-food production lags regional peers, and domestic supply cannot meet demand, especially during the tourism season.[7] Food is an important import, and Montenegro has a large agri-food trade deficit (agri-food exports declined from 28% of total export in 2014 to 13% in 2020, with deficit amounts of around EUR 400 million in 2020).[8]

The analysis of the structure of imports shows that fresh pork and beef, cheese, fruits and vegetables are still mostly imported from the EU, while oils, wine and mushrooms were the most represented exports to the EU. The level of utilisation of the preferential quota for wine is still at a very low level, which is only 22%. Generally, wine and meat are Montenegro's main agri-food exports, but only account for 5% and 2% of total exports respectively. Montenegro's main container and bulk export port is Bar on the Adriatic Sea.[9] The main markets for export, as well as the import of the agri-food sector, are CEFTA and EU countries, where Serbia is seen as the biggest market with a contribution to export in the amount of 17.7% and import of 22%.[10]

The volumes of agri-food production that are insufficient to satisfy domestic demand are strongly related to the natural conditions in the country. Much of Montenegro's fragmented agri-food production is in mountainous areas. Montenegro's rugged terrain and varied climate offer unique challenges for cultivators and food producers. The regional climates within the country vary widely. Coastal areas have a Mediterranean climate, while rural areas are continental. These natural conditions affect Montenegrin crop varieties and agricultural output. Olives, citrus fruits, and wine grapes grow well in coastal areas due to the warm, dry climate. Inland regions are ideal for wheat, corn, and other grain crops. Montenegro has steep mountains, deep canyons, and limited coastal areas. This terrain makes farming and transporting goods difficult. This raises both producer and consumer costs.[11]

[7] Operative Program for Implementation of S3 in Montenegro (2021-2024), Ministry of Science of Montenegro, 2022.

[8] MAFWM (Ministry of Agriculture, Forestry and Water Management). 2019. "Socio-Economic Assessment of IPARD-like 2 Funds." Government of Montenegro, Podgorica.

[9] MIF (Montenegro Ministry of Finance and Social Welfare). 2017. "Montenegro Development Directions 2018–2021." Government of Montenegro, Podgorica.

[10] MONSTAT foreign exchange data, 2021.

[11] World Bank. 2020. "Montenegro—Institutional Development and Agriculture Strengthening Project." Implementation Completion and Results Report ICR00005107, World Bank, Washington, DC.

There is no available data or study that may provide information on the use of technology and general technological trends in agri-food. However, based on interviews conducted, the level of technological progress in agri-food in Montenegro is on a low level, and more details are given in the Digital niche in this Report.

Policy background and key stakeholders

Agriculture, forestry and fishing is considered priority sector for achieving Montenegro's strategic development goal of increased quality of life. Long-term goals for Montenegrin agriculture include increasing productivity and implementing EU food safety standards. Sector diagnostics have highlighted the limitations of agri-food exports but emphasised niche opportunities, such as wine and olive oil, organic production, medicinal herbs and spices, honey, and mushroom and truffle harvesting.[12] Montenegro's Smart Specialisation Strategy (S3) has identified sustainable agriculture as one of the country's priority areas for development.[13] The government has recognised the importance of supporting local farmers and promoting sustainable agricultural practices in order to improve food security and enhance the country's economic growth.

Montenegro has a developed institutional framework overseeing the agri-food sector, which is aligned with the EU agenda. The umbrella institution is the Ministry of Agriculture, Forestry and Water Management (MAFW), which proposes laws, and by-laws, defines agrarian policy and other measures and systemic solutions in the field of agriculture. Within the Ministry, there are advisory departments, that are providing counselling, recommendations, controls, and instructions to agricultural producers. Additionally, there are specific advisory departments within the Ministry as well as specific bodies, such as Monteorganica, which are providing control and certification for organic production. In addition, there are specific laboratories that are testing the quality and safety of agricultural products: Specialist Veterinary Laboratory, Institute of Public Health, Centre for Ecotoxicological Testing (CETI), Phytosanitary Laboratory, and Dairy Laboratory, among others.

To support innovation, including in the agri-food sector, in July 2020 the Government adopted a new regulatory framework through the Law on Innovation Activity for boosting **innovation in public and private sectors** and for improving the governance structure for implementing innovation measures at the national and local level. One of the most important measures introduced by the Law on Innovation Activity is the establishment of the Innovation Fund of Montenegro (IF) through the Ministry of Economic Development of Montenegro. The IF plays a key role in developing and implementing government innovation policy based on the smart specialisation concept and is intended for innovative entrepreneurship as a driver of sustainable economic development through innovative enterprise development, Smart Specialisation Strategy (S3) implementation and monitoring and raising absorption capacities for EU funding and preparation for ESI funds.[14]

In September 2021, the Government of Montenegro adopted the **Innovation Program** 2021-2024. The goal of the Innovation Program was to present in one place all relevant innovation support programmes planned in the coming period, focused on the entire innovation development cycle: from the idea itself to its commercialisation and market entry. It contains the programme framework of the Innovation Fund of Montenegro, which refers to the following **support instruments**: 1) Programme

[12] MIF (Montenegro Ministry of Finance and Social Welfare). 2017. "Montenegro Development Directions 2018–2021." Government of Montenegro, Podgorica.
[13] Ministry of Science of Montenegro, (2019). Smart specialisation strategy of Montenegro 2019–2024.
[14] Innovation Fund of Montenegro, internal documents.

line for innovations in companies; 2) “Proof of concept” programme; 3) “Green jobs” programme; 4) Programme of innovation vouchers; 5) Programme line for inciting innovations through the transfer of technologies; and 6) Programme line of collaborative grants for innovations. The aim of these fundamental IF support instruments mostly relates to the encouragement of technological innovations with the key mission of providing support to the overall development of innovative products and services, from idea to market launch, aligned with S3 priorities and goals of the European Green Deal. IF launched its first instruments of support for the innovative community in Montenegro during 2022, a public call for innovation vouchers, as well as a public call for the collaborative grants for innovations with total EUR 770,000 budget.

Substantial support for the development of agriculture in Montenegro is also provided by associations such as the Chamber of Commerce of Montenegro, the Montenegro Business Alliance, the Union of Employers of Montenegro, as well as the Innovation Fund of Montenegro, Tehnopolis, and the Centres of Excellence – FoodHub and Centre of Excellence for Biomedical Research (CEBIMER).

Employment in the agri-food sector

There is a notable lack of **employment** data structured by sex, educational level and occupational groups at the NACE level (data not disaggregated by NACE sectors is presented in Table 13 in the Annex of the Report).[15] The same situation concerns the data on sales, turnover and income, so the real contribution of the agri-food sector to employment and economy in general is unclear. An important data gap concerns the food processing activities in particular. This section, therefore, provides a broader overview of the available statistics with a heavier focus on the agriculture sector.

When it comes to the occupational structure for the whole economy, the highest number of employed (27%) in Montenegro are service and sales workers, and only 3.5% are skilled agricultural, forestry and fishery workers. In 2021 around 16,600 persons were employed in agri-food, making around 7.8% of total employment. Around 66% of them were engaged in Crop and animal production (A1) and around 25% - in the manufacturing of food and beverages (C10-11) (see more details in Table 12 in the Annex of this Report).

When it comes to the **employed** in agricultural holdings, a total of 99,235 persons were engaged in agricultural activities in the same year. Age structure clearly reflects the high percentage of the population over 65 years (23% of the total engaged population). Considering that this is a ‘retirement’ age these numbers are worrying, particularly as the percentage of the early employment-age population is extremely low. Persons under 34 years old comprise only 18% of the total number (see the table below). This implies that young people in Montenegro are not willing to stay on farms and work in agriculture. The same was confirmed by our interviews. Agricultural work is physically demanding, particularly in Montenegro, which is already characterised by low technological development; as well as particularly poorly paid.

[15] LFS data. MONSTAT is producing data on A and C NACE level, and there are limited data on A1, A3 and C10-11 level due to policy and scope of data collection MONSTAT is operating. For empty fields in the Table data do not exist or the sample is very small, so data are not accurate and thus not provided by MONSTAT.

TABLE 3. EMPLOYED IN AGRICULTURAL HOLDINGS BY AGE GROUPS (2016)

Agricultural holdings	The total labour force in holding						
	Montenegro	Under 24 years	Between 25 and 34 years	Between 35 and 44 years	Between 45 and 54 years	Between 55 and 64 years	65 and over
FSS 2016	99,236	7,381 (7.5%)	10,562 (10.5%)	14,815 (15%)	20,690 (21%)	22,495 (23%)	23,293 (23%)

Source: FSS - Farm structure survey 2016 (Statistical Office of Montenegro).

The **average monthly gross earnings** in the agriculture, forestry and fishing sector amounted to EUR 668 in 2021, constituting 84% of the average wage in the country, while average gross earnings in the food processing sector amounted to EUR 422.[16] Within the agriculture, forestry and fishing sector, the earnings are higher in fishery, while in the manufacturing sector, the earnings in the production of beverages are almost four times higher compared to average earnings in food production.

TABLE 4. GROSS AND NET EARNINGS IN TARGETED NACE LEVELS (2021)

NACE	Earnings (gross) in EUR
A1 Crop and animal production, hunting and related service activities	675
A3 Fishing and aquaculture	788
C10 Manufacture of food products	422
C11 Manufacture of beverages	1,688

Source: MONSTAT, 2022.

On average, members of an agricultural holding in Montenegro (i.e. the holder and other working members) have 0.473 annual working units (AWU) of farm work.[17] This means that they work on a part-time basis and spend less than half of their full-time hours on it. Again, consistent with the data on the age distribution of workers, older people are spending more hours working in the holding compared to younger.

TABLE 5. LABOUR FORCE AT FAMILY AGRICULTURAL HOLDINGS BY AGE GROUPS, AND ANNUAL WORK UNITS (AWU) (2016)

Category (years old)	Total number of employees				AWU	
	Agricultural census (2010)	%	FSS (2016)	%	Number	%
Up to 24	6,717	6.8	7,381	7.43	2,304	5.0
Between 24 and 34	11,340	11.5	10,562	10.64	4,838	10.4
Between 35 and 44	15,675	15.9	14,816	14.93	7,606	16.4
Between 45 and 54	21,562	21.9	20,689	20.84	10,447	22.5
Between 55 and 64	19,894	20.2	22,495	22.66	10,001.6	21.5
65 years and over	23,198	23.6	23,293	23.47	11,237.3	24.3
Montenegro total	98,341	100.0	99,236	100.0	46,473.0	100.0

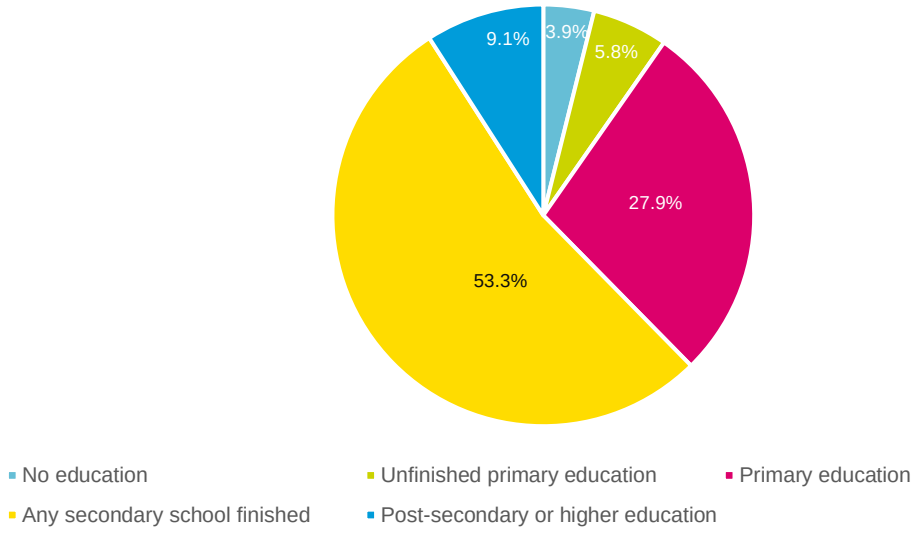
Source: Statistical Office of Montenegro, Agricultural Census 2010 and FSS 2016.

