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### JUSTIFICATION OF THE USE OF CRITICAL TECHNOLOGIES IN THE AGRICULTURE ON THE BASIS OF FORESIGHT DESIGN METHODOLOGY

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**Abstract.** The article considers the results of using the method of critical foresight technologies in relation to the agricultural sector at the regional level, considering the region as a subject of competitive processes in the context of globalization. The purpose of the study is to determine the critical technology in the agro-industrial complex at the regional level, capable of implementing the final phase of Foresight to affect the industry, markets, environment and ultimately – the competitiveness of the region. Outlining the scope of foresight, the author considers the following key issues in this area, which are: agri-environmental condition of land, social issues – job creation in rural areas, ensuring food production for the population, necessary for medical standards and affordable prices. The research of foresight is focusing on the trends of innovation in the field of science and technology. The results of research have shown that the technology of grazing dairy herds can become a critical technology, a potential factor in the revival of animal husbandry in the region. This approach will solve the problem of maintaining soil fertility as a key competence in the development of the region's agricultural and industrial complex, necessary for high yields of crops, and will solve social problems with job creation, providing food in accordance with medical standards, dairy market development.

**Key words:** foresight, future forecasting, critical technologies, communication.

**JEL Classification:** C53, Q24, O13.

### INTRODUCTION

In modern science, there are many methods and technologies of economic forecasting, which with varying degrees of possibility can represent real picture of the future. They are widely covered in the world scientific literature. In world practice, foresight technology, which means "prediction" in English, is designed to study the future or as a forecast of the future development of economic activities, is considered as an effective forecasting tool. Most authors consider the use of foresight at the national, global level, devoted to theoretical and methodological aspects. The lack of experience in practical application as an effective tool is one of the problems in increasing the competitiveness of regions in the current conditions.

## **LITERATURE REVIEW**

The economic literature reveals various aspects of foresight technology, in particular, the European Association for Technology Transfer, Innovation and Industrial Information (CORDIS) describes in its program materials as follows: Foresight includes actions focused on thinking, discussing and outlining the future, The Australian Innovation Center defines foresight as a systematic reflection on the future and impact on the future (Akhmetzhanova et al.).

According to many scientists, B. Martin proposed classic definition of this technology: “the process associated with a systematic attempt to look into the distant future of science, technology, economics and society to identify areas of strategic research and technology that are likely to bring the greatest economic and social benefits” (Kuklina, 2007); L.M. Hochberg, Russian professor, believes that “Foresight is a system of methods for expert assessment of long-term prospects for innovative development” (Sizov, 2012); director of German Center for Future Research and Forsyth IS K. Kuls, points out that Forsyth - is not only “the choice of winners” in research and technology, such as strategically important areas of research, technology, but also the choice of “losers” – those areas that will not develop (Sizov, 2012).

The unsolved part of the general problem is insufficient study of the practice of “critical technologies” that can apply one of the defining differences of foresight from other methods - to influence the future, try to shape it, use it for active event management and develop practical measures to motivate civilians, institutions.

## **PAPER OBJECTIVE**

The purpose of this work is to determine the critical technology in the agro-industrial complex at the regional level, which in the implementation of the post-foresight phase can affect the production of the industry, market, environment and ultimately – the competitiveness of the agricultural sector.

## **METHODOLOGY**

To substantiate the theoretical positions and reasoning of the conclusions general scientific methods are used, including system, abstract-logical approach, as well as methods of formalization, analysis and synthesis of information, comparative analysis and expert assessments, graphical visualization of factual information.

## **RESULT AND DISCUSSION**

The term critical technology is understood by Bimber and Popper with RAND as a factor / evaluation criterion in specific areas, thus linking technology to the production process of any particular product. In this case, the definition of “criticality” is understood not as a characteristic of the technology itself, but as a quality inherited in the product that was obtained at the output, as a result of using a particular technology (European Foundation for the Improvement of Living and Working Conditions, 2003). Research of critical technologies can be carried out not only in the field of technology, but also to apply these methods in the social and economic sphere. However, this requires the development of new, improved criteria for determining what is considered critical. For critical technologies, these criteria are as follows. Critical technologies must:

- correlates with the political course and decision-making;
- clearly divide what is considered critical (advanced) and non-critical in technology;
- get a reproducible result, which can later be used in other areas and not very competent people (European Foundation for the Improvement of Living and Working Conditions, 2003).

