

Challenges and innovative approaches in the agricultural and food industry and changing consumer behaviour in the milk and milk products market: Case of Slovakia

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Abstract: The negative consequences faced by the entire planet, the intensification of natural disasters, global warming, lowering the level of groundwater, deforestation, deterioration of corals and the underwater world, soil degradation, and the change of species diversity, testify to the necessity of introducing reforms in the agricultural-food complex. Fulfilling such a goal and creating added value of innovation potential can only be created in the conditions of functioning structures strengthened by system support, which requires reviewing and introducing change in food systems. The recent financial crisis, later the pandemic, and the current going military conflict in Ukraine, caused problems in supplier-customer relations, and made humanity feel how the issue of food security and self-sufficiency can be easily and quickly disrupted. If farmers and food producers are to be able to respond to challenges and at the same time ensure the EU's strategic goals, it is necessary to have support in research and innovation. Agricultural research and innovation in the EU is characterised by a long-term strategic approach that focuses on creating value from the land through sustainable primary production and strengthening rural innovation. It is an important tool in the fight against challenges such as climate change, environmental degradation, and biodiversity loss. In view of the above, it is necessary to transform food systems, apply regenerative agriculture, introduce alternative land-saving farming systems, observe the principles of sowing procedures and greater diversification of crops in the sowing procedure, reduce the consumption of agrochemicals, naturally integrate plant and animal production into agricultural business entities in relation to the circular economy, use farm waste for bioenergy production, protect agricultural land, implement measures to retain water in the country and support regions.

Keywords: consumer patterns; dairy industry; ecosystem management; food system resilience; new agrifood systems

In terms of achieving Sustainable Development Goals (SDGs), it is necessary to place great emphasis on innovation (Yakovleva et al. 2017). Research and innovation play an important role in stimulating smart

and sustainable growth and are essential in creating new jobs. Research brings new knowledge, it is decisive in the development of new or innovative products, processes, and services, which allow increasing

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productivity, competitiveness in the industry, and customer satisfaction. Innovation is a key driving factor in the evolution of every organisation. Thanks to innovations, new products are introduced, improved, and developed, to increase work efficiency and reduce costs, but finally, there is also an increase in quality. Stimulating innovation in enterprises is an integral part of good management and is also part of approaches to quality management. The main goal of the scientific article is to identify innovative approaches in agricultural and food enterprises in the dairy vertical, to identify the future needs of primary milk producers and processors in relation to the new programming period, and to evaluate the innovative change in consumer behaviour on the milk and milk products market. Based on surveys carried out in primary agricultural production companies, milk production companies, and final consumers, key problems, changes in conditions on the market, and trends in the milk products market were demonstrated. The market of domestic agri-food commodities in the SR was significantly reduced in recent years, resulting in the attenuation of critical agricultural and breeding processes. The agrarian traditions of the business environment, which flow from the qualified human resources, adequate natural conditions, a high proportion of the rural population, with a high level of unemployment in a large part of Slovakia's regions, as well as other factors, represent an opportunity to revitalize the agricultural business (Simo et al. 2016). In many low-income countries, governments have implemented health and rural development programs to reduce malnutrition and are beginning to take action to address malnutrition but have

struggled to adopt systemic strategies. More comprehensive nutrition outcomes that balance multiple desired outcomes related to nutrition, food security, climate, environment, and socio-economic development (Béné et al. 2019; Vermeulen et al. 2020).

Innovation and innovation management. Innovations are most often applied in Slovakia in the areas of precise organic regenerative agriculture, further in areas such as minimisation technologies, agri-ecological approaches to agriculture, nano, and biotechnology, the sphere of permaculture, or e-agriculture. Agriculture is affected by many undesirable impacts and variables such as production depends mainly on weather conditions, market, and risks, mostly the risk of inputs or outputs price uncertainty, and mean market risk (Hupková et al. 2018). In the conditions of the Slovak Republic, the food industry faces many challenges, including connection with innovative approaches. In 2014, the dairy businesses participated by 6.9% in the innovation of the food industry, which takes them to second place in the sector (Naglova et al. 2017). However, the added value of innovation potential can only be created in the conditions of functioning structures and internal and external communication, with the help of system support in the form of adequately selected support tools (Dzurová et al. 2021). Emphasis must be placed on the effective transfer of knowledge and its preservation, i.e. promoting best practices (Pullman and Wu 2021). This continuously leads to the development of internal resources in the company, which are also the innovation potential and bring companies a competitive advantage in the longer term (Mendenhall and Singer 2019). Innovation is pos-

