REPORT ON SUSTAINABILITY IN AGRI-FOOD VALUE CHAINS.

CASE STUDIES FROM THE MEDITERRANEAN REGIONS & THE MIDDLE EAST.

CASE STUDY: BY-PRODUCTS AND WASTE

Mirela: Hello Izabela! In this recording we will focus on agricultural by-products and waste. As we know, they contribute to greenhouse emissions and when sent to landfill they can result in environmental harm due to microbial decomposition. Waste management in agriculture can pose challenges, but it also offers opportunities for new activities. My first question concerns the challenges posed by waste management. Is it sustainable? Which agricultural chains should be more concerned about it?

Izabela: *The generation of agricultural by-products and waste has important environmental, economic, and social sustainability impacts, contributing to greenhouse gas emissions and resulting in environmental problems when sent to landfill due to microbial decomposition and leachate production and, in turn, lead to health impacts. Therefore, the use of waste and by-products in agri-food value chains provides an important resource-efficiency opportunity for contributing to the UN Sustainable Development Goals.*

In the case of olive oil production for example, substantial quantities of waste are produced with high levels of phytotoxicity, with negative consequences on soil microbial populations on land, aquatic environments and air quality. Although there have been some measures and taxes imposed by agricultural services to reduce these practices, the impacts of such interventions have to date been insufficient and inconsistent. There is a critical need for guidelines to manage this waste through technologies that minimise their environmental impact and support sustainable resource use.

Management of agricultural waste is also costly, so realising ways to reduce and effectively manage existing waste streams presents a significant economic opportunity for the agricultural sector. Globally, a third of all food is wasted from the points of production and consumption, but the factors that contribute to it are highly complex and context dependent. Some researchers have gone so far as to state that

“FLW [food loss and waste] realities vary so significantly across regions that they might be thought of as completely separate phenomena, affecting different types of food for different reasons—and even with different consequences.” Although greater attention is being paid to addressing food loss and waste, more investment in empirical research is needed to identify the most appropriate strategies for reducing waste according to context, commodity, and stage in the supply chain. In our case study, we examine waste management challenges and potential solutions in citrus, olive mill and pistachio value chains.

A significant adverse economic impact of by-product and waste production relates to the costs of handling solid waste in landfills. Innovative and resource-efficient uses of food waste and by-products – either as raw materials or food additives – could contribute important gains for industry and deliver nutritional and health benefits, and address these negative economic impacts.

Our review found that an important opportunity for the olive oil industry is the use of by-products for things like pomace oil, cattle feed, biofuel and energy, particle board, fertilisers; and the production of furfuraldehyde, phenols and polyphenols for the pharmaceutical industry and cosmetics. Exploring these options could help provide added value to olive oil production, increasing processing industry margins. It is important to note that the suitability of the use of particular by-products depends on the agricultural products in question, as well as environmental conditions. Therefore, further research, innovation and training are needed to support optimal use of by-products in ways that generate value for agricultural producers.

Mirela: In our case study we provide examples of successful waste management in Mediterranean regions, focusing specifically on citrus, olive mill and pistachio waste. Could you highlight the main points?

Izabela: *Sure Mirela. Our case study examined citrus waste management in southern Italy, olive mill waste management, and pistachio waste in Greece, and we were really interested in the different approaches being taken by producers in these different contexts.*

In southern Italy, citrus waste represents a potentially unexploited resource for sustainable development in rural areas. This waste makes up 50-60% of citrus production volume, and is mainly made up of water, mono- and disaccharides, and some limited amounts of oils in peel waste. The management of this waste is a major issue for citrus processors – the pre-treatments needed before its disposal are really costly, and the essential oils pose environmental risks if not properly treated. Technological innovations that aim to convert potential environmental hazards into a valuable resource have been developed to valorise citrus waste, including pectin extraction, dietary fibre extraction, biogas production, ruminant feed and essential oil extraction. Our review of the research found indicated that one of the main criteria for choosing alternative valorisation pathways is the distance between the citrus processors and the citrus by-products plant. The return from each alternative, such as cattle feed pellets, essential oils and biofuels production, may influence the propensity to invest in a multifunctional plant.

Then, turning to olive mill waste – this is a significant environmental problem in Mediterranean regions, as such waste is generated in vast quantities over short periods of time. Olive mill wastewater has been considered the most polluting and problematic form of waste produced by olive mills in all Mediterranean countries, as high phenol, lipid and organic acid concentrations make waste phytotoxic. However, this waste contains a large proportion of organic matter and a wide range of nutrients that could be recycled and constitute a valuable resource. A range of methods exist for the valorisation of olive mill waste, including second oil extraction, combustion, gasification, anaerobic digestion, composting and solid fermentation. Stone recovery in the olive oil extraction process can provide an opportunity to increase both incomes and environmental sustainability, by improving the quality of extra virgin olive oil and by providing a higher quality stone to be used as a biomass fuel. The most suitable valorisation strategy of course depends on the social, agricultural or industrial environment of a particular olive mill.

We also examined the example of pistachio waste in Greece. Harvested pistachio nuts are covered with organic outer pericarps, that is the hulls, and endocarps, the shells, which are removed during the processes of de-hulling and shelling. In Greece, 7000 tons of pistachio waste are disposed of annually. The dominant waste

management option currently used for hulls and shells is on-farm dumping/uncontrolled disposal, even though this is considered illegal under the Waste Framework Directive. The widespread nature of this approach has been found to be due to the high cost of transport, lack of adequate farm waste treatment facilities, convenience and lack of guidance. But such disposal causes serious environmental problems. There has, however, been considerable attention to the production of compost and biochar from pistachio waste, as a possible strategy for improving soil quality and productivity, sequestering soil carbon and mitigating greenhouse gas emissions. In a 2017 study examining the use of pistachio by-products and waste in Greece, Bartzas and Komnitsas concluded that application of compost and biochar - rather than the use of chemical fertilisers - offers significant environmental benefits. The reuse and recycling of agricultural residues can also provide additional income to farmers due to the achievement of higher yields.

Mirela: Finally, my last question is related to SDG 12: sustainable production and consumption and the concept of circularity. Do you think that efficient waste management can help achieve food security?

Izabela: *Some researchers argue that valorisation of waste streams, and moving to more circular models, can reduce waste accumulation, as well as provide new economic opportunities for farming communities, thus supporting social wellbeing. Furthermore, the generation of food additives from agricultural by-products has been presented as having the potential to malnutrition and hunger in countries of production.*

It think it is really important to note here, that food security is a broader issue of equitable distribution that in certain geopolitical contexts is partially addressed through urgent humanitarian aid, rather than being an issue of adequate by-product use and the need to improve production efficiency. Of course, efficiency improvements can certainly contribute to reducing environmental impacts, increasing value for producers and reducing waste disposal costs, but we found that broader structural conditions and institutional support need to be considered for really securing long-term food security and resilience across agri-food value chains. This is where we need to see more research attention to the interactions between SDG 12

on responsible consumption and production, and SDG 16, on peace, justice and strong institutions – to find ways of ensuring more sustainable global value chains that are sensitive to contexts; and to recognise the need for peace, justice and strong institutions as a fundamental prerequisite for sustainability.

Mirela: Thank you Izabela for introducing us to the case study on by-products and waste management.

Izabela: *Thank you Mirela!*

Mirela: More information and sources can be found in the "Report on Sustainability in Agri-food Value Chains. Case studies from the Mediterranean Regions and the Middle East" which is available on our project website https://agricultural-voices.sussex.ac.uk/.