We chose the regional Foresight, because the competitiveness of the region means the ability to perceive global development trends, adapt to them and adapt them to themselves in such a way as to engage in global processes without destroying internal integrity and preserving their national and cultural identity (Kalyuzhnova, 2008).

The areas, where Foresight can be applied, can vary. Based on the list of fixed calls and threats, we can determine the scope of the foresight. As such an area, we choose the region's agro-industrial complex. Outlining the scope of foresight, it is impossible not to touch on such key issues in this area, where the agricultural and environmental condition of land is closely linked with the specifics and features of land resources as a means of production. Moreover, it is a key competence, the main wealth of the region; social issues – job creation in rural areas, ensuring the production of food for the population, necessary for medical standards and at affordable prices, changing the pricing policy for agricultural products and the market. All these aspects are directly related to the meaning of the term "competitiveness" for the region. Elimination of unemployment, a decent standard of living for the population as one of the key participants, profitability for business, budget deficit, investment attractiveness for regional authorities – these are the project participants whose consent must be obtained (Kalyuzhnova, 2008).

Ukraine is among the ten largest grain exporters in the world. It ranks the first place in sunflower seeds and oil export. In the context of globalization and food problem exacerbation in the world, Ukraine will increase markets. It can realize created opportunities in order to integrate onto the globalized market with dignity. According to the President of the Ukrainian Agrarian Confederation L. Kozachenko, the world community sees Ukraine as a source of food production in the long run for 500 million people, including 45 million people in Ukraine. However, there are risks in which these opportunities may not be realized. In 2013, Zaporizhzhia region was at the fifth place for the production of sunflower seeds and winter wheat in Ukraine. In 2018 Zaporizhzhia region was not in the top ten for wheat production in accordance with the results of agricultural production. However, it ranked the 9th among the regions of Ukraine for sunflower production (State Statistics Committee of Ukraine, 2019).

Internal analysis has shown that in the current state of affairs in the agricultural and industrial complex, the region risks to lose its main key competence in the coming years, land fertility, namely. According to the State Agency of Land Resources in the Zaporizhzhia region, 1545.5 thousand hectares of surveyed arable land in the region have different percentages of humus (Tsybrov, 2012):

- a) 1.3 thousand hectares have a humus content in the arable layer of more than 5.0%;
- b) 83.0 thousand hectares – from 4.1 to 5.0%;
- c) 520.0 – from 3.1 to 4.0%;
- d) 771.4 – from 2.1 to 3.0%;
- e) less than 2% of humus - 169.8 thousand hectares.

In such conditions, 85-90% of the crop yield is obtained due to the natural fertility of grants and only 10-15% is obtained due to fertilizers. There is an acute deficit of humus and mineral nutrients of plants. In 2010 – 2012, the negative balance of humus in the region reached 712 kg / ha on average. It can fluctuate in areas from 500 to 800 kg / ha (Markin et al., 2011). In 2018, the average negative balance of humus reached 780 kg / ha (Soils Protection Institute of Ukraine, 2019).

This situation has developed as a result of a catastrophic decline in mineral and organic fertilizers against the background of increased production of cereals and sunflower. In 2018, the application of organic fertilizers amounted to only 137.8 thousand tons, which is 78 times less than in 1990 (Fig. 1). In 1990, 151.6 thousand tons of mineral fertilizers were applied to crops of all kinds of plants. In 2000 only 10 thousand tons were applied. Mineral fertilizers were applied at the level of about 20 thousand tons from 2002 to 2005. Starting from 2016, the application of mineral fertilizers exceeded the level of more than 50 thousand tons. It amounted to 67.3 thousand tons in