Table 1. Development of average annual consumption of selected commodities in 2010–2020 (kg × volumes)

Year	Milk and products together	Drinking milk	Cheeses and curds	Butter	Cream	Sour milk products	Dried and condensed milk
2010	162.8	54.5	9.9	2.6	2.8	13.8	1.1
2011	156.9	53.1	10.4	2.9	2.5	13.7	1.1
2012	158.6	54.3	10.1	3.2	2.4	14.3	0.9
2013	158.5	49.3	11.4	3.0	2.9	14.7	1,2
2014	166.8	48.3	11.5	3.2	2.9	16.2	0.8
2015	169.2	48.1	12.2	3.6	3.1	16.7	0.7
2016	176.2	46.5	14.0	3.9	2.9	17.3	0.7
2017	174.6	46.4	13.5	3.7	2.8	17.4	0.7
2018	172.1	46.0	13.3	3,4	2.7	16.8	0.7
2019	172.8	44.5	14.4	3.7	3.2	13.8	0.9
2020	179.3	50.2	14.4	–	3.6	14.9	0.6

Source: own elaboration based on data from the Statistic Office in SR

itively associated with organisational performance and helps to achieve sustainability not only in agricultural enterprises but in other areas as well (Vrabcová and Urbancová 2023). From the wide range of opinions of practitioners, theorists, and institutions, innovation has many characteristics. In the field of innovation management, it is necessary to apply a systematic approach, which requires the acquisition of basic skills, which are: monitoring the environment, ensuring balance, the ability to recognize the limitations of one's own technological base, the ability to create technologies within the company – own research departments, the ability to manage development projects, the ability to effectively implement changes, the ability to learn from the results of the innovation process, and finally the ability to incorporate effective routines into the structures and processes of the company (Mormina 2019). The motivation to consume milk and milk products can be categorised into four groups: nutritional composition, positive impact on health, tradition, and use. We further read that while the beneficial nutritional composition can be considered a recognised fact, there are assumptions that other motivational elements may not have the same informative value for the individual (Kurajdová et al. 2015). For a better idea of the situation in the milk and yogurt market, we present Table 1.

In EU countries, milk production costs have been gradually increasing in recent years because of the increase in milk yields and the associated higher feed consumption, as well as increasing prices for inputs such as feed, labour energy, and investment (Syrůček et al. 2023). The prices of dairy products on the Global Dairy Trade exchange fell in the period from December to January 2022 (Hansen 2022).

MATERIAL AND METHODS

Attention is paid to innovative approaches in the dairy vertical at three levels: primary milk production, milk and yogurt processing, and consumer behaviour in the milk and yogurt market. The output of the research is a comprehensive analysis of innovative approaches in the dairy vertical and changes in consumer behaviour in the Slovak Republic. The scientific article uses primary and secondary data obtained from its own research. The questionnaire survey intended for primary milk producers in Slovakia was carried out in cooperation with the Slovak Association of Primary Milk Producers. Background data was obtained based on three research carried out in the period from September 2020 to February 2022. The target group was primary milk

producers, processors of milk and yogurt, and consumers in Slovakia. When evaluating the data we use method binary logistics regression, multinomial regression, ordinal regression, chi-square test, Cramer's V coefficient, Spearman's correlation, and the non-parametric model of the Kolmogorov-Smirnov test. Attention is paid to the formulation of hypotheses (null and alternative) and to deciding the level of significance. The statistical software IBM SPSS Statistics 25 was used to process the data and test the following hypotheses:

H_1 : The ability of a company to innovate depends on the size of the company.

H_2 : There is a dependence between the age of the respondent and the preference for a plant-based alternative to milk.

H_3 : There is a dependence between the respondent's education and the preference for a plant-based alternative to milk.

In hypothesis testing, if the P -value (0.05) is lower than a significant level, H_0 was rejected, and the alternative hypothesis was confirmed.

