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Addressing the current and Future skIll needs for sustainability, digitalization and the bio-Economy in agricuLture: European skills agenDa and Strategy

D1.1: Stakeholders strategic plans and analysis report	
Document description	The growth strategy of the sector will be summarized through the available material and directives from the EU, producers associations and industries, in a comprehensive report in M6
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1 Introduction

As European agriculture is facing many challenges, the Food 2030 policy highlights the vulnerability of agri-production due to the globalisation of the markets, increasing competition, the prices' volatility and the economic uncertainty along with the low incremental crop productivity. Those vulnerabilities are stressed by increasing demand for food and feed, while environmental concerns increase and climatic changes generate more uncertainties. Moving from business-as-usual agriculture to Sustainable farming is a complex process that requires a system approach, including reshaping the role of the farmer: from mere producer of food and commodities, to an entrepreneur that incorporates other activities (agritourist, food processing, selling of local produce to name a few) including to be a "wise manager of the natural capital".

The agricultural economy is intrinsically modelled by objectives of environmental, economic and social sustainability, political influences and by the evolution of consumers' tastes and values. For these reasons, the "human factor" and the capacity of science and entrepreneurship play a fundamental role in shaping the future of agriculture. The challenge of the occupational transformation in the agriculture and food sectors is therefore to continue to assure sustainability, health and well-being by using all the resources made available by scientific advancements and technological support. To bridge the gap between the high-level objectives and tasks of the global reshaping induced by the bio-based economy, agriculture stakeholders must be active in mobilising competences and skills that are essential to maintaining a sufficient flow of knowledge and abilities in line with the desired competitive goals. Educational provisions and good recruitment of human resources are hence an important part of the redesign strategy of agriculture and bioeconomy stakeholders.

Bioeconomy allows tackling many of the challenges that agriculture is facing by linking the various actors of the value chain and by making use of a new circular economy model. However, proper skills strategy is missing to allow farmers to address it successfully.

A clear EU sectoral skills strategy is needed to improve risk management, stem the loss of practical skills, improve understanding of new technologies, develop business and leadership skills, as well as bring about a more coordinated approach to skills development.

FIELDS is a project structured to achieve a dynamic integration of skills and competences for the agriculture sector into a coherent framework, linking knowledge, innovation and competition for a successful and sustainable bioeconomy. The project will develop a comprehensive and sustainable strategy for the feasibility of a skilled agriculture and circular bioeconomy fully integrated into the stream of a global food supply chain consistent with the Sustainable Development Goals (SDGs) as defined by the United Nations.

The first step of the project is to draw an overall view of the sector and its future needs and to identify the current and future skills gaps and training needs through surveys and focus groups involving relevant stakeholders. The consortium will also identify good practices, valuable experiences, existing studies, partnerships and policies.

The purpose of Task 1.1 is to collect information with the goals of: i) generating a database on previous projects, results, best practices and organisations/stakeholders (D1.2), and ii) producing a comprehensive state

of the art report of the sector, for both stakeholders and training providers, that will inform a Growth Sectoral Strategy proposal (D 1.1).

As part of this task, EfVET and LLLP have carried out a mapping of the most relevant European frameworks used to support, guide and promote Vocational Education and Training Systems in Europe in acknowledgement of:

- the role of VET in the lifelong learning systems,
- the role of VET in equipping citizens with the knowledge, skills and competences required from the labour market and
- the contribution towards the mutual understanding and transparency in what concerns recognition and validation of qualifications, transferability and certification.

This mapping will help harmonise the exchanges, work carried out across sectors in Europe and understand how different requirements related to qualifications, and quality (and mobility) would look like in different countries (see chapter 3).

''Growth strategy'' includes trends and strategies/policies at EU level of the sectors Sustainability, Digitalisation, Bioeconomy, through the available material and directives from the EU, producers associations and industries. A trend, according to FAO (1) and FIT4FOOD2030 project (Report on baseline and description of identified trends, drivers and barriers of EU food system and R&I) is defined as: "*A development or change over a long time which is likely to affect society or parts of it after a few years. A trend cannot easily be influenced in a mechanical way by individual organizations, players, or nations. It is often a result of specific drivers or can be promoted by strong influencers. It becomes visible only in retrospective*."

The goal of the project is to develop a sectoral skill strategy to support the change and growth of agriculture and the bioeconomy, by allowing matching demand and supply of skills while taking into account the digitalisation and the innovation of the sector.

The report will be also used in WP2 to be able to standardise the skill needs and create occupational profiles that will be prioritised in order to directly create curricula and training for them within the project.

2 Growth strategy - Trends and policies

This chapter summarized the three main sectors, with inputs of needs that arose from relevant past national and EU based projects, EU policy papers, EU level studies from knowledge organisations and reports of associations. Each sub-chapter is divided into three paragraphs: i) Description of the sector through a literature research, ii) Trend of the sector at European level and iii) EU policies.

According to FAO (1), a trend is a "*directional assessment of something that is changing or developing over time. Often this is a result of specific drivers. For example, as a result of the driver "globalization," there is increasing demand for ethnic or specialty foods across the globe*." Other definitions state that a trend is a general tendency or direction of a development or change over time, a pattern of micro-decisions, i.e. consumer choices or behaviour. Following the definition of the European Foresight Platform, "*a trend may be strong or weak, increasing, decreasing or stable. There is no guarantee that a trend observed in the past will continue in the future. What is interesting about trends is that normally most players, organizations or even nations cannot do much to change them – they are larger than the power of individual organizations and often nation states as well*" (EFP, 2018 [1]).

We are going to analyse separately the trends and policies for sustainability, bioeconomy and digitalisation in the following chapters.

2.1 Sustainability

2.1.1 Description

According to Hayati *et al.* (2), sustainable agriculture is a global, dynamic process-taking place in three dimensions (economic, environmental and social) and at five levels (field, farmstead, local community, national and international levels). The term sustainable agriculture was developed based on Brundtland Report published in 1987 in and is based on the broader paradigm of sustainable development: "*Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs*". More than 70 definitions of sustainable agriculture can be found in the literature. They reflect different priorities, diverse goals and specific values for specific stakeholders (3).

Therefore, there are many descriptions of sustainable agriculture due to an extensive disparity in terms of how sustainability in agriculture or agricultural sustainability is outlined and how it is followed in the decision-making process. In scientific literature, sustainable agriculture is often linked to 'alternative' agriculture concepts, such as ecological, low-input (energy, water, soil use), environmentally sensitive, biodynamic, community, extensive, fresh farm, free breeding, low inputs, organic, regenerative, permaculture, prudent use, etc. (4).

[1] EFP, European Foresight Platform (2018): http://www.foresight-platform.eu/community/forlearn/how-todo-foresight/methods/analysis/megatrend-trend-driver-issue/, last accessed Nov. 16, 2020

In agricultural systems, sustainability incorporates the concepts of resilience (i.e. the ability of systems to face and overcome a traumatic event or a period of difficulty) and persistence (the ability of systems to last over time without significant variations for long periods) and cope with broader economic, social and environmental results.

Sustainable growth is a key objective of the EU, taking as its objective the continuous improvement of the quality of life and well-being of present and future generations, combining economic growth, environmental protection and social justice. Currently, the fundamental document defining the future of Europe is “A Strategy for Smart, Sustainable and Inclusive growth. EUROPE 2020” (5).

Thirty one percent of global greenhouse gas emissions have been attributed to agriculture and forestry (6) and according to FAO (7), at least 70 % of the pesticide pollution in fresh waters is estimated to originate from agriculture. On the other hand, the sector has important functions; besides being necessary for everybody’s life and wellbeing, agriculture (including forestry and fisheries) provides livelihoods for 40 percent of today’s global population, including many of the world’s poor. Thus, sustainable growth of the agricultural sector is a necessity from the perspective of the environment, society and economy (8).

2.1.2 Trends

The interest in the sustainability of agricultural and food systems can be traced to environmental concerns that began to appear in the 1950s–1960s. Today, concerns about sustainability centre on the need to develop agricultural technologies and practices that: (i) do not have adverse effects on the environment, (ii) are accessible to and effective for farmers, and (iii) lead to both improvements in food productivity and competitiveness and have positive side effects on environmental goods and services (9).

Based on a recent study on the assessment of sustainability in agriculture of the European Union Countries (8), the highest level of sustainability in agriculture is recorded in two countries from Central and Eastern Europe. This is a result of the predominant share of farms running extensive production at an average level, thanks also to the low animal stocking density and a relatively low level of employment per 100 ha. Renewable energy from agriculture similarly had a positive effect on the level of sustainability (i.e. Czech Republic accounting for 18.1% of total production of renewable energy). The new EU member states have relatively high sustainability, due to lower intensity and less concentration of production, however, the realization of the social and economic effects in those member states is at a significantly lower level than in the old member states. Other factors that characterize the high level of sustainability in EU countries, especially in Ireland is due to a high level of arable land per capita (1.049 ha per person). Nevertheless, the emission of methane, being the key pollutant in the sector, is a factor that negatively affects the sustainability of Irish agriculture. On the one hand, the United Kingdom recorded the lowest level of agricultural sustainability characterized by a high level of labour productivity, connected with a relatively low level of employment in agriculture (1.21%) and with quite a low number of workers per 100 ha of utilized agricultural area (1.72 annual work unit /100 ha) (8).

