The utility of the outcomes is negatively (reversely) correlated with the number of days required for crossing the route. Hence, the utility of shipping within 27 days, $u(27)$, is lower than the utility of shipping for 18 days, $u(18)$. If the utility function is linear with respect to the days of shipping, one may calculate the alternatives of the expected utilities and corresponding risks of loss of profitability from the transport operation.

$$\text{EU (Northern route)} =$$
$$= 0{,}83 \cdot u\,(27) + 0{,}17 \cdot u\,(14) = u\,(24{,}79)$$

$$\text{EU (Sothern route)} =$$
$$= 0{,}83 \cdot u\,(18) + 0{,}17 \cdot u\,(21) = u\,(18{,}51)$$

Conclusion. Therefore, the Southern route is optimal because the expected utility $u(18.51)$ according to the previous assumption is greater than the expected utility $u(24.79)$.

Bayesian logical network, like logical probability in general, is based on knowledge, so it is called epistemological probability. As a rule, it is acceptable for small-scale economic problems that posess sufficient knowledge of the relationship between the elements of the system. If knowledge about the system and its elements is insufficiant, the elements of fuzzy logic are added to the Bayesian model, which improves the testing of the conclusions of the system of the general Bayesian network. Under such conditions, it is called a Bayesian network of fuzzy logic.

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ЛОГІЧНІ ВИМІРИ ЕКОНОМІЧНИХ РИЗИКІВ

Досліджується економічна природа ризиків, зумовлених взаємодією місцевих (внутрішніх і зовнішніх) та глобальних факторів, що впливають на перебіг економічних подій. Логічні виміри економічних ризиків розглядаються переважно в контексті імовірнісних підходів, сформульованих К. Поппером та Дж. М. Кейнсом. Прикладні аспекти аналізуються на основі теореми Баєса про умовну ймовірність і теорії прийняття р ішень, яка розглядає максимізацію очікуваної вартості, максимізацію очікуваної грошової вартості та максимізацію очікуваної корисності.

Ключові слова: ризик, невизначеність, ймовірність, логічна ймовірність, логічна близькість, аналіз ризику.

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ЛОГИЧЕСКИЕ ИЗМЕРЕНИЯ ЭКОНОМИЧЕСКИХ РИСКОВ

Исследуется экономическая природа рисков, обусловленных взаимодействием местных (внутренних и внешних) и глобальных факторов, влияющих на ход экономических событий. Логические измерения экономических рисков рассматриваются преимущественно в контексте вероятностных подходов, сформулированных К. Поппером и Дж. М. Кейнсом. Прикладные аспекты анализируются на основе теоремы Байеса об условной вероятности и теории принятия решений, которая рассматривает максимизацию ожидаемой стоимости, максимизацию ожидаемой денежной стоимости и максимизацию ожидаемой полезности.

Ключевые слова: риск, неопределенность, вероятность, логическая вероятность, логическая близость, анализ риска.

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INNOVATIVE NATURE OF THE WORLD AND DOMESTIC MARKET OF AGRICULTURAL PRODUCTS

The place and role of agro – innovations are investigated. They are found to be the main driving force both of development of the agricultural products' domestic market and of competitive advantages' formation for the participants in the world market. Accelerated introduction of new generation digital technologies in the agro-industrial complex is determined by the effective use of organizational advantages of the Ukrainian model of agricultural development. Organic production is the latest trend in the world market of agricultural products. However, the advanced technologies actively used by farmers around the world are vertical farms, aquaponics, unmanned aerial vehicles, advances in robotics, and more. Such an active demand for technological innovations and their active use in agriculture contributes to the development of the agri-industry itself, as well as areas that ensure the development and production of innovative products. State assistance and support of farmers' interest in technological innovations, which is implemented in various monetary and budgetary policy measures, remains an urgent issue.

Keywords: innovations, technologies, agro-industrial complex, competitive advantages.

Introduction. Ukraine is confidently increasing its position on the world market regarding the export of agro-industrial complex products. But maintaining the achieved results and reaching the leaders in new product segments require the most efficient use of opportunities provided by the market, accelerated technological development.

The population of the Earth is constantly growing. According to UN forecasts, in three decades the population will grow by 15–20 %, and the world's food needs will double by this time.

World agricultural production has entered a period of global change due to a combination of a number of factors,

the key of which are: global climate change; growth and change in the structure of consumption associated with population growth and welfare growth; the technological revolution, which in recent decades has completely changed the structure of industrial production, is coming to agriculture.

The agro-industrial complex is becoming the focus of interests of global investors and an important tool of international policy. Changes are taking place both in the market and in the organization of agricultural production, in the structure of consumption, in the system of agri-innovation.