2017. In 2018 it amounted to 91.4 and 109.8 thousand tons, respectively (State Statistics Committee of Ukraine, 2019).

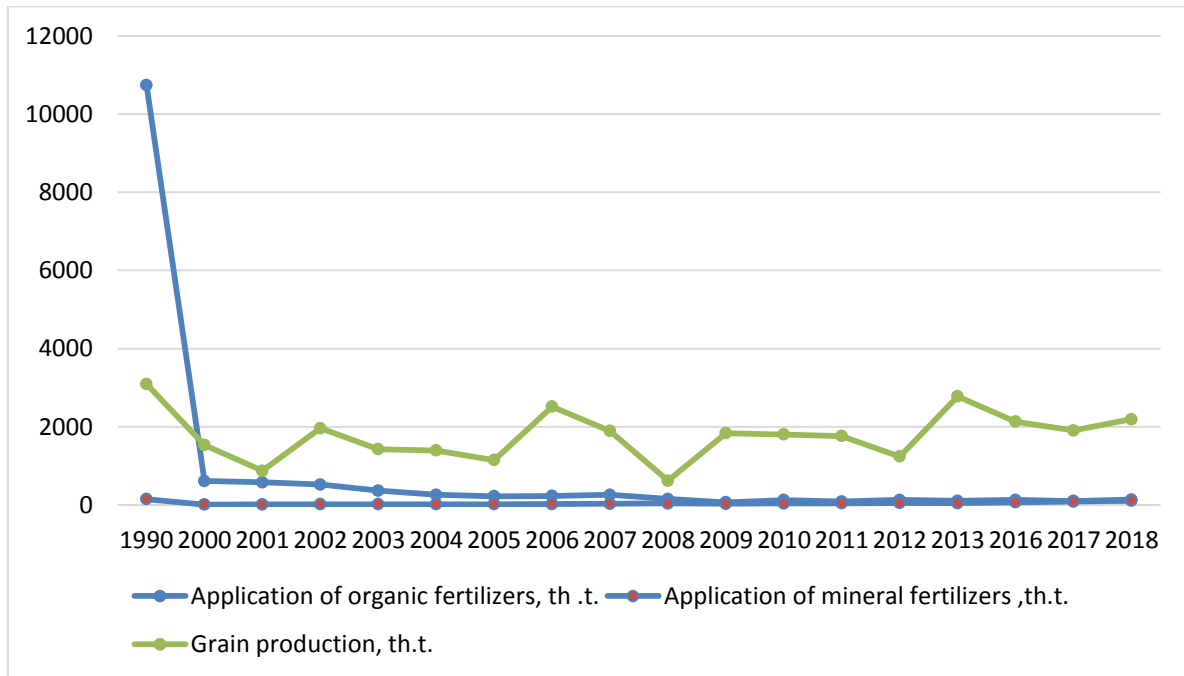


Figure 1. Application of mineral and organic fertilizers and grain production in the Zaporizhzhia region in 1990 – 2018

Source: State Statistics Committee of Ukraine, 2019.

Agricultural lands in the region are in crisis, there is a decrease in soil fertility due to the loss of humus and basic plant nutrients. The shortage of organic fertilizers has developed as a result of a sharp reduction in the number of cattle. On January 1, 2018, the number of cows in agricultural enterprises in the region is about 7.1 thousand heads. It is only 2.2% out of the 1991 amount (State Statistics Committee of Ukraine, 2018-2019). There is a reduction in livestock production. So it happened because it is unprofitable to produce it. Table.1 approves this.

Table 1

The results of the sale of milk in the Zaporizhzhia region

Indicator	Year			
	2010	2016	2017	2018
The cost of 1 quintal, UAH	249,81	440,90	553,85	691,29
The average selling price of 1 quintal, UAH	280,59	501,74	705,06	732,77
The level of profitability (loss),%	12,32	13,80	27,30	6,00

Source: State Statistics Committee of Ukraine, 2019.

In 2018, the profitability of milk production was about 6% (Table 1), the loss of cattle for meat was 45,16 % (Table 2).

