TREE
Micro- and project-based learning programme for Teaching ciRcular Economy and Ecological awareness in VET

Funded by the European Union

TRAINING LESSON 6 - Part 2 (Agrifood sector)

Title	○ **Environmental-friendly practices at the workplace**
Part of the training course referred to in this lesson	□ Part 1 General information about sustainability and CE Part 2 Specific Information about: □ Wood sector □ Plastic sector X Agrifood sector
EQF level	Level 3
Where the lesson was tested	//
General Learning objective(s) according to the Bloom Taxonomy https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/	X **Create** Produce new or original work (design, assemble, construct, investigate, formulate) □ **Evaluate** Justify a stand or decision (appraise, argue, defend, critique, select, support) X **Analyze** Draw connections among ideas (differentiate, organize, relate, compare, distinguish, test, experiment) X **Apply** Use information in new situations (execute, implement, solve, use, demonstrate, operate) X **Understand** Explain ideas or concepts (classify, discuss, describe, identify, locate, translate) X **Remember** Recall facts and basic concepts (define, duplicate, list, memorize, repeat)
Specific learning objective(s)	● To understand various alternative eco-friendly practices for converting agri food waste into useful raw materials. ● To understand the concept of circular economy in the agricultural sector.
Cognitive, socioemotional and behavioural outcomes	**SDG 2 Zero Hunger End hunger** Socio-emotional learning objectives:

	1. The learner is able to communicate on the issues and connections between combating hunger and promoting sustainable agriculture and improved nutrition. **SDG 4 Quality Education** <u>Cognitive learning objectives:</u> - The learner understands the important role of culture in achieving sustainability. - The learner understands that education can help create a more sustainable, equitable and peaceful world <u>Socio-emotional learning objectives:</u> – The learner is able through participatory methods to motivate and empower others to demand and use educational opportunities. – The learner is able to recognize the intrinsic value of education and to analyse and identify their own learning needs in their personal development. – The learner is able to recognize the importance of their own skills for improving their life, in particular for employment and entrepreneurship <u>Behavioural learning objectives:</u> – The learner is able to contribute to facilitating and implementing quality education for all, ESD and related approaches at different levels. 2 – The learner is able to use all opportunities for their own education throughout their life, and to apply the acquired knowledge in everyday situations to promote sustainable development **SDG 7 Affordable and Clean Energy** <u>Cognitive learning objectives:</u> - The learner knows about different energy resources – renewable and non-renewable – and their respective advantages and disadvantages including environmental impacts, health issues, usage, safety and energy security, and their share in the energy mix at the local, national and global level. - The learner knows about harmful impacts of unsustainable energy production, understands how renewable energy technologies can help to drive sustainable development and understands the need for new and innovative technologies and especially technology transfer in collaborations between countries. S**DG 12 Responsible Consumption and Production** <u>Cognitive learning objectives:</u> -The learner understands how individual lifestyle choices influence social, economic and environmental development. <u>Socio-emotional learning objectives:</u> – The learner is able to envision sustainable lifestyles. – The learner is able to feel responsible for the environmental and social impacts of their own individual behaviour as a producer or consumer.

	Behavioural learning objectives: – *The* learner is able to plan, implement and evaluate consumption-related activities using existing sustainability criteria. – the learner is able to take on critically on their role as an active stakeholder in the market.
Green skill(s) addressed	X Creative problem-solving X Forward-thinking X Monitoring skills X Analytical skills X Lean production □ Maintenance and repair skills X Pollution prevention X Eco-design X Management skills □ Impact quantification X Life-cycle management X Science skills X Waste management X Environmental auditing □ Ecosystem management □ Other_____
Duration	15 min.
Structure and content of the lesson	**Introduction** Nowadays, the health and quality of life of the ecosystem is strongly determined by the amount of waste, which is gradually increasing. Agri-food waste can be found along the entire food supply chain - raw material production, industrial processing, distribution, household processing and consumption, with the volume of waste differing depending on the stages and type of food products. A large amount of this waste is immediately disposed of in a landfill (46%) or incinerated (24%). Generally, by-products are simply considered waste rather than being seen as a new resource to be used. Since the waste is disposed of immediately, the inability to obtain economic value from the by-products is inevitable and may cause economic losses. Although some of these wastes can have a positive impact on the environment, for example, organic food waste is the natural fertilizer for plants. Food waste generates methane when it decomposes, which can contribute to climate change in the form of greenhouse gas emissions. In addition to methane generation from decomposing food waste, greenhouse gas emissions can also come from food production and distribution activities in the supply chain. The circular economy concept has been adapted from living systems, which are called feedback-rich systems. The term “feedback-rich" is used to describe living systems because, in nature, there is no waste. In natural systems, when waste is returned to nature, it is further processed by the organism to become resources for other living organisms. An example of this would be the life cycle of animals. When animals defecate or die, their waste or carcasses are processed by bacteria to become nutrients in the soil. Nutrients are used by plants for growth and later plants become food for animals. A similar concept