[16] MONSTAT (2022). Labor Force Survey.

[17] Annual work unit (AWU) is the full-time equivalent employment, i.e. the total hours worked divided by the average annual hours worked in full-time jobs in the country. One annual work unit corresponds to the work performed by one person who is occupied on an agricultural holding on a full-time basis.

The structure of total working persons on **family agricultural holdings** by educational attainment is dominated by secondary school education, followed by primary education (see the figure below).[18] A notable share – almost 38% - have not completed secondary education.

FIGURE 1. THE EDUCATIONAL STRUCTURE OF WORKERS IN FAMILY AGRICULTURAL HOLDINGS (2016)



Source: FSS - Farm structure survey 2016 (Statistical Office of Montenegro).

Based on available data from the Employment Office of Montenegro, agriculture and manufacturing presents a small portion of the total demand for labour. In 2021, there were only 10 vacancies in agriculture (0.31%) and 120 vacancies in manufacturing (3.76%); while in 2022 total number of job openings in agriculture in manufacturing was 6 (0.08% of the total number) and 168 (2.22%), respectively. There is no data that could allow to estimate the specific number of vacancies in agri-food.

Education in the agri-food sector

Significant support for the development of agriculture in Montenegro is provided by research and educational institutions. In the field of education, three university programmes, five secondary vocational education programmes in the areas of agriculture and the broader food value chain have been established (education system in Montenegro by ISCED and the national qualification system is presented in Table 14 in the Annex of the Report).

There are two main institutions that provide **higher education** in the agri-food sector – the University of Montenegro and the University of Donja Gorica.

- Within the University of Montenegro, the Biotechnical Faculty (formerly the Agricultural Institute) has an important role in agri-food education at the tertiary level. During its 84 years of existence, it has been engaging in the application of research and the implementation of educational and other activities that contribute to the development of Montenegrin agriculture.

[18] Note: Similar data for processing sector were not available.

- At the University of Donja Gorica, the Faculty of Food Technology, Food Safety and Ecology (FFTFSE) is an important player in education, as well as scientific and research activities. Academic study programs at both Biotechnical Faculty and Faculty of Food Technology, Food Safety and Ecology (FFTFSE) are organised according to the model: three years (Undergraduate studies), two years (Master studies) and three years (PhD Studies). As a scientific research institution, FFTFSE engages in basic and applied research, provision of services, promotion and networking, and cooperation. In 2017, the Laboratory for Food Quality and Safety was established at FFTFSE, becoming the only authorised laboratory in Montenegro for the analysis of honey quality.

When it comes to **secondary school education and VET**, there are limited programmes available in Montenegro. Secondary Agriculture School in Bar is offering two relevant programmes in a duration of four years, and prepares Veterinary technicians, Agricultural technicians, and Food technicians.[19] In the Secondary Vocational School "Spasoje Raspopovic", there are four programmes in the agri-food area: Agriculture, production and processing, Milk processing, Nurseryman and flower growing, and Fruit and wine production, for a duration of three and four years.[20]

In relation to the basic knowledge provided within the study programmes, students have the opportunity to acquire additional knowledge, i.e. adapt to market requirements in relation to skills, primarily through professional development and stays abroad at partner institutions, but also through work on research and innovation projects.

The total number of students admitted to the education programmes in the fields of agriculture, production and processing of food is presented in the table below. There is a downward trend in the number of students at the tertiary level, which is in line with a general trend in Montenegro (the total number of students at the tertial level decreased from 22,201 in 2016 to 17,679 in 2022). A similar situation is found in secondary schools, where a downward trend exists at the general level (from 7,681 students in 2016 to 6,557 in 2022).[21]

TABLE 6. THE NUMBER OF STUDENTS ADMITTED TO AGRICULTURE RELATED PROGRAMS AT SECONDARY AND TERTIARY EDUCATION PROGRAMMES

Year	Number of students ISCED 3&4	Number of students ISCED 6&7
2017/2018	180	675
2018/2019	190	625
2019/2020	132	564
2020/2021	137	549
2021/2022	123	529

Source: MONSTAT

Based on the feedback from companies interviewed for the purpose of this report, in general, the programmes that exist are in line with the needs of the market, and cover the necessary qualifications for occupations considerably well. However, the companies highlighted an issue of the quality of the study programmes in terms of their links with practical experience; and the lack of skills obtained through practical experience for students. In both VET and tertiary education and training programs in the field, the quality of the programs needs to be improved and they need to be more connected to

[19] Available here.
[20] Available here.
[21] MONSTAT, Educational data.

real-world experience in the industry. To address this issue, a better link between educational institutions and companies is desirable.

Some tertiary level education providers place students for **internships with companies**. Among the most important companies that are considered leaders in the Montenegrin food industry, the following stand out: IM 'Goranović', dairy 'Srna', dairy 'Lazine', brewery 'Trebjesa', brewery 'Mamut', 'Beer Academy', bakery 'Impe'", company '13. jul Plantaže', and 'Farma Miljanić'.

The interviewed education and training providers are constantly improving knowledge of their staff through seminars, conferences, research, and consultancy, which are organised by the institution itself and other institutions in the country and abroad.

When it comes to the **non-formal training possibilities**, there is no register of such activities nor institutions that are providing such training in continuity and with regular frequency. Different types of workshops, informational days and training are organised ad hoc, and mainly by Ministries, the Chamber of commerce, international organisations (FAO, UNDP, EBRD, WB etc), NGOs and universities and are mainly related to specific activities or project those institutions are implementing and calls for proposals or funding opportunities. A list of examples of such training offers that is collected through interviews and desk research is presented in the Annex.

Training programmes are flexible to address the needs of entrepreneurs to the extent it is possible due to academic and resource constraints, and flexibility is reflected in organising evening courses, online courses, practical workshops, competitions, conferences, and the like. The universities regularly organise conferences, workshops, and lectures, at which well-known businessmen are guests and successful entrepreneurial stories are presented. In this sense, the Entrepreneurial Nest at UDG, the Student Business Centre and the events they organise play a particularly important role. These training programmes are broader in scope but are useful for the agri-food sector. Training offers are promoted through websites, emails, social networks, but also open days, roadshows to different locations and bigger companies.

Business intermediary bodies provide support for agri-food SMEs, such as provision of information, training, counselling, coaching, mentoring, and networking. The Chamber of Commerce, for example, has a specific committee in the sector of agriculture, where some big companies are members. Some of them provide training on the production of quality and healthy food by reducing pressure on the environment, market research, cluster development, marketing, and similar (see more details in the Annex to this report). Ad-hoc training (as well as seminars, workshops, discussions, round tables etc) is also sometimes organised based on the need and request, focusing on internalisation, networking, funding opportunities, and similar topics related to business development. Similarly, Science technology park (NTC), Tehnopolis, or Innovation Fund are organising specific training with the aim to support businesses in the application processes for competition, grant schemes etc. organised by the institution. The list of relevant training offers is presented in Table 15 in the Annex.

There is no formalised and systematised monitoring and data collection on the occupational profile and skills needs of companies active in the agri-food value chain. This makes it difficult to design effective education and training programmes that satisfy the needs of businesses. The interviewed tertiary education providers in interviews, as well as business intermediaries, reported engaging in periodical, ad hoc activities to understand the needs. They mainly rely on relevant governmental strategic documents in the field (such as the Strategy of Agriculture). According to the interviewees, the most demanded skills (technical and non-technical) and occupations in the agri-food sector

recognised by training providers but not limited to are: **Food Safety, Bioinformatics, Molecular Biology, Genomics, Food Technology (Dairy and Fish production), and Project Management.**

DIGITALISATION IN AGRICULTURE AND FOOD PROCESSING

The digitalisation of 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 niche of digitalisation in agri-food focuses on businesses developing and producing 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).

In Montenegro, the slow and low adoption of digital technology in the agri-food industry presents significant challenges, including the availability of skilled workers. Montenegro also lacks producers of digital technology for agri-food, so most analyses focus on stakeholders that apply digital technologies in agri-food production.

This chapter provides an overview of the market niche for digitalisation in agri-food in Montenegro, highlighting its key economic indicators. It also discusses the demand and supply for skills in the niche and the programmes, tools, and activities available to match the niche's demand and supply.

The profile of the market niche and the stakeholder ecosystem

General context

Most of the activities related to the niche in Montenegro relate to the Information and communication technologies (ICT) sector. It has become essential and present in all priority areas of development in Montenegro, as well as in all economic and social aspects of life, with a recognised trend of growth. The development and implementation of ICTs are of essential importance for economic progress and digital transformation, including strengthening of opportunities for workers, digitally modified businesses, and new digital businesses.[22] As of 2020, the share of the ICT sector in Montenegro's GDP was 4%.[23]

[22] UNDP (2020). Human Development Report of Montenegro for 2020.
[23] Monstat (2020). Gross Domestic Product of Montenegro/ Available here.

To provide some figures, in 2021, the Montenegrin IT sector consisted of 690 companies (showing a 23% increase from the previous year) that engage in activities such as computer programming, consulting, and other related activities and information services. The sector employed 1,832 workers, which marked a 20.9% increase from 2020. The revenue of the IT sector stood at EUR 71,665,580, 14.9% more than the previous reporting period. The sector's profit was EUR 12,568,031 – 38.8% more than the previous year (however, there was also a 20.7% increase in losses). [24]

People are attracted to the sector by high and growing wages – to the extent that not everyone gets to be employed. For example, based on the 2020 ETF report on Montenegro's performance in IT education and training over the preceding five years, progress in the employability of recent graduates had not been achieved. In 2018, the employability of students with IT specialisation in general was 61% in Montenegro, while the EU average was 80%.[25]

However, these figures only provide the context to the niche in focus. No specific registry exists that would understand the numbers and characteristics of SMEs that engage in the development and production of digital solutions for agri-food. Nevertheless, the study did identify a number of start-ups, projects and initiatives resulting from specific international projects, collaborations, and government support programmes. Some of them are presented in the text below.

Generally, the opportunities for innovation in the agri-food sector are recognised by the interviewed stakeholders in Montenegro. Digitalisation creates opportunities for agriculture and its upstream and downstream partners, affecting food processing companies, traders, and consumers. It simplifies documentation, transparency, and traceability for all value-creation processes. Digital solutions aid in connecting farmers to achieve a smarter, modern, and sustainable future of food and farming. Opportunities are seen particularly in the conversion of analogue information into digital form, optimising growth conditions by means of sensory analysis and precise application technology such as satellite imaging, weather tracking, soil and water sensors, and so on. Cross-farm networking could also lead to lower-cost procurement of farm inputs, so that farms can produce more cost-effectively.

However, there are many challenges such as the lack of knowledge, lack of financial resources and investments needed, small turnovers and small markets, gaps in linking research outputs with producers, and others. Additionally, there is no specific programme that is dealing with education and training in digitalising agri-food. There are generic ICT programmes that may apply to agriculture, or the above-mentioned agricultural programmes that may include innovative elements.