2.1.2.1 European projects

At European level, several projects deal with Agricultural Sustainability issues, most of them under the framework of Horizon 2020 programme: Agrimax, is developing and demonstrating the production of multiple, high-value products from crop and food-processing waste. The project is also developing economically competitive routes to the commercialisation of these products, using flexible, and possibly cooperatively run processing facilities. EcoStack is developing ecologically, economically and socially sustainable crop production strategies via stacking of biodiversity service providers and bio-inspired tools for crop protection, within and around agricultural fields, in order to enhance sustainability of food production systems across Europe. FIT4FOOD2030 aims to connect stakeholders in the European food system at multiple levels (cities/regions, countries, and Europe), that will make Research & Innovation policies on Food and Nutrition Security more coherent, build competences of current and future researchers, entrepreneurs, policy-makers, and society at large, and raise awareness of FOOD 2030. LIFT project goal is to identify the potential benefits of the adoption of ecological farming in the EU and to understand how socio-economic and policy factors affect the adoption, performance and sustainability of ecological farming at various scales, from the level of the single farm to that of a territory. NEXTFOOD drives the crucial transition to more sustainable and competitive agri-food and forestry systems' development by designing and implementing education and training systems to prepare budding or already practising professionals with competencies to push the green shift in our rapidly changing society.

Also, Erasmus+ programme funded several projects related to sustainability topics.

PLANET project deals with renewable energy in agriculture. Green jobs are growing at a double rate in agriculture than other sectors. However, they require management and maintenance skills to upkeep and maintain Renewable Energy Sources (RES) plants on a daily basis. PLANET action aims to tackle this need, providing training to: Farmers willing to invest in RES, Owners of RES plant, Advisor and Consultants, Students increasing their employability and mobility. The goal of the project is to provide innovative training to farmers who own RES plants or want to invest, with practical and ICT skills in a work-based environment related to the daily management of the plant. The training will also be available for consultants or students as initial vocational training.

Innovation is also an important driver for agrifood companies. Ecotrophelia competition and FoodLab proejct (European food business transfer laboratory for stimulating entrepreneurial skills, for fostering innovation and for business creation in the food sector) provide a framework to develop innovative food products. The project is based on a learning approach and an entrepreneurial spirit in students, to foster interactions between stakeholders in Food and Drink innovation and to guide the development of the innovative projects. The FoodLab project has enabled the setting up of European Food-business Transfer Laboratory supported by a shared web - platform, centralizing ad hoc learning and training contents/tool guidelines to create/help future entrepreneurs with dedicated modules to promote interactions with food companies, technical centres or business angels.

SAGRI "Skills Alliance for Sustainable Agriculture" purpose is to provide farmers and agricultural stakeholders with knowledge, skills and competencies in the field of agro-environmental technology for sustainable agriculture. The SAGRI project will allow agricultural workers to acquire the skills, the knowledge and the ability to understand and analyse agro-environmental systems as natural ecosystems modified by human activity.

2.1.3 EU policies

17 Sustainable Development Goals (SDGs) were adopted during the United Nations Summit on Sustainable Development, Agenda 2020 and the European Union (EU) has also adopted 17 UN SDGs for 2030 (10). The participating countries committed to work together on achieving a sustainable development path together (11), together with the Strategy for Smart, Sustainable and Inclusive growth. EUROPE 2020 (5).

The EU is doing its utmost to fight climate change by introducing ambitious policies. One of these goals is the European Green Deal, which is a plan to make the EU's economy sustainable. It aims to boost the efficient use of resources by moving to a clean, circular economy while restoring biodiversity and cutting pollution.

In response to the recent pandemic outbreak due to the Covid-19, the European Commission has approved an investment package of more than €280 million from the EU budget for new LIFE programme projects (https://ec.europa.eu/easme/en/life). The Commission has allocated funds to projects on environment, resource efficiency, nature and biodiversity, and environmental governance and information. In addition, on climate action, the EU allocated resources to support climate change mitigation, adaptation, governance and informational projects. This includes major investments aimed to enhance Europe's biodiversity, improve energy efficiency in buildings, and reduce the negative impact of energy-intensive industries on our planet.

Among other challenges, these projects will support the EU Biodiversity Strategy to 2030 (12), contribute to EU Green recovery post Covid-19, and help Europe become a climate-neutral continent by 2050. In addition, as many of these new projects involve several countries working together, LIFE's impact will be felt across every Member State.

The COVID-19 pandemic has been a blow to economies across the EU. The Commission reacted swiftly with proposals on the contribution of employment and social policy to the recovery. Among these proposals is included the ambitious European Skills Agenda for sustainable competitiveness, social fairness and resilience (https://ec.europa.eu/social/main.jsp?catId=1223&langId=en). VET is an integral part of this agenda.

2.2 Digitalisation

2.2.1 Description

Electronics, automation technology and the connection of machines to the Internet have massively changed the possibilities in agricultural production (13).

The digitalization of the economy is the side effect of the automation of serial operations in agriculture and the introduction of management and control systems to regulate production processes based on modern technologies. Historically, both aspects are constant companions of agriculture, which has been driven more strongly by the growth of farms for at least two decades (14).

The quality of business planning and analysis depends on the availability of high-quality information. A farm management and information system (FMIS) can provide this information by enabling the central collection and storage of data from a wide variety of areas, as well as their linking and processing to information that is

relevant for the execution of the activities on a farm (15). The data collected in an FMIS can be internal (internal and external trade) or external, whereby the latter can encompass the entire value chain, on a horizontal (inter-company) or on a vertical (upstream and downstream) level. In this context, the terms “Big Data” and “Agriculture 4.0” are used very often. Big data describes data that is primarily characterized by the three dimensions of volume (data volume), velocity (speed at which the data volumes are generated and transferred) and variety (bandwidth of the data types). If technologies such as precision farming and remote sensing are networked with one another at the data level, one speaks of Agriculture 4.0 (16). A FMIS based on agriculture 4.0 is a comprehensive tool for the decision-making in agricultural operations.

At present, a wide range of data from different systems is already available for agricultural operations (e.g. precision farming, animal husbandry, meteorological data, normative data for business planning, current input and output prices, etc.). On the one hand, there are technical problems with regard to data linkage and integration (lack of homogeneous interfaces) and analysis (lots of data, but little information) and, on the other hand, problems with the organizational design of the data exchange and data sovereignty and security. Proprietary solutions of large companies and open systems that allow easy and free access and exchange of information (keyword: open data) are seen as possible future scenarios for the latter point (17,18). In addition, a good telecommunication structure (broadband internet) is a basic requirement for FMIS in the context of Agriculture 4.0 (19). Therefore, central solutions are needed which, on the one hand, enable the processing and exchange of information and at the same time create fair rules on data property and privacy.

2.2.2 Trends

Sensors and electronics on machines were originally used for control, regulation and monitoring. Only later was it started to record and evaluate measured values. Initially, such parameters were only shown on a display or printed out, and later transferred to the office PC using a data carrier. Harvesting machines and tractors are nowadays increasingly being equipped with a SIM card, with which a connection to the Internet can be established. A number of new functions are possible with these so-called telemetry systems. The vehicle manufacturers can call up error codes and carry out remote diagnosis or remote maintenance of the vehicle. This is an enormous advantage, especially with busy harvesting machines, as it is possible to react more quickly in the event of a fault. New internet-based software tools are available for logistics, especially for harvest chains. These new technologies are often summarized under the term “Smart Farming” and "Precision farming"

The basic functions for new agricultural machinery and equipment, therefore, will include data acquisition, order management, field navigation, fleet management, online data transfer and open interfaces required (20).

Merging data from different sources often requires specialist knowledge and is time-consuming. The construction of data platforms with corresponding interfaces and generally accepted semantics, via which data from different sources can be automatically exchanged with different applications, is only just beginning. The automatic exchange of data is a prerequisite for a time-efficient Smart Farming. In order to automatically suggest possible, sensible measures from the recorded data or to create application maps for the control of

machines, agricultural expertise must be represented in algorithms. Generally recognized and verified algorithms missing currently still for many measures.

A lack of knowledge about the possibilities and operation of machines and programs for smart farming is repeatedly cited as a challenge (21). The lack of knowledge is not only a problem for managers and employees on farms, but also for teachers and in advisory services. Problems also exist in this context in the agricultural machinery trade and in workshops. In addition to school-based training, the content must also be taken into account in training offers for working people. Waiting for the generation change is not a sensible option. Due to the rapid development, in addition to training, ongoing training for teachers, consultants and farmers is central to the successful use of the systems.

Training is a vital issue for two main reasons: the adoption of new Information and communication technology and software requires skilled people, and skilled people can drive change in the technology supply and ICT solutions available. Besides training, there are still some issues to be solved in this domain, related to innovation adoption, listed below.

Missing machine equipment: On the one hand, reliable sensors must first be developed and integrated into the control of machines at low cost; on the other hand, due to the low utilization and the resulting long service life, many “non-digitized” machines are in use after a while and will continue to be so for a few years. The agricultural machinery manufacturers are working on the first problem and they will continuously bring innovations to the market. In order to shorten the useful life according to time and thus to align with the duration of the development cycles in IT and electronics, the annual utilization of the machines must be increased. Either this is possible through company growth or it can be done cost-effectively by using sharing equipment across many farmers.