is the goal of the circular economy, where waste from one process should be used as much as possible to become resources for other processes. Besides reducing the amount of waste, this system will also lead to a sustainable system, the ultimate goal of the circular economy concept.
Globally, the agro-industry generates valuable materials such as agricultural food waste with well-known potential. Conventional food waste management includes the production of compost, energy and bioethanol. Alternative routes include the valorization of food waste as a source of bioactive compounds for use in the food, pharmaceutical and cosmetic industries.
Let's have a look at some Environmentally-friendly practices at the workplace in the agri-food industry.

TOPIC 1. Useful ingredients from agro-food waste (AFW)

Industrial food processing generates specific by-products. Large amounts of peelings, pomace, trimmings, seeds, pits, stems, and leaves are shed from fruits and vegetables. Milling of cereals generates bran, the bean industry produces large quantities of husks, pods and poor quality beans. Peels, husks, skins and shells are the main wastes from the primary processing of nuts and oilseeds.

One of the methods of waste processing is the extraction of bioactive molecules. Drying and size reduction techniques, extraction and fermentation are the main strategies for converting agro-food waste into useful ingredients.

- Drying and size reduction techniques
  Food powders and flours are the simplest form in which AFW can be processed to be incorporated as a useful ingredient in conventional foods. The production of food powders and flours from AFW depends on the aggregate state of the waste, which can be liquid, solid or paste. In case of liquid waste, drying technique is applied, while in case of solid material, the size should be reduced by crushing and grinding, pulverization, granulation and mixing. Wastes from the processing of fruit, vegetables and oilseeds, such as pomace, are usually first dried, then reduced in size.
- Extraction methods
  New environmentally friendly methods, including extraction by ultrasound, extraction by microwave, and fluidic extraction, are used to extract useful ingredients.
- Fermentation and enzyme treatments
  Bioprocesses such as fermentation and enzyme technology are additional approaches for converting agro-food waste into value-added products. Different strains of microorganisms and different enzymes are used for different types of waste. Microorganisms cause the fermentation process and lead to the production of by-products. Enzymes are catalysts that depolymerize plant cell wall polysaccharides to accelerate the release of bound compounds.

TOPIC 2: Production of dietary fiber. They are increasingly used in the food and pharmaceutical industries and show great promise as a potential food additive and/or as a functional food ingredient, important for the development of healthy value-added products.

TOPIC 3: Production of absorbents

Agro-food waste has a low lignocellulosic content. This encourages research to prepare biomass-rich eco-materials as renewable, low-cost and sustainable water adsorbents with wastewater treatment applications. Today, there are many treatment technologies that are applied to reduce water pollution and control environmental quality. The adsorption process is considered the best and cheapest option for wastewater treatment. When using adsorbents from agro-food waste, the cost of the process is reduced even more, and on the other hand, the absorbents will be made of biological materials. Inexpensive adsorbent means a material that is highly abundant in nature or obtained from industry, such as waste with a high capacity for reuse with minimal processing.

TOPIC 4: Production of organic fertilizers.

Organic fertilizer utilizes the organic waste put into it, mainly vegetable and fruit waste. One of the methods is to use black soldier fly larvae. The process is quite simple in theory: the black soldier larvae eat the organic (fruit and vegetable) waste and then the organic waste produced by the larvae is processed to become organic fertilizer. The process of making organic fertilizers using black soldier larvae is faster than the simple process of making organic fertilizers using bacteria. While with black soldier larvae a cake can be produced in 4–5 days, the production of organic fertilizer using bacteria takes up to 7 days. There are various benefits of using this organic fertilizer in agricultural activities, some of them are: it is absorbed quickly and efficiently by plants; because it is an organic fertilizer, it can increase the activity of positive microorganisms in the soil, increase root and stem growth, and also suppress the possibility of plant pests and diseases.

Conclusion

From the examples presented, it is evident that agricultural food waste and by-products provide a wide opportunity for the isolation of natural bioactive compounds with possible potential applications in the food, pharmaceutical and cosmetic industries. The isolation of natural bioactive compounds, pigments, vitamins, oils and others by food enrichment can open a new niche in the food sector (development of new functional foods). Fibers extracted from waste and by-products can find potential applications in the food industry, as a low-calorie filler, useful as a substitute for flour or fat or to improve water and oil absorption, change viscosity and other functional properties of products or as a natural ingredient to provide oxidative stability and increase the shelf life of foods.