The **main goal** of the article is to analyze the innovative component in the general model of development of the world market of agricultural products and to determine the place and prospects of Ukraine for its further integration in a strong competitive position in the world market.

Recent literature review. Theoretical scientific heritage and achievements in the field of theoretical principles and practical recommendations for solving problems of international trade, including agricultural products, and its regulation are devoted to the works of domestic and foreign scientists: O. Shnyrkova, O. Mykhaylenko, T. Tsygankova; A. Egorov and T. Eroshyna study topical issues of international exchange of agricultural goods in their works; the works of M. Porter, D. Ricardo, P. Samuelson are devoted to theories of competitive advantages; the innovative aspect is investigated in the works of O. Stupnytsky, L. Fedulova, S. Davymuk and others.

However, the analysis of scientific works in this area shows the lack of a comprehensive approach in presenting an innovative model of development of the world market of agricultural products and defining the place and role of Ukraine in it.

Main research results. Among the key areas of change in the global agro-industrial complex are: production; consumption; global market; innovations; farm.

The global market for agricultural raw materials and food is awaiting a resumption of rising prices. The wave of mergers and acquisitions in the industry has led to a significant intensification of the land market.

Significant reductions in clean water have already affected not only China and India (water shortages are a traditional problem in these countries), but also the American Midwest, where depletion of aquifers calls into question the possibility of maintaining high yields on irrigated lands. Problems such as soil degradation and the restriction of environmentally harmful farming methods need special attention. For example, in the European Union, agriculture is a source of 10 % of CO2 emissions and more than 50 % of other greenhouse gases, and the agro-industrial complex is a source of 90 %–95 % of ammonia emissions. In the EU, 75 % of used agricultural land is prone to erosion, of which almost 20 % lose more than 10 tons per hectare per year.

Countries and intergovernmental associations are now stepping up work to develop a system of global trade agreements, increasing the promotion of national agricultural products, strengthening the protection of their markets.

Innovations in the agro-industrial complex are experiencing an explosive growth. In the medium term, they will determine the new leaders of the agricultural market. In recent years, the volume of innovations in startups specializing in new agricultural technologies has increased more than 10 times. Robotics, artificial intelligence, and other technologies are becoming commonplace not only on the industrial assembly line, but also in agricultural production. The process of change affects not only startups. Mergers and acquisitions in the "big six" of agri-technological companies are expected to continue [7].

Another important global trend is the active development of centers for the implementation of advanced agricultural technologies as a new tool for state support for the development of agro-industrial complex.

For farms, the trend is the growth of markets with high added value. Key technological innovations are aquaponics, widespread introduction of IT, biological pest control, as well as the development of small mechanization. Interestingly, the best-selling farm car in the UK market in recent years has become a utilitarian ATV.

Widespread introduction of digital technologies is a key trend of the world economy of the last decade. In agriculture, the industry standard is the use of repositioning systems, integrated fleet management, precision farming. But as cross-sectoral analysis shows, the real digital revolution in global agriculture is still ahead.

The world leaders in the introduction of digital technologies are IT companies, media, finance, and insurance. In real production and logistics, the level of digitization is much lower. Agriculture closes the list.

The main deterrent is the peculiarities of agricultural production. But several current trends suggest that this situation will change radically in the coming years. The development and production of robotic agricultural machinery is now at the forefront of innovation.

In general, there are three stages of development and implementation of digital technologies in agriculture:

- pilot technologies: technologies of repositioning, monitoring of the condition of agricultural machinery, etc. are starting to be introduced;
- saturation of the market: currently the number of digital technologies and industry standards in agriculture has reached a critical mass. Virtually all equipment manufacturers, including companies from China and India, offer their own programs and solutions that optimize the use of their machines and equipment. There are several solutions related to precision farming. A variety of options for the use of geodata for crop forecasting, crop optimization, logistics management, etc. are offered. Additional pressure on the user is provided by the arrival of a new generation of agricultural technologies – the Internet of Things and the blockchain;
- integration is a key trend of the future: companies will be a leader in the digitalization of agriculture, which will be able to offer common standards and solutions that combine existing developments in the field of digital agricultural technologies and eliminate the problem of choice and associated risks [11].

It is possible to solve the problem of digital technology development in global agriculture by creating integrated cloud services. Such services will take over the acquisition of data from digital units of agricultural equipment and ensure compatibility of different formats and protocols. In addition, a single service can provide the most efficient use of data that is useful to all agricultural companies in the region – remote sensing, hyperspectral aerial photography, weather forecast data, etc.

An additional advantage of such a cloud service will be marketing and logistical support for farmers. Access to information will reduce the risks of crop overproduction, provide access to real prices for agricultural products and reduce the cost of intermediary services, simplify the construction of transport chains.