The aim of the questionnaire research designated primary producers was to evaluate the current state of primary milk production companies and identify the needs and expectations of Slovak primary milk producers in relation to the new Common Agricultural Policy (CAP) program, period 2021–2027. The research involved 30 dairy companies in Slovakia (of which 9 micro-enterprises, 9 small enterprises, and 11 medium-sized enterprises), while the ownership of the studied enterprises is in up to 19 Slovak-owned dairy companies and 11 enterprises are in foreign ownership. The examined sample produces products from cows (15 enterprises), sheep (14 enterprises), lactose-free milk (1 enterprise) and one enterprise produces products from coconut substitutes. The questionnaire was divided into four sections: identification questions, a look at innovations in the company over the past years, product and business policy, and plans.

The goal of questionnaire research focused on consumers was to obtain information about consumer behaviour in the milk and yogurt market, to determine changes in consumer behaviour on the market with selected commodities. As part of the achievement of the research goal, a questionnaire was developed for Slovak residents without age restrictions. The questions were worded to refer to consumer behaviour within the household, not to the individual. The form itself consisted of three sections A, B, and C Section; section A included 8 statistical questions and 10 questions that we consider to be basic questions related to the respon-

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dents’ eating styles. Section B contained 12 questions related to the issue of consumer behaviour in the cow’s milk market. Section C covered questions in the framework of consumer behaviour in the yogurt market and contained a total of 14 questions. The research was carried out online.

RESULTS AND DISCUSSION

In the Slovak Republic, approximately 378 establishments that process milk and produce dairy products are currently approved by the State Veterinary and Food Administration. Since the dairy sector has experienced three dairy crises in the last ten years in addition to global crises, this sector in Slovakia is currently weakened and financially undersized due to large market fluctuations. To maintain employment, which exceeds more than ten thousand employees, it is important to do everything to stabilize this sector.

It is interesting that in 2015, when milk quotas were cancelled on April 1st, the number of cows in Slovakia did not increase. However, this finding can also be influenced by the fact that Slovakia had an annual milk production quota of one billion L in recent years, but for a long time it only filled approximately four-fifths of it. The decline in the number of farm animals in Slovakia can also be caused by a decline in livestock reproduction, as evidenced by the fact that the indicators of reproduction of the basic herd and the reproductive characteristics of livestock deteriorate year-on-year (Table 2; Švikruhá et al. 2020).

In areas such as milking, feeding, and watering, some primary producers have quite large plans. For their farms, they want to provide various innovative technologies, devices, and tools that would facilitate their work and increase the efficiency of work, as well as the animal life quality. It is, for example, feed technologies, waterers, feed mixer trucks, cooling boxes, and equipment.

Figure 1 shows the types of investments that farmers intend to make. Purchase of various technologies, such as feed mixing wagons, feeding technologies and waterers, robotic feed grabbers, mechanised means of feeding,

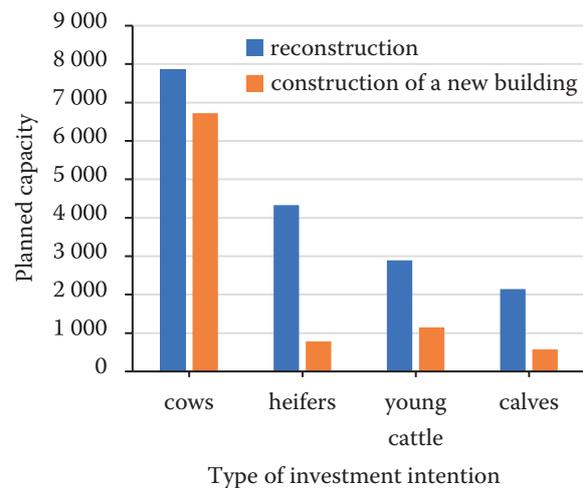


Figure 1. Ratio of types of investment intentions

Source: own elaboration

and feeding robots. The estimated volume of necessary investments in feeding and watering is approximately 8 million EUR according to the analysed sample.

The research carried out on Slovak dairy companies shows that out of 30 companies, we can consider 10% of companies as innovation leaders, 25% as moderate innovators, 40% as average innovators, and 10% as weak innovators. Strong innovators are primarily medium-sized and large companies, which on average implement 10 innovations during the year (Table 3).

The correctness of the testing was tested based on a non-parametric test using the one-sample Kolmogorov-Smirnov test (Bergsma 2013). The results are shown in Table 4.

