

**JUDIT NAGY<sup>1</sup> AND ZSÓFIA JÁMBOR<sup>2</sup>**

## **COMPETITIVENESS IN FOOD INDUSTRY: THE ROLE OF INDUSTRY 4.0**

### **Abstract**

The food and drink industry are the largest manufacturing sectors in Europe in terms of jobs and value added. The industry is rather concentrated and in such circumstances, it would be very important to know what are the competitive advantages of the manufacturers, what can less developed countries learn from the corporate practices of the more advanced countries. Within the food industry, research into the dairy industry has been reduced. The aim of the researchers is to explore the position of Hungary among the major dairy producers and define, what to learn, what technology should be developed - especially with regard to the opportunities offered by digitization - to increase the competitiveness of the Hungarian sector. The study uses two methodologies. On the one hand, it explores the areas and solutions of digitization technology in the dairy industry in detail through literature analysis. On the other hand, interviews has been carried out with Hungarian players in the industry to explore the possibilities of using these modern technology solutions at companies with different corporate backgrounds, and in companies of different size.

**Keywords:** Industry 4.0, digitalization, human resource, food industry

**JEL Codes:** L23, L66, O33

### **1. Introduction**

There are 600,000 dairy farms in the European Union and together with the 12,000 milk processing companies they produce 15 percent of the EU's agricultural production value. One quarter of global milk production is also processed in this region, and European milk consumption is three times the world average. 87% of dairy products produced in the EU are also delivered to consumers within the Union (Lemoine, 2016).

In world trade, dairy products represent a low proportion, as typically the milk produced in a country is consumed within the country, but their share of consumption is steadily increasing with the expansion of a healthy lifestyle and their role is expected to continue to grow. The biggest growth is expected in the developing countries, India and China (4-5%), while in the developed world only 0.8-1% growth is expected in the forthcoming decades (European Committee, 2018).

In this study, we analyse the literature and the content available on the Internet, in order to assess the potential of Industry 4.0 for dairy companies. In the first chapter, we review the European situation of the sector and then deal with the role of the Hungarian dairy sector and its changes in recent decades. We analyse the competitiveness of the European and Hungarian dairy industry by analysing the World Bank WITS database. We uncover the shortcomings that cause the competitive disadvantage of the Hungarian dairy industry. In a separate chapter, we are dealing with the issue of Industry 4.0 and the possibilities that the technological achievements could successfully ensure in the dairy industry. In the results section we summarize our findings and in conclusions we make our suggestions on the possibilities of technological development of the sector and outline further directions of research.

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## **2. Dairy industry in the European Union and in Hungary**

### **2.1. Dairy industry in EU**

According to data from WITS (World Bank World Integrated Trade Solutions), Germany, the Netherlands, France and Belgium were the largest European dairy exporting countries between 2012 and 2017. Cheese, butter, cream, liquid milk and fresh dairy products are the most sought products in the European Union, if we regard the product level (AHDB, 2016). A significant part of EU dairy production is realized in Germany and in the Baltic Sea countries, with a production volume of 37.4% and 31.4% of sales in 2012 (Jansik et al., 2014). 42% to 43% of the world's cheese production is also linked to the European Union, which is the market leader in the world, while the share of EU products in the other segments is declining due to the dynamically growing dairy production in the developing countries (Tacken et al., 2009). Achieving competitiveness by EU it has a key role to achieve economies of scale, produce high value-added products and accumulate innovation and knowledge. (Poppe, 2008). The TOP 10 dairy exporting countries in EU cover a very large part of the region's total production (91%, between 2012 and 2017). Between 2012 and 17, Germany, the Netherlands, France and Belgium were the largest European dairy exporting countries, and the top three countries already cover more than 50 percent of total production. Hungary contributes to European performance with a stable 1 percent export value. It is worth highlighting Poland, as the only Central-Eastern European state to be included in the TOP 10 list. Due to the high export concentration value mentioned above, we will focus on the analysis of the EU's TOP 10 dairy exporting country and Hungary (WITS, 2018).

### **2.2. Hungarian dairy industry**

The operation of the Hungarian dairy market has been determined by two events over the past thirty years (Dairy Association, 2013): on the one hand, due to the political and economical system change, actual product prices were set by the actual production costs instead of the regulated prices until then, resulting in a significant price increase and resulting in that in 1995 per capita dairy consumption fell to a historic low (Kürthy et al., 2016). On the other hand, with the accession to the European Union, the market faced another challenge with its strong international competitors through its uninterrupted products. All this resulted in a strong concentration of the industry (Kürthy et al., 2016).

