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CHALLENGES OF RAW MILK TRANSPORTATION AND POSSIBILITIES OF THEIR SOLUTIONS: A CASE OF LITHUANIAN DAIRY COOPERATIVES

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Abstract. *Logistics plays an important role in various fields. In this case agriculture is not an exception. The discussed branch of agriculture in this article is dairy farming. The importance of logistics in dairy sector is undeniable. The main participants in dairy sector are milk producers, dairy cooperatives and milk processing plants. The main challenges related to raw milk transportation in dairy cooperatives and the possibilities to solve them are presented in this article. It is important to identify the main challenges in raw milk transportation and find ways to solve problems that arise in order to avoid losses of raw milk and ensure a more efficient path of raw milk from milk producers to the finished production. The authors of the article present a theoretical model of raw milk transportation in dairy cooperatives improvement, in the presented model not only the problematic aspects in raw milk transportation are pointed out, but also possible technological and innovative solutions are provided. After applying a questionnaire survey and a semi-structured interview, the results of an empirical research, that confirmed the existence of challenges in raw milk transportation identified in the theoretical part, are presented.*

Keywords: *raw milk, dairy cooperatives, transportation of raw milk, challenges of transportation, solution, technological solutions, innovations.*

Introduction

One of the oldest and significant branches of agriculture in Lithuania is dairy farming. Lithuania stands out in terms of raw milk production and processing of dairy products in comparison with other Baltic countries. Moreover, considering the volume of dairy products export and the diversity of countries to which the dairy products are exported, dairy sector significantly contributes to Lithuania's prosperity in economic aspect. Milk producers, dairy cooperatives and milk processing plants play an important role in dairy sector, although in this article the attention is paid particularly to dairy cooperatives. These days, logistics play an important role in dairy sector as well as in the other business areas. Dairy cooperatives often face logistical challenges related to raw milk transportation.

Raw milk transportation is analyzed in the scientific literature from various aspects. Indicators of raw milk quality can be related not only to such aspects as raw milk collection and storage, but also, as Roman (2018) states, to raw milk transportation. It can be said, that considering the specific qualities of raw milk, it cannot be stored or transported for a long time. As Roman (2018) found out one of the problems, specifically in the dairy sector, is the transportation of raw milk. Paraffin, Zindove and Chimonyo (2018) as well analyze the aspect of raw milk transportation. While analyzing the factors influencing the contamination of raw milk, authors as one of the factors name transportation (Paraffin, Zindove & Chimonyo, 2018).

Daud, Putro and Basri (2015) state, that poor conditions of transportation in the agribusiness are one of the serious problems in raw milk transportation. The special transport with a refrigeration system is required while transporting perishable products (raw milk) that as well are very sensitive to contamination and temperature changes. Certain problems associated with vehicles during raw milk transportation can cause raw milk losses (Daud, Putro & Basri, 2015). Zhang, Cheng, Chen, Guo and Gao (2018) state, that to dairy products the control of raw milk quality is important, the quality of raw milk is affected by the temperature, taking into account this fact, the authors think, that in the dairy sector the temperature monitoring system for raw milk transportation would be useful.

The issues of raw milk transportation are actively discussed in the scientific literature. The transportation of raw milk can affect both the quality of raw milk and it's further processing. It is necessary to identify the main challenges faced by the Lithuanian dairy cooperatives and assess the possibilities for their solution in order to avoid losses of raw milk and ensure a more effective transportation of raw milk.

The goal of this article is to identify the main challenges that are faced during raw milk transportation in Lithuanian dairy cooperatives and present possible solutions to solve the identified challenges.

Research methods: analysis and synthesis of scientific literature, analysis of legislation and regulations, the method of quantitative research – questionnaire survey, qualitative research method – semi-structured interview.