Key stakeholders

The Ministry of Agriculture, Forestry and Water Management (MAFWM) and the Ministry of Science and Technology (MST) are the two main institutions dealing with digitalisation in the agri-food sector. MST organised several calls for proposals for co-financing innovative solutions in S3 priority areas, including agri-food, as well as the Innovation Programme 2021-2024 for support and financing of innovations in Montenegro in general, where agri-food is one of the priority sectors. In June 2022, MAFWM and MST realised a call for financing innovation in agriculture. Through those different calls, eight initiatives for the introduction of innovation in the agricultural sector were supported. When it comes to innovation in the agri-food sector, a working group was established on the state level,

[24] Operative Program for Implementation of S3 in Montenegro (2021-2024), Ministry of Science of Montenegro, 2022.
[25] ETF (2020). European Training Foundation, "Developments in vocational educational policy in Montenegro".

consisting of and UNDP consultant; a cluster “Try Home Made”; a DG representative; and a representative of MAFWM with a goal to support innovation and cooperation in the agri-food.

There are several **business intermediary bodies** operating in the agri-food sector as a whole, or supporting innovative activities in general. Such bodies include the Chamber of Commerce, Agricultural Cluster, Tehnopolis, Science Technology Park, Innovation Fund and others. Each of the interviewed intermediary bodies sees potential and space for innovation and digitalisation in agri-food sector. Tehnopolis and Innovation Fund have specific activities aimed to support innovation and digitalisation in agriculture.

Several relevant projects and activities are with mentioning in the context of this niche. Although the majority of them are still in the development phase and were launched recently, they are ultimately expected to contribute to knowledge increase, as well as the development of solutions to support technological improvements and digitalisation of agri-food. Implementation and financing of those solutions are seen as the major challenges to be addressed. Some examples are presented below.[26]

- In early 2020, the Centre of Excellence for Digitisation of Risk Assessment in the Field of Food Safety and Precise Certification of Food Authenticity (FoodHub) was launched by a consortium of University Donja Gorica and 11 other national and international institutions, with the support of Ministry of Science. The main role of this Centre of Excellence is to research and develop technological solutions that can be applied in industrial and traditional food production processes, while maintaining the authenticity of the product and its traditional characteristics. The goal of the Centre of Excellence is to offer reliable, science-based solutions for: eliminating food safety risks and hazard identification, developing digital risk assessment tools, reliable product certification, and monitoring of food authenticity. This should be achieved through laboratory and genetic analysis, the development of appropriate software with integrated data management, database linking, and interactive food value chain monitoring.

- Project Digitisation of municipal/city land management (ME, RS, BiH, 2019-2022) is aimed at better management of municipal land through the presentation of challenges, requirements and best practices in this area. It is implemented with the financial support of the German Ministry of Economic Cooperation and Development, and in partnership with the Chamber of Economy of Montenegro. Several municipalities in Montenegro have been selected to establish or improve land management in their systems with the support of the digital solution AgroLIFE,[27] developed by Telegroup. It is expected that the project will result in modernisation of land management services and procedures in selected local governments in these countries; improved forms of land management by farmers and increased efficiency in the work of farmers.

- The project Vitalising ICT Relevance in agricultural learning – VIRAL aims to promote the use of ICT in the agricultural communities of the Western Balkans, through the collaboration of regional educational institutions in agriculture. It seeks to enable the integration of agriculture and ICT engineering to strengthen academic and business cooperation. Specific objectives include increasing the capacity of higher education institutions in ICT application and generating solutions, improving employment opportunities for agricultural graduates, and strengthening the regional platform for academic and business cooperation. The project is led by the University of Banja Luka in BiH, and has multiple partners across the Western Balkans, the Netherlands,

[26] Status of Digital Agriculture in 18 countries of Europe and Central Asia”, International Telecommunication Union and Food and Agriculture Organization of the United Nations, 2020 available here.

[27] AgroLIFE is a software application specially developed for automated agriculture production processes management. The software generates data on total area of land disposed by the company, as well as on plants, seeding plans, harvest, necessary expenses for fuels and seeds. Based on GIS technology, the application contains a large number of modules monitoring complex production processes completely adjustable to business process of each individual agriculture company. More information is available here.

Slovenia, and Romania. In Montenegro, the project is implemented by IEC Tehnopolis.[28] Recently, as part of the project, a manual for farmers and educators was published: "A toolkit for educators on application of the selected hardware and software in agriculture: robotics, GIS, deployment of drones, IoT, mobile apps".[29]

- BIO-ICT (Centre of Excellence in Bioinformatics)[30] is the first Centre of Excellence developed in Montenegro, implemented as a three-year research programme at the University of Montenegro, led by the Faculty of Electrical Engineering and financed by the Ministry of Science of Montenegro. Other partners on the project are three leading Montenegrin research institutions (Biotechnical Faculty, Institute for Marine Biology and Institute of Public Health), two international universities (St. Petersburg Scientific Research Centre for Ecological Safety from Russia and Centre for TeleInFrastruktur (CTIF) from Denmark) and two successful Montenegrin SMEs (COGIMAR and Green House Jovović). BIO-ICT Centre of Excellence is focused on development and implementation of novel bioinformatics technologies, as well as bringing innovative ICT based solutions in various bioeconomy sectors, related to sustainable food security, blue growth, bio-based innovation for sustainable goods and services. Under the umbrella of the BIO-ICT Centre of Excellence, many different products have been made. Some examples are presented in the box below.

BOX 1. INNOVATIVE PRODUCTS AND SERVICES DEVELOPED BY THE BIO-ICT CENTRE OF EXCELLENCE

- LiveGate is an Internet of Things (IoT) platform that enables its users to easily send data from various sensors to the cloud. The data are stored in a database and graphically presented to users, with the option to be exported in different formats (JSON, CSV/XLS). The solution has been implemented using open source tools: Linux, LAMP stack, PHP programming language and Laravel framework. The data integration has been tested using sensor nodes based on Arduino, Raspberry Pi, Libelium Plug and Sense, and PC. The solution is open for further development with respect to additional IoT protocols, data types, and interfacing to analytics tools. Current work is focused on integrating Octave, R and Python programming languages with the LiveGate platform. Users now can choose from a variety of predefined analytic tools (data plotting, histogram plotting), calculating data parameters, calculating data correlation from a single node and performing data clusterisation, but they can also upload custom scripts. At the moment, LiveGate is used actively at BIO-ICT soil and water monitoring, and it will be upgraded for larger commercial use.

- SEMaR platform, using incorporated IoT features, can improve ecological monitoring of seawater parameters by performing data measuring, data transfer, data processing, data analysis and presentation, and finally decision-making upon the processed data. It enables automated and online ecological monitoring and processing of seawater parameters, avoiding direct human involvement in water sampling and manual processing of measured parameters later on. Additional "green energy" solution represents solar power units that make the power independent.

- Digitalisation of the soil database (digital soil mapping) has been done for the first time in Montenegro by BIO-ICT researchers. The soil database of Montenegro contains values of physical and chemical parameters of soil, and it is used for clustering. Clusterised soil data has been presented on a dynamic map and compared with an existing pedologic map made by experts. In addition, different types of thematic pedologic maps were made and integrated into a web application.

- Smart Irrigation System allows an easy and flexible irrigation process by providing optimum water consumption according to the needs of the plants. The most important input parameters of the algorithm for smart irrigation are soil characteristics, moisture and soil temperature, humidity and air temperature and plant tissue humidity. The collection of these data is allowed by using Wireless Sensor Networks (WSN). Based on the obtained data, the main controller unit determines the moments of switching on and off solenoid valves that regulate the flow of water. This system provides the possibility for users to configure the time schedule for irrigation, where the closing of the valves can be scheduled based on the

[28] More information is available here.
[29] More information is available here.
[30] More information is available here.

duration of irrigation or the amount of water that is released. Configuration and control of the system can be performed manually, on the main control unit, or remotely, by commands sent over the SMS service.

- Bioportal.me is a portal created for farmers and people who buy their products. It consists of four parts: Agromar Market, Agricultural Issues, BIO-ICT services and Advertisements. The Agromarar market allows agricultural producers to sell their goods to users of the portal, and it is currently in the development phase.

Despite the presence of such research and development activities, the level of their practical application and/ or commercialisation remains very low. For instance, the research could not identify any applications of the mentioned innovation in their regular business activities. Also, very few companies providing digitalisation solutions for agriculture and food processing exist in Montenegro.

Companies representing the niche

Three Montenegrin companies were selected to provide qualitative insight into the niche (please see

The list of interviewees for more details). In their daily operations, the interviewed companies develop digital tools like web platforms that function across different operating systems, such as Android and iOS, to connect and educate farmers. One of them has developed an e-commerce platform to support and connect farmers and producers of agricultural products with customers who buy their products. The portal allows agricultural producers to sell their goods to users, and it has been operating for the last five years. It also offers a possibility for farmers to start cooperation and joint projects and activities. The other two interviewed companies develop Internet of Things (IoT) technological solutions (both hardware and software) foe agri-food production. One of them develops smart water dispensers for bees for honey producers. The other focuses on fish farms and offers automated fish feeding devices. The representatives emphasised that they have already invested in, and plan to continue investing in, the creation of new products and services to broaden their business offerings.

All three companies were micro-enterprises (with two to four employees in total, including one to two on a full-time basis.), and have operated, for the last few years, on a small scale, with a turnover of less than EUR 10,000 per year. The companies were established as an outcome of calls for proposals organised by relevant governmental institutions (i.e., Tehnopolis, Ministry of Science and Technology etc). They were focused on the Montenegrin market with the ambition to grow to the region. However, at the time of data collection, their operations were limited to Montenegro due to the lack of financial resources.

The majority of the interviewed companies were limited liability companies, and few were still in a form of start-ups. Companies mainly had staff with ICT backgrounds. Additionally, they employed administrative staff with marketing and business backgrounds. The level of education of employees differed across companies, however, the majority (80%) were with tertiary-level degrees, and the rest held secondary school degrees. In one of the companies, the owner was a woman, and there was an equal distribution of men and women among staff. In the other two companies, the owner was a man, and the overall gender distribution was almost even. The average salaries ranged between EUR 500 and EUR 700 net, monthly.

The **main challenges** companies were facing in expanding their production and/or internationalisation were related to the lack of financial resources, small size of the market, and the lack of demand for an introduction of a higher level of technology from the agricultural holdings. The latter were faced with financial limitations, small turnovers and lack of knowledge, among other obstacles limiting the demand for digital innovations.

The levels of cooperation with other stakeholders in the ecosystem differed among the interviewed companies. For example, start-ups that were established through different calls and granting schemes of public institutions or business intermediaries (such as the Innovation Centre or Tehnopolis) had very good cooperation with them. Companies that started their businesses on their own had almost no communication, cooperation and trust in public institutions, training providers or business intermediary bodies. They believed that there is almost no communication and support to SMEs and entrepreneurs from government and linked institutions, and that all support was reserved for big companies in the field.

Skills demand

There are no official data or research that can provide statistics in terms of both skills demand and skills supply in this niche. Based on data collected from the company interviews, the most needed **occupations** are electrical engineers, ICT professionals, marketing, sales, and business professionals

with ISCED 6 and 7 educational levels, as well as ISCED 4 or 5, when it comes to basic administrative jobs. Needs for professionals in the agri-food sector is not recognised as a priority by companies. Information and knowledge that is agri-food discipline-specific are mainly provided through cooperation with research institutions whose major is linked with agri-food (such as universities or secondary schools) or other agri-food companies.