Most often, there is the application of more sustainable packaging materials, a change in technological procedures, and a change in pricing policy. In recent years, the researched dairy enterprises have drawn ideas for introducing innovations primarily from the competition, and the source of financing innovative activities is their own resources (Figure 2).

In 77% of dairy companies, specific innovations are introduced based on consumer preferences. Managers

Table 2. Development of farm animals in Slovakia in the years 2010–2020

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Cattle	467 125	463 358	471 091	467 820	465 543	457 586	446 112	439 826	438 855	432 253	424 755
Cows	204 386	201 307	202 589	198 978	201 795	199 509	194 191	194 676	194 708	191 851	183 955
Dairy cows	159 260	154 105	150 272	144 875	143 083	139 229	132 610	129 863	127 871	125 848	117 159

Source: own elaboration based on data from the Statistic Office in SR

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Table 3. Ordinal regression – the company’s ability to innovate; link function – logit

Innovation ability	Category of innovator	Estimate	SE	Forest	df	Sig.	Lower bound	Upper bound
(How would you evaluate the company’s ability to innovate?)	innovative leader	–5.562	1.733	10.298	1	0.001	–8.959	–2.165
	strong innovator	–3.690	1.425	6.711	1	0.010	–6.482	–0.898
	average innovator	–1.563	1.176	1.764	1	0.0184	–3.868	0.743
	mild innovator	–0.321	1.237	0.067	1	0.795	–2.774	2.103
Location	how many employees does your company employ?	–1.796	0.748	5.761	1	0.016	–3.263	–0.329

Source: own elaboration

of dairy companies evaluate the introduced innovations, which they consider positive as they have increased sales and revenues, but the negative side is increased costs, risk of change, and administrative burden.

The following findings and conclusions emerge from research in dairy enterprises: *i*) The company’s ability to innovate depends on the size of the company; *ii*) in recent years, the investigated dairy enterprises have innovated production and packaging technologies and procedures within the framework of production; *iii*) changes in price policy occur under the influence of more frequent and dramatic global crises; *iv*) product, marketing, and technological innovations proved to be positively evaluated areas; respondents assessed the success of the introduced innovations primarily based on increased sales and lower costs; *v*) in up to 77% of cases, specific innovations are introduced based on consumer preferences; con-

sumer preferences are tracked in up to 85% of cases; *vi*) in 80% of businesses, they noticed a change in consumer behaviour during the COVID-19 pandemic; this change consisted primarily of a decrease in the number of visitors to stores and a change in consumer behaviour in relation to healthier products and more ecological packaging.

Consumer behaviour research pointed to a change in consumer behaviour among respondents buying milk and yogurt. Buying cow’s milk in Slovakia is still dominant, but only 634 respondents also prefer buying plant-based alternatives to milk. Respondents buy sheep’s milk to the smallest extent. Research points to the fact that roughly every third person in Slovakia is reducing or considering reducing their consumption of animal products. There are several reasons why people increasingly include plant-based foods in their diet, and these are health, environmental impact, animal

Table 4. One-Sample Kolmogorov-Smirnov test – the company’s ability to innovate

Category		How many employees does your company employ?	How would you evaluate the company’s ability to innovate?
<i>N</i>		20	20
Normal parameters <i>a, b</i>	mean	1.65	2.90
	SD	0.671	1.119
Most extreme differences	absolutely	0.284	0.214
	positive	0.284	0.214
	negative	–0.249	–0.186
Test statistics		0.284	0.214
Asymp. Sig. (2-tailed) <i>c</i>		< 0.001	0.017
Monte Carlo Sig. (2-tailed) <i>d</i>	Sig.	< 0.001	0.017
	99% confidence interval	lower bound	0.000
		upper bound	0.001

a – test distribution is normal; *b* – calculated from data; *c* – Lilliefors’s Significance Correction; *d* – Lilliefors’s method based on 10 000 Monte Carlo samples with starting seed 2 000 000