Table 2

*The results of the sale of beef in the Zaporizhzhia region*

Indicator	Year			
	2010	2016	2017	2018
<b>The cost of 1 quintal, UAH</b>	528,50	691,23	045,86	917,00
<b>The cost of 1 quintal, UAH</b>	33,26	200,09	266,30	051,23
<b>The level of profitability (loss),%</b>	-38,94	-29,04	-38,10	-45,16

Source: State Statistics Committee of Ukraine, 2019.

As the production of milk and beef is unprofitable, region’s agricultural producers prefer the production of crop products: wheat and sunflower.

Table 3 shows that since 2008 the share of crop production exceeds 70%.

Table 3

*The structure of agricultural products in the Zaporizhzhia region*

Year	1995	2000	2005	2006	2007	2008	2009	2010	2016	2017	2018
<b>Crop production, %</b>	552,7	556,8	772,8	664,5	557,2	770,0	772,5	880,3	885,6	887,3	885,0
<b>Livestock products, %</b>	447,3	443,2	227,2	335,5	442,8	330,0	227,5	119,7	114,4	112,7	115,0

Source: State Statistics Committee of Ukraine, 2019.

In 2018 the share of livestock products decreased to 15.0%. In addition to the environmental problem the existing disproportion in the development between animal husbandry and crop production has created a number of social problems. The contraction of the livestock sector has led to rising rural unemployment.

Milk production has decreased by more than 24 times from 1990 to 2018 (State Statistics Committee of Ukraine, 2019). The recommended consumption of milk and dairy products is 392 kg per head per year. Milk production per capita is declining. In 1995, 280 kg of milk was produced per head. 200 kg of milk was produced in 2004. In 2018 142 kg of milk was produce. The fund of consumption of milk and dairy products in the region decreased from 436.5 thousand tons in 1995 to 320.9 thousand tons in 2000 (Prokopenko, 2017-2019). Since 2001, there has been an upward trend. Over the last twenty years the consumption fund has averaged about 300.0 thousand tons per

year. In 2018 consumption of milk and dairy products amounted to 175 kg per head per year. This is much lower than the recommended norm (Prokopenko, 2017-2019).

Compared to the indicators of developed European countries, this tendency is becoming dangerous to public health. For example, in France, one person consumes about 400 kg of dairy products per year; residents of the Scandinavian countries, Sweden, Denmark and Finland namely, consume more than 500 kg of milk per year (Krylova, 2011).

Analysis of beef consumption shows that the production of beef and veal per head decreases from 21 kg in 1990 to 6 kg in 2010 – 2018. Corresponding to the scientifically substantiated nutrition, the rational norm provides consumption of 82 kg of meat a year by one person. 32 kg (39%) of beef is the amount consumed by one person. Consumption of meat and meat products per head in the Zaporizhzhia region is much less than the norm (Prokopenko, 2017-2019). In 2018, the fund of meat consumption per head amounted to 54.9 kg per year. The volume of milk and beef production depends on the number of cattle, including cows. According to statistics (State Statistics Committee of Ukraine, 2018-2019), the number of cattle is declining every year in the Zaporizhzhia region. The logical solution to the problem of low profitability of milk production is to reduce its cost by reducing the most expensive items. Calculations show that in 2018 the largest share in the structure of the cost of milk production is the cost of feed, which covers 53.7% (State Statistics Committee of Ukraine, 2017-2019).

In our research, we focused on foresight focusing on trends in innovation in science and technology.

As the region is dominated by stall keeping cows, a significant share in the cost of feed is the cost of fuel and lubricants for tillage, crop care, mowing, transportation of feed to livestock complexes, their unloading and distribution to animals. A system of grazing cattle, which is successfully used in advanced countries, may be an alternative to producers of cow's milk.

The popularity and efficiency of pasture-based dairy production is due to the spread of the so-called “New Zealand System”, which is formed in New Zealand and is based exclusively on the pasture system of milk production. New Zealand's largest company, Fonterra Cooperative Group Limited, is also the world's largest exporter of milk and dairy products. Fonterra consists of farming cooperatives, which in total annually collect about 17 billion liters of milk, which is 89% of the country's dairy production (Fonterra Annual Results, 2014).

