
Determinants of Innovation in Dairy Farms in Poland

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Abstract:

Purpose: The article aimed to present the conditions for introducing innovations in Polish farms. Due to the diversity in agricultural production, this research's focus was narrowed down to the group of farms specializing in milk production.

Design/Methodology/Approach: The analysis – alongside the literature review - was conducted using primary data collected through surveys carried out amongst 1047 milk producers operating in Poland. The selection of the sample was planned so that the study's outcomes could be generalized and applied to the entire population of milk producers.

Findings: The research results have shown that various factors influence the modernization of farms specializing in milk production. As the most important, respondents indicated streamlining the work (making it more comfortable) on the farm, this was rated at 0.519. The next factor was an improvement in the quality of milk produced (0.499), increase of production efficiency (0.490), and compliance with animal welfare requirements (0.469).

Practical Implications: Technological changes related to the introduction of innovations in farms are mainly of an exogenous origin. In principle, it is not observed that farmers carry out their research self-activities; in the vast majority of cases, the innovations are made in a non-agricultural environment.

Originality/Value: The effect of innovations, which are introduced on farms, are firstly material effects - boiling down to the modernization of the farmer's work environment, and secondly - changes in the volume and structure of production that can lead to the generation of higher income from agricultural activity.

Keywords: Innovation, farms, milk production, Poland.

JEL classification: Q00, Q12.

Paper Type: Research article.

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1. Introduction

The interest in innovation and innovation processes has not lost its importance since Schumpeter proved their importance as a factor in enterprises' development and competitiveness (Antonelli, 2002). According to Schumpeter (1960), the essence of competitiveness comes from innovative activity. Currently, innovation is considered a way of increasing industries and economies (Popławski, 2006).

Innovation is one of the leading, next to knowledge, trust, and entrepreneurship, the paradigm of modern enterprise management, which enables competitive advantage and market success. At the time of continuous changes in the global economy and the changing expectations of customers, innovation not only allows the company to sustain itself in the market but, most importantly, allows for its development. The implementation of innovations in new products, modern technologies, more efficient organizational methods, and different forms of communication with the customer allows a company to win new markets, get more customers, and increase profit. The positive effects of this for individual regions and the entire country, including reducing the level of unemployment, changes in the structure and size of consumption, increased GDP, and improved the socio-economic situation.

In a globalized economy, each sector, including the agri-food sector, is under the influence of global processes and development trends; this also applies to innovation. However, it should be acknowledged that agriculture is a specific sector. Diederer *et al.* (2003) noted that agri-food is an example of a supplier-dominated sector, which is made up of multiple farms, most of which produce a relatively homogeneous production used in agri-food processing. This aspect, only to a minimal extent, has an impact on entrepreneurship and innovation. Individual agricultural producers do not have resources and are not big enough to invest in research and development to benefit from it later. Therefore, the motivation to develop innovativeness is low. Consequently, technological changes in agriculture mainly occur through diffusion, absorption, or market adoption of innovation generated elsewhere, e.g., by commercial suppliers of agricultural equipment or products such as seeds and fertilizers, or by public research and development centers (Instytut Ekonomiki Rolnictwa, 2016; Diederer *et al.*, 2003).

Innovative changes in agriculture, especially in developing countries, would not be possible without institutional changes (e.g., agricultural reform, reorganization of property relations, institutional protection of tenants, and existence within economic groups), which contribute to the practical and quick modernization of farms. The quality of information and its distribution play an important role here. The distortion of market (price) information, e.g., by protectionist policies, leads to disruption of adaptation processes and incorrect distribution of resources.

The process of innovation development in the agri-food industry evolves with the changing vision of agriculture and rural areas. Until recently, the focus was almost exclusively on searching for and implementing technologies leading to agricultural

productivity growth. With time, it was found that the intensification of production – stemming from technological changes - hurt the environment. This justifies the growing interest in the idea of sustainable agriculture, which puts production, economic, environmental, and social goals on an equal footing (Prandecki, 2017). Regarding agriculture, the need to respect the principles of sustainable development is critical because it intensively utilizes natural resources, affects ecological systems and the socio-cultural aspect of rural areas (Czyżewski and Guth, 2016).

The analysis of innovativeness of the agricultural sector should consider the heterogeneity of directions in which production is going. Many factors determine the direction of production on a farm, such as geographical location, resources, climatic and natural conditions, whereas the selected production direction (specialization) is the one that determines the implementation of innovative solutions. For this reason, it was decided that this study will focus on just one direction of agricultural production - milk production.