Although numerous major international dairy companies have purchased smaller or larger shares in old Hungarian dairy companies, the dairy industry still has difficulty in catching up with the technological and productivity levels of EU member states with a more advanced dairy industry (Dairy Association, 2013). As raw material costs account for 70-80% of the cost of products in the dairy industry, energy costs account for another 5 to 15% (Kürthy et al., 2016). Until 2012, the Agricultural Rural Development Agency granted investment aid of HUF 78.8 billion to 366 plants. Most of them started in the first half of 2013. Investing companies were typically big employers, with large-scale production and sales volumes that were able to secure self-sufficiency and have a viable vision for market survival (Dairy Association, 2013). Developments are even more necessary because the efficiency and financial indicators of the Hungarian dairy sector reflect poor performance (Kürthy et al., 2016).

Besides the domestic market, the competitiveness of the dairy industry of a country is also influenced by the trade with foreign markets (Bojnec and Fertő, 2014). After joining the EU, the export of Hungarian dairy products increased almost fourfold, but the processing level of these products was quite unfavourable, in 2014 almost two-thirds of exports were raw milk, cheese and fresh cheese (30.9%) and other processed products (9.5%). The main destinations for raw milk are Italy, Romania and Slovakia, while the Italian market was also the main target in cheese exports, but the sector also exported significant quantities to Arab countries (Kürthy et al., 2016).

Hungarian milk production, although able to cover the country's needs, cannot offer wide range of products that can serve the varied needs of the domestic consumer. Due to this, the import significantly exceeds the export value, and the imported, high value added processed dairy products (mainly cheeses, dessert preparations and butter products) cause a negative balance of 33 million euros in 2014 (Dairy Association, 2013; Kürthy et al., 2016).

### **2.3. Competitiveness in dairy industry**

The dairy industry is a significant sector of the manufacturing industry, with a strong competition between players on both national and international markets. The competitiveness of a country's dairy industry is largely determined by the structure of the industry, the number, size and geographical distribution of competitors, the ownership structure and the cost of production resources (Jansik et al., 2014). The competitiveness of the dairy industry can also be measured through market performance, which should be distinguished in two directions: domestic demand and exports (Bojnec and Fertő, 2014). The stability of market positions occupied by companies in the domestic market also predicts the ability to compete with imports in both price and product range. Generally speaking, the larger internal market allows companies to achieve economies of scale and financial stability, which increases the likelihood of foreign market success (Jansik et al., 2014). Smaller dairy companies in smaller countries are constantly struggling to achieve economies of scale, which either intensify competition and lead to high concentration on the market or force operators to export.

Competitiveness, interpreted at national level, is deeply rooted in the theory of international trade, which deals with the question: why the different nations are trading with each other. Among the answers to this question, Ricardo's (1817) theory (the theory of comparative advantages) has been most influential, according to which countries should focus on the production of goods with comparative advantages.

Based on Ricardo's theory of comparative advantages, Balassa (1965) created an index (Balassa index) which was designed to measure the comparative advantage. However, there are different methods to measure competitiveness, just think about competitiveness indices of World Economic Forum or World Bank. As the study focuses on trade-based macro-competitiveness, we have chosen the Balassa index, which is able to capture competitiveness through commercial processes.

The study is based on the manifest comparative advantage index developed by Balassa (1965), which is structured as follows:

$$RCA_{ij} = \left( \frac{X_{ij}}{X_{it}} \right) / \left( \frac{X_{nj}}{X_{nt}} \right) \quad (1)$$

where we determine the share of a country's exports of a given product ( $X_{ij}$ ) compared to its total exports ( $X_{it}$ ), then compare it with the proportion of exports ( $X_{nj}$ ) and total exports ( $X_{nt}$ ) of a reference group of countries from that product. If the RCA index is higher than one, the given country has a comparative advantage in the given product compared to the reference countries if it is less than one, it is competitive disadvantage. In the course of our study, the competitiveness of the European Union and Hungary's dairy industry was analysed using the above index, the results are presented in Table 1 below.