Lack of opportunity to deal with the technology: Not all those employed in agriculture are ready or able to deal with the new technologies at work, and business models to exploit these technologies are also lacking.

Establishment of standardized terms and work processes: The systems used, i.e. machines and software have limited flexibility, this results in a need to standardize work processes within the company or between the companies.

Time required introducing the systems: When setting up extensive systems on the farm, considerable costs, time and training can be expected and the return of the investment could be quite long.

The main technologies and systems is digitalisation sector are:

- Technologies: Internet of Things (IoT), Radio Frequency IDentification (RFID), sensors, robotics, cloud technology, Unmanned Aerial Vehicles (UAV - drones), Artificial Intelligence (AI), Blockchains (BC), Big Data (BD);
- Management Information Systems (MIS):
    - Farming: fields operations management, site specific management, machine management, inventory management, reporting, quality assurance, health management, feed management and feed intake, productivity, sales, finance, customer relationships, marketing;

- Food industry: Enterprise Resource Planning (ERP), Manufacturing Executing Systems (MES) and integrated shop floor control, supply/value chain information management, performance management
- Forestry: forest inventory management, harvest planning, timber logistics integrated with harvest management, traceability, forest safety management

The impact digitalisation on business practices/models can be summarised in:

- Business internal: key activities and resources
  - agriculture plant: crop selection, crop/weed identification, disease/nutrient deficiency identification, yield prediction, harvest, irrigation, minerals accounting, etc.
  - agriculture animal: feed intake, mineral supplementation, animal health/ health monitoring, medicines, fertility, minerals accounting, etc.
  - food industry: recycling and waste management, by-products, traceability (e.g. separation of product flows), (new product development(?))
  - forestry: forest inventory management, harvest planning, timber logistics integrated with harvest management, traceability, forest safety management
- Business external: value proposition, customer relationships, customer segments, channels, key partners:
  - Design new product features (e.g. quality differentiation, adding information (provenance, processing information), labelling
  - New ways to interact with customers (e.g. internet sales, social media)
  - Address new market segments and channels (e.g. direct sales, connecting to national market)
  - Traceability (safety, quality attributes)
  - Communication of production data for planning and marketing purposes
  - Support interaction with stakeholders: government, advisory services, financial institutions; connect to sector best practices databases
- Cost structure and revenue streams
  - Performance management (integrate economic and environmental data from internal and external operations); think of sustainability dashboards
  - Financial management
  - Others

2.2.2.1 Connectivity

Digital connectivity is considered a social right in the EU[2]. The use of advanced digital technologies, such as AI, Internet of Things, cloud computing and big data analysis will enhance productivity, improve efficiency and open up new opportunities for European businesses in all sectors, all of which are crucial for the economic recovery. While businesses are getting more and more digitised, only a fraction of SMEs rely on advanced cloud (17%) and big data applications (12%). Malta is the European leader in big data (24% of companies), while Finland is the most advanced on the uptake of cloud services (50% of companies). There is a substantial gap

[2] https://composite-indicators.jrc.ec.europa.eu/social-scoreboard/ last access 30 November 2020

between large companies and SMEs. This gap exists for not only advanced technologies, but also for basic digital solutions such as having an enterprise resource planning (ERP) software package and e-commerce (22).

Based on the Digital Economy and Society Index (DESI) 2020 (22), although already 85% of citizens used the internet in 2019, prior to the COVID-19 crisis, only 58% possessed at least basic digital skills. Digital skills are the backbone of the digital society, without which one cannot fully benefit from digital technologies. While the current crisis may be having the positive impact of increasing the number of internet users, the development of digital skills does not come automatically with increased usage. The percentage of people having at least basic digital skills went up slightly from 55% in 2015 to 58% in 2019. The Netherlands and Finland are the frontrunners in the EU, while Bulgaria and Romania are lagging behind.

In connectivity, Denmark had the highest score, followed by Sweden, Luxembourg, Latvia and Spain. Greece, Cyprus and Bulgaria had the weakest performance. As for the mobile broadband sub-dimension, Finland, Germany, Italy, Hungary and Denmark lead Europe, while Bulgaria and Slovenia registered the lowest scores.

Broadband is available to all households in the EU. Primary internet access at home is provided mainly by fixed technologies, which remained stable at 97%. Among these technologies, xDSL has the largest footprint (91%) Broadband coverage of rural areas remains challenging as 10% of households are not covered by any fixed network and 41% are not covered by any Next Generation Access technology.

Overall very high capacity network (VHCN) coverage shows a spectacular increase between 2011 and 2019 from 10% to 44%. In rural areas, growth was lower, but still significant, from 2% to 20% within the same time period. The significant gap between total and rural VHCN coverage shows the regional disparities in digital opportunities and confirms that more investment is needed in rural areas in order to catch up (22).

2.2.2.2 European projects

ASKFOOD aims to create a permanent knowledge alliance between businesses and Higher Education Institutions in the food-related sectors. The ASKFOOD project focuses on the creation of a new educational eco-system for innovation and sustainability of the food system by: 1) upgrading and modernizing training and educational methodologies by implementing an Open Innovation framework; 2) feeding the innovation and entrepreneurial mind-set of the future generation of graduates in food and food-related studies by piloting acceleration and growth hacking solutions in responses to common and cross-sectoral challenges connected with the food system; 3) developing cross-industry, multisector, transdisciplinary knowledge platforms to promote the knowledge alliance between businesses and HEIs in the food-related sectors, and 4) Improving academia-industry and stakeholders' interplay in a Quintuple Helix innovation model at EU and international level.

AFarCloud project will provide a distributed platform for autonomous farming that will allow the integration and cooperation of agriculture Cyber Physical Systems in real-time in order to increase efficiency, productivity, animal health, food quality and reduce farm labour costs. This platform will be integrated with farm management software and will support monitoring and decision- making solutions based on big data and real time data mining techniques. The AFarCloud project also aims to make farming robots accessible to more users by enabling farming vehicles to work in a cooperative mesh, thus opening up new applications and ensuring

re- usability, as heterogeneous standard vehicles can combine their capabilities in order to lift farmer revenue and reduce labour costs.

CYBELE (Scalable big data analytics for fostering precision agriculture and livestock farming) aspires at demonstrating how the convergence of HPC, Big Data, Cloud Computing and IoT can revolutionize farming, reduce scarcity and increase food supply, bringing social, economic, and environmental benefits. CYBELE generates innovation and creates value in the domain of agri-food, and its verticals in the sub-domains of precision agriculture, livestock and fish farming, as demonstrated by nine real-life industrial cases to be supported, empowering capacity building within the industrial and research community. CYBELE intends to safeguard that stakeholders have integrated, unmediated access to a vast amount of large-scale datasets of diverse types from a variety of sources. The stakeholders are capable of generating value and extracting insights because of the secure and unmediated access to large-scale HPC infrastructures supporting data discovery, processing, combination and visualization services, solving challenges modelled as mathematical algorithms requiring high computing power.

Agricultural technologies and innovations offer significant opportunities to improve the efficiency and effectiveness of farm businesses, through optimized yields, reduced environmental impact, and increased profitability. However, farmer adoption of these technologies is often limited and therefore the benefits are not realized. This project builds on the 2018 EIT -Food Educating for Technology Take-off (ETTO) project, which used students as ambassadors to encourage farmers' adoption of technologies. The 2019 project included the unique recruitment of farmer champions and technology ambassadors (including machinery dealerships) who were trained in relevant aspects of technology and then they became the trainer. Alongside world-leading industry and academic institutes, the farmer champions and technology ambassadors developed engagement activities where they were responsible for encouraging the wider farming community in the UK/Ireland, Germany and Italy.

IoF2020 project aims to accelerate the adoption of IoT in 5 different agri-food sectors, namely: meat, dairy, vegetables, fruits and arable farming. It particularly aims at strengthening the competitiveness of farming and food chains in Europe, and securing sufficient, safe and healthy food to European consumers. The project aims also to consolidate Europe's leading position in the global IoT industry by fostering a symbiotic ecosystem of farmers, food industry, technology providers and research institutes. The project consists of a consortium of 73 partners, led by Wageningen UR. The project is organized around 35 use cases grouped in 5 trials, each focussed on a specific agri-food sector. The information technology group leads a use case on meat transparency and traceability that is part of the meat trial and contributes in the design of generic IoT solution architecture to be used in diverse use cases.

2.2.3 EU policies

The Federal Department of Economics, Education and Research are currently dealing with the topic of digitization in agriculture in Germany by the Federal Ministry of Food and Agriculture and in Switzerland as part of similar initiatives. In Germany, the Society for Computer Science in Agriculture, Forestry and Food Management is also a scientific institution that researches specifically on this topic (www.gil-net.de).

With regard to the organizational structure of data exchange in digital agriculture, in addition to initiatives (promoting example of innovative start-ups), especially joint efforts at EU level appear on a national level purposeful. This is done through a pooling of public interests to design approaches for data exchange and data processing in the context of Agriculture 4.0 and to develop fair rules from this.

Not only agriculture but also the training in general has to exploit the digitalisation opportunities. Especially in this last year, because of the COVID-19 pandemic, education and training institutions all over the world have had to innovate to ensure continuity in teaching. Those involved in VET are no exception. The European Commission has captured more than 250 examples and ideas from over 30 countries of how VET providers and other VET stakeholders have adapted.