According to business stakeholders, digital skills, digital marketing, and e-commerce are highly sought-after in the Montenegrin labour market. However, they also emphasised the importance of cross-cutting skills, particularly in marketing, and human resources training, due to the specificity of their businesses.

Companies reported that they did not experience problems in finding specialists needed for their operations and projects in the local markets. They believed that when it comes to digitalisation, Montenegro had a very good pool of experts and professionals that possess relevant skills and can adopt new knowledge. They typically recruited employees via social media, referrals from manufacturers, personal connections, and professional networks. Some companies were engaging recent graduates on a part-time basis, mainly from Bio-Technology School, though their work and activities are rather administrative than specialised in agri-food and digitalisation.

The interviewed companies also highlighted the significance of inter-disciplinary skills, such as combining digital technologies with agriculture and agronomy or various areas of economics (such as marketing), as well as skills in data analytics and precision agriculture/ smart farming. Among soft skills mentioned as relevant were the willingness to pursue professional development, adaptability to company's environment, and openness to new business ventures. The interviewees acknowledged that these soft skills are challenging to find.

In addition to the occupations mentioned by the interviewed companies and reported above, based on companies' skills needs, it can be assumed that the following occupational profiles can be relevant for developers of digital solutions in agri-food in Montenegro (see the table below).[31]

TABLE 7. OCCUPATIONS RELEVANT FOR DIGITALISATION IN AGRI-FOOD

Technical occupations related to ICT	
• 2511.3 - data analyst • 2511.4 - data scientist	• 2512 - Software developers
Technical occupations related to agri-food	
• 2132.1 - agricultural scientist	• 2132.2 - agronomist
Business support occupations	
• 1221.5 - digital marketing manager • 2431.10 - marketing consultant • 2431.11 - market research analyst	• 1212.2 - human resources manager • 4416.1 - human resources assistant

As these are mainly recently established companies with a low scale of activities, at the time of data collection they did not have vacancies and were not looking for new employees, although they acknowledged that such a need is likely to emerge in the upcoming years. The companies' representatives forecasted that IT, business and marketing-related skills will be in demand. Meanwhile, because of the lack of demand for digital innovations from agri-food companies, the interviewees expected that the demand for highly specialised skills and professions will be less needed in the niche (e.g. AI, IoT, automatisation, and robotics applications in agri-food).

[31] Based on skillsets in the ESCO classification of Skills, Competences and Occupations. Available here.

The interviewed companies believe that the Montenegrin labour market has a sufficient labour force with the required skills. The challenges that the companies face are instead related to financing and support to start their production and scale up their activities. Companies are not taking part in surveys or other assessments about skills needs, as they are not aware of such surveys and have never been contacted in that regard.

Skills supply

The education and training in ICT in Montenegro are provided at various levels. To begin with, several VET programmes for IT technicians are available in several secondary schools in Montenegro (see the box below). These programmes generally offer a mix of theoretical and practical coursework, including subjects such as programming, databases, computer networks, web design, and multimedia. Successful completion of these programs can lead to a vocational diploma and prepare students for further studies or careers in the ICT industry.

BOX 2. ICT TRAINING PROGRAMMES IN SECONDARY SCHOOLS

- Secondary School of Economics - IT technician
- Secondary School of Electrical Engineering - IT technician
- Secondary School of Information Technologies - IT technician
- Secondary School of Economics and Hospitality Management - IT technician
- Secondary School of Transport and Communications - IT technician

At the tertiary level of education, several major universities in Montenegro offer formal ICT education programs (see the box below).

BOX 3. PROVIDERS OF UNIVERSITY EDUCATION IN ICT

- University of Montenegro - Faculty of Electrical Engineering: Department of Computer Science and Engineering, Department of Information Systems and Technology, Department of Software Engineering
- University of Montenegro - Faculty of Information Technology: Department of Information Technology and Department of Computer Science
- Mediterranean University - Faculty of Information Technology: Department of Software Engineering, Department of Information Systems and Management, Department of Computer Science
- University of Donja Gorica - Faculty of Information Technology: Department of Information Systems and Technology, Department of Software Engineering
- University of Donja Gorica - Faculty of Electrical Engineering: Department of Computer Science and Engineering
- University of Donja Gorica - Faculty of Business and Economics: Department of Business Informatics.

There are no ICT programmes that have a focus on agri-food sector specifically.

However, existing agri-food programmes mentioned in the previous sections contain courses on IT that provide students with useful skills. For example, the Secondary Agricultural school in Bar, at the final stage of the Agricultural technician programme, is offering IT as a mandatory course. This is a generic course, not specifically linked with agri-food, but gives students basic information, and helps building general IT skills. A similar situation is with other programmes on this level. When it comes to the tertial level, our research found a similar situation. IT courses exist in almost each study programme in agri-food. For example, an undergraduate study programme Plant Production contains a course “Mathematics with IT”, where the focus is on basic programmes, such as Excel, Word, and R.

There is no official data that answer the question if graduates are able to find suitable jobs. However, based on information from universities about 65% of students find a job immediately after completing undergraduate studies.

The business stakeholders have argued that **basic IT skills** exist in the market, and that graduates can support the application of digital solutions in agriculture. As small-scale companies, they mainly rely on their own resources and if they need to outsource, they can easily find relevant skills in the local market.

Interviewed **higher education training providers** cooperate with chambers of commerce, SME agencies, innovation hubs, business associations, and other intermediary bodies in designing or **adjusting the training curricula**. A large number of associates and professors at universities that are directly involved in designing or adjusting the training curricula come from different companies, creating a link between businesses and education and training providers in developing the training offer. Proposals received directly from representatives of companies and institutions are extremely important for the continuous improvement of the quality of curricula. A similar approach exists on the VET level, with schools and the Centre for Vocational Education involved in these processes.

There is a certain level of cooperation between businesses and educational institutions. They collaborate on an ad hoc basis on specific projects and needs, mainly related to connecting research with business solutions. The role of certain business intermediary bodies (like Tehnopolis and Innovation Fund) in skills development in the digitalisation of agri-food and general agri-food is seen as very important by businesses. At the same time, businesses believe that certain bodies that have existed for a long time, and are providing support to businesses in general, are not seen as useful (such as the Chamber of Commerce, Union of employers, clusters etc). The reason for that is seen in their rather general profile, which is not devoted to the agri-food sector or innovations specifically.

Training that is provided **in-house** in the interviewed companies is limited to the nature of company business, company processes and procedures, administrative activities, etc. Such training is mainly delivered in the first months of employment, as well as ad hoc, when needed. One of the interviewed companies cooperated with public employment service – they employed a graduate from the list of the Employment Office of Montenegro on a part-time basis, through an apprenticeship programme. The interviewed companies are not members of trade unions/employer organisations as they do not see any benefit for them. They believe that this is reserved for bigger companies who are taking a large market share. Additionally, there is no cooperation with education and training institutions. Companies believe that formal education is important, however, they appreciate the skills and experience that candidates gain through informal or non-formal training.

Matching the demand and supply

Although Montenegro does not have a developed niche of economic activities related to the digitalisation for the agri-food industry at present, the demand for digital skills is evident and anticipated to increase in the future as a result of the expansion of digitalisation and technological advancements worldwide. In this context, it is essential to match demand and supply for digital skills to guarantee the sector's sustainable growth.

Digital technologies in agriculture and food processing are still underutilised due to a variety of causes:

- Based on the interviews conducted with stakeholders, digitalisation in agri-food is on a low level and is reflected in a few small companies (and start-ups) that are operating on a low-scale level, have a small number of employees and have no needs for additional employment currently. Companies have ideas on how to expand their businesses and production, however, they are lacking financial support.
- The agri-food sector in Montenegro does not demonstrate high demand for digital skills in agri-food. Some demand exists and it is mainly related to digital marketing, e-commerce, and smart farming. However, considering global trends and increasing competition from abroad, changing consumer preferences, and the need for more efficient production methods, it is expected in future that the demand for digital skills will increase.
- This study demonstrated a lack of specific educational programmes aimed at the digitalisation of the agri-food sector. There is no statistical data or evidence that can indicate the demand for skills or the supply of skills, and as a result, the mismatch that exists in that regard. There is a lack of programmes in both higher and secondary education that encompass multiple fields. In Montenegro, students cannot simultaneously study fields such as information technology and agriculture. Introducing multidisciplinary programs involving agriculture, business, engineering, and ICT could establish a new group of professionals capable of implementing and transferring technology from more advanced economies to domestic companies in order to address this issue.
- Additionally, education in the agri-food sector, according to business perceptions, has a weak relationship with labour demand, research and innovation, and other areas that would attract university graduates. The key problems appear to be traditional teaching techniques, limited possibilities to gain practical skills, and insufficient integration of university research and innovation.
- With the exception of a few ad hoc initiatives, non-formal education is not recognised as a significant mechanism for supporting the digitalisation of agriculture. The ecosystem includes business intermediaries, but talent development is not structured and systematised. Additionally, talents acquired through informal learning are not recognised formally.
- Collaboration between the ICT sector and the agri-food sector is infrequent in the country. Due to the fact that salaries in the IT industry and the niche in question are substantially higher than the national average, the agri-food industry, which can offer lower-than-average salaries, is less likely to recruit individuals with ICT educational backgrounds.

Matching the demand and supply for digital skills in the agri-food sector in Montenegro requires a concerted effort from all stakeholders. By developing the digital skills of the workforce in this sector, Montenegro can ensure that its agri-food sector remains competitive, sustainable, and resilient to future challenges.

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).

The biochemical and microbial products niche in Montenegro is extremely small and not developed. Unfortunately, Montenegro lacks the necessary capabilities to produce fertilisers, nitrogen compounds, pesticides, and other agrochemical products. There are no registered producers of microbial and biochemical products for agri-food. This results in significant data gaps for the country, which we will elaborate on below.

This chapter commences with an overview of the overall profile of the biochemical and microbial products niche for agri-food in Montenegro. We will then examine the demand and supply of skills in this niche, as well as the available programmes, tools, and activities in Montenegro to match the demand and supply.

The profile of the market niche

General context

As mentioned, Montenegro does not manufacture fertilisers, nitrogen compounds, pesticides, or other agrochemical products. The country relies on imported pesticides, fertilisers, chemicals for detergents, lubricating oils, and raw materials for the agri-food industry. The sector is primarily dominated by trading activities and operators, who mostly import chemical fertilisers, and production activities are relatively scarce. These businesses are mostly agri-pharmacies, that sell the (bio)chemical products. Agri-pharmacies are mainly small-scale companies and are not involved in cooperation with educational institutions, business intermediary bodies and similar institutions.

There is no statistics on the relevant NACE sub-sectors manufacture of fertilisers and nitrogen compounds (C20.1.5), manufacture of pesticides and other agrochemical products (C20.2), and research and experimental development on biotechnology (M72.1.1).

To provide some context on the use of biochemical and microbial products for agri-food in Montenegro, we present statistics on the use of fertilisers. The table below shows the use of nitrogen, phosphorus, and potassium (NPK) fertilisers in the EU and in Montenegro in 2017-2019, as well as the structure of NPK usage in 2019, and the index for each country compared to the year 2015. In 2019, the EU used a total of 138 units of NPK, with nitrogen being the highest, followed by potassium and phosphorus. In comparison, Montenegro used a total of 147 units of NPK, with potassium and phosphorus being equal at 38 units, and nitrogen being slightly lower at 72 units. The index for the EU

- 27 was 96, which means that their NPK usage had decreased by 4% compared to 2015. In contrast, Montenegro's index was 90, indicating that their NPK usage had decreased by 10% compared to 2015.