Role of logistics in dairy sector

Logistics processes play an important role in the daily activities of various industries and organizations whether they are practiced less frequently or more often. Various activities such as market research and forecasting of demand for specific types of products, purchasing material resources necessary for production, organization of material flows in production, organization of goods distribution: selection and packaging of finished products, their transportation to the destination, delivery of products to the consumer and registration of necessary documentation can be attributed to the logistics (Kurbatova, Aisner & Mazurov, 2020, p.2). Moreover, the importance of logistics in agriculture is undeniable. Logistics in agriculture covers a wide range of topics: flow of resources, its management and optimization, minimizing risks, use of outsourcing, IT applying in logistics systems, impact of state policy, infrastructure (Radžele-Šulce, 2011, p.73). Agricultural logistics can be defined as a branch of industry and an important part of agricultural production and management activities for the sustainable development of the agricultural economy. Dairy logistics involves the transport of milk, cheese and other dairy products. The goal in dairy logistics is to keep the product clean, keep the product cold and keep the product moving (Robbins, 2019). Taking into consideration the mentioned definition, during raw milk transportation it is important to ensure that raw milk is not damaged during the transportation process and to assure that raw milk meets the quality requirements set out in legislation and regulations.

The main peculiarities of raw milk transportation and emerging challenges

Dairy farms, dairy cooperatives, milk processors or other entities relating their activity with dairy sector face various challenges and difficulties. Regulations and statutory requirements, qualitative indicators of raw milk, purchase prices for raw milk, perspectives and situation of dairy sector are the most common and most widely discussed problems in the

scientific literature. Furthermore, one of the already mentioned problems also could be raw milk transportation. In dairy sector human factor, environment and transport system can be distinguished as causes of dairy products losses (Lipińska, Tomaszewska & Kolozyn-Krajewska, 2019). Like other agricultural sectors presently challenged by environmental constraints, the dairy sector is also pushed to move towards environmental sustainability and is urged to change practices (Munsch-Alatossava & Alatossava, 2019). Analysis of the scientific literature revealed that in the dairy sector various aspects and spheres can be improved. One of those mentioned spheres could be raw milk transportation.

As the literature studies revealed such elements as load, vehicles and transport roads play an important role in raw milk transportation. Certain challenges and the problematic aspects in raw milk transportation can be associated with the earlier mentioned elements. Based on the analysis of the scientific literature and in view of the evolving world these days, problematic aspects in raw milk transportation can be solved with the help of technological solutions and innovations. After the systemization of the scientific literature analysis, the authors presented the theoretical model of raw milk transportation and its improvement in dairy cooperatives depicted in the Figure 1.