The European Vocational Skills Week, organised by the European Commission in cooperation with the German Presidency of the Council of the European Union, was recently held, where various issues were addressed (https://ec.europa.eu/social/vocational-skills-week/). Among others, it focused on VET excellence offered by the digital transition and the potential of VET for a green economy. Other sessions explored VET internationalisation and the future of work-based learning.

The European Vocational Skills Week is an annual event where local, regional or national organisations highlight the very best of VET, a path to a more fulfilling personal and professional life. European Vocational Skills Week is a platform to make VET's potential more widely known, and an opportunity to exchange information and good practice across Europe and beyond. This edition's theme is VET for Green and Digital Transitions, in line with the Commission priorities of a "European Green Deal" and a "Europe fit for the digital age".

The rapid shift towards a climate neutral Europe and digital transformation is changing the way we work, learn, take part in society and lead our everyday lives and, as stated by the President of the European Commission, Ursula Von der Leyen: "*The best investment in our future is the investment in our people. Skills and education drive Europe's competitiveness and innovation. But Europe is not yet fully ready. I will ensure that we use all the tools and funds at our disposal to redress this balance*". The Covid-19 pandemic has also had a profound impact on millions of people in the EU who have lost their job or experienced significant income loss. Many will need to acquire new skills and move to new jobs in a different sector of economy. More will need to upskill to keep their job in a new work environment. For young people, entry in the labour market could be very challenging. The new European Skills Agenda builds upon the ten actions of the Commission's 2016 Skills Agenda (23).

2.3 Bioeconomy

2.3.1 Description

"Bioeconomy can be defined as those parts of the economy that use renewable biological resources from land and sea – such as crops, forests, fish, animals and microorganisms – to produce food, materials and energy" (EC 2020). In the future, Bioeconomy is expected to transform the current fossil-based economical system into

a more sustainable one that considers various dimensions, such as food security, resource scarcity and climate change. The world will face an increasing demand for food and energy due to an ever-increasing population. Therefore, renewable energy and resource-use-efficient technologies must be fostered which increase productivity in agriculture, forestry and aquaculture. At the same time, this process must happen within the planetary boundaries and without jeopardizing our ecosystems and biodiversity. Bioeconomy in agriculture also means an increasing productivity, while reducing losses in the production, storage, transport and processing of foodstuff. In particular, the circular bioeconomy stressed the recyclability and reuse of the resources and the streams that originate within a cycle of a production and consumption, to reduce losses and re-engineering processes in a way that minimize the waste and the losses at any stage for agriculture, agrifood and forestry domain.

Bioeconomy aims to ensure food security and increase the innovative use of resources in a competitive society in a manner friendly to the natural environment (24).

2.3.2 Trends

One of the most important trends in the bioeconomy is a shift towards sustainable agriculture. This can also be described as 'sustainable intensification', which means a sufficient foodstuff and biomass production for an ever-increasing population without compromising the world's ecosystem functions and biodiversity. This aim can be reached by a further development and use of innovative production techniques targeting at more efficacy in the exploitation of natural resources. The knowledge-based approach of bioeconomy is a prerequisite for its implementation since farmers need to be made aware of the needs for a sustainable agriculture and, hence, be trained in the methods to create a more sustainable cultivation system. In order to plan a holistic value chain that meets the demands of bio-based technologies and a more sustainable economy, agents in this value chain have to understand the processes of biomass production and its supply chain on a global scale (in (25) pp. 102)

Many trends in Bioeconomy research are oriented towards the Sustainable Development Goals set by the UN. The EU had been an active partner in contributing to the 2030 agenda that defines the 17 SGD goals, passed in 2015. Food loss is one of the most pivotal problems to be mentioned here since it deals with an ecological and a socio-economical dimension. The total food waste in the EU sums up to around 88 million tons (https://ec.europa.eu/food/safety/food_waste_en). While facing a food loss of 35% among cereals before getting to the consumer, the number is even as high as 50% for perishable goods such as fresh fruits and vegetables (26). In order to mitigate those losses in primary production, new disease-resistant varieties must be bred. Further, more effective crop protection measures must be implemented, as well as better training for farmers who are expected to apply new technologies. For example, more sustainable cultivation methods should be examined to reduce the input of phosphate fertilizer, which is often made from rock phosphate – a finite and already scarce resource and, therefore, the European Commission added it to its list of critical raw materials in 2014. In addition, innovative infrastructure for storage and transportation or efficient processing and conversion methods must be fostered. Beyond primary production, most of the food waste is caused by the consumers. Here, many different aspects come into play. Among other things consumers' expectations,

concerning the look of food could lead to rejection of impeccable food, as well as a misinterpretation or lack of understanding of the best before date. Digitalization can be a key driver for building smart food supply chains, traceability or combat food fraud. Lastly, raising the awareness of consumers and enabling them to identify bio based, sustainable products through training and campaigns are additional important aspects. As a paramount topic, all trends in the Bioeconomy can be subsumed under the goal of tackling climate change since this is the very basis of all actions to be followed, such as providing sustainable food production by arable land.

2.3.2.1 European projects

Several EU projects where FIELDS partners were involved deal with the problem of food loss, for example the Horizon 2020 project REFRESH (see Annex I). It *"focused on the reduction of avoidable waste and improved valorisation of food resources and to develop strategic agreements to reduce food waste with governments, business and local stakeholders in four pilot countries"* (REFRESH). One important factor is to always integrate all relevant stakeholders and to not underestimate consumer engagement. Another project is the EIT Food project Pro4Bake (see Annex I) which combines some of the aforementioned identified trends and needs. With the help of algorithms and computational application, Pro4Bake aims at more efficient resource usage, taking into account not only process optimisation but also the demand forecast of bread products. In turn, the production will be tailored to a needs-based output. Another key element in resource efficient production and hence, CO_2 mitigation actions, are short supply chains (SFSC). Short food supply chains are a well-defined term by the European Commission as *"being the chains in which foods involved are identified by, and traceable to a farmer and for which the number of intermediaries between farmer and consumer should be minimal or ideally nil"* (27). A cutting-edge project dealing with this challenge is SMARTCHAIN (see Annex I). This project will stimulate demand-driven innovation in short food supply chains to improve competitiveness and foster rural development using a multi-actor approach (SMARTCHAIN). Another project investigating SFSCs is SKIN (see Annex I) which *"aims to systematize the existing knowledge, fostering demand-driven innovation, building long-term collaboration among European farmers and cooperatives, facilitate stakeholder engagement and promote innovation through demand-driven research in the short food supply chain domain".*

With reference to the importance of a more sustainable agriculture that not only deals with the foodstuff production, but also biomass, new resources that do not compete with food crops need to be investigated. One promising approach is the usage of microalgae as it is fostered by another Horizon 2020 project – ProFuture (see Annex I). This project is *"aiming to scale up microalgae production and prepare the market uptake of microalgae proteins as ingredients for innovative and sustainable food and feed products".*

As mentioned before, all expertise has to be brought into action by practitioners such as farmers. Therefore, several projects are funded to conduct research in the field of educational approaches towards a bio-based economy. For example, the ERASMUS+ project ABBEE (See Annex I) focuses on students, as the future professionals, in order to train them in the concept of Bioeconomy by transferring and implementing innovative practices. *"With this project, a knowledge triangle is formed between research, education and industry of key-role stakeholders in Europe in which they work together to improve education and facilitate innovation in the area of the bio-based economy".*

The food & drink industry is the EU largest manufacturing sector in terms of turnover, value added and employment (28), but despite financial and market turmoil, it remains stable and resilient. Innovation is a main challenge that, in a wider food system approach, needs to be implemented by taking into account the impact in our society and natural environment. The food sector is also increasing its connections with other economic and manufacturing sectors (e.g. tourism, nanotech, ICT, pharma, bioeconomy) due to emerging trends in consumption styles, technology advancements, sustainability standards and health concerns. A better coordination among these sectors is necessary to tackle emerging challenges, catch common opportunities in the job market for food studies graduates and lead innovation in the food production chain.

2.3.3 EU policies

A real EU bioeconomy policy started in 2005 with the EC conference "New Perspectives on the Knowledge-Based Bio-Economy". Later in 2007, a workshop in the city of Cologne established the definition of a bioeconomy strategy in Europe with a two-tiered approach (29). Firstly, the importance of biotechnology was identified as *"an important pillar of Europe's economy by 2030, indispensable to sustainable economic growth, employment, energy supply and to maintaining the standard of living"* ((30), p. 4). This dimension fostered the innovation in the biotechnology sector (Birner in: (25) p. 20). Secondly, the usage of crops as a resource substitution was defined as *"renewable industrial feedstock to produce biofuels, biopolymers and chemicals. […] By 2020, in addition to the then mature gasification technologies, the conversion of lignocellulosic biomass by enzymatic hydrolysis will be standard technology opening up access to large feedstock supplies for bioprocesses and the production of transport fuels"* ((30), p. 4).