TABLE 8. THE USE OF NPK (NITROGEN, PHOSPHORUS AND POTASSIUM)

NPK	2017				2018				2019				Structure NPK 2019			Index
Country	N	P	K	NPK	N	P	K	NPK	N	P	K	NPK	N	P	K	2019 /2015
EU (27)	91	22	25	138	88	22	26	135	87	23	25	135	64%	17%	19%	96
MNE	72	38	38	147	86	34	35	156	84	33	34	151	55%	22%	23%	90

Source: FAO/FAOSTAT, 2022.

In terms of the use of NPK fertilisers, Montenegro has a higher reliance on them compared to the EU. In 2019, the structure of NPK use in Montenegro was 55% Nitrogen, 22% Phosphorus, and 23% Potassium, while in the EU-27 countries, it was 64% Nitrogen, 17% Phosphorus, and 19% Potassium.

The table below shows the use of pesticides in Montenegro in terms of consumption in kilograms per hectare (kg/ha) from 2015 to 2019, as well as the corresponding data for the EU over the same period.

TABLE 9. THE USE OF PESTICIDES IN MONTENEGRO, CONSUMPTION OF PPP KG/HA (2015-2019)

PPP	2015	2016	2017	2018	2019	Index 2019/2015
EU (27)	3.07	3.14	3.09	3.16	3.13	102
MNE	5.51	6.25	6.23	6.23	6.07	110

Source: FAO/FAOSTAT 2022. Available here.

In 2015, Montenegro's pesticide consumption was 5.51 kg/ha, which was significantly higher than the EU average of 3.07 kg/ha. The consumption increased in the following years, reaching 6.07 kg/ha in 2019, while the EU average remained relatively stable at around 3.13 kg/ha. The column index 2019/2015 shows that in 2019, Montenegro's pesticide consumption was 10% higher than in 2015, while the EU average remained relatively constant over the same period. This indicates that Montenegro's use of pesticides has increased over the years and is significantly higher than the EU average.

This suggests that Montenegro may be over-relying on nitrogen-based fertilisers, which can lead to soil degradation, water pollution, and other environmental issues. It also implies the relevance of innovation in the area, which the biochemical and microbial products could bring.

Key stakeholders

The monitoring and control of plant protection products in Montenegro are primarily carried out by the Directorate for Food Safety, Veterinary and Phytosanitary Affairs, which operates under the Ministry of Agriculture, Forestry, and Water Management. Sector for Phytosanitary Affairs (SPA) is responsible for implementing regulations related to plant protection products (PPP), including their import, distribution, sale, and use. They conduct inspections and monitoring activities to ensure compliance with these regulations and take appropriate enforcement actions in case of violations. Additionally, the

SPA plays a role in monitoring and controlling plant protection products by providing expertise and advice on their safe and effective use.

While activities of **business intermediary bodies** rather relate to the agri-food sector as a whole, there are some programmes and activities that are organised by Tehnopolis, such as the biotechnology laboratory, further described below[32]. Activities are project-based, and include trainings, mentoring and networking, not for the biochemical and microbial products niche in particular, but for the agri-food and entrepreneurship/SMEs support and innovation in general. For example, Tehnopolis organised three roundtables with key actors from the agricultural and innovation community in Montenegro, as part of the activities related to the establishment of the first laboratory for innovation in agri-food in Montenegro (FILA).

Public sector representatives in this specific niche, as mentioned above are part of the wider system and there is only one Directorate in the line Ministry. Agriculture and agri-food are part of a wider sector or innovation as a wider goal. Activities, knowledge, studies and plans in this specific niche are limited and are linked with in general agri-food and innovation, or both. There are no specific training programmes available in this niche, nor specific projects or activities.

The following projects and initiatives, though much wider in scope, may be considered as support to this particular niche:

- The project on *Strengthening and empowering cross-border innovation networks through Fertilisation Innovation Labs in Agri-food (FILA*) aims for improving the connection between research and SMEs through the creation of cross-border laboratories for fertilisation and innovation in agri-food, is led by IEC Tehnopolis in Montenegro. FILA laboratories are innovative environments that favour collaboration between actors of innovation systems, especially between business and research, in order to improve access to research results for companies, especially SMEs, thus stimulating the creation of innovative solutions and innovative start-ups for further investment in innovation. The total budget for Montenegro was EUR 175,277. The project aimed to improve cooperation among key actors in Montenegro's innovation system in order to increase the competitiveness of small and medium-sized enterprises. This was to be achieved by providing better access to research, which would help create innovative solutions. To achieve this goal, the project established the first laboratory for innovation and fertilisation in agri-food in Montenegro, called the FILA innovative laboratory. The training was conducted for FILA innovation brokers, as well as the community of practice workshops, and FILA incubation programme for start-up companies in the field of agriculture.
- Biotechnology Laboratory, *BioLab Tehnopolis*, is providing support to agricultural producers and agricultural development, both through the provision of its own service and through the integration of the academic and business sectors. The mission of the Biotechnology Laboratory is to provide support and services to agriculture in Montenegro, in order to develop new products and improve the quality of existing ones in order to reduce import dependence and encourage exports of our products. Goal is to encourage the transfer of knowledge and innovation, in order to create new products, as well as improve the quality of existing ones. BioLab Tehnopolis is equipped with three highly sophisticated devices: (i) liquid chromatograph with mass spectrometry (HPLC LC / MS Agilent Technologies 1260 HPLC / Ultivo MS), (ii) q16 Real Time PCR I and (iii) Bruker's S1 Titan 800 XRF analyser.

Companies representing the niche

As there is no official register of companies in this niche, it was not possible to identify companies for interviews, except for agri-pharmacies which are rather retailers selling products relevant to this niche.

[32] More information is available here.

Only one company related to the niche was interviewed. It was a retailer (agri-pharmacy) of biochemical and microbial products (such as crop probiotics, bio-fertilisers, and bio-stimulants). This was a small family business that had been operating for the last 20 years, with an average annual turnover is less than EUR 100,000. They were a local company, linked to one city and they did not see a need to invest in technology or digitalisation, as they had limited financial resources and were not interested to expand to other markets.

The company was owned by a woman and had four employees. Employed staff were mainly salespeople and one manager. The employees mainly had secondary education. Regarding the gender structure, 75% of employees were women. The company outsourced certain services, such as accounts monitoring. The average salary at the company was around EUR 450 and was in line with competitors (however much lower than the countrywide average salary, constituting only 40% of it).

The company was not a member of any employer or industry organisations. The company representative said that they did not have time to engage in these activities, and did not see benefits in participation.

Skills demand

Data on skills demand in Montenegro in this niche are scarce, especially given that producers representing this niche were not identified in the country.

Given the activities of the interviewed company, the skills and competencies they needed were more related to sales, business and management than to technical knowledge related to microbiology or biochemistry. The company believed that education institutions prepare specialists with relevant skills and limited additional training (in-company) is required. It mentioned having participated in an apprenticeship programme organised by the Employment office, as that represents some kind of financial support and “free of charge” help to the company. However, this was a limited instance, and these activities did not continue after the programme’s end. All employees in the company participate in internal training when needed. They do not work with other companies or business intermediary bodies to jointly request relevant training from social partners or training providers. They do not cooperate with education and training institutions. The company appreciates all skills and experience that the candidate gained via any training (including informal or non-formal training).

Based on the skills needs mentioned by the company, the following business support occupational profiles can supposedly be of relevance for retailers of biochemical and microbial products, among other occupations:

- 1221 - Sales and marketing managers
- 2433.6.2 - technical sales representative in chemical products
- 4311.2 - sales support assistant

Skills supply

Existing educational programmes that are relevant to this niche cover agri-food in general. At both secondary and tertial educational levels there is no specific programme that covers this niche. However, if the market niche of biochemical and microbial production in the country starts to develop, some existing wider programmes at the tertiary and VET levels can already serve as a basis for skills supply for the niche.

For example, in university programmes such as Technologies in animal production, Crop and vegetable farming, Plant protection, and similar, biochemistry and microbiology are part of certain courses rather than the focus of a programme. The programme Plant Production is consisting of certain courses, such as Microbiology and Plant Biochemistry. The Plant Protection programme contains courses relevant to this niche such as Technology of plant protection, Nematology and Tools for Plant Protection.[33]

On the **tertiary education level**, the University of Montenegro also offers Bachelor programmes in Biology and Chemistry:

- The **Biology** Bachelor programme equips students with knowledge and skills related to cellular processes and concepts related to morphology, anatomy, histology, and physiology. Students are also trained to understand ecological relationships, conduct field research, and be familiar with metabolic and genetic diversity. The student should also be able to explain the impact of pollutants on organisms, understand the principles of evolution, and critically evaluate the need for biodiversity protection. They should be able to read and understand relevant scientific literature, use relevant scientific tools and technologies, and work independently in laboratories.
- The **Chemistry** Bachelor programme aims at providing students with competences related to the structure of matter, basic laws of chemistry, and chemical reactions, as well as the physicochemical regularities that govern them. After the completion of studies, the students should be able to use various methods of material analysis and characterisation, select appropriate engineering materials, and understand the basic types of industrial processes. They should be able to apply their knowledge to participate in the management of industrial production and make decisions related to production. Additionally, the programme teaches skills in identifying and treating gas emissions that occur in the industry and understanding the importance of sustainable development for resource exploitation and environmental protection. They should also be able to apply their knowledge of thermodynamics and electrochemical kinetics to protect materials from corrosion. The goal is also to prepare students to address chemical and technological problems in an environmentally responsible and sustainable way.

Furthermore, the existing VET programmes in chemistry and biology can provide skills that are relevant to the niche.

The following relevant **vocational programmes** are taught in **secondary schools** in Montenegro. For example, the **Environmental Protection Technician** is trained to monitor and manage pollutant emissions, ensure proper storage of waste materials, sample harmful substances, and participate in testing procedures for water, air, and soil samples. Protecting and revitalising the environment by applying environmental regulations is also covered in the study programme.

The **Chemical Technology Technician** and **Chemical Laboratory Technician** programmes aim to equip students with the skills to optimise chemical reactions for production, with an emphasis on energy and material savings and reduced environmental impact. The curriculum covers chemical calculations, analytical, physical, and organic chemistry, instrumental methods, engineering knowledge of technological operations, and various inorganic and organic technologies necessary for designing and managing sustainable chemical processes.

When it comes to CVET, this specialised field of study lacks a curriculum designed specifically for it. No specific informal or non-formal training programmes were identified in this area. Typically, students receive their education at agricultural institutions or chemical schools. These institutions cover the two

[33] University of Montenegro, University Donja Gorica.

main areas of knowledge that are relevant to this niche, but there is no specialised curriculum that integrates both fields.

Matching the demand and supply

It was difficult to provide an analysis of the skills supply and demand in this niche since data on a number of programmes available, and particularly data on students enrolled disaggregated per programme do not exist and were not possible to obtain.

Considering the low level of SME activity in this niche that is limited to only retailing of chemical and microbial products rather than producing them, data and analysis of skills demand, supply and mismatch is very limited.

Companies engaged in sales of such products did not seem to face big challenges in finding employees with the required skills and competencies and if needed they organised internal training and mentoring conducted by managers/owners and senior employees.

ORGANIC AND FUNCTIONAL FOODS

Organic farming involves farming methods that prioritise the natural life cycles of plants and animals. In organic farming, the use of harmful substances like artificial fertilisers, certain types of pesticides and insecticides, and food additives is generally prohibited by regulations.