Poland has a long-standing tradition of breeding dairy cattle. Before 1989, state-owned farms had the relatively best dairy herds. However, the vast majority of cattle were raised on small family farms. These were usually small herds, which did not allow effective implementation of biological progress, technical and technological. The systemic changes in Poland after 1989 led to essential changes in the area of milk processing and consequently forced rapid changes in cattle breeding. There was a significant concentration of production, fast technological and technical development of farms (Belitz *et al.*, 2009; Kowalska *et al.*, 2020). The raw material quality has improved significantly, which was extremely important from the point of view of a consumer and processing plants (Sycheva *et al.*, 2019). As a result, Polish farmers in milk production have been steadily closing the gap between them and the best-performing dairy farms in the European Union. Innovation in dairy farms is significant, and as Chindime *et al.* (2017) stressed in their work, based on the example of farms in Malawi, to implement innovation more efficiently, there is a need for more efficient social networks, access to knowledge, input, and foreign sources of financing for agricultural activities.

2. Material and Research Methods

The activity of farms in undertaking innovative solutions is determined by external and internal conditions that affect their functioning. However, these conditions are defined by factors that may have a diverse impact (stimulating or de-stimulating) and uneven strength on the intensity of innovative actions undertaken by farmers.

The article aimed to present the determinants of introducing innovations in Polish farms specializing in milk production. In addition to the literature review, the article's primary source of knowledge was the results from own surveys that covered 1047 Polish milk producers. The surveys were conducted between 2015 and 2016. When selecting the research sample, the survey was designed so that conclusions can be generalized to the entire population of milk producers. To capture a broader and more

comprehensive view of determinants of innovation on farms, many survey questions allowed for multiple-choice responses. When assessing the importance of factors stimulating and de-stimulating the introduction of innovation on their farm, farmers used 1-5 Likert scale to assign adequate importance of a given factor, where: 1 meant a shallow level, 2 - low, 3 - average, 4 - high, 5 - very high.

This article applies the validity indicator used by Kola, Kujawka, and Kuzel (2005) to analyze information collated. The indicator was calculated according to the following equation.:

$$W = \frac{\sum_{i=1}^k n_i w_i}{k N}, \quad (1)$$

where:

W – validity indicator

i –rating index

n_i –number of indications of a given factor on the i -th place

k –maximum rating on a scale from 1 to k

N –of respondents who answered the question

w_i –the rating corresponding to the place of factor i (the indicator takes values from 0 to 1, the higher value, the more important the factor is)

The calculation of the validity index was necessary to indicate the position of a given factor in the hierarchy of importance.

3. Results and Discussion

Introducing innovations in farms is unique because, in this case, it is difficult to talk about creating solutions on one's own. Although there are signs of creativity and inventiveness of farmers undertaking innovative activities, they are rare. This is confirmed by the survey results, as less than 1/4 respondents introduced changes in their farms initiated by farmers themselves. A farmer endowed with inventiveness sees the possibilities of introducing novelties faster than others, seeks changes, and applies them to his business. Thus, it contributes to the creation of new values of a material or intangible. More often, however, changes made on a farm are introducing solutions that arise in the agricultural environment.

The research results lead to the conclusion that the changes associated with the modernization of production introduced in farms specializing in milk production were primarily of an investment nature. Investment activities carried out on farms are a symptom of farmers' active attitude to adapt to changing environmental conditions. The process of investment implementation is often preceded by searching for and gathering information on new solutions. The risk of introducing innovations is also assessed.

The highest position in the hierarchy of importance of the factors that prompted the respondents to introduce innovations (Figure 1) was streamlining the work (making it more comfortable) on the farm. This factor weighted indicator 0.519.

Undoubtedly, work on the farm is not easy; it requires much commitment and physical strength and is carried out under unpredictable fluctuations. This variation of determinants and the related uncertainty of the farmer's activity results, among others, from changing weather conditions, market changes, changes in the institutional environment. It should be emphasized, that the indicated streamlining of the work in dairy farms was most often associated with modern machines and equipment in the production process.

The results obtained are consistent with those of other authors. They also pointed out (Józwiak *et al.* 2010) that Polish dairy farms, in order to streamline the production, made investments in, among others, mechanical milking machines, tanks for cooling and storing milk, which not only made farmers' work more comfortable but also had a positive impact on the quality of the production. Given the research results, the improved quality of produced milk was ranked second in the hierarchy of importance of factors stimulating the surveyed farms' innovativeness. This factor weighted indicator 0.499.

The stimulation of dairy farms' innovation, as necessary (weight 0.490) as the improvement of milk quality, increased production efficiency. New technologies in dairy farms are used, among others, to conserve green fodder. Therefore, the losses of these goods due to weather conditions contribute to the increase of milk quality.