**Table 1. Balassa index values for EU TOP10 dairy exporter countries and Hungary between 2000-2017**

Country	2000-2005	2006-2011	2012-2017	2000-2017
Germany	0.98	0.93	0.88	0.93
The Netherlands	1.21	1.08	1.29	1.19
France	1.48	1.67	1.73	1.62
Belgium	1.39	1.21	1.35	1.32
Italy	0.46	0.52	0.64	0.54
Denmark	2.56	2.13	2.02	2.24
Poland	0.72	1.24	1.03	1.00
Ireland	1.25	1.54	1.43	1.41
United Kingdom	0.56	0.55	0.55	0.55
Austria	1.33	1.15	1.09	1.20
Hungary	0.12	0.36	0.38	0.29

Source: Own calculations, based on WITS (2018) database.

The results show that the ranking of the most competitive countries (Denmark, France, Ireland and Belgium) is not fully aligned with the order of the largest dairy exporters (Germany, the Netherlands, France and Belgium). Looking for the reasons for this, we see a tendency showing that the highest customer value can be achieved by producing high-end products (Poppe, 2008; Dairy Association, 2013) and the countries, good at this (like France in skimmed milk and yogurt, Ireland in skimmed milk and butter, Belgium in cream, sweetened milk and other processed cheeses) (WITS, 2018), specializing in the production of one or a few of these products.

## **2.4. Industry 4.0 technologies for dairy industry**

The fourth industrial revolution is based on digitization and data, the computer is just a tool. The source of the competitive advantage can be not only the coordinated production (eg automation, robotization), but also that company will able to filter out the relevant information from the generated data to support decision-making (Nagy et al., 2018). These technological solutions offer many opportunities to support the processes of milk production, processing and sales (Vervesys, 2016).

To support dairy production, many precision farming or smart farming solutions are available (e.g. drone stock observation, milking robot application) (DMIGB, s.a.), but these are not the subject of this paper. Real time data, sharing on the expected quantity and quality of milk coming from the farm can provide opportunity for more efficient operations and production planning. It is possible to ensure the continuous operation of the plant and to balance the processes.

During the processing - as the raw material and the end product are both perishable - the well-organized, continuous control of the production and logistics processes, and the constant monitoring of quality are critical issues, which can be ensured by sensors and e.g. smart applications on packaging.

Modern digitalization solutions can support sustainability goals and serving consumer trends for example by ensuring that the extensive tracking and tracing of raw materials and auxiliary materials contributes to the growth of food safety, serving the quality and safety needs of the customers towards food products. Modern equipment is energy efficient, which can result in a significant cost advantage for the company due to the low profit rate of dairy products (Peternell, 2016). On the other hand, in the case of products that require a cooling chain, a device must be provided to check that the cooling chain has not been broken for a longer period than is allowed to prevent the product being placed on the shelves in inappropriate quality (Kroll, 2015).

The following chapters compare the characteristics of the market and the technology options, and then deduce the consequences.

### 3. Results

High-value-added products from the European Union's dairy countries are challenging for Hungarian dairy processors. Market changes clearly point to the direction of further increase in processed dairy products (Dairy Association, 2013), so Hungarian producers have to move towards highly processed products. As Kürthy et al. (2016) point out, there are success products that are competitive on foreign markets (cheese, fresh cheese), but significant technological and capacity investments are needed. At the same time, Kürthy et al. (2016) draw attention to a worrying trend. The processors interviewed during their survey do not understand how the lack of cost-effective production resulting in cost disadvantage and out-of-date machines hinder them on international markets, and some have no need for advanced technology. The results we disclose present the positions in the competitiveness ranking at the country level, and there is also an opportunity at the product level to show which countries have the comparative advantage in which product (s). In this research we revealed that all the countries of the European Union are able to present at least one dairy product with a competitive advantage, including Hungary, for low-fat raw milk. At the same time, the result is that raw milk is sold abroad by producers at low purchase prices - typically to Italy, Slovakia and Romania - and then re-imported in processed form.

At the same time, technological solutions offer the opportunity to develop a broad spectrum of milk production and processing, some of which will become a basic requirement for customers and consumers after a while (full traceability). Not only can production benefit from the data gathered through technological tools, but economic activity becomes more transparent, more controllable, and the sources of inefficiency become apparent.

### 4. Conclusions

In order to ensure the stable development of milk processing in the coming years and to serve the higher growth in developing countries, milk-producing countries should be prepared to increase their capacities. Increasing customer expectations on the market also mean that products should be highly processed, and our results show that higher-end products are key to competitiveness.

