

SECONDARY USE OF RAW MATERIALS IN FOOD SECTOR ENTERPRISES IN POLAND

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Abstract Circular economy (CE) nowadays has a significant impact on economic development. Reusing by-products is one of the key components of the CE paradigm, particularly important in industries using biological raw materials for production. This subject is widely discussed in many publications in the field of economics, while the practical use is scarcely described. The aim of the study was to verify whether companies operating on the Polish food industry market are re-using by-products for further production, what are the benefits of such an approach and whether it's time for a new way of managing by-products. Computer-assisted telephone interviews were conducted to verify opinions about the cost-effectiveness and competitiveness of enterprises in terms of reusing by-products and closing loop in production. The study covered 100 food industry companies. The most important conclusions are: (1) 92% of companies reuse by-products, (2) CE principles contribute to the improvement of competitiveness and cost-effectiveness, (3) 21% of companies are planning investments that will enable "closing the loop". There are processes in the analyzed sector that indicates increasing interest in implementing the principles of the CE by production companies.

Keywords:

circular economy, circular economy implementation, food waste hierarchy, closed loop, sustainable resource use

1 Introduction

Global human population growth increases the demand for food, which is associated with increasing use and shrinking of natural resources, e.g., water, energy or agricultural land. Moreover, growing consumption increase CO₂ emissions to the atmosphere. The development of the food sector in a sustainable way should reconcile three goals: economic, environmental and social. Reducing the consumption of natural resources is one of the essential elements of sustainable development (EMF, 2015). It is necessary to efficiently manage limited resources. To manage efficiently in sustainable meaning enterprises may implement the principles of the "circular economy" (CE) as a business model (UN, 2019).

The circular economy is targeted at making optimum use of natural resources, raw materials and products and re-using them. This means that all resources are still used in a way that adds the most value to the economy and causes the least damage to the environment. The circular economy aims to use natural resources for longer and as far as possible (Rood et al, 2019, p. 4).

The circular economy nowadays has a significant impact on economic development, more broadly, on the development of civilization. CE is included in many national strategies as well economic one and those for the development of individual industries includes agriculture and the food industry. This subject is widely discussed in many publications in the field of economics, while its use in practice is still scarcely described, especially in the realities of the Polish economy.

Poland is an important producer of food products, not only domestically, but within the EU. In 2019, it was the largest producer of poultry meat and the fourth largest producer of pork in EU (Podstawka, 2020). Moreover, Poland was the largest producer of apples in the EU, second largest producer of rye and oats, and third largest of potatoes, sugar beets and rape (Statistics Poland, 2020). Such large food production generates significant amounts of biological waste, which potentially creates opportunities for optimization and implementation of circular economy concepts (Deloitte, 2018).

2 Literature review

A review of literature on the circular economy in the food sector shows that exist higher and lower value possibilities of reusing natural resources. A circular economy promotes making optimal use and reuse of raw materials and products in order from higher-value to lower-value what is called cascading hierarchy (Cicullo et al., 2021).

Food processing companies may implement operations leading to closing the loop. (Aznar-Sánchez et al., 2020) Levels in the cascading food recovery hierarchy (from most preferable to least preferable), based on Moerman's Ladder: (Rood et al., 2017)

- a) Preventing food losses
- b) Human food
- c) Converted into human food (food processing)
- d) Used in animal feed
- e) Use as raw materials in the industry
- f) Process into fertilizer through fermentation or composting
- g) Applied for sustainable energy: biogas or biofuel
- h) Other energy purposes: incineration

Levels in the hierarchy were the basis for designing the study. Research focused on points C – H, as activities that can be implemented in factories. The hierarchy of operation importance was used in the study as a criterion for evaluating the advancement of enterprises about implementing the concept of the circular economy in the functioning of the enterprise.

2.1 Computer-assisted telephone interviewing

Based on theoretical and empirical micro-foundations, a survey was conducted to understand how Polish enterprises in the agri-food sector manage waste and by-products. The study was conducted using computer-assisted telephone interviewing where interviewers conducted surveys over the phone after prior training. The responders were owners, managing directors and production managers.

The surveys were conducted in 100 companies in Poland producing by-products. Companies were randomly selected from 1832 companies meeting the research assumptions from Bisnode database.

The study covered food industry companies operating in industries with the greatest amount and diversity of biological waste. The survey was conducted among enterprises from the following industries: (i) meat (N=36), (ii) dairy (N=22), (iii) fruit and vegetable processing (N=29) and (iv) cereal processing (N=13). These are significant branches of the food sector in Poland, accounting for 72% of the value sold in enterprises employing over 49 people (EMIS, 2018, p. 8).

As a result of the research, it was found that in the case of 92% of the surveyed companies, by-products are used as raw materials in other processes. The remaining 8% of the surveyed companies do not reuse by-products.

3 Results and discussion

3.1 Hierarchy

It can be concluded that the surveyed food enterprises utilize by-products following the concept of cascade management of biomass apart from human food.

In terms of cascading hierarchy by-products are most often used for animal feed (27%), then for the production of organic fertilizers (21%), as a raw material in other industries (20%), as biogas/biofuel (18%), for food processing (10%) and other energy purposes (4%). This means that Polish companies in the food industry maximize the possibilities of using by-products from their production as raw materials in other types of production, despite human food where is going 10% of by-products.

Analyzing the way of using by-products in various food sectors, the meat industry is the one in which the principles of the cascading hierarchy are best implemented. In this industry, the highest percentage of by-products intended for the most valuable re-use methods (feed production, organic fertilizers and as a raw material in other industries). Also, the fruit-vegetable and cereal processing industry follows the circular economy however high percentage of by-products is used for the production

of biogas and biofuel (less valuable ways of using by-products). Research shows that the dairy industry makes the least use of the by-product management potential. Whey, which is the main by-product in dairy farming, can be used for both food production and animal feeding, but the largest percentage goes to biogas and biofuels.