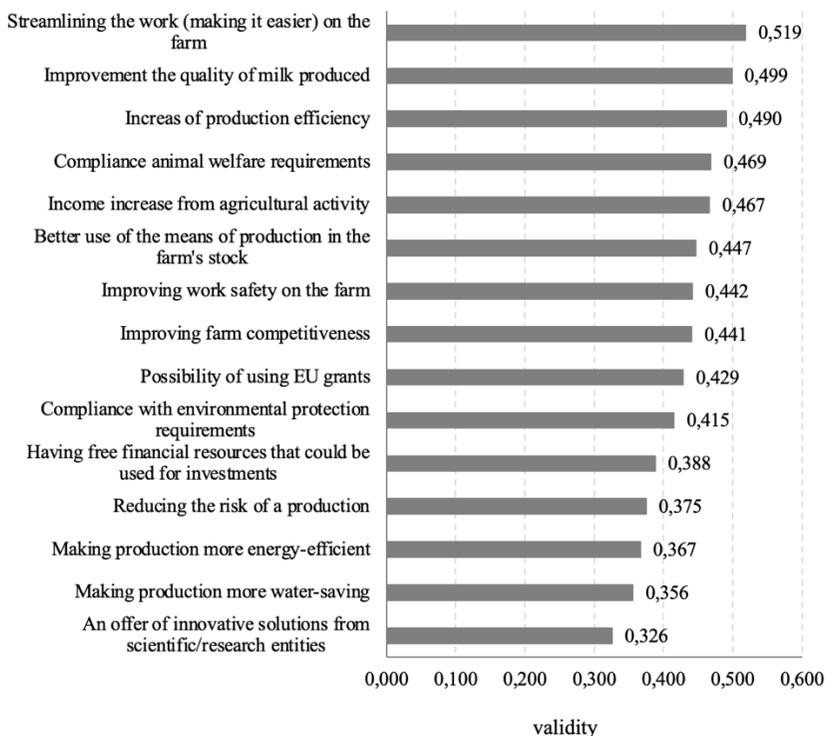
The lowest weights among the factors stimulating innovation implementation were obtained: making production more energy-efficient (weight 0.367) and more water-efficient (weight 0.356). Although water is an essential factor of agricultural production, both in plant and animal breeding, the answers' structure suggests that Polish milk farmers - although they should - still do not care enough about this resource's economic management.

In the classification of renewable water resources, Poland is in 179th place among the countries of the world. Therefore, an essential issue in this country's water management is to increase water resources while using them more efficiently. This is an imperative resulting from both the current state of affairs and unfavorable forecasts for the geographical region where Poland is located regarding global climate change (it will be warmer and less rainfall) (Jankowiak and Bienkowski, 2011).

Farmers' awareness of the need to use water sparingly is expected to grow. According to the data published by Copa-Cogeca, climate change, which increasingly often results in extreme weather events, will aggravate water availability problems. Therefore, it is necessary to mobilize means, including mainly intangible ones (organization, new technologies, new varieties, education), to use the potential,

practical productivity of agriculture in conditions of water deficits (Jankowski, Bienkowski, 2011).

Figure 1. Factors stimulating the introduction of innovation in Polish dairy farms



Source: Results of own research.

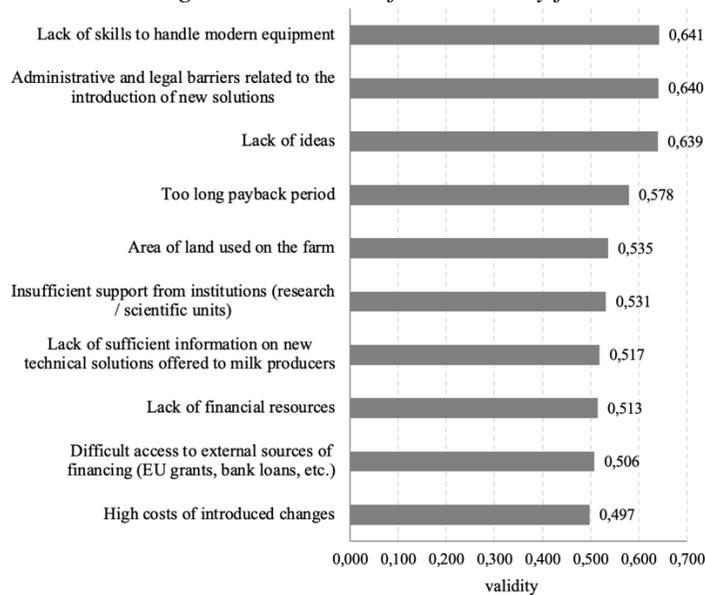
A modern farm's functioning is also directly connected with the need to cover the growing demand for energy, especially electricity. As Wójcicki (2006) points out, the need to respect energy (and the natural environment) results from the fact that the primary reserves of coal, oil, and gas are depleting, and their consumption is growing dynamically. Moreover, the combustion of solid, liquid, and gaseous fuels emits carbon dioxide and other gases into the atmosphere, so the concentration of greenhouse gases and local pollution increases. It is also important to note that fuel and energy prices are on an upward trend. Therefore, farmers should look for new solutions. One of them is renewable energy sources, but the development of these sources should focus less on burning biomass and more on obtaining solar, hydro, geothermal, and other unconventional energy.