Source: own elaboration

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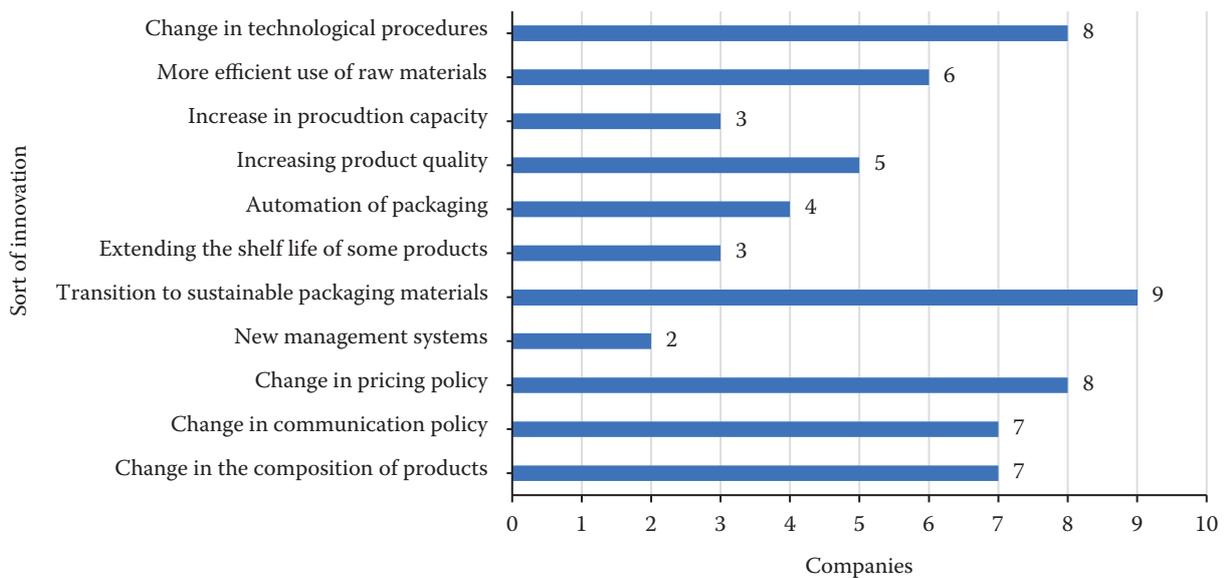


Figure 2. The area of introducing innovation in dairy companies

Source: own elaboration

welfare, a wide selection of plant-based alternatives or so-called 'adventurous consumers' who want to try the products (Figure 3).

The survey showed that in as many as 519 households, the consumption of coconut substitutes is up to 10 L per month. It is interesting that 51 households consume a soy alternative in a volume of 10.1 to 15 L per month. Households consume more than 15 L per month only as part of almond and soy substitutes, but these are exceptional cases (Figure 4).

The proposed model explains the relationship between the variables at the level of 12.4%. The regression model describes the variability of the variables to the preference of the plant-based milk alternative at 17%, which represents a low value, therefore we verified the dependence with the help of the correlation matrix. It was confirmed to us that there is a dependence between the respondent's age and the preference for a plant-based milk alternative (Table 5).