Functional foods, which are also known as nutraceuticals, are highly nutritious foods or food supplements that provide various health benefits to consumers such as disease prevention, proper development, and overall health balance.

In Montenegro, the majority of production in the agri-food niche occurs within the organic foods segment. Functional food business registration as such does not exist, and the number of companies producing functional foods is rather low. Except for one pharmacy that is producing specific wellness products (teas, drops, syrups, etc.) using inputs collected from Montenegrin forests, land and mountains (mainly wild herbs and fruits), and few start-ups, there is not much activity happening in this segment.

This chapter provides an overview of the niche's profile in Montenegro and discusses the skills demand and supply for the niche, as well as available programmes, tools, and activities to address the demand and supply in the niche.

The profile of the market niche and the stakeholder ecosystem

General context

According to the data of the MAFWM, 423 producers were registered in the Register of Organic Production by 2020, out of which 181 are certified. The number of registered producers increased by 7.6%, while the number of certified increased by 30.21% in 2020 compared to 2019. Over 90% of organic producers were based in the northern part of the country, while 8% were in located in the central and southern parts of Montenegro. The total agricultural area under organic production was

4,823 ha or 1.8% of the total agricultural area in 2020, [34] lower compared to the European average (3.4%)[35].

By 2020, 306.33 ha of organic production in perennial plantations was certified, which is a 36% increase compared to 2016. Apples and plums are the most certified fruits, and potato is the most certified vegetable. Most produced are chokeberry and apple juice. In the olive growing sector (including olive oil processing), there is one long-term organic producer and seven producers in transition.[36]

According to the data for the period 2016-2020, there is a significant increase in agricultural land and crops in organic farming. Thus, the increase in the area under permanent crops is 36%, while the increase in organic meadows and pastures in the observed period is even higher and constitutes 47%.

TABLE 10. ORGANIC PRODUCTION 2016 – 2020

Area of Production	2016	2017	2018	2019	2020
Perennial plantings (ha)	412	426	456	508	564
Arable land (ha)	272	262	309	321	307
Meadows and pastures (ha)	2,680	2,032	3,696	3,925	3,952
Cattle breeding (heads)	n/a	n/a	403	39	393
Sheep breeding (heads)	1,428	863	1,092	1,309	1,369
Beekeeping (hives)	506	839	1,103	1,964	3,381
Poultry (hens)	267	390	170	160	300

Source: MAFWM, 2020

When it comes to **employment**, there is no official statistical data disaggregated to the two-digit NACE level in the subsectors relevant to organic and functional food production (NACE A1.1, A1.2, A1.3, A1.5, A1.6).

Key stakeholders

Organic production in Montenegro is regulated by the Organic Law. The law was adopted in 2013 to harmonise national legislation with Council Regulation (EC) No. 834/2007 on organic production and labelling of organic products and repealing Regulation (EEC) No. 2092/91. Then, bylaws were adopted to achieve full harmonisation with Commission Regulation (EC) No. 889/2008 of 5 September 2008 laying out detailed rules for the application of Council Regulation (EC) No. 834/2007 on organic production and labelling of organic products. “Monteorganica" was established as domestic control body to perform organic production control and certification according to MEST EN ISO/IEC 17065:2013. Two public laboratories (CETI and the Institute of Public Health) are accredited to perform organic production analyses according to MEST EN ISO/IEC 17025.

Public institutions that were interviewed are supporting the agriculture sector in general and innovation and digitalisation in general, and are not specifically specialised in organic and functional food.
They believe that considering the Montenegrin natural resources, land structure and climate, there is huge potential for organic and functional food development. Main challenges were seen in the size of

[34] Programme for Development of Agriculture and Rural Areas in Montenegro under IPARD IIII 2021-2027, Ministry of Agriculture, Forestry and Water Management, 2022.
[35] “The World of Organic Agriculture Statistics and Emerging Trends 2022”, Research Institute of Organic Agriculture FiBL IFOAM – Organics International, available here.
[36] Programme for Development of Agriculture and Rural Areas in Montenegro under IPARD IIII 2021-2027, Ministry of Agriculture, Forestry and Water Management, 2022.

the market and unfair competition mainly mirrored in price competition of foreign companies, inability to achieve economy of scale due to the size of the market, small size producers that cannot obtain supply continuity, as well as small parcels owned by farmers, that cannot ensure the required level of production and meet market needs.

Business intermediary bodies are providing the same type of support as presented for the other two niches and are engaged through the same schemes and programmes in organic and functional production. Based on the interviewed business intermediary bodies, there is great potential in organic food production, particularly when it comes to the production of dairy products, meat, olive, fruits (apples, plumbs, grapes), vegetables (potato, tomato), crops (buckwheat, corn), and medical plants.

Support for organic producers is determined through national funds, more precisely through the Agrobudget measure "Support to organic production". It is carried out in the form of direct payments, per hectare in crop production and per conditional head of livestock, poultry and hives, in livestock production. In addition to national support measures, in the previous period (2009-2012), international assistance through two programmes contributes to a growing interest in organic farming in Montenegro. Through the programmes - Organic agriculture in Montenegro - joint support small producers in organic agriculture (FAO) and Programme of development of organic agriculture in Montenegro (Government of Denmark - DANIDA), the MAFWM in association with the Government of Denmark supported 53 investments by organic producers to the amount of EUR 1,721,442.79.[37]

Companies representing the niche

The interviewed companies that operate in this niche were producers of milk and milk products, meat, as well as a functional food (spelt juice). Two of the three companies were owned by men and one by women. Two companies had an annual turnover of over EUR 100,000 per year, while the third company had a low level of turnover and was in the initial stages of development. All companies were registered as limited liability entities. The companies were mainly selling their products on the local market, and only one company had some export experience (exporting to Slovenia, Sweden and Germany), though there was an ambition to grow and enter regional market.

Functional food companies were very rare in Montenegro, and there is no statistical data or register of this type of companies. As per our research, there is one pharmacy that is selling certain products that have a specific beneficial effect on health beyond their basic nutritional value (such as herbs, drops, vitamins etc). Also, there is one small company (that we interviewed) producing spelt juice that has multi benefits for overall health and benefits of the body. The functional food niche is therefore generally underdeveloped and very small.

The interviewed companies mainly have experienced employees, however, there was always a certain share of early-stage employees, who recently graduated. Companies mainly employed full-time staff. The gender structure of employees varied: in one company 80% of employees were women, while in the other gender was evenly distributed. The staff included members who were university educated (with agricultural background; business background and economics, as well as ICT) and staff with secondary education (administrative staff, workers working in production, stable, or in the field). The average salary in the companies was in the range of EUR 450 to 600. According to the companies, their salaries were in line with local competition.

[37] Ibid.

At the time of data collection, the interviewed companies applied basic **technologies** related to the automatisation of milking, grass mow, staking, etc. Some of them had developed project proposals related to high-level use of technology that would, for example, measure the quality and structure of milk, provide chips that will provide a full history of production, quality and certification, so that the final user is aware of the quality and all other details of the product. The funding was an issue. Each company was planning to invest in developing new or improved products.

The companies reported facing many **challenges** in expanding production and/or internationalisation, namely:

- Lack of financial resources (agri-food budget is rather small and makes only 1.5% of the total Montenegrin budget);
- Inability to get support from governmental programmes that are mostly reserved for big companies;
- Inefficient government administration and lack of knowledge in governmental bodies to support new product developments and higher technological processes;
- Small target market size;
- The process of obtaining funds, as well as certification and approval of products was very slow and resource-intensive;

In the development of new products and improvement of existing ones, companies have to rely on their own capacities or receive support through their international business network. The major issue companies see in communication between governmental entities and European Commission and other EU relevant bodies, is that it is not reflecting the real issues and needs of the farmers and agri-food producers. Additionally, companies had the impression that the government was using limited agriculture support measures that were available to countries in the EU accession process (5 out of 30 measures are used in Montenegro as part of the IPARD programme).

Skills demand

In the interviewed companies, there were no vacancies available at the time of data collection, considering the current season (winter 2022) and economic situation. The companies were ready to employ new staff if they obtained additional financial resources to invest in technological improvements and scale up the production level.

Based on the occupational profiles of current employees in companies, skills in agricultural production, food processing and packaging, quality control, and marketing are in demand. Additionally, companies rely on administrative occupations, and lower-skilled workers that support production.

The interviewed companies emphasised teamwork and the willingness to work and learn as the most important skills they considered in employment. Knowledge of the agri-food sector and food production processes, as well as user ICT skills were important for the companies too.

Based on these skills needs, it can be assumed that occupations in demand include (but are not limited to) the following (see the table below).[38]

[38] Based on skillsets in the ESCO classification of Skills, Competences and Occupations. Available here.

TABLE 11. OCCUPATIONS RELEVANT FOR ORGANIC AND FUNCTIONAL FOOD COMPANIES

Technical occupations	
• 2132.1 - agricultural scientist • 2132.2 - agronomist • 2145.1.4 - food technologist • 2263.2 - food safety specialist	• 3119.5 - food technician • 3142.1 - agricultural technician • 3240.2 - veterinary technician • 8160.34 - food production operator
Business support occupations	
• 1221.5 - digital marketing manager	• 2431.10 - marketing consultant • 2431.11 - market research analyst

As per the perspective of the companies interviewed, one of the biggest challenges in the niche, particularly when it comes to ICT skills, was **staff retention**. Skilled staff were looking for jobs abroad. Economic and political situation in Montenegro was believed to push young people to emigrate abroad and look for work outside Montenegro.

The interviewed companies cooperated with education and training providers, mainly to share real business experiences with university students and to address their own training needs. Companies stressed that the quality of knowledge of graduates is low level, when it comes to practical skills. However, when it comes to business intermediary bodies, there was no interest in cooperation with them on the side of the interviewed companies, as they did not see any benefits from this cooperation.

Skills supply

There are several educational programmes that are relevant for both the organic and functional foods segments of the niche. Nevertheless, these programmes are broad in nature, and there are no programmes devoted specifically to organic agriculture and food processing, or functional foods.

Higher **education** is organised through academic and applied study programmes. Relevant programmes are offered at both Bachelor and Master levels (see the box below).

Graduate academic studies are conducted through two study programmes:

- Plant production
- Animal husbandry.

Academic Master study programs are:

- Fruit growing, viticulture and oenology;
- Crop and vegetable farming;
- Plant protection;
- Technologies in animal production.

The graduate applied study programs are organised as follows:

- Continental fruit growing (Bijelo Polje);
- Mediterranean fruit production (Bar).
- Postgraduate master applied studies are organised as:

- Continental fruit growing and medicinal plants (Bijelo Polje);
- Nursery Production (Bar).

The undergraduate study programme within the Faculty of Food Technology, Food Safety and Ecology is organised as a general course during the first two years of study, while in the third-year students are directed to one of the following modules: (1) Technological engineering; (2) Sanitary engineering; (3) Engineering in the HoReCa system and (4) Ecological engineering.

At the Faculty of Food Technology, Food Safety and Ecology, there are the following postgraduate study programmes (two-year Master studies):

- Food technology;
- Technology of products of plant origin;
- Technology of products of animal origin;
- Viticulture and winemaking;
- Sanitary engineering in the food sector;
- Sanitary engineering;
- Engineering in the food safety system (HoReCa);
- Urban agriculture.