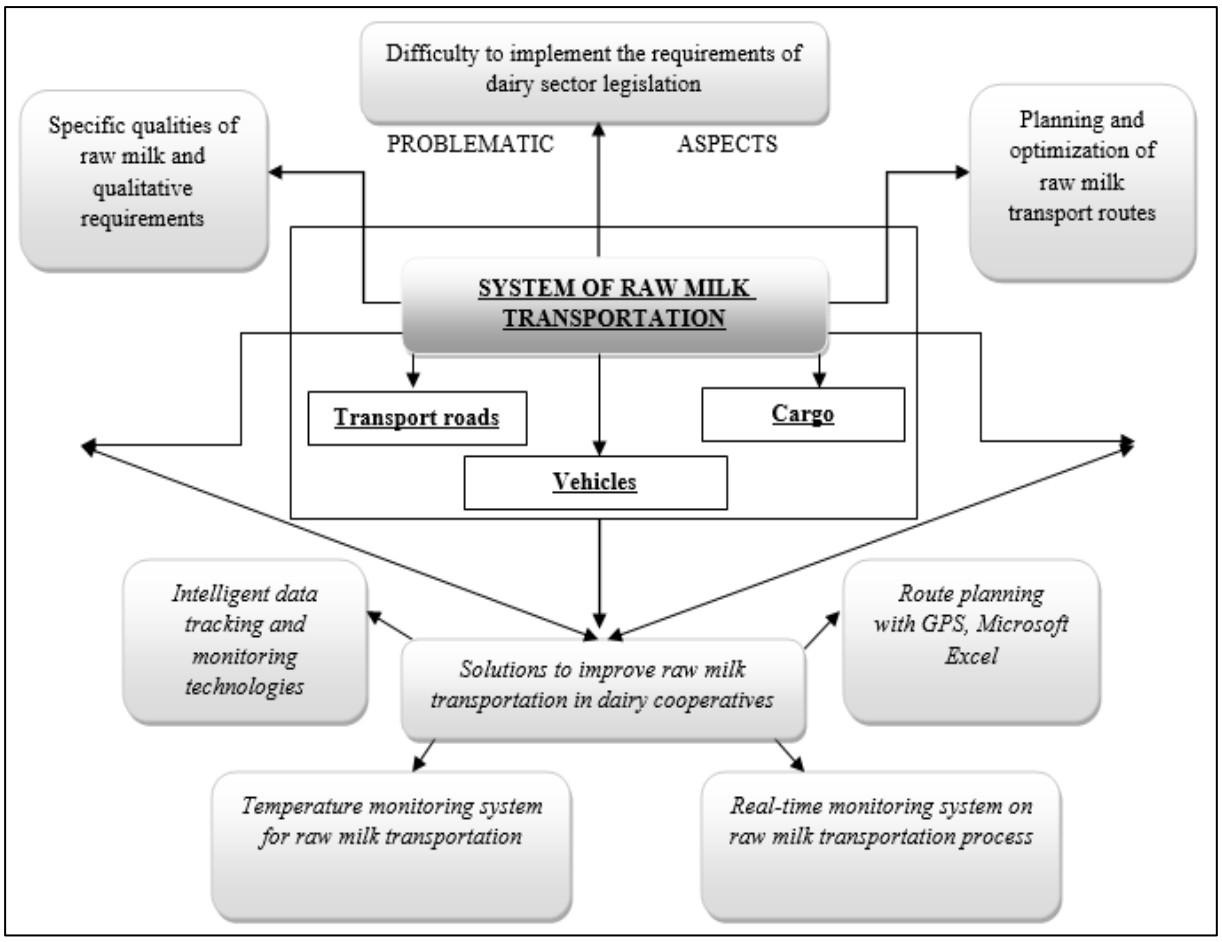

Figure 1. Theoretical model of raw milk transportation and improvement in dairy cooperatives

As a cargo raw milk has a number of different characteristics. Firstly, raw milk as well as the other agricultural products has biological qualities. The maintenance of the suitable temperature and assurance of proper hygiene are important elements to raw milk. Taking into

account the mentioned fact, raw milk can be defined as a specific cargo requiring special conditions of carriage and storage. It can be assumed, that as a cargo raw milk causes difficulty in the further raw milk transportation. To be more specific, it is complicated to decide how the cargo should be transported, which vehicle should be used as well as to plan and optimize the transport routes of raw milk.

Transport roads is also one more important element in raw milk transportation. Raw milk is transported by road transport taking into account it's specific and other biological qualities in order to preserve the high quality of raw milk more efficiently and to deliver raw milk to certain place in time. It is most convenient to transport raw milk by road due to such reasons as speed, safety, greater opportunities to reach less developed areas or roads.

The final important element in raw milk transportation is vehicles. In order to choose the most suitable vehicle to transport raw milk attention should be paid to such elements as amount of raw milk transported, the geographical location of the area, accessibility, and the cost of transportation for cargo (Dairy technology, 2014). Considering the specific qualities of raw milk, the most suitable vehicle for raw milk transportation using road transport are milk tankers. Raw milk is transported by milk tankers, as they are a relatively fast vehicles, have a lower cost with higher milk volumes, provide better temperature control, a lower risk of raw milk contamination and time advantage when loading / unloading cargo (Dairy technology, 2014).

Cargo, transport roads and vehicles can be associated with the main problematic aspects in raw milk transportation in dairy cooperatives. These include difficulty to implement the requirements of dairy sector legislation, specific qualities of raw milk and qualitative requirements and planning and optimization of raw milk transport routes.