The lowest weight (0.326) in the hierarchy of factors stimulating innovativeness of the surveyed farms was given to innovative solutions by scientific (research) units. This may indicate low commercialization of scientific research results in Poland. Looking for the reasons for this state, Sieniewska (2014) observed that the interest of the R&D sector in implementing new technological solutions into business practice

is relatively low. There is also a lack of innovative culture. Meanwhile, when building a knowledge-based economy, it is necessary to effectively use the scientific community's intellectual and technological resources, especially that the potential of knowledge and innovative solutions generated at universities is enormous.

The process of implementing innovations is not easy and requires the farmer to confront many adversities. Factors hindering innovativeness may concern different aspects of innovation activity and may have heterogeneous origins and character (Jasiński, 2014). The analysis of the answers obtained in the survey concludes that, depending on the adopted systematics, internal or knowledge-related barriers were assigned the most significant importance. According to the information presented in Figure 2, among the factors limiting dairy farmers' innovativeness, respondents gave the highest importance to the lack of skills to serve modern equipment (weight 0.641) and lack of ideas (0.639), as well as to administrative and legal barriers (0.640).

Figure 2. Factors inhibiting the innovation of Polish dairy farms



Source: Results of own research.

As there are few comprehensive studies on-farm innovation in the literature, the results may be a big surprise. This is because they are in opposition to the results of research conducted among entrepreneurs. The research carried out by Juchniwicz and Grzybowska (2010) showed that as many as $\frac{2}{3}$ entities from the SME sector listed external barriers (related to the company's environment) among the factors limiting their innovativeness. In turn, the Polish Central Statistical Office (2012) research concludes that relatively few entrepreneurs connect innovation barriers with knowledge-related factors.

Modern times are characterized by very intensive technological development. The use of these technologies makes the functioning of farms much more comfortable. Agriculture is a sector of the economy where not so much information and knowledge, but practical application is essential. To achieve success in farm management, solid professional preparation is necessary, but one cannot stop there. Doing the agricultural activity in the free-market conditions and permanent changes in the farm's surroundings requires constant access to up-to-date sources of information (Babuchowska and Marks-Bielska, 2015). Therefore, contemporary dairy farmers should be open to new solutions and improve their skills to facilitate innovation.

In national and foreign literature on the issue, innovation's limitations usually involve financial (cost) factors. This is because the cost of many innovative technologies, especially at an early stage of their diffusion, is high, and the resources available to those interested in implementing innovations are low. Even though there are many possibilities to obtain an external source of financing for innovations, the procedures connected with obtaining and accounting discourage potential recipients. However, the farmers surveyed gave cost barriers the lowest weight. They were: 0.513 in case of lack of financial resources, 0.506 in case of difficult access to external sources of financing, 0.497 in case of high costs of introducing changes.

It should be noted that the barrier - too long a period of return on investment obtained a slightly higher value of the indicator, which was 0.578. Return on investment is one of the critical methods to assess investment projects' profitability, including those related to the introduction of innovations. However, it is not the only criterion that should be taken into account when deciding to implement innovative solutions on the farm. Benefits result from implementing a project challenging to express in monetary units, e.g., streamlining of work, maybe an argument in favor of the investment.

4. Conclusion

Technological changes related to the introduction of innovations in farms are mainly of an exogenous origin. In principle, it is not observed that farmers carry out their research self-activities; in the vast majority of cases, the innovations are made in a non-agricultural environment. The decision to innovate on farms depends on many factors that are more or less critical from the point of view of the agricultural producer. In this area, a category of factors can be identified that favors the introduction of new solutions (stimulants) and barriers to innovation (de stimulants).

The results of research conducted among Polish farms specializing in milk production, presented in the study, allowed us to state that the most critical (weight) among the factors stimulating the implementation of innovations was the fact that they will streamline work, improve the quality of milk, improve production efficiency. However, it also showed that farmers' awareness of the importance of climate problems was still low, as demonstrated by the fact that the savings of water and electricity, which could be obtained through new technical solutions, were given

a relatively low weight among stimulants. The analysis of innovation barriers revealed, in turn, that, in the opinion of the respondents, internal factors related to the interpersonal characteristics of agricultural producers (lack of skills to operate new equipment, lack of ideas) were of most significant importance.

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