In 2014, Fonterra Co-operative Group Limited ranked second in the world in milk production with a market share of 2.9% according to the IFCN Dairy Research Center (Brockotter, 2014). Dairy Farmers of America, a world market share of which is 3.7%, is in the first place.

In the United States, the cost of feed in milk production is 35-50%. It is proved that rationally organized milk production based on grazing cows reduces production costs and increases the net income of small and medium enterprises by \$ 150 per cow compared to the usual system of keeping.

Research by Ukrainian scientists also confirms that the most effective way to solve the problem of effective management of the dairy industry should be the widespread introduction of grazing in the region of cows in the summer. Researchers of the Crimean Institute of Agro-Industrial Production conducted an experiment on economic evaluation of types of keeping and feeding rations of cows (Prihodko et al., 2011), the results of which are given in Table 4.

Table 4

*Economic assessment of types of keeping cows in the summer with an average annual milk yield of 5000 kg / goal*

Indicator	Types of saving		
	1	2	3
Average daily milk yield , kg / goal	16,7	16,7	16,7
Daily feed requirement, k.unit./goal.	13,2	13,2	13,2
Feed costs per 1 kg of milk, unit	0,79	0,79	0,79
Area of fodder crops per 1 head	0,62	0,43	0,49
Area of fodder crops for the production of 1 ton of milk, ha	0,12	0,09	0,1
The cost of the daily ration, UAH	5,03	3,16	4,1
The cost of feed. units, UAH	0,38	0,24	0,31
The cost of milk, UAH / kg	0,86	0,54	0,7

Source: after Prikhodko et al. (2011)

Notes: 1 – Stable with the use of green conveyor crops. 2 – Pasture. 3 – Pasture with top dressing of green conveyor crops (50%).

Due to the use of cheaper and complete feed in cattle grazing, the cost of a feed unit in feeding rations is lower by UAH 0.14. The area of fodder land per head is lower by 0.19 ha and by 0.03 ha for the production of a ton of milk compared to the stall, comparing the way of keeping animals and feeding them food on a green conveyor.

The results of the study define that by reducing the costs associated with mowing, transportation and distribution of feed to animals, the cost of feed units for grazing is reduced by 37%, which can significantly increase the profitability of milk production.

Summing up the above arguments, we can conclude that the technology of grazing dairy herds can become a critical technology, a potential factor in the revival of animal husbandry.

When using grazing cows in the Zaporizhzhia region, a real reduction in feed costs by 20 – 30% is possible. In accordance with the indicators of 2018 it has increased the profitability of milk production to 24 – 26%.

Thus, the key factor of success in the revival of dairy farming in the Zaporizhzhia region is the development and implementation of modern technology that will make it possible to increase productivity, production quality and reduce production costs. The development of milk production should be based on feed of own production. This approach will solve the problem of maintaining soil fertility as a key competence in the development of the region's agro-industrial complex, necessary for high yields of crops, and will solve social problems with job creation, providing food in accordance with medical standards, dairy market development.

The presence of an initiative group and an artefact of critical technology that can influence the future, try to shape it, use it for active event management and develop practical measures to achieve

the chosen benchmarks is an important result. The main problem of a foresight is how to integrate its results into the process of public policy. Public policy is understood as the government's response to a publicly recognized problem in specific political, legal and social and economic conditions through various ways of interfering in social reality (Chemerys, 2012).

Subjects of state power and local governments, large and medium-sized businesses, research institutions and universities, infrastructure companies, NGOs are involved to the participants of this stage (Figure 2). The task of this stage is to reconcile the “ideal” scientific vision with the real features and possibilities of practice, to identify limitations, to assess organizational features and conditions (Krymova, 2009). I. Kuklina notes: “Particular attention in foresight’s works is paid to the creation of communication platforms for people who prepare and make decisions” (Kuklina, p.50, 2007).