In accordance with the procedure established by the laws of the Republic of Lithuania, the conditions of raw milk transportation ensure, that raw milk complies with the established quality requirements. The importance of the deadline for the delivery of raw milk to the required point is also highlighted in foreign scientific literature. Raw milk selected by the dairy cooperatives must be delivered to the set point within a specific time limit or it will be considered spoiled, so every transport route needs to be considered very carefully (Polat & Topaloğlu, 2019). In order to ensure raw milk quality and temperature regime during raw milk transportation in Lithuania certain requirements and restrictions were introduced in the raw milk transportation in 2011 (Lietuvos Respublikos žemės ūkio ministerija, 2019). Legislation of dairy sector requirements poses challenges in planning transport routes of raw milk, ensuring raw milk quality, and making it difficult to select and maintain vehicles for raw milk transportation.

Specific qualities of raw milk and qualitative requirements also cause challenges in raw milk transportation. Most agricultural products are perishable so in order to preserve the quality and freshness of agricultural products, it is important to pay attention to such aspects as short shelf life, high requirements for storage and transportation (Zhang, Qiu & Zhang, 2017). In order to preserve the specific characteristics and high quality of raw milk, vehicles used for the raw milk transportation should be a closed type, protect the transported raw milk from extreme temperature changes, dust or other adverse conditions and factors (Regulation (EC) No 853/2004 of the European Parliament and of the council). The specific qualities of raw milk make it difficult to transport, because raw milk cannot be transported with regular vehicles, special milk tankers are required for its transportation.

Finally, another problematic aspect of raw milk transportation, which is most often highlighted in the scientific literature, is the planning and optimization of raw milk transport routes. The problem of transport routing is a common problem in various fields of activity. As in any other areas of logistics, the '7Rs' principle can be applied in agricultural logistics: the

right product, the right quality, the right quantity, the right time, the right place, the right customer, the right price (Wajszczuk, 2016). While transporting raw milk it is important to maintain and preserve suitable quality of raw milk. In order to avoid losses and to deliver the required cargo of the right quality and at the right time as quickly and efficiently as possible it is important to think and plan carefully each transport route. The type of problems related to designing of raw milk transport routes include the fact that rural road network may not be adequately designed for the large tankers, requirements to transport fresh and high-quality raw milk, the need to reroute because of traffic (Callaghan, O 'Connor & Goulding, 2018).

The main challenges faced by the Lithuanian dairy cooperatives during raw milk transportation

In order to investigate, whether in the case of Lithuanian dairy cooperatives, the challenges and problematic aspects singled out in the scientific literature are faced, a quantitative research method – questionnaire survey, and a qualitative research method – semi-structured interview were used. The aim of quantitative research was to elucidate the expression of problems singled out in the scientific literature related to raw milk transportation in dairy cooperatives. A questionnaire survey consisted of 17 questions. In this article only a part of research results is presented. The research was conducted in January-March of 2021, questionnaire survey was sent to 28 dairy cooperatives by email.

The results of quantitative research showed, that Lithuanian dairy cooperatives during raw milk transportation face challenges because of such factors as geographical location of dairy farms, peculiarities of road transportation, dislocation of milk processors which also complicate the planning and optimization of raw milk transport routes. Other challenges arise because of the difficulty to implement the requirements of dairy sector legislation, to maintain high quality of raw milk, meet the requirements of delivery deadlines to the relevant point in accordance with the established regulatory enactments. Moreover, the challenges are faced because of short shelf life of raw milk, maintenance and assurance of the right temperature (see Figure 2).

Qualitative research method – semi-structured interview was used to evaluate raw milk transportation in dairy cooperatives in the point of view of other dairy sector participants – milk processing plant. Any concrete problems faced by dairy cooperatives during raw milk transportation were not identified by the results of qualitative research, as the informant's cooperation with dairy cooperatives is based on purchase and sale agreements, that protect against possible raw milk delivery deadlines or quality violations. Although, the informant did not name any concrete problems, that could cause challenges for Lithuanian dairy cooperatives during raw milk transportation, informant does not contradict that technological solutions and innovations are necessary and would improve the process of raw milk transportation.