Bioeconomy has found a significant place in the EU scientific research program Horizon 2020 (31). In 2012, the European Commission launched and adopted Europe's first bioeconomy strategy addressing the production of renewable biological resources and their conversion into vital products and bioenergy with the goal of a: *"more innovative and low-emissions economy, reconciling demands for sustainable agriculture and fisheries, food security, and the sustainable use of renewable biological resources for industrial purposes, while ensuring biodiversity and environmental protection"*. Back in 2018, this strategy was updated to set a new focus on the scope of actions. More specifically, the Industrial Policy Strategy, the Circular Economy Action Plan and the Communication on Accelerating Clean Energy Innovation were re-defined by stressing the needs of a sustainable and circular Bioeconomy. This update also incorporated a three-tiered approach that comprises:

a) strengthening and scale-up of the bio-based sector, by unlocking investments and markets
b) deploying local Bioeconomy across entire Europe
c) being aware of the ecological boundaries of the Bioeconomy (EC 2020[3])

Among the actions of the 2018 updated European Bioeconomy Strategy, action 2.4 Promote education, training and skills across the bioeconomy is one of the fourteen actions proposed in the plan. This action aims at reducing skills shortages and skills mismatches across the bioeconomy by supporting development of new

[3] EC 2020 Research and innovation on the bioeconomy, funding, collaboration and job opportunities, projects and results, events and news: https://ec.europa.eu/research/bioeconomy/index.cfm?pg=policy last accessed Sept. 17, 2020

and updated curricula which respond to the diverse and evolving needs of stakeholders and sectors in the bioeconomy.

Within this action, the RTD-Bioeconomy organised a workshop in Brussels in October 2019. Coordinators of FIELDS were invited to participate, along with many stakeholders representative in Europe. The questions to be addressed were related to the key barriers to develop skills through VET, University Education and entrepreneurship for different domains of bioeconomy: food systems, agriculture and forestry, bio-based innovation systems.

To the questions related to the key barriers for developing skills, the summary of the replies were:

Lack of purpose and system thinking. Students learn about how but not why something is relevant (e.g. climate change). There is a need to contextualise -- why is it relevant to learn or do something.

Lack of connection between the three forms of education (VET, University and Entrepreneurship). Vocational education has a wealth of experience and uses innovative pedagogic technologies. The university systems should learn from these VET schools but often the link is missing.

There is a lack of connection between stakeholders and training entities. The effects are a mistrust of uptake of information and knowledge, so we need to empower the links between training entities and stakeholder. For example, if a university and their scientists are not well connected with the world of farmers, farmers do not trust them.

Multi-actor approach skills are relevant. There is a need for soft skills to interact with different groups and stakeholders as well. The link between different groups is not relevant.

There are also barriers at the teacher level; reluctance to change is often a generational issue that yields to a conservatory approach. Knowledge about bioeconomy, awareness of new teaching tools, materials or approaches are other reasons. It is difficult to attract but also to keep talent. Often new teaching materials are in English, which makes it so much harder to reach a more remote village in a country where few people speak English fluently.

Another barrier is the lack of mapping platforms with available data on institutions providing training in this area.

Also, there is no common understanding and lack of terms related to Bioeconomy, lack of business cases, and there is a lack of skills for SME and farmers who cannot afford specific staff to address some knowledge needed. They have lack of time and motivation to participate and they need success stories, this could engage them in the training.

Especially for the bio-based innovation systems, the participants point out the lack of resources for investing in educational and training programmes, the fragmented knowledge that characterize bioeconomy and particularly bio-based innovation systems bring a new comprehensive and cross-sectorial context. Education as well as the new generation of experts, that should fulfil the needs of stakeholders and industry, need to adapt to it. There is also a fear of changing/shifting jobs, and in this case, we need leading examples, success implementation stories, and relatively slow adaptation of educational programs in this domain by universities.

3 European Frameworks in Vocational Education and Training

The Fields Project aims at understanding how to address the challenges and opportunities the agriculture sector is facing nowadays and explore these opportunities in the development of new business models in the light of emerging skills in the labour market more specifically in the sectors of bio economy, sustainability and the use of digital technology. This will lead to the development of training modules in the sector targeting Vocational Education and Training (VET) providers at EQF levels 4 and 5.

More specifically, the project aims at developing four training modules in the areas of soft skills, sustainability, bioeconomy, and digitalization to cover the areas of innovation in bioeconomy, agriculture, and forestry. These training modules are related to the occupational profiles developed based on the skills gap analysis of the sector conducted by partners of the project and will be complemented with an apprenticeship period. The pilot of the training will be carried out in Austria, France, Finland, Italy, the Netherlands, Spain and Ireland. In order to do so, partners of FIELDS will undertake a series of action, that will lead to the following results: (i) a set of occupational profiles developed; (ii) detailed curricula aligned with the occupational profiles, identifying also the specific methodology for each EQF level; (iii) a framework detailing the process that will be put in place to assure the transferability of the curricula; (iv) an apprenticeship database and framework per country.

These frameworks are the result of the work carried by the European Commission, throughout the years. With the purpose of addressing the pitfalls that the VET sector face related to factors, such as the diversity and great differences between VET systems across the EU countries; the quality and relevance of the training offer to the market needs; the low attractiveness of VET quite often regarded as a second choice by many; the low share of work based learning and lower levels of international mobility when compared to other sectors, such as higher education.

These are expected to respond to the above-mentioned challenges by providing reference points to all stakeholders (colleges, employers, trade unions, chambers among others) directly or indirectly involved in VET. They provide general recommendations to be used as reference across sectors in the vocational education and training systems. The purpose is to highlight key aspects that should be taken into consideration when developing the occupational profiles and the training modules.

3.1 EQF – European Qualification Framework

The European Qualifications Framework (EQF) is a reference framework that helps communication and comparison between qualification systems in Europe. Structured in 8 levels, where 1 presents the lowest level of proficiency and 8 the highest. These reference levels are described in terms of learning outcomes: knowledge, skills and competences. This allows any national qualifications systems - National Qualifications Frameworks (NQFs) - in Europe to relate to the EQF levels. Learners, graduates, providers and employers can use these levels to understand and compare qualifications awarded in different countries and by different education and training systems. This approach enables the comparison of all types and levels of qualifications including qualifications from higher education, vocational education and training and general education, but also qualifications awarded by the private sector and international organisations. Currently, all the countries

that integrate the partnership of the FIELDS Project have an NQF aligned with the EQF, despite the fact that countries have different stages of development and there are small variations in level descriptors.

Table 1. Compare the state of development of the National Qualifications Framework in the countries that will be part of the Pilot of the training: Austria, Finland, France, Ireland, Italy, Spain and The Netherlands. (Overview of National qualifications framework developments in Europe 2019 *https://www.cedefop.europa.eu/files/8609_en.pdf)*

Country	Scope of the framework	Number of levels	Level descriptors	NQF linked to EQF
Austria	Designed as a comprehensive NQF; currently, includes qualifications awarded in higher education and VET qualifications at levels 4, 5 and 6 from formal education and training; it includes two qualifications from the health sector at level 8.	Eight	• knowledge • skills • competence	2012
Finland	Comprehensive framework including all State-recognised qualifications. No qualification linked to EQF level 1.	Eight	• integrated level descriptors include knowledge, skills and key competences	2017
France	NQF covers all levels and types of vocationally and professionally oriented qualifications and the national baccalaureate (general, technological and vocational). Open to qualifications awarded outside the formal education system.	Eight	• complexity of knowledge • level of skills and know-how • degree of responsibility and autonomy	2010
Ireland	Comprehensive NQF including all types and levels of qualification from formal education and training	10 with five classes of award type	• knowledge • skills • competence	2009
Italy	Designed as a comprehensive framework; it will include all levels and types of qualification from formal education and training and regional qualifications.	Eight	• knowledge • skills • autonomy and responsibility	2013
Spain	Designed as a comprehensive NQF for lifelong learning; will include all levels and types of qualification from formal education and training.	Eight	• knowledge • skills and abilities • competence	
The Netherlands	Comprehensive NQF including all levels and types of qualification from formal education and training (except primary education). Open to qualifications offered outside the formal education system. Qualifications below EQF level 1 included at entry level.	Eight, including a sublevel at level 4 (4+), and an entry level	• context, • knowledge • skills • responsibility and independence	2011, 2019 update

Particular attention should be put on the different descriptors used for EQF levels 4 and 5 as listed on Table 2 below.

Table 2. Description of EQF levels 4 and 5 (https://europa.eu/europass/en/description-eight-eqf-levels)

EQF Level	Knowledge	Skills	Responsibility and autonomy
4	Factual and theoretical knowledge in broad contexts within a field of work or study	A range of cognitive and practical skills required to generate solutions to specific problems in a field of work or study	Exercise self-management within the guidelines of work or study contexts that are usually predictable, but are subject to change; supervise the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities
5	Comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge	A comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems	Exercise management and supervision in contexts of work or study activities where there is unpredictable change; review and develop performance of self and others

The topic of qualifications, particularly at International level, is very relevant for the labour market. Nevertheless, they are also important for the National and European perspectives as they promote common trust and cooperation at operational level, increasing also the transparency of qualifications awarded at International level. It is, therefore, important to assure that the descriptors of the FIELDS training curricula are in line with the National qualifications framework of the countries in which the pilot will be carried.