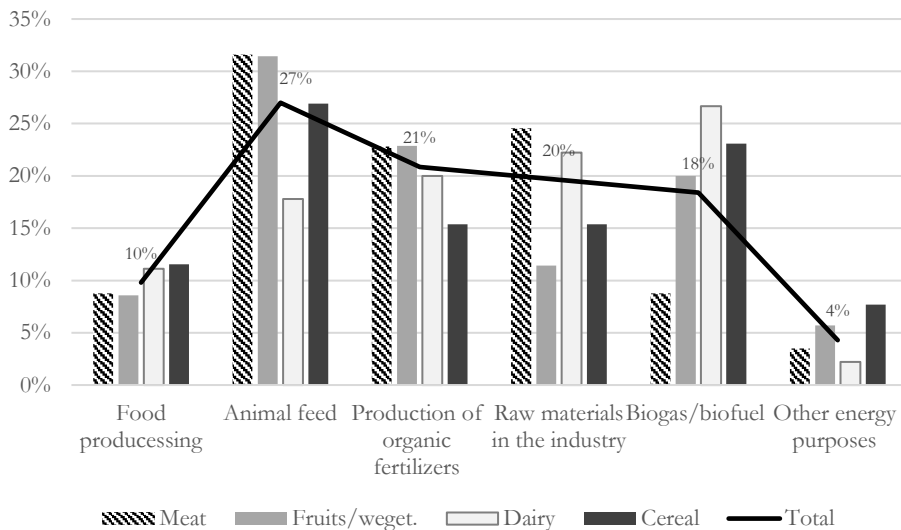


Figure 1: Structure of answers to the question: How the by-products are used? - in sectors

Source: Own study based on the research: "The reuse of raw materials as an element of the circular economy and the possibility of strengthening the competitive position of food industry enterprises", SGH KNOP, Warsaw 2020.

3.2 The place of re-use

In the surveyed companies, by-products are reused mainly outside the production plants in which they are produced. The minority of by-product production plant is a place for its further development. Most of them are sold or processed at the business partner's facility and a significant proportion is given away free of charge. Bones, hooves and whey are mainly distributed for free. The reason for this may be the necessity to carry out investments in the plant, organizational changes or low profitability of processing at the place of production.

The place of by-products recovery is similar across all sectors. It can be concluded that the implementation of the circular economy is the most advanced in the case of the meat industry and the least advanced in the dairy industry. All the surveyed companies in the meat industry recycle by-products and are intended mainly for animal feed (a valuable way of using the by-product). Among the dairy enterprises surveyed, 79% of the remaining dairies use their whey for biogas (a less valuable use of by-products) and 21% utilize whey. Meat industry by-products are easier to reuse as they do not require such advanced technologies moreover are a more expensive raw material compared to whey.

3.3 Improvement of competitiveness and cost-effectiveness

Based on the responses can be inferred that closing the loop brings savings in the production. Respondents mostly agree with the research question “does the implementation of the circular concept lead to savings in production?”. The organizational and production changes that would have to be made to reuse a variety of by-products for production result in savings.

In addition to savings in production, the reuse of raw materials brings environmental effects in the form of less waste, reduction of soil, water and air pollution, and has the opposite effect to the pressure to intensify agriculture, because raw materials are used in a more efficient way. The respondents mostly agree (57%) and strongly agree (31%) with the issue that the activities of the circular economy have a positive impact on the natural environment.

Most respondents agree that closing the loop and introducing the concept of circular economy as a business model increases the competitiveness of enterprises. On the basis of the conducted research, we can conclude that a closed loop improves the competitive position.

The principles of the circular economy were created to protect our planet from excessive waste, but for the implementation of this idea to a large extent, it is necessary that their consequence is the results in the form of effective management of raw materials, savings in production, attractive products, or strengthening the company's image as a socially responsible enterprise.

3.4 Investments

In 21% of enterprises plan to make investments that will enable "closing the loop" means limiting losses in food production, valorization of by-products and their recycling, or management of by-products and other processes. In 36% of enterprises, such investments are considered. More than half of the interviewed companies planning or considering investing in circular economy systems. Such a large scale of phenomenon in the industry indicates the need and great importance of this economic concept, which brings savings and promotes environmentally friendly production.

4 Conclusions and implications

The results of the study show that enterprises are in the process of change and implementation of the circular economy principles in production plants. Food companies do little to re-use their by-products from their plants and transfer very little by-products for human food. This raises the question of whether closing the loop within a single enterprise is economically effective and whether it is possible to use the by-products for more food purposes and more for high-value use. There may be various reasons why this does not happen. It can be the lack of a market or unfamiliarity. It needs to be looking for an application that offers the highest economic value with the least damage to the environment. Also, conflicting goals may be a barrier. The high-value use of residue streams cannot always be reconciled with the legislation on food safety, fertilizers and waste management. For example, bone meal cannot be used in animal feed because of the risk of disease. Moreover, in some cases, lower-value use may be less economically profitable than a higher value. An example can be energy policy. Energy policy aims to encourage sustainable energy and, therefore, the fermentation of residue streams is subsidized. These residue streams, however, could be used more profitably as food, animal feed or as resources for bio-refining, depending on the fermented raw material. To promote a circular food production system the government plays an important role by facilitating cooperation, as well as encouraging innovation and data transparency on residue streams also weighing up the different goals (Rood et al., 2018, p. 24).

According to research, the implementation of the principles of the circular economy is becoming increasingly important for food production plants. This confirms that the principles of the circular economy are an important issue in the contemporary food industry

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