The use of agro-food waste and by-products (rich in pectin, fiber, lignin, cellulose and hemicellulose) to produce new biodegradable bioplastics is another area to be explored. Optimizing the processes of isolation, extraction, processing and production of secondary products from agricultural food waste is a sustainable approach and a necessity to address the environmental problems of bio-waste. These methods can underpin the circular economy in

	this sector for zero-waste production.
References	Eurosat, September 2022, Amount of waste recovered increases in 2020 https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20220913-1 Ruth Nattassha , Yuanita Handayati, Togar M. Simatupang and Manahan Siallagan – October 2020, Understanding circular economy implementation in the agri-food supply chain: the case of an Indonesian organic fertiliser producer Understanding circular economy implementation in the agri-food supply chain: the case of an Indonesian organic fertiliser producer | Agriculture & Food Security | Full Text (biomedcentral.com) Ecaterina Matei, Maria Râpă, Andra Mihaela Predescu, Anca Andreea T, 2021, Valorization of Agri-Food Wastes as Sustainable Eco-Materials for Wastewater Treatment: Current State and New Perspectives Materials | Free Full-Text | Valorization of Agri-Food Wastes as Sustainable Eco-Materials for Wastewater Treatment: Current State and New Perspectives (mdpi.com) Manal Hamam, Gaetano Chinnici, Giuseppe Di Vita, March 2021, Circular Economy Models in Agro-Food Systems: A Review https://www.mdpi.com/2071-1050/13/6/3453 Sana Ben-Othman, Ivi Jõudu and Rajeev Bhat 2020, Bioactives From Agri-Food Wastes: Present Insights and Future Challenges https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7037811/
Interactive questions for R3	1. The waste from the agrifood sector can only be used to produce fertilizers and energy. True **False** 2. The concept of the circular economy has been adapted from: **The living systems** Basic economic principles 3. Which of the methods for utilization of agrifood waste was not mentioned in today's lesson? - **Useful ingredients from agri-food waste**

	- Production of dietary fiber - Production of absorbents - Production of biogas - Production of organic fertilizers.
Keywords	Biomass, fiber, absorbent, bioactive substances
Questions for reflection	Give examples of farmers. What crops are grown in the region? Are you familiar with the processing of agricultural waste in the region? Watch the organic waste recovery good practice video from France. Veoaly group, November 2019, Organic waste recovery | Veolia https://www.youtube.com/watch?v=lHyL41grGUo Give examples of farmers. What crops are grown in the region? Are you familiar with the processing of agricultural waste in the region? Watch the organic waste recovery good practice video from Thailand. DW news, January 2020, Thailand: Turning straw into gold | Global Ideas https://www.youtube.com/watch?v=H8kodphRkAc The main building material of plants is cellulose. As we know, clothes made from natural materials, such as cotton for example, have the best hygienic and anti-allergic properties. At the same time, cotton production leads to environmental pollution. Is it possible to turn waste into a resource? Watch the video of this happening in Nebraska. Consider what other products are made from cellulose. For homework, look for good practices for using cellulose from agricultural waste as raw materials for new productions KQED QUEST, 2014, Farm Waste Fashionistas https://www.youtube.com/watch?v=FcaMyWY6gU0
Additional resources	**VIDEOS** ClimateScience - Solve Climate Change, August 2021, Food Waste: The Hidden Cost of the Food We Throw Out I ClimateScience #9 https://www.youtube.com/watch?v=ishA6kry8nc Self Sufficient Me, January 2022, Turn Kitchen Scraps into Compost in Just 90 minutes | Nagual Review https://www.youtube.com/watch?v=axPpw5uPv1I WorlDynamics, November 2019, Agro-food & Circular Economy https://www.youtube.com/watch?v=CzR_ArBQXi0 **DOCUMENTS** European commission, Horizon 2020, May 2019Sustainable techno-

	economic solutions for the agricultural value chain Sustainable food waste reduction solutions bolster our bioeconomy | AgroCycle Project | Results in brief | H2020 | CORDIS | European Commission (europa.eu) Massimiliano Di Mattia, February 2021, VALE Valorization of agri-food wastes for olive oil production VALE Valorization of agri-food wastes for olive oil production | Interreg Europe - Sharing solutions for better policy
Icons & related info for the hints of the PowerPoint presentation	 This hint is used to indicate that there's a link to other websites with additional information.  This is used within the PPT to indicate that something important is written/ to invite the reader to pay attention to essential information.  This hint indicates a question/task for reflection.
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