Any person or social group affected by a collective (social) issue addressed in the field of public policy is a potential public policy actor. Public policy actors are also called stakeholders or groups that have a common interest in solving or maintaining the status quo of a public problem. Public policy actors are divided into three types:

- social groups that are the cause of the social problem (target groups or target groups);
- social groups that experience the negative impact of this problem (final users);
- political and administrative authorities that develop and implement public policy.

In addition to these types of actors, there are so-called “third parties”, who are indirectly affected by public policy. They benefit from this or they are deprived of their capabilities (Chemerys, 2012).

The relationship of the actors is shown in Figure 2:

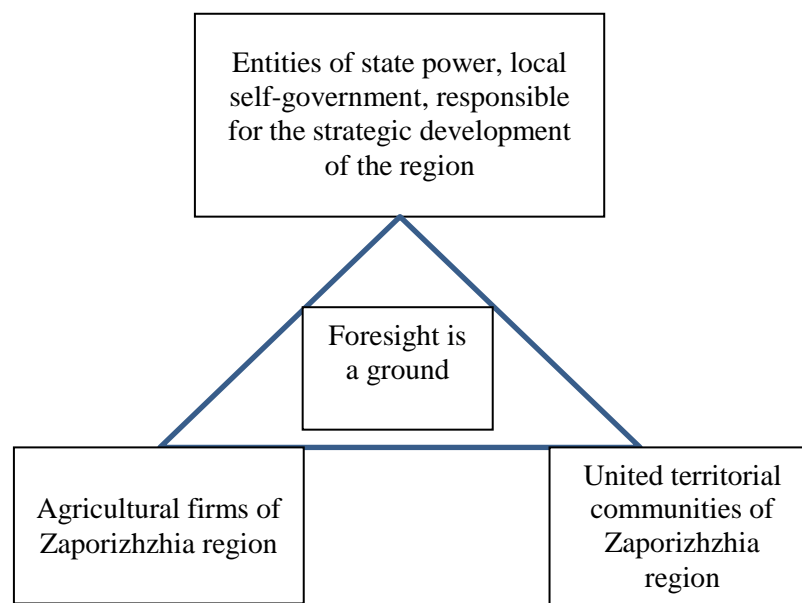


Figure 2. Foresight is a platform at the regional level

In this version, the social group that is the cause of the negative impact of the social problem, i.e. the target group, namely. The target groups are farmers in the Zaporizhzhia region, agricultural firms. Their number is more than 65. The sown area of each is more than 1000 hectares. In our opinion, large land tenants must be engaged in animal husbandry in accordance with the established legal norm. The position of this group will determine whether the foundation of future changes will be laid in the present.

The social group, that is negatively affected by this problem, is represented by the citizens of



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the united territorial communities of Zaporizhzhia region. These are 57 united territorial communities of rural, settlement and urban type. They are end users of all consequences of the negative decision of the considered problem: ecological one. That is the degradation of soil fertility. Social problem is unemployment in the countryside. Medical problem is the lack of necessary livestock products at affordable prices. Moreover, low quality of life and, finally, it reduces life expectancy.

The third actor is the political and administrative bodies. They are the following: Zaporizhzhia Regional State Administration, Zaporizhzhia Regional Council, which develop and implement public policy.

Public discussion within three participants of actors will reduce the time required to analyze the problem, detail the causal links, identify obstacles and possible impacts on the situation, and streamline the process of formulating the problem and the roadmap for its implementation.

Public policy tools provide identification of a public problem based on the interests of stakeholders, putting the problem on the government agenda, developing alternative solutions and choosing the best solution, implementing the policy, monitoring its implementation and assessing the consequences.

The purpose of this stage is to form unified idea of the situation in the region, the attitude to the decisions made and directions of development of all members of the interested public and thus create an opportunity to influence the development of the distant future.

## CONCLUSION

The results of research revealed that the technology of grazing dairy herds can become a critical technology, a potential factor in the revival of animal husbandry in the region.