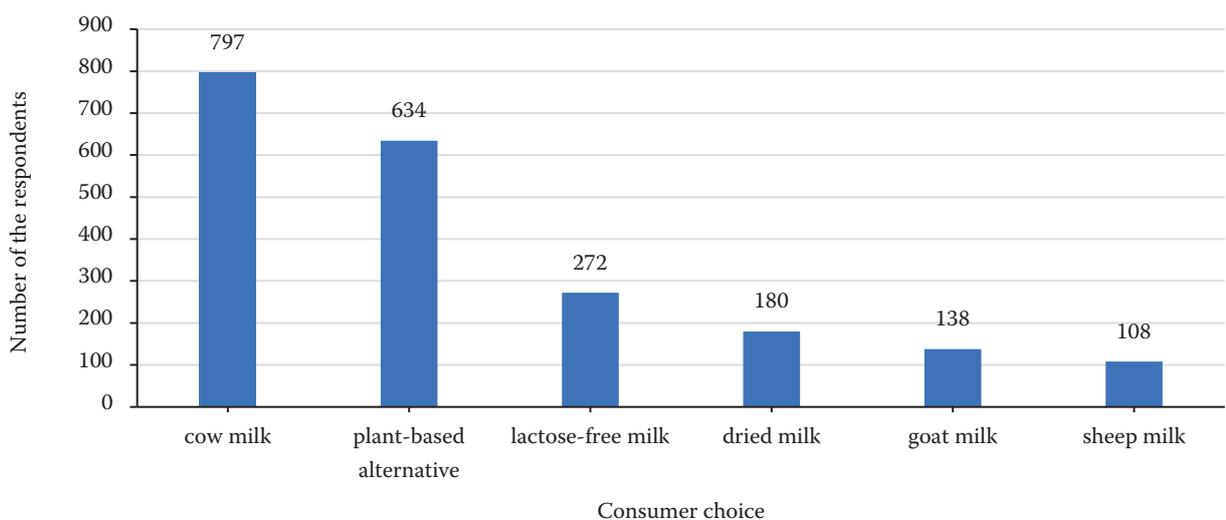


Figure 3. Milk consumption in households in the Slovak Republic

Source: own elaboration

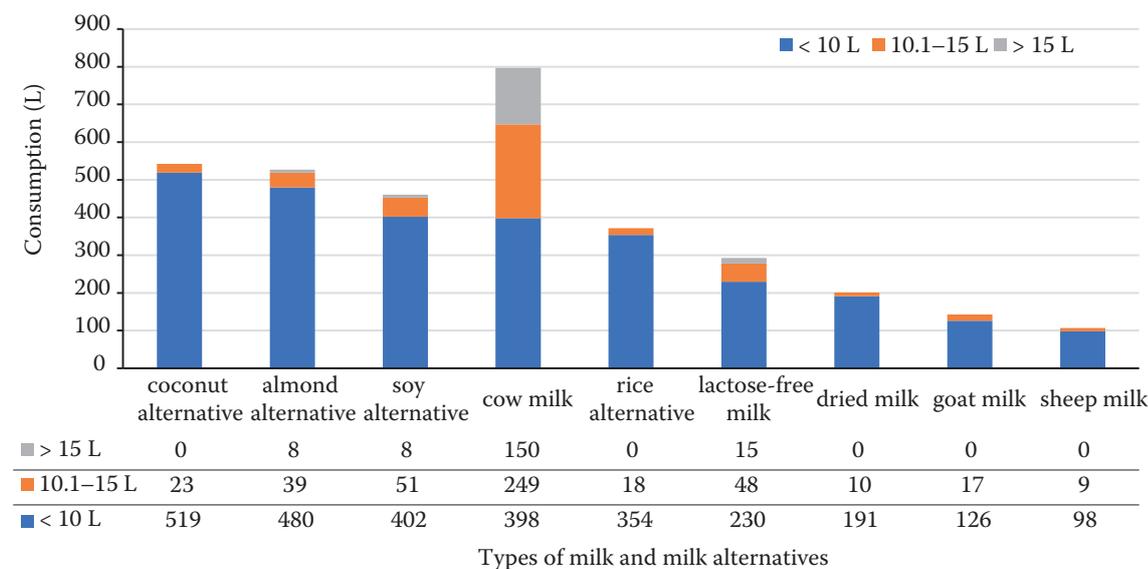


Figure 4. Monthly consumption of selected commodities per household

Source: own elaboration

The relationship between the level of education and the consumption of plant-based milk substitutes was also investigated in the same way. Research shows that people with higher education prefer plant-based milk substitutes. It was confirmed to us that there is a dependence between the respondent's education and the preference for a plant-based alternative to milk (Table 6).

Based on the conducted research we can come to the following findings and conclusions. The following changes occurred in consumer behaviour in the milk and yogurt market: 747 (72%) respondents confirmed that cow's milk is purchased for their household needs, while 633 (61%) respondents hold the idea that cow's milk should not be part of the daily diet. This is probably also why up to 581 (56%) respondents also buy a plant-based alternative. There is a dependence between the respondent's age, education, and preference for plant-based alternatives to milk, higher consumption

of plant-based alternatives, higher consumption of milk due to the long-term stay of the whole family at home, and the related daily cooking, higher interest in buying powdered milk, buying larger quantities at a low intensity, purchasing stocks of shelf-stable milk, frequent preparation of homemade yogurts, inability to buy selected types of goods in stores (absence due to impulse purchases in huge quantities, due to the creation of consumer stocks). The behaviour was also influenced by the changed time regime of establishments, limited access to shopping abroad, and the transition of respondents to a different eating style for various reasons. In the case of milk, 203 (18%) respondents are in favour of higher quality and 108 (10%) are in favour of a lower price. The perception of the quality and price of milk and yogurt is a decisive motivating factor in their purchase. According to the survey, the biggest influence when choosing/purchasing cow's milk and yogurt is the taste of the