3.2 EQAVET - European Quality Assurance Reference Framework

EQAVET is a reference instrument aiming to help EU countries to promote and direct the continuous improvement of their vocational training systems from common agreed references. In addition to contributing to improving quality, its purpose is to establish mutual trust between VET systems and facilitate the acceptance and recognition of the skills and competences acquired in different countries and educational settings. The framework provides guidance on how to develop a quality assurance system and contains examples of different approaches used by Member States. It is grounded on the principle that quality assurance applies across all levels of the system and involves a collective responsibility to work together with all relevant stakeholders to improve VET. This is particularly important when developing International training curricula as it should match the quality standards defined by each country. On a practical level, there are 4 stages in the quality assurance cycle that should be followed namely:

Stage 1: Planning – Set up clear, appropriate and measurable goals and objectives in terms of policies, procedures, tasks and human resources. Stage 2: Implementation – Establish procedures to ensure the achievement of goals and objectives (e.g. development of partnerships, involvement of stakeholders, allocation of resources and organizational or operational procedures). Stage 3: Evaluation – Design mechanisms for the evaluation of achievements and outcomes by collecting and processing data in order to make informed assessments/evaluation. Stage 4: Review – Develop procedures in order to achieve the

targeted outcomes and/or new objectives; after processing feedback, key stakeholders conduct discussion and analysis in order to devise procedures for change. These four stages of the quality assurance cycle are interrelated and need to be addressed together.

The quality assurance cycle – planning, implementation, evaluation and review of VET – is supported by common quality criteria, indicative descriptors and a set of indicators, that are used as a toolbox from which VET providers can select the more relevant indicators for their quality assurance system. In the framework of the FIELDS project, the indicators that have been identified as the more relevant to the project have been already identified.

3.3 ECVET- European Credit system for Vocational Education and Training

The main purpose of this framework is to facilitate the transfer of learning credits from one qualification system to another being therefore linked to the mobility experience of learners. It offers a framework for making learners more mobile and qualifications more portable, laying down principles and technical specifications and making use of existing national legislation and regulations. It applies to VET qualifications at all levels of the EQF.

ECVET is a European system of accumulation and transfer of credits and has been designed to enable the recognition of the learning outcomes of an individual in a learning pathway to a qualification. The system favours the documentation, validation and recognition of achieved learning outcomes acquired, in particular in the framework of transnational mobility, in both formal VET and in non-formal context. It is individual-focused and based on the learning outcomes approach, defined in terms of the knowledge, skills and competences that combined will lead to a qualification. This enables a more accurate design of training courses, which answers to the training needs of employees. Some of the ECVET concepts and processes are already embedded in many qualification systems across Europe such as ECTS (European Credit Transfer Scheme).

ECVET has been set up to work with other European tools, more specifically the EQF and EQAVET to achieve greater compatibility and facilitate the permeability and transferability between different VET systems in Europe and their qualifications being a critical tool for enhancing and assuring VET mobility. The four stages of EQAVET mentioned earlier can be applied to specific learner experiences in mobility programmes and more broadly, to ECVET partnerships.

ECVET has a formal structure that includes the following procedures:

- **Identification of Learning outcomes of the qualification**: defined as statements of knowledge, skills, and competence that can be achieved in a variety of contexts.
- **Definition of Units of learning outcomes:** defined as components of qualifications. Units can be assessed, validated and recognized.
- **Attributing ECVET points**, which provide additional information about units and qualifications in a numerical form. **Representing the qualification and each unit by a specific number of ECVET credit points.** In the countries in which a credit system already exists, the existent credit system should be

followed, and in the other countries, a decision regarding how to proceed will have to be made (one example could be for example linking ECVET points to the Credits

- **Attributing Credits**: that is given for assessing and documenting the learning outcome of a learner. Credit can be transferred to other contexts and accumulated to achieve a qualification based on the qualification standards and regulations existing in the participating countries.
- **Signing a Memorandum of Understanding** between organisations involved in the mobility agreeing to the different roles that have been allocated with the terms and confirming their acceptance of quality assurance, assessment, validation and recognition criteria and procedures as adequate for credit transfer;

These procedures are of extreme importance in order to ensure the validation and recognition processes of learning outcomes, as well as credit transfer and accumulation and should be applied within the framework of the FIELDS project.

3.4 ESCO - European Skills, Competences, Qualifications and Occupations

ESCO describes, identifies and classifies professional occupations, skills, and qualifications relevant for the EU labour market and education and training. One of ESCO's main missions is to build stronger bridges between education and training and the labour market, contributing to reducing skill mismatches and supporting the better functioning of the latter. The vision behind ESCO is the provision of a common reference language that could support transparency, translation, comparison, identification and analysis of the content of a qualification, thus helping to indicate how those relate to the skills and occupations needed across occupations and sectors. ESCO Platform should be used as a guide when working on the development of the occupational profiles and specific qualifications associated with these new or reviewed profiles. It is important to assure regular communication with ESCO when proposing new occupational profiles ensuring these are based on evidence resulting from the analysis carried out by the relevant stakeholders involved in the Project.

EQF, EQAVET, ECVET and ESCO are, as mentioned, general reference points to support Member States and more specifically VET providers to develop a harmonized approach to VET training in areas, such as learning outcomes, quality of the training and validation and recognition of skills and competencies acquired to facilitate the mobility experiences. These are the reference frameworks for the FIELDS project and it is important to assure that throughout the process of developing the training curricula all relevant stakeholders (at national and European levels) are engaged. It also important that specific frameworks are developed with the purpose of guiding the whole process from the description of qualifications (linked to the different occupational profiles) to the definition of learning outcomes and attribution of ECVET points, assuring that processes and results are aligned with the common quality criteria as identified by the partners.

4 Annex I

Table 1. European and national projects

Project name *	Description	Country	Project program	Sus **	Bio **	Dig **
ABBEE	The overall objective of this Strategic Partnership is to inspire and train a new generation of (bio-based economy) students and help accelerate the transition towards a bio-based economy via education of future professionals. New innovative educational approaches can inspire students, professionals and entrepreneurs to become more active in the bio-based society. The focus of the Strategic Partnership, ABBEE, is on developing, transferring and implementing innovative practices in the field of bio-based economy and to exchange experiences at a European level. Website: https://www.wur.nl/en/project/ABBEE.htm	EU	Erasmus+		X	
Added value of Agriculture (UWD)	It is widely known that farmers provide the population with valuable food. The many side effects of their work, which are positively visible in social systems as a whole, are often not recognized. This project aims to contribute to make the added value of agriculture visible to society. These added value areas include food sovereignty, green care, nature and landscape protection, local recreation, preservation of culture and cultural landscape, creation and preservation of jobs in rural areas. Website: https://www.umweltdachverband.at/themen/bildung-und-forschung/mehrwert-landwirts	Austria	National	X		
AFarCloud (Mtech)	AFarCloud will provide a distributed platform for autonomous farming that will allow the integration and cooperation of agriculture Cyber Physical Systems in real-time in order to increase efficiency, productivity, animal health, food quality and reduce farm labour costs. This platform will be integrated with farm management software and will support monitoring and decision- making solutions based on big data and real time data mining techniques. The	EU	Horizon2020, ECSEL Joint Undertaking (JU) under grant agreemen			X

	AFarCloud project also aims to make farming robots accessible to more users by enabling farming vehicles to work in a cooperative mesh, thus opening up new applications and ensuring re-usability, as heterogeneous standard vehicles can combine their capabilities in order to lift farmer revenue and reduce labour costs. 60 partners, 1.9.2018 - 31.8.2021. Website: http://www.afarcloud.eu/about-the-project/		t No 783221			
Agrimax (LVA)	Agrimax is an EU-funded project that is developing and demonstrating the production of multiple, high-value products from crop and food-processing waste. The project is also developing economically competitive routes to the commercialisation of these products, using flexible, and possibly cooperatively run processing facilities. The project will maximise the EU's sustainability while providing new bio-based compounds for the chemicals, food-packaging and agricultural sectors. Website: http://agrimax-project.eu/	EU	Horizon 2020	X		
ASKFOOD (LVA)	ASKFOOD aims to create a permanent knowledge alliance between businesses and Higher Education Institutions in the food-related sectors. The ASKFOOD project focuses on the creation of a new «educational» eco-system for innovation and sustainability of the food system by 1) upgrading and modernizing training and educational methodologies by implementing an Open Innovation framework; 2) feeding the innovation and entrepreneurial mind-set of the future generation of graduates in food and food-related studies by piloting acceleration and growth hacking solutions in responses to common and cross-sectoral challenges connected with the food system; 3) developing cross-industry, multisector, transdisciplinary knowledge platforms to promote the knowledge alliance between businesses and HEIs in the food-related sectors, and 4) Improving academia-industry and stakeholders' interplay in a Quintuple Helix innovation model at EU and international level. Website: https://www.askfood.eu/	EU	Erasmus+	X	X	X