Studies have shown that the use of technology for grazing dairy animals justify the prospects for the use of critical technologies in the agro-industrial complex on the basis of foresight design methodology.

The technology of grazing animals, based on modern advances in science and practice, can be the subject of dialogue and further cooperation between all stakeholders in order to address issues related to environmental degradation and reducing soil fertility. A key challenge of the region is to reduce rising unemployment, to reduce elimination of disparities in the agricultural sector between livestock and crop production. One of the main targets is an increase in livestock production in accordance with medical standards. Secondly, the main targets are to lay the foundations for changing the future, to increase the competitiveness of the region.

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## **ОБҐРУНТУВАННЯ ВИКОРИСТАННЯ В АПК КРИТИЧНИХ ТЕХНОЛОГІЙ НА ОСНОВІ МЕТОДОЛОГІЇ ФОРСАЙТ-ПРОЕКТУВАННЯ**

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У статті розглянуто результати використання методу критичних технологій форсайта стосовно аграрному сектору на регіональному рівні, розглядаючи регіон як суб'єкт конкурентних процесів в умовах глобалізації. Мета дослідження полягає у визначенні критичної технології в АПК на регіональному рівні, здатної при реалізації заключної фази форсайта вплинути на виробництво галузі, ринки, навколишнє середовище і в кінцевому результаті - на конкурентоспроможність галузі регіону. Окреслюючи область застосування форсайта, автор розглядають такі ключові питання даної галузі, якими є: агроекологічний стан земель, соціальні питання – створення робочих місць в сільській місцевості, забезпечення виробництва продуктів харчування для населення, необхідного за медичними нормами і за доступними цінами. Дослідник фокусування форсайта акцентував на тенденціях розвитку інновацій в області науки і технологій. Результати досліджень виявили, що технологія пасовищного утримання молочного стада може стати критичною технологією, потенційним фактором відродження тваринництва в регіоні. Викладений підхід вирішить проблему збереження ґрунтової родючості як ключової компетенції в розвитку АПК регіону, необхідного для отримання високих врожаїв сільськогосподарських культур, а також дозволить вирішити соціальні проблеми зі створенням робочих місць, забезпечення

населення продуктами харчування у відповідність з медичними нормами, розвиток ринку молочної продукції.

**Ключові слова:** форсайт, прогнозування майбутнього, критичні технології, комунікація

## ОБОСНОВАНИЕ ИСПОЛЬЗОВАНИЯ В АПК КРИТИЧЕСКИХ ТЕХНОЛОГИЙ НА ОСНОВЕ МЕТОДОЛОГИИ ФОРСАЙТ-ПРОЕКТИРОВАНИЯ

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В статье рассмотрены результаты использования метода критических технологий форсайта применительно к аграрному сектору на региональном уровне, рассматривая регион как субъект конкурентных процессов в условиях глобализации. Цель исследования заключается в определении критической технологии в АПК на региональном уровне, способной при реализации заключительной фазы форсайта повлиять на производство отрасли, рынки, окружающую среду и в конечном результате – на конкурентоспособность отрасли региона. Очерчивая область применения форсайта, автор рассматривает такие ключевые вопросы данной области, какими являются: агроэкологическое состояние земель, социальные вопросы – создания рабочих мест в сельской местности, обеспечение производства продуктов питания для населения, необходимого по медицинским нормам и по доступным ценам. Исследователь фокусировку форсайта акцентировал на тенденциях развития инноваций в области науки и технологий. Результаты исследований выявили, что технология пастбищного содержания молочного стада может стать критической технологией, потенциальным фактором возрождения животноводства в регионе. Изложенный подход решит проблему сохранения почвенного плодородия как ключевой компетенции в развитии АПК региона, необходимого для получения высоких урожаев сельскохозяйственных культур, а также позволит решить социальные проблемы с созданием рабочих мест, обеспечения населения продуктами питания в соответствии с медицинскими нормами, развитие рынка молочной продукции.

**Ключевые слова:** форсайт, прогнозирование будущего, критические технологии, коммуникация.