Table 5. Binary logistic regression – preference of plant alternative based on age

Choice	Age category	B	SE	Forest	df	Sig.	Exp(B)	Lower bound	Upper bound
	intercept	0.693	0.612	1.281	1	0.258	–	–	–
	age < 18	19.526	0.000	–	1	–	302 112 574.13	302 112 574.13	302 112 574.13
Yes	age 18–34	–1.022	0.686	2.218	1	0.136	0.360	0.094	1.381
	age 35–50	–1.520	0.762	3.980	1	0.046	0.219	0.049	0.974
	age > 51	0 ^b	–	–	0	–	–	–	–

^apreference category is no; ^bthis parameter is set to zero because it is redundant; B – predicted change in Log Odds; sig. – significance

Source: own elaboration

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Table 6. Binary logistic regression – preference of plant alternative based on education

Category	Category of reached education	<i>B</i>	SE	Forest	df	Sig.	Exp(<i>B</i>)	Lower bound	Upper bound
	education	–	–	25.762	5	< 0.001	–	–	–
	less than high school	–0.093	0.573	0.026	1	0.872	0.911	0.296	2.804
	high school	–0.748	0.485	2.377	1	0.123	0.473	0.183	1.225
Step 1 ^a	high school with diploma or GED	–0.870	0.497	3.071	1	0.080	0.419	0.158	1.109
	bachelor’s degree	–1.217	0.491	6.139	1	0.013	0.296	0.113	0.775
	master’s degree	–0.016	0.571	0.001	1	0.978	0.984	0.322	3.013
	doctorate degree	0.539	0.476	1.284	1	0.257	1.714	–	–

^avariable(s) entered on step 1: Education; *B* – predicted change in Log Odds; GED – General Educational Development Test; sig. – significance

Source: own elaboration

given product, and according to the survey, advertising has the least influence, while milk and yogurt are most often bought in hypermarkets and supermarkets. Only 156 (15%) respondents would be interested in any innovation of cow’s milk. The respondents’ ideas about milk innovation are glass bottles with the possibility of return are preferred, innovations related to composition (fortification) and fat content, innovations related to the offer of different packaging volumes, and interest in innovations related to milk flavours.

CONCLUSION

In areas such as milking, feeding, and watering, some primary producers have relatively large plans within their capabilities. For their farms, they want to provide various innovative technologies, devices, and tools that would facilitate their work and increase the efficiency of work, as well as the animal life quality. It is, for example, feed technologies, waterers, feed mixer trucks, cooling boxes, and equipment. Water security, storage capacity, grazing system, waste management, and welfare are all areas that often require high investment costs as well as expert knowledge. Primary milk producers, despite the above, want to build and reconstruct to a greater or lesser extent in the future programming period. Special attention must be paid to waste management since animal production is often criticised for the negative consequences resulting from its activities, which have a negative impact on climate change. The respondents themselves stated that they would support the construction of biopower plants or biogas stations. In addition, they are inclined to procure and implement various innovative technologies that would minimize the risk of water contamination.

As part of improving the quality of animals on the farm, some respondents said that they would also be in favour of the construction of bedding boxes and fitness enclosures for animals. On the one hand, we investigate that the situation in primary production is critical and obviously financially undersized, but on the other hand, primary producers have shown interest in modern technologies and innovative solutions. Furthermore, it was found that 49% of enterprises will sell milk directly, through deliveries to the processor. This form of sales was also popular in the past, and apparently, it will not be any different in the new programming period. In the area of primary production, it is necessary to support the growth of small and medium-sized enterprises in economically weak regions with high unemployment (support for bioproduction processing). Support investment subsidies primarily oriented towards technological and production innovations. Initiate the entry of capital into primary production, the property connection of the food industry with primary production, considering the observance of the rules of economic competition. Furthermore, it is necessary to strengthen the cooperation of primary producers to improve the quality of products and innovations. Improve the transfer of knowledge from science and research into practice to improve the business environment. Ensure targeted provision of a sufficient level of support from national sources and EU funds.

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