Vocational education and training programmes that are relevant to the niche of organic and functional foods production are listed in the earlier of this report (see Education in the agri-food sector section for more details). As with higher education programmes, VET programmes are broader in scope and do not have a specialised focus on the organic or functional foods production.

As described in the previous niche, there are activities and training organised by different business intermediary bodies or other organisations. Though there is no training directly targeting this specific niche, there is a training offer that is useful for the development of marketing, business, networking, and similar skills. For example, Tehnopolis had organised a set of workshops aimed at mapping the innovation needs of the companies and agricultural producers in the field of food production, the protection of natural resources during the production cycle, as well as mapping innovation needs in order to mitigate the effects of climate change. Another aim of the workshops was to analyse the identified needs with researchers, start-up companies and innovators from the mentioned areas, all in order to identify potential solutions and improve their businesses. Companies from this particular niche could benefit from this training, too.

Matching the demand and supply

Based on interviews with companies, the existing local market and local educational system possess needed relevant professions and educational programmes for organic and functional food production. Required technical skills and knowledge areas include agricultural production, food processing and packaging, and quality control, and marketing. Among business support skills and transversal skills, employers look for user ICT skills, administrative support skills, and soft skills such as teamwork and willingness to work and learn. Companies in the niche demonstrated demand for both high-skilled professionals and low-skilled occupations to support agricultural production and processing.

However, the level of knowledge of graduates is not at the required level. According to businesses, knowledge and skills are more general, and focused on theory rather than practice. Furthermore, although there are several educational programmes both at university and VET levels relevant to both the organic and functional food segments, they are broad in nature, and there are no specialised programmes focused on organic agriculture and food processing or functional foods. Cooperation and links between academia and businesses are lacking.

As a result, companies need to invest in training early-stage employees since their knowledge is too theoretical and is not linked with practice and business mindset. Typically, companies offer their own training programmes which are focused on developing technical skills for operating machinery and equipment, understanding business and production operations and processes, etc. These training programmes are usually short-term in nature.

Additionally, the companies participate in professional internship programmes, which provide students with temporary work opportunities for several months. While there is limited information available on the specific skills that are taught through these programmes, it is likely that they also focus on technical skills, such as operating machinery, production process, administration, etc.

CONCLUSIONS

Agri-food represents a significant source of income in Montenegro as nearly a quarter of the country's population, especially in rural areas, earns a living from agriculture. Modernising agricultural production and processing, upgrading rural infrastructure, and diversifying rural economic activities have advanced Montenegrin agriculture. However, the Montenegrin agri-food sector is still relatively underdeveloped, and many problems exist, including limited adoption of new technology, small, dispersed farms, poor processing, and insufficient food safety requirements. The specific niches that were the focus of this study are also at the very early stage of development in the country.

The agri-food sector in Montenegro generally has a low level of innovation and **digitalisation**. The niche of activities related to developing and producing digitalisation solutions for agri-food is also very small. There are only a few start-ups, small companies, projects, and initiatives active in the niche. These are mostly small firms with a turnover of less than EUR 10,000 per year and few employees. These companies are mostly formed through government calls for proposals (e.g. by Tehnopolis, Ministry of Science and Technology). All companies are focused on the Montenegrin market with an ambition to expand to the region. Products and services offered apply technological improvements using both hardware and software solutions.

Biochemical and microbial production does not take place in Montenegro. There are no registered producers of microbial and biochemical products for agri-food. The market niche is to a large part represented by retailers, in the form of agri-pharmacies who are offering some biochemical and microbial products for the agri-food sector.

The **organic and functional foods** market niche is more developed than the other two niches presented in this report. According to the data of the MAFWM, 423 producers were registered in the Register of Organic Production by 2020, out of which 181 were certified. The number of registered producers increased by 7.6% in 2020, while the number of certified increased by 30.21% compared to 2019. Companies active in this niche apply basic technologies that are related to the automatisation of

milking, grass mowing, staking, etc. Some interviewed companies have interesting ideas and develop project proposals which are related to the high level use of technology and have intention to invest in developing new or improved products.

Companies across all investigated niches reported a lack of financial resources and investments, small turnovers, market size, and lack of demand for higher-level technologies from agricultural holdings, gaps in linking research outputs with producers are the main problems enterprises face when growing output and/or **internationalisation**.

The two investigated niches present in Montenegro require a highly skilled workforce. **Research and educational institutions** support the development of Montenegro's agri-food sector. In the field of agri-food in general, three university programmes and five secondary vocational education programmes have been established. When it comes to digitalisation specifically, Montenegro is said to have a particularly good pool of experts and professionals with relevant skills. However, a number of issues remain in securing an appropriate skills supply for innovation in this sector and specific niches. This includes, primarily, a lack of tailored programmes combining technical skills in new technologies and agriculture, and a heavy focus on theory rather than practice and job-related skills. The recent graduates are also often reported to lack soft skills, such as teamwork, problem-solving, and a learning mindset.

Various non-formal training options exist to help fill some of the skills gaps. Different types of workshops, informational days, and training are organised ad hoc by Ministries, Chambers of Commerce, international organisations (FAO, UNDP, EBRD, WB etc.), NGOs, and universities. They are usually related to a specific activity or project those institutions are implementing and call for proposals or funding opportunities.

There are several **business intermediary bodies** operating in the agri-food sector in general, or supporting innovative activities in general, including agriculture, such as the Chamber of Commerce, Agricultural Cluster, Tehnopolis, Science Technology Park, Innovation Fund etc. There is a certain level of cooperation between businesses and educational institutions. It is usually ad-hoc, based on specific projects and needs, and is mainly related to connecting research with business solutions.

Nevertheless, the findings indicate the need to further improve the skills development opportunities for young professionals. Strengthening inter-institutional cooperation between education and research institutions and businesses is one of the areas of needed improvement.

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THE LIST OF INTERVIEWEES

Name	Organisation	Title	Stakeholder type	Interview date
Marko Maras	Seljak.me	Founder and CEO	Business, digitalisation in agri-food	30/11/2022
Obrad Drakulovic	Honey SWAT	Founder	Business, digitalisation in agri-food	12/12/2022
Bogdan Maksimovic	Montenegro company, Fish feed project (start-up)	Founder and CEO	Business, digitalisation in agri-food	13/12/2022
Aleksandrina Vujacic	Academy for Urban Ecological Engineering	Founder and CEO	Business, organic and functional foods	02/11/2022
Raso Miljanic	Dairy Farm Miljanic	Founder and CEO	Business, organic and functional foods	02/11/2022
Gordana Radovic	Tuko company	Founder and CEO	Business, organic and functional foods	20/11/2022
Mirjana Goranovic	Agri-pharmacy Radovic	Founder and CEO	Business, biochemical and microbial products	24/11/2022
Ms Lidija Rmuš	Chamber of Economy of Montenegro	General Secretary	Business intermediary	28/11/2022
Mr Velibor Bošković	Science Technology Park of Montenegro	CEO	Business intermediary/ training provider	31/11/2022
Milijana Aleksic & Vanja Zoric Sundic	Tehnopolis	Deputy Director and Bio lab manager	Business intermediary	09/12/2022
Snexana Scepanovic	Innovation Fund of Montenegro	Director	Business intermediary	04/12/2022
Ms Dubravka Radulovic	Ministry of Agriculture	Advisor	Public institution	02/12/2022
Marijeta Barjaktarović	Ministry of Science and Technology	Advisor	Public institution	05/12/2022
Mr Mirko Knežević	Biotechnical Faculty, BIO-ICT Centre of Excellence	Professor	Education and training provider	08/12/2022
Mr Amil Orahovac	University of Donja Gorica	Researcher at Centre of Excellence (Food Hub)	Education and training provider	17/11/2022
Sandra Brkanovic	Vocational Educational Centre of Montenegro	Hear of research and Qualification development department	Education and training provider/public institution	21/12/2022

ANNEX

Labour market in Montenegro

According to the Statistical Office of Montenegro data (Labour Force Survey) for 2021, there were 254,800 of the active population in Montenegro, out of which there were 212.6 thousand employed persons (83.4%) and 42.2 thousand unemployed (16.6%). The educational structure of the labour force (active population) shows that 60.9% of persons have finished secondary school, followed by persons who have graduated from tertiary education 31.7% and persons who finished primary school or lower education 7.4%. The highest share in the educational structure of persons outside the labour force has persons with completed secondary education, 55.6%; then 33.9% of persons with primary school or lower education and the remaining 10.5% have graduated tertiary education.

The latest available data for 2021 demonstrates that in total, 40% of people employed are professionals with secondary education, 36% are with certain vocational programmes and around 23% with higher education. 57% of employees are men and 47% are women.

TABLE 12. PERSONS IN EMPLOYMENT SEX, AGE AND RELEVANT NACE LEVEL (1 000), 2021

SEX	NACE	AGE GROUPS			Total
		15-24	25-54	55-64	
MEN	A1	n/a	4.5	1.9	6.5
	A3		n/a		
	C10-11		2.0	n/a	2.3
	Total		7.5	2.2	10.1
WOMEN	A1		3.6		4.4
	A3		n/a		
	C10-11		1.3	n/a	1.9
	Total		5.1	n/a	6.4
TOTAL	A1		8.2	2.6	10.9
	A3		n/a		
	C10-11		3.3	n/a	4.2
	Total		12.6	3.3	16.6

Source: Statistical Office of Montenegro, 2022

TABLE 13. EMPLOYED PEOPLE BY SEX, EDUCATION LEVEL AND ISCO OCCUPATIONAL GROUP FOR 2021 (AS A PERCENTAGE)

ISCO occupational group	Higher education	VET	Secondary education
TOTAL	***100***	***100***	***100***
Managers	7.9	2.4	2.8
Professionals	59.9		
Technicians and associate professionals	16.1	14.4	14.1
Clerical support workers	5	9.1	9.6
Service and sales workers	7.9	31.5	32.7
Skilled agricultural, forestry and fishery workers	n/a	4.7	4.5
Craft and related trades workers	n/a	14.5	13.7
Plant and machine operators, and assemblers	n/a	12.2	11.2
Elementary occupations	n/a	9.3	9.4
Male (% out of total number)	**45.3**	**62.8**	**60.3**
Managers	10.8	2.8	3.1
Professionals	51.6	n/a	n/a

ISCO occupational group	Higher education	VET	Secondary education
TOTAL	***100***	***100***	***100***
Technicians and associate professionals	18.4	10.6	11.4
Clerical support workers	5.2	7.3	7.8
Service and sales workers	7.7	23.2	23.1
Skilled agricultural, forestry and fishery workers	n/a	5.5	5.5
Craft and related trades workers	n/a	21.6	20.7
Plant and machine operators, and assemblers	n/a	19.5	18.4
Elementary occupations	n/a	7	7.4
Female	***54.7***	***37.2***	***39.7***
Managers	5.4	n/a	2.5
Professionals	66.9	n/a	n/a
Technicians and associate professionals	14.2	20.4	18
Clerical support workers	4.8	11.8	12.2
Service and sales workers	8	44.3	46.5
Skilled agricultural, forestry and fishery workers	n/a	3.5	3
Craft and related trades workers	n/a	3.5	3.5
Plant and machine operators, and assemblers	n/a	n/a	n/a
Elementary occupations	n/a	12.9	12.3

Source: Statistical Office of Montenegro, 2022

Educational system in Montenegro

TABLE 14. EDUCATION SYSTEM IN MONTENEGRO BY ISCED AND THE NATIONAL QUALIFICATIONS FRAMEWORK (NQF)