Baltic Slurry (ProAgria)	Baltic Slurry Acidification (March 2016 – February 2019) aimed to promote the implementation of slurry acidification techniques throughout the Baltic Sea Region. Slurry acidification techniques (SATs) reduce the ammonia losses from livestock manure and thus reduce airborne eutrophication of the Baltic Sea. The use of SATs provides clear environmental benefits for the region. The use of SATs also benefits farmers by increasing the nitrogen use efficiency of their manure fertilizers and thereby decreasing their dependency on mineral nitrogen. Website: http://balticslurry.eu/	EU	EU union	X		
Cybele (WUR)	CYBELE (Scalable big data analytics for fostering precision agriculture and livestock farming) aspires at demonstrating how the convergence of HPC, Big Data, Cloud Computing and IoT can revolutionize farming, reduce scarcity and increase food supply, bringing social, economic, and environmental benefits. CYBELE generates innovation and creates value in the domain of agri-food, and its verticals in the sub-domains of precision agriculture, livestock and fish farming, as demonstrated by nine real-life industrial cases to be supported, empowering capacity building within the industrial and research community. CYBELE intends to safeguard that stakeholders have integrated, unmediated access to a vast amount of large-scale datasets of diverse types from a variety of sources. The stakeholders are capable of generating value and extracting insights because of the secure and unmediated access to large-scale HPC infrastructures supporting data discovery, processing, combination and visualization services, solving challenges modelled as mathematical algorithms requiring high computing power. Responsible WUR group: Information Technology Group (https://www.wur.nl/en/Research-Results/Chair-groups/Social-Sciences/Information-Technology-Group.htm) Website: http://www.cybele-project.eu	Netherlands	Horizon 2020			X
EcoStack (ProAgria)	EcoStack will develop ecologically, economically and socially sustainable crop production strategies via stacking of biodiversity service providers and bio-inspired tools for crop protection, within and around agricultural fields, in order to enhance	EU	Horizon 2020	X		

	sustainability of food production systems across Europe. Website: https://www.ecostack-h2020.eu/					
Efficiency Check (ZAR)	Within the EIP-AGRI project "Efficiency Check", a modern and practical web application was developed to support dairy farmers in taking targeted measures to improve the economic and nutrient-related efficiency of milk production. By visualizing the relationships between management measures, husbandry conditions, animal health and diseases and their economic effects, the aim is to increase farm managers' awareness of animal welfare and health. Website: http://en.zar.at/Projects/efficiency-check.html	Austria	EIP-AGRI, Austria			X
Fit4Food2030	The overall aim of FIT4FOOD2030 is to support the European Commission (EC) with the development and implementation of the FOOD 2030 research & innovation policy framework, to future-proof the European food systems. The main objective towards that is to create a multi-stakeholder platform – the FOOD 2030 Platform. The FOOD 2030 Platform, connecting stakeholders in the European food system at multiple levels (cities/regions, countries, and Europe), will make Research & Innovation (R&I) policies on Food and Nutrition Security (FNS) more coherent, build competences of current and future researchers, entrepreneurs, policy-makers, and society at large, and raise awareness of FOOD 2030 Website: https://fit4food2030.eu	EU	Horizon 2020	X	X	
Focus on farmers (UOR)	Agricultural technologies and innovations offer significant opportunities to improve the efficiency and effectiveness of farm businesses, through optimized yields, reduced environmental impact, and increased profitability. However, farmer adoption of these technologies is often limited and therefore the benefits are not realized. This project builds on the 2018 EIT -Food Educating for Technology Take-off (ETTO) project, which used students as ambassadors to encourage farmers' adoption of technologies. The 2019 project included the unique recruitment of farmer champions and technology ambassadors (including machinery dealerships) who were trained in relevant aspects of technology and then they became the trainer. Alongside world-leading industry and academic	EU	EIT Food			X

	institutes, the farmer champions and technology ambassadors developed engagement activities where they were responsible for encouraging the wider farming community in the UK/Ireland, Germany and Italy. Website: https://www.eitfood.eu/education/projects/focus-on-farmers					
FOODLAB (GZS)	The FoodLab project (European food business transfer laboratory for stimulating entrepreneurial skills, for fostering innovation and for business creation in the food sector) has developed a project - based learning approach and an entrepreneurial spirit in students, foster interactions between stakeholders in Food and Drink innovation and guide the development of the innovative projects. The FOODLAB project has enabled the setting up of European Food-business Transfer Laboratory supported by a shared web - platform centralizing ad hoc learning and training contents/tool guidelines to create/help future entrepreneurs with dedicated modules to promote interactions with food companies, technical centres or business angels. Website: http://map.aginfra.eu/content/foodlab-european-food-innovation-incubator	EU	Erasmus+	X		X
INNOSETA (UPC)	The main objective of the INNOSETA project is to establish a self-sustaining and innovative thematic network on crop protection and the sustainable use of plant protection products (spray equipment, training and advice) to help close the gap between the numerous European research projects and the use that farmers make of all this. The project promotes the exchange of new ideas and information between the industry, the university and the research centres and the agricultural community so that existing scientific and commercial solutions can be widely disseminated and applied, while identifying the needs of the sector. The aim is to eliminate the gap between the scientific world and the agricultural sector Website: http://www.innoseta.eu	Spain	Csa Spraying	X		
IoF2020 (WUR)	The project aims to accelerate the adoption of IoT in 5 different agri-food sectors, namely: meat, dairy, vegetables, fruits and arable farming. It particularly	Netherlands	Horizon 2020			X

	aims at strengthening the competitiveness of farming and food chains in Europe, and securing sufficient, safe and healthy food to European consumers. The project aims also to consolidate Europe's leading position in the global IoT industry by fostering a symbiotic ecosystem of farmers, food industry, technology providers and research institutes. The project consists of a consortium of 73 partners, led by Wageningen UR. The project is organized around 35 use cases grouped in 5 trials, each focussed on a specific agri-food sector. The information technology group leads a use case on meat transparency and traceability that is part of the meat trial and contributes in the design of generic IoT solution architecture to be used in diverse use cases. Responsible group at WUR: Information Technology Group (https://www.wur.nl/en/Research-Results/Chair-groups/Social-Sciences/Information-Technology-Group.htm) Website: http://IoF2020.eu					
KOC HRANA (GXS)	Project Competence centre for human resource development (KOC HRANA) has been established to soar and develop competences, productivity, creativity and innovativeness of Slovenia agri-food sector. Website: https://www.pgz.si/si/koc_hrana	EU	European	X		X
LIFT (INRAE)	Ecological approaches to farming practices are gaining interest across Europe. As this interest grows there is a pressing need to assess the potential contributions these practices may make, the contexts in which they function and their attractiveness to farmers as potential adopters. In particular, ecological agriculture must be assessed against the aim of promoting the improved performance and sustainability of farms, rural environment, rural societies and economies, together. The overall goal of LIFT is to identify the potential benefits of the adoption of ecological farming in the European Union (EU) and to understand how socio-economic and policy factors impact the adoption, performance and sustainability of ecological farming at various scales, from the level of the single farm to that of a territory. To meet this goal, LIFT will assess the determinants of adoption of ecological approaches, and evaluate the performance and overall	France	Horizon 2020	X		

	sustainability of these approaches in comparison to more conventional agriculture across a range of farm systems and geographic scales. LIFT will also develop new private arrangements and policy instruments that could improve the adoption and subsequent performance and sustainability of the rural nexus. For this, LIFT will suggest an innovative framework for multi-scale sustainability assessment aimed at identifying critical paths toward the adoption of ecological approaches to enhance public goods and ecosystem services delivery. This will be achieved through the integration of transdisciplinary scientific knowledge and stakeholder expertise to co-develop innovative decision-support tools. The project will inform and support EU priorities relating to agriculture and the environment in order to promote the performance and sustainability of the combined rural system. At least 30 case studies will be performed in order to reflect the enormous variety in the socio-economic and biophysical conditions for agriculture across the EU. Website: https://www.lift-h2020.eu/					
NextFood	NEXTFOOD drives the crucial transition to more sustainable and competitive agri-food and forestry systems development by designing and implementing education and training systems to prepare budding or already practising professionals with competencies to push the green shift in our rapidly changing society. NEXTFOOD challenges the linear view of knowledge transfer as a top-down process from research to advice and practice, and supports the transition to more learner-centric, participatory, action-based and action-oriented education and learning in agri-food and forestry systems. The overall aim of NEXTFOOD is an Innovative European science and education roadmap for sustainable agriculture along the value chain from research via fabrication into application. Website: https://www.nextfood-project.eu	Sweden	Horizon 2020	X	X	
NoAW (Inra)	The project is dealing with innovative approaches to turn agricultural waste into ecological and economic assets. Driven by a «zero-waste» society requirement, NoAW aims to apply a circular economy approach to agricultural wastes on a territorial and seasonal scale. The NoAW project	EU	RIA, No waste	X	X	

	considers that mostly unavoidable and continuously generated agro-wastes are a true resource for valorisation. NoAW aims to pave the way for a sustainable agro-waste bio-refinery concept by shifting from a conventional environmental assessment to a nearly eco-design approach where special consideration is given for the environmental impacts of the product and process even in the design phase. NoAW intends to explore the potential of agro-waste to be converted into a portfolio of eco-efficient products which are produced using fewer resources and creating less pollution such as bio-energy, bio-fertilizers, bio-packaging and bio-molecules, in symbiosis with urban waste conversion. Website: https://noaw2020.eu					
OPAL-Life (LUKE)	OPAL-Life aims at mitigating greenhouse gas emissions from agriculture following the principle of sustainable intensification. This means combining environmental benefits, profitability of the farm and social aspects. Started in 2015 until 2021. Website: https://www.opal.fi/en/project/	Finland	LIFE	X		
PEFMED (FIAB)	PEFMED is the largest transnational initiative ever carried out in the Mediterranean space to encourage a pool of companies, from 9 Mediterranean agri-food regional systems belonging to 6 Mediterranean Countries (Italy, Spain, France, Portugal, Greece and Slovenia), to green the own production according to the new EU Product Environmental Footprint method (PEF). The unique next-generation method to assess the environmental performances of a product during its lifecycle. Between 2016-2019, hundreds of companies, LCA specialists, business analysts and national agri-food associations cooperate to foster targeted systemic eco-innovation interventions within industrial clusters, raise the market value of PEF-compliant productions and galvanize the regional Smart Specialization Strategies (RIS3) goals related to innovation in agri-food and industrial production. Website: https://pefmed.interreg-med.eu/	EU	INTERREG MED	X		
PLANET (UNITO)	Green jobs are growing at a double rate in Agriculture than other sectors. However, they	Italy	Erasmus+	X	X	