Due to the high concentration of the dairy industry in Hungary, investments in industrial technology can be conceived mainly by large, strong players. However, for both large and SMEs, it is possible to use Industry 4.0 solutions in supportive processes: preventive maintenance, planning and warehouse processes. Because products need to be traceable from a food safety point of view, their supply with identifiers has been incorporated into the production process in most places. The use of these identifiers to track warehouse or transport inventory can also help optimize logistics processes. The cost of this can also be borne by an SME, and automation and robotization can be the next step.

We will continue our research in a practical direction. After processing the reviewed literature and technology descriptions, we are looking for dairy companies to explore whether they have started, either consciously or not, digitalisation. We would like to look for both large and SME sized companies and we would like to prepare a comparative analysis in a case study, which may serve as a benchmark for Hungarian industry players.

## References

- Agriculture and Horticulture Development Board (AHDB) (2016). Average milk yield. Accessed: 12.10.2018. URL: <https://dairy.ahdb.org.uk/market-information/farming-data/milk-yield/average-milk-yield/#.W8BqnmgzaUl>.
- Balassa, B. (1965). Trade Liberalization and Revealed Comparative Advantage. The Manchester School, 33, 99-123.
- Bojnec, Š., & Fertő, I. (2014). Export competitiveness of dairy products on global markets: The case of the European Union countries. *Journal of dairy science*, 97(10), 6151-6163.
- Dairy Association (2013): A magyar tejágazat helyzete és fejlődésének lehetséges iránya (The situation and possible direction of development of the Hungarian dairy sector), Hungarian Dairy Association, Budapest.
- DMIGB (s.a.): Technology in diary farming: how new gadgets are changing the game. Accessed: 23.07.2018. URL: <http://www.drinkmilkinglassbottles.com/technology-in-dairy-farming/>.
- European Committee (2018). Short-term Outlook for EU agricultural markets in 2018 and 2019. Accessed: 12.10.2018. URL: [https://ec.europa.eu/agriculture/markets-and-prices/short-term-outlook\\_en](https://ec.europa.eu/agriculture/markets-and-prices/short-term-outlook_en).
- Jansik, C., Irz, X., & Kuosmanen, N. (2014). Competitiveness of Northern European dairy chains. MTT *Agrifood Reseach Finland*, Paper No.116.
- Kroll, K.M. (2015). The diary supply chain: from farm to fridge. Accessed: 20.07.2018. URL: <https://www.inboundlogistics.com/cms/article/the-dairy-supply-chain-from-farm-to-fridge/>.
- Kürthy, Gy., Dudás, Gy., Felkai, B.O. (szerk.) (2016). A magyarországi élelmiszeripar helyzete és jövőképe (The situation and vision of the food industry in Hungary). Agrárgazdasági Kutató Intézet.
- Lemoine, R. (2016). European dairy sector rising to all challenges, *Revue Laitière Française*, 767, 1-12. Accessed: 23.07.2018. URL: [https://www.rlf.fr/reussir/fichiers/107/JYE21Y0F\\_1.pdf](https://www.rlf.fr/reussir/fichiers/107/JYE21Y0F_1.pdf).
- Nagy, J., Oláh, J., Erdei, E., Máté, D., & Popp, J. (2018). The Role and Impact of Industry 4.0 and the Internet of Things on the Business Strategy of the Value Chain—The Case of Hungary. *Sustainability*, 10(10), 3491.
- Peternell, C. (2016): Interview mit Herrn Christoph Peternell, COO der Hochdorf-Gruppe. Accessed: 30.07.2018. URL: <http://www.acs-ag.com/aktuell-erfahrungsberichte-interview-mit-herrn-christoph-peternell>.
- Poppe, K. J. (2008.): Regulation and competitiveness in the European dairy industry. LEI Wageningen UR. Accessed: 25.07.2018. URL: <http://ec.europa.eu/DocsRoom/documents/3363/attachments/1/translations/en/renditions/pdf>.
- Ricardo, D. (1817). The principles of political economy and taxation, New York: Macmillan, 1909.
- Tacken, G. M. L., Banse, M. A. H., Batowska, A., Gardebroek, C. (2009). Competitiveness of the EU dairy industry. LEI Wageningen UR. Accessed: 28.10.2018. URL: <http://edepot.wur.nl/10766>.

Vervesys, (2016). Trends and technology adaptation in dairy industry. Accessed: 30.07.2018. URL: <http://blog.vervesys.com/trends-and-technology-adoption-in-dairy-industry/>.

World Integrated Trade Solution (WITS) database (2018). World bank. Open databases. Accessed: 20.07.2018. URL: <https://wits.worldbank.org/>.