ISCED	NQF	Education programme
ISCED 3	IV	Agriculture, production and food processing
ISCED 3	IV	Agricultural technician
ISCED 3	III	Milk processing
ISCED 3	III	Nurseryman and flower grower
ISCED 3	III	Fruit and wine production
ISCED 6 & 7	VI 1 &VII 1	Plant production
ISCED 6 & 7	VI 1 &VII 1	Animal husbandry
ISCED 6 & 7	VI 1 &VII 1	Continental fruit growing
ISCED 6 & 7	VI 1 &VII 1	Mediterranean Fruit production
ISCED 6 & 7	VI 1 &VII 1	Technological engineering
ISCED 6 & 7	VI 1 &VII 1	Sanitary engineering
ISCED 6 & 7	VI 1 &VII 1	Engineering in the HoReCa system
ISCED 6 & 7	VI 1 &VII 1	Ecological engineering
ISCED 7	VII 2	Fruit growing, viticulture and oenology
ISCED 7	VII 2	Crop and vegetable farming
ISCED 7	VII 2	Plant protection
ISCED 7	VII 2	Technologies in animal production
ISCED 7	VII 2	Continental fruit growing and medicinal plants
ISCED 7	VII 2	Nursery Production
ISCED 7	VII 2	The technology of products of plant origin

ISCED	NQF	Education programme
ISCED 7	VII 2	The technology of products of animal origin
ISCED 7	VII 2	Viticulture and winemaking
ISCED 7	VII 2	Sanitary engineering in the food sector
ISCED 7	VII 2	Sanitary engineering
ISCED 7	VII 2	Engineering in the food safety system (HoReCa)
ISCED 7	VII 2	Urban agriculture
ISCED 8	VIII	PhD studies: Biotechnic

Source: University of Montenegro, University of Donja Gorica

Informal training offers by business intermediary bodies

TABLE 15. INFORMAL TRAINING BY SELECTED BUSINESS INTERMEDIARY BODIES

Training/seminar/roundtable title	Date (month/ year)	Aim of the training	Representatives from the agri-food business sector attended (Yes/No and few details-how many, producing what etc)
TEHNOPOLIS			
FILA Living Lab I - Meeting with the actors of the innovation chains in Montenegro	02/2019	IEC Tehnopolis organised three round tables with key actors from the agricultural and innovation community in Montenegro, as part of the activities related to the establishment of the first laboratory for innovation and fertilization in agri-food in Montenegro (FILA).	Yes In total, 23 participants from different institutions attended the round table.
FILA Living Lab II - Meeting with the actors of the innovation chains in Montenegro	03/2019		Yes In total, 15 participants from different institutions attended the round table.
FILA Living lab III - Meeting with the actors of the innovation chains in Montenegro	04/2019		Yes In total, 13 participants from different institutions attended the round table.
FILA Training for innovation brokers	02/2020	The main aim of the training was to build the capacities of 11 young people from the agro-food sector, in order to become innovation brokers. The main role of an innovation broker is to facilitate the identification of SMEs' needs and to enhance the cooperation between them and research institutions in order to improve their production processes and create innovative products.	Yes In total, 11 participants from different agri-food business organisations attended the training.
FILA Community of practice training I - Production of quality and healthy food by reducing pressure on the environment	10/2020	The workshops aimed to map the innovation needs of the companies and agricultural producers in the field of food production, and the protection of natural resources during the production cycle, as well as mapping innovations, and needs in order to mitigate the effects of climate change, from the aspect of agriculture. Also, another aim of the workshops was to analyse the identified needs with researchers, startup companies and innovators from the mentioned areas, all in order to identify potential	Yes In total, 17 participants from different institutions/organisations attended the training.
FILA Community of practice training II - Protection of natural resources as an integral part of the production processes in agriculture	10/2020		Yes In total, 10 participants from different institutions/organisations attended the training.
FILA Community of practice training III - Mitigation of the consequences of climate	11/2020		Yes In total, 10 participants from different

Training/seminar/roundtable title	Date (month/ year)	Aim of the training	Representatives from the agri-food business sector attended (Yes/No and few details-how many, producing what etc)
change, with sustainable production processes		solutions and improve their businesses.	institutions/organisations attended the training.
FILA Incubation Programme - Training	12/2020	The programme was dedicated to startups from the agri-food sector in Montenegro, with the aim of transferring knowledge and skills for innovative product creation.	Yes In total, 5 startups from Montenegro participated in the training within the incubation program.
VIRAL Hackathon	05/2021	The main aim of the hackathon was to create innovative solutions in the field of agri-food, based on the application of information technology through software, hardware and/or combined solutions.	Yes In total, 4 teams (in total 13 members) participated in the competitive part, while the total number of participants, coming from different institutions/organisations in the hackathon was 39.
VIRAL EXPO SmAgTech event – Vol. 1	11/2021	The main aim of the EXPO event was to gather all relevant stakeholders from sectors related to agriculture and IT technologies and to discuss the challenges and possibilities of IT technologies application in the agri-food sector.	Yes *The event was organised online and the total number of registered participants from 20 countries was 503.
Market research – Training	02/2022	The main aim of the training was to introduce participants to the concept, types and importance of market research. The target groups were representatives of different institutions, organisations and MSMEs enterprises from the agri-food sector of Montenegro.	Yes The total number of participants was 18.
Cluster development – Training	02/2022	The main aim of the training was to introduce participants to the concept of clusters, the reasons and advantages of their establishment, stages of cluster development, their classification and benefits of membership and their classification, while the special focus was on the development of innovative clusters and their networking. The target groups were representatives of different institutions, organisations and MSMEs enterprises from the agri-food sector of Montenegro.	Yes The total number of participants was 19.
Fair of European projects	05/2022	The main aim of the event that was organised by CEM was to present the implemented projects and ongoing ones that are financed with the funds of various pre-accession assistance programs to the general public. IEC Tehnopolis participated and presented to the wider audience all projects, among them those related to the agri-food sector.	Yes

Training/seminar/roundtable title	Date (month/ year)	Aim of the training	Representatives from the agri-food business sector attended (Yes/No and few details-how many, producing what etc)
How to write EU proposal - Training	07/2022	The main aim of the workshop was to introduce the participants to the concept of EU-funded project proposals. During the workshop, participants gained the knowledge about preparation of the project proposal and all steps within project implementation. The target groups were representatives of different institutions, organisations and MSMEs enterprises from the agri-food sector of Montenegro.	Yes The total number of participants was 22.
Technology transfer – Training	07/2022	The main aim of the workshop was to introduce the participants to the concept of Technology Transfer. During the workshop, participants gained the knowledge about protection of intellectual property rights in Montenegro and abroad, Invention - Patent: A road into the unknown, Intellectual property and technology transfer, Technology transfer and innovative ecosystem, Organisations for technology transfer and Human capital as the basis of technological transfer. The target groups were representatives of different institutions, organisations and MSMEs enterprises from the agri-food sector of Montenegro.	Yes The total number of participants was 14.
Fair of innovative projects in the fields of S3 Strategy of smart specialization	09/2022	The main aim of the event which was organised by the Ministry of Science and technological development of Montenegro and the Ministry of Economic Development and Tourism of Montenegro was to present the implemented projects and ongoing ones that are aimed at the development of smart specialization in Montenegro. IEC Tehnopolis participated presented to the wider audience all projects, among them those related to the agri-food sector.	Yes.
VIRAL EXPO SmAgTech event – Vol. 2	11/2022	The main aim of the EXPO event was to gather all relevant stakeholders from sectors related to agriculture and IT technologies and to discuss the challenges and possibilities of IT technologies application in the agri-food sector.	Yes *The event was organised online and the total number of registered participants from 21 countries was 596.
BoostMeUp Mentoring sessions	2021-2022	Within the BoostMeUp program, financial and non-financial support was provided to several startups that were developing ideas in the field of the agri-food sector (Solar villager - Smart computer for agricultural holdings control, Orhis – Automatic	Yes The total number of start-ups was 5, while the total number of team members was 25.

Training/seminar/roundtable title	Date (month/ year)	Aim of the training	Representatives from the agri-food business sector attended (Yes/No and few details-how many, producing what etc)
		plant smart pot, SunBun - Thermal food processing without environment pollution, Seljak.me – The first Montenegrin digital village, Honey SWAT – Sanitary Water Dispenser for Bees).	
RISE Mentoring sessions	2021	Within the RISE program, IEC Tehnopolis provided support to startups from the field of the agri-food sector (Okusi.me - Digital base of agricultural manufacturers and service providers of rural tourism on Balkan and Wineroom – a web platform that connects wine lovers with wineries and enables them to book a visit to the winery in rural and urban areas).	Yes The total number of start-ups was 2, while the total number of team members was 5.
INNOVATION FUND			
Presentation of the Fund for Development Innovation support system	02/2022	In the first year of the Fund's operation, the training aimed to explain to potential applicants the role of the Fund in the innovation ecosystem of Montenegro and present the support in the form of grant schemes that they can expect in 2022. Also, the Fund has practically since its foundation started educating potential applicants on various topics related to the preparation of tender documents for the Fund's innovation programs. All training sessions were organised in a hybrid format, and training recordings were sent to all participants. In addition, the Fund has started activities on the creation of short video educational materials that would serve as support for applicants during the preparation of applications (https://fondzainovacije.me/vlog)	The training was attended by representatives of companies from the agri-food sector, and the interest of this sector in the possibility of obtaining grants for innovative projects is noticeable. On average, 6-10 representatives from the agri-food sector attended the training, which is the smallest percentage compared to other sectors. Small and medium-sized companies producing olive oil, olive products, wine, milk and dairy products were present. Most individual producers from the agri-food sector are not registered or are registered as "farms", and do not fall into the category of MSMEs that can receive grants. In this sense, initiatives should be launched at the national level and mechanisms should be created that would enable both individual producers and agri-food farms to be able to use national and EU grants.
Innovative entrepreneurship and business community	03/2022		
Innovation policy and strategy of smart specialization of Montenegro	03/2022		
Financing innovation: the path from idea to realization	04/2022		
Matching solutions and markets	04/2022		
Intellectual property - the basics	04/2022		
Preparation of tender documentation for the Innovation Vouchers program	05/2002		
Market and business policy	05/2022		
The team and its relevance to success	July and September 2022		
Preparation of tender documentation for the Collaborative Grants for Innovation program			
Public assistance	09/2022		
How to present your project to the Investment Committee	09/2022		
How to pitch	12/2022		
Public procurement for beneficiaries of grants from the Innovation Fund	Every week since July 2022	Online info educational sessions for the preparation of tender documents for the open calls of the Innovation Fund.	

Training/seminar/roundtable title	Date (month/ year)	Aim of the training	Representatives from the agri-food business sector attended (Yes/No and few details-how many, producing what etc)
			In addition, our impression is that individual producers and farms, which make up the largest part of the agricultural and food sector in Montenegro, are not sufficiently involved in support programs at the national level, as well as that they do not have the necessary knowledge and skills about the possibilities of innovation in business methods.
An innovative approach for the sustainable development of the blue economy	09/2022	Raising awareness of the importance of innovation for the sustainable development of Montenegro, with a special emphasis on innovative solutions in the priority areas of the smart specialisation strategy.	The round tables were attended by medium/larger companies from the food processing industry in the area of olive oil and olive products production (Barska ultra), wineries and producers of milk and milk products.
Food technologies and food safety	09/2022		
How to get safe food? How is product authenticity preserved?	09/2022		
Application of the latest ICT trends and the importance of technology transfer with foreign ecosystems	10/2022		
How innovations can encourage the development of the innovative ecosystem of Montenegro	11/2022		