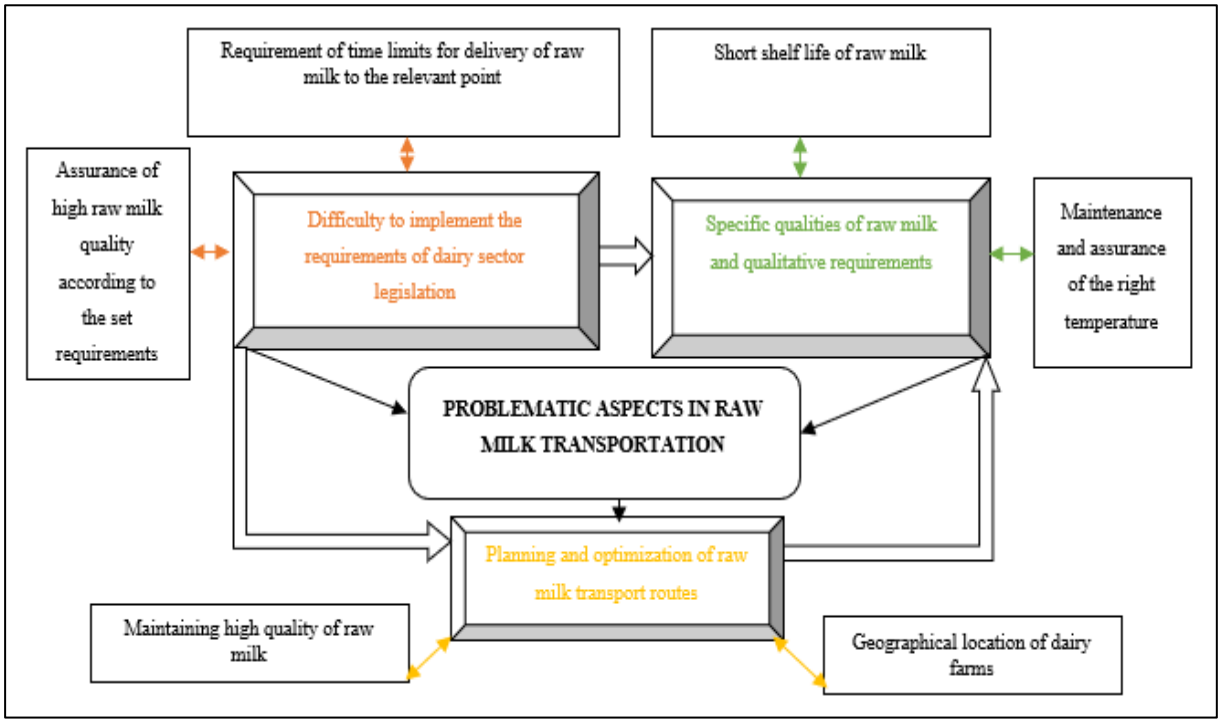

Figure 2. The main challenges of raw milk transportation in Lithuanian dairy cooperatives

Possibilities of solving challenges in raw milk transportation in Lithuanian dairy cooperatives

More efficient and faster raw milk transportation in Lithuanian dairy cooperatives could be assured using technological solutions and innovations. In dairy sector are already known and used such innovations as supercooling technology, which enables fresh dairy products to travel long distances by ship. As well such innovation as mastitis detection technology is known in order to avoid financial losses due to poor milk quality (Burrell, 2020). Certain technological solutions and innovations could be indeed useful in raw milk transportation, and the Lithuanian dairy cooperatives, who participated in quantitative research, themselves tend to invest in technological solutions and innovations according to the need and agree that the potential improvement solutions depicted in Figure 1 could serve in raw milk transportation. The mentioned solutions are intelligent data tracking and monitoring technologies, temperature monitoring system for raw milk transportation, real-time monitoring system on raw milk transportation process, route planning with GPS, Microsoft Excel.