	require management and maintenance skills to upkeep and maintain RES plants on a daily basis. PLANET action aims to tackle this need, providing training to: - Farmers willing to invest in RES - Owners of RES plant - Advisor and Consultants - Students increasing their employability and mobility The goal of the project is to provide innovative training to farmers who own RES plants or want to invest, with practical and ICT skills in a work-based environment related to the daily management of the plant. The training will also be available for consultants or students as initial vocational training. Website: https://www.erasmus-planet.eu/					
Pro4Bake	Present machinery in bakeries is used to optimize the production process. The reduction of make span and idle time of machines, but also combinations thereof will lead to a higher economic and ecological efficiency, thus, lower production costs for bakeries and lower climate change impact for society. The tool is developed using a flow-shop model, optimized by evolutionary algorithms, digital twins and artificial intelligence procedures. Adaptation to consumers' preferences will minimize food waste, hence, ecological footprint in bakeries, and lead to further optimization of the baking process, product range and amount. Website: https://www.eitfood.eu/innovation/projects/optimization-of-bakery-processes-by-a-computational-tool-together-with-consumer-feedback-to-minimize-ecological-footprint-and-food-waste-2020	EU	EIT Food		X	
ProFuture	ProFuture is a European-funded Horizon 2020 research project aiming to scale up microalgae production and prepare the market uptake of microalgae proteins as ingredients for innovative and sustainable food and feed products. Website: https://www.pro-future.eu/about	EU	Horizon 2020		X	
RACS (MAPA)	Description: The aim of the Project (Red Agraria de Cultivos Sostenibles) is to create a Spanish network of different groups such as Research Centers, farmers, consultants and Associations (NGOs) to exchange experiences related with agriculture and develop an on-line platform to exchange knowledge at National level.	Spain	National Rural Development Program	X	X	

	Website: https://www.redagrariadecultivossostenibles.org/					
REINWASTE (FIAB)	REINWASTE aims at helping Companies from the Food industry and the Agriculture reduce in very drastic ways their own packaging and replace them by recycled plastics. The project sets up a methodology to prevent and minimize their waste and valorise the use of bio-based materials within the products and processes. With the support of three influencing Public and Private Partnerships, three value chains are involved in testing innovative solutions in inorganic waste: horticulture in Andalucía, meat in Sud-PACA, dairy in Emilia-Romagna. External expert teams will cooperate with Companies according to a collaborative and open innovation approach. Innovative solutions are planned to move towards Bosnia-Herzegovina, involving the academic and scientific world. Website: https://reinwaste.interreg-med.eu/	EU	INTERREG MED	X		
REFRESH	REFRESH focused on the reduction of avoidable waste and improved valorisation of food resources. Backed by research to better understand the drivers of food waste, the project supported better decision-making by industry and individual consumers. The project took an innovative, systemic approach to curb food waste through a holistic "Framework for Action". REFRESH built on and went beyond existing initiatives to develop, evaluate, and ensure the spread of social, technological, and organisational insights and practices related to food waste. This was underpinned with guidance to legislators and policy makers to help support effective governance to tackle food waste. Website: https://eu-refresh.org	EU	Horizon 2020	X	X	
SAGRI (AUA	SAGRI "Skills Alliance for Sustainable Agriculture" is a three-year Erasmus+ project. The purpose of the SAGRI project is to provide farmers and agricultural stakeholders with knowledge, skills and competencies in the field of agro-environmental technology for sustainable agriculture. The SAGRI project will allow agricultural workers to acquire the skills, the knowledge and the ability to understand and analyse agro-environmental systems as natural ecosystems modified by human activity.	EU	Erasmus Plus – Knowledge Alliance	X		X

	Website: www.sagriproject.eu					
SDGs Labs	DGs Labs aims to build a culture of collaboration and knowledge exchange between different stakeholders involved in agribusiness and food production with the goal of holistic incorporation of the Sustainable Development Goals (SDGs) into modern business practices of the sector. Over the course of the project, universities, businesses, NGOs and start-up incubators alike will work closely together to accomplish this through 2 main streams: Translating the abstract SDGs into practical business solutions for actors all along the supply chain in the agribusiness and food production sector. Developing innovative methods, tools and co-learning environments for future collaborations. Website: https://sdgs-labs.eu	Austria	Erasmus+ KA	X	X	
SKIN	SKIN is an ambitious initiative in the domain of Short Food Supply Chain (SFSC), which aims to systematize the existing knowledge, fostering demand-driven innovation, building long-term collaboration among European farmers and cooperatives, facilitate stakeholder's engagement and promote innovation through demand-driven research in the short food supply chain domain. Re-connecting the two extremities of the food supply chain, reconciling producers with citizens, stimulating mutual trust and establishing a short chain based on common values on food, its origin and production method. A common base, upon which to build a new community characterised by a multi-faced (geographical, ethical and co-operative) proximity between food producers and society. The ultimate objective is to establish a permanent association of stakeholders, working on the improvement of SFSC's efficiency for the economic growth of the sector for the benefits of European farmers and citizens. Website: http://www.shortfoodchain.eu/the-project/the-project.kl	EU	Horizon 2020		X	
SMARTCHAIN (UHOH)	SMARTCHAIN will stimulate demand-driven innovation in short food supply chains to improve competitiveness and foster rural development using a multi-actor approach. The project is using an interactive innovation model where all actors	EU	Horizon 2020	X	X	

	involved in the project (entrepreneurs and practitioners directly involved in running short food supply chains, representatives of organisations concerned with supporting short food supply chains and a number of researchers with different expertise who specialise in short food supply chains) are working together to make best use of scientific and practical knowledge for the co-creation and diffusion of novel solutions ready to solve practical problems. Website: https://www.smartchain-h2020.eu/					
SUPROMED (EC)	SUPROMED (Sustainable production in water-limited environments of Mediterranean agro-ecosystem) is a new project co-funded under the PRIMA 2018 programme section I Farming Systems, for a period of 3 years. The project started in October 2019 and it is composed of a multidisciplinary team of ten partners from five countries Spain (UCLM, ITAP, HISPATEC), France (SEMIDE), Greece (UTH, 3DSA), Lebanon (DIFAF, ULFA) and Tunisia (INRGREF, INGC). The main objective of SUPROMED is to enhance the economic and environmental sustainability of Mediterranean farming systems through a more efficient management of water, energy and fertilizers. SUPROMED is combining different models and tools: water, energy and fertilisation management models, meteorological and climatic tools in order to develop, implement and validate an end user's IT platform aiming to provide effective advice for more efficient crop management. Website: http://www.supromed.eu/	EU	PRIMA, European.	X		X
SUWANU (UNITO)	Sustainable Water treatment and Nutrient reuse options. Objective Agricultural practices put the biggest pressure on fresh water resources for irrigation (55% of the water use in Europe) and on fertilizer usage. The European farmers face serious problems such as freshwater scarcity and nutrient availability, extreme climate conditions and the growing demand of the increasing population. This results in rising prices for mineral fertilizers and food, risky measures such as untreated wastewater applications on fields, and environmental damages from overexploitation of resources. Even though important local efforts have been made on research activities and initiatives for wastewater treatment	Spain	Funded under: FP7-REGIONS	X		

	and reuse in agriculture, an integrated approach is needed among regions, which are developing such research, incentivizing scientific, governmental and business collaboration within wastewater reuse in Europe and supporting the establishment of common European guidelines and parameters for water and nutrient exploitation efficiency. Website: https://cordis.europa.eu/project/id/319998					
SYNERGIE (CERTH)	In various domains (workplace, home, public spaces) where humans and robots have to work together, wearable devices provide information that can support context recognition and context awareness regarding human subjects (Cifuentes et al., 2014). This awareness can be used for action planning of robots and coordination between robots and humans (Cheein et al., 2015). One of the potential domains for such application is agricultural intensive production systems where operational links in the production and supply chain are seen as emerging areas of human-robot synergetic approaches. The project objective is to develop a knowledge-based human-robot synergistic system for high-value crops (HVCs) handling operations including out-door harvesting and in-door storage in order to achieve an overall improved efficiency in HVCs logistics. Research will be performed along two axes with the aim: (i) to improve human-machine synergy by introducing augmentation technologies to support machine's situation awareness including workers' activities, and (ii) to increase system efficiency by optimising information-based operations planning. Website: https://ibo.certh.gr/project/synergie/	Greece	National			X

* In bracket the acronym of the Coordinating organisation

** Sus = Sustainability; Bio = Bio-economy; Dig = Digitalisation

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