Each technological solution or innovation cost no only time, but also investments and financial resources. Raw milk transportation in Lithuanian dairy cooperatives is unimaginable without special equipment, detailed planning and organization of raw milk transportation processes, but still considering today's modern world, Lithuanian dairy cooperatives could consider the importance of technological solutions and innovations to assure even more efficient and reliable raw milk transportation process.

It can be assumed, that temperature monitoring system for raw milk transportation would be useful for Lithuanian dairy cooperatives as the biggest challenges for Lithuanian dairy cooperatives today are related to high quality of raw milk maintenance. Temperature monitoring system for raw milk transportation in the case of Lithuanian dairy cooperatives would provide such advantages as more reliable assurance and maintenance of raw milk high

quality, lower losses of raw milk during transportation process, more effective implementation of the requirements of the laws regulating the dairy sector (in terms of quality), faster and more efficient decision making and the organization of work in the raw milk transportation.

Although, Lithuanian dairy cooperatives face the greatest challenges in maintaining high quality of raw milk, Lithuanian dairy cooperatives should take into account the problematic aspect of planning and optimizing transport routes in order to improve raw milk transportation. It is quite difficult to plan and optimize raw milk transport routes in such a way that the raw milk transport route would be as short as possible and the cost of transport is kept to a minimum without the use of smart technologies or innovations. In Lithuanian dairy cooperatives, the problem of planning and optimization of raw milk transport routes could be solved with the help of intelligent route planning systems that would facilitate transportation and decision-making in raw milk transportation. One of such systems could be Milk Moovement. Milk Moovement system would facilitate planning and optimization of raw milk transportation routes, as it allows to constantly monitor data related to raw milk collection and its delivery to the certain location, track and obtain information on the amount of raw milk collected, it's temperature, distance of raw milk transport route, speed of vehicle.

Conclusions

In Lithuania, dairy farming is one of the most important branches of agriculture, which plays an important role in creating economic added value for the country and creating jobs. Most of the Lithuanian dairy products are exported to various countries. The dairy sector, like other branches of agriculture practiced in Lithuania, contributes to the country's prosperity. In order to avoid raw milk losses and to assure an efficient journey of raw milk from milk producers to finished products, it is important to pay attention to challenges of raw milk transportation.

Dairy cooperatives face challenges and problematic aspects such as difficulty to implement the requirements of dairy sector legislation, specific qualities of raw milk and qualitative requirements, planning and optimization of raw milk transport routes.

These days it is difficult to implement the requirements of dairy sector legislation because of such challenges as requirement of time limits for delivery of raw milk to the relevant point, assurance of high raw milk quality according to the set requirements, specific qualities of raw milk and qualitative requirements are complicated because of the short shelf life of raw milk, maintenance and assurance of the right temperature. Finally, because of such challenges as maintaining high quality of raw milk and geographical location of dairy farms it is difficult to plan and optimize transport routes of raw milk. The analysis of the empirical research revealed, that the biggest challenges for Lithuanian dairy cooperatives are posed by the factors related to the preservation of raw milk high quality.

These days, technological solutions and innovations are often used to improve certain processes or to overcome the challenges that arise in daily activities. In order to improve the transportation of raw milk and maintain the high quality of raw milk, Lithuanian dairy cooperatives are proposed to apply a temperature monitoring system for raw milk transportation, which would assure constant monitoring of raw milk temperature and more efficient preservation of raw milk high quality. Despite the fact that these days planning and optimization of transport routes is not one of the main challenges for Lithuanian dairy cooperatives, another proposal to improve raw milk transportation in Lithuanian dairy cooperatives is a smart transport route planning system Milk Moovement with the help of which it would be easier to predict possible failures during raw milk transportation (traffic disruptions)

and, where possible, more easily change the raw milk transport route so that raw milk is delivered to the appropriate point in time.

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