The effect of the introduction of unified cloud services for agriculture may be a doubling of profits per hectare [1]. The finding of such services will create the preconditions for a significant acceleration of digitalization of agriculture.

Accelerated introduction of a new generation of digital technologies for the Ukrainian agro-industrial complex is an effective way to use the organizational advantages of the Ukrainian model of agricultural development. In addition, it will significantly increase the efficiency of invest-

ment in the agro-industrial complex, raise the return on each hryvnia invested. The creation of a single state cloud service can be a crucial element of non-financial state support for agriculture.

The use of a systematic, well-thought-out state approach to the introduction of a new generation of digital technologies in agriculture should become an important and promising component of the strategy of development of the Ukrainian agro-industrial complex.

New ambitious tasks of agricultural development require further development of the agricultural financing system, bringing it to a new quality level. The following tasks of development are allocated as priority:

- reduction of terms of decision-making on granting for financing in agro-branch;
- providing more flexible financing conditions that meet the specifics of the agricultural business, which is exposed to significant climate risks;
- further simplification of access to bank and leasing financing for small agribusiness;
- reducing bank interest rates on loans, expanding access to government support [9].

Supporting high rates of development, intensification of investments requires increasing the reliability of investment and expanding the number of investors in agriculture. Modern financial technologies can significantly increase the speed of transactions, provide multifactor analysis of large amounts of data.

It is important that such technologies are implemented not only in the United States, the EU, Canada, and other developed countries. Successful experience in the introduction of modern financial technologies, focused primarily on small agribusiness, farmers, is in a few rapidly growing African countries: South Africa, Kenya, Nigeria, Tanzania. International support and weakness of "traditional" financial institutions have created a good climate in these countries for innovations in the field of financial technology.

It is interesting and important to understand the system of integrated automated scoring which are used for assessment of the creditworthiness of farmers and agricultural entrepreneurs in Kenya. The advantage of this system became wide access to credit and a high rate of return.

A very simple procedure for cooperation is implemented for the user:

- It is enough for farmers and small entrepreneurs to send an application by e-mail and provide a few key financial data: harvest, revenue, expenses. Then the system analyzes the creditworthiness and, in case of a positive decision, opens access to the requested funds. It uses its own payment system, built based on mobile communication.
- Financial institutions are offered a range of services aimed at solving such key problems as reducing transaction costs, improving the reliability of the analysis of borrowers (risk management), portfolio expansion [4].

The scoring system used is based on modern financial technology, which combines highly efficient data search algorithms, processing large arrays of information, decision-making based on neural networks.

Adaptation of Ukrainian legislation for the introduction of new financial technologies will significantly increase the investment attractiveness of the agro-industrial complex of Ukraine, simplify the organization of export supplies of agricultural products to the Middle East and North Africa. It will also allow to take an important step in achieving the goals of the strategy of development of the agro-industrial complex of Ukraine.

Another trend in the global agricultural sector is the technology of protected soil, provide high efficiency of agricultural production and in general allow to solve one of the main problems of investment in agriculture – a significant impact of adverse environmental factors.

Protected soil agriculture requires access to modern technologies: computer control of nutrient solutions, temperature, and humidity of the environment, etc. An example of the active use of natural competitive advantages for the development of agricultural production of protected soil is Israel. Now this country not only exports vegetables grown in greenhouses but is also the largest supplier of agricultural technology in the world.

New technologies such as LED light sources with an optimal spectrum of radiation and aeroponics for photosynthesis have made it possible to take the next step in the development of agricultural production of protected soil.

From a practical point of view, the application of aeroponics technologies has led to the creation of "vertical farms" – a new format of agricultural production [8].

Placing vertical farms directly in the city, near a shop or restaurant significantly reduces the cost of transporting products, maintaining freshness, and so on. Such farms allow to use any free areas or even to make them mobile, based on the truck.

The projected average market growth rate is 25 % per year. The main components of this market are lighting systems, equipment for aero- and hydroponics, load-bearing structures, usually container-type, as well as computer equipment and software.

The largest markets for vertical farm equipment are Southeast Asia and the United States – about 30 % of the world market each.

For Ukraine, the task of developing agriculture of protected soil is particularly acute. The use of vertical farm technologies is an opportunity to become one of the world leaders in the application of modern agricultural technologies and reduce the risks of investing in the industry. The market for vertical farm equipment is growing rapidly. This is a good opportunity for the development of domestic high-tech production.

One of the new directions of technological development is the market of agricultural unmanned aerial vehicles. According to forecasts, it is one of the fastest growing high-tech markets in the world. The average annual growth rate is estimated at 30 % per year [10].

The largest national market for agricultural drones is the United States. Currently, this country sells about a third of all drones. But in the long run, high growth rates will show the markets of Europe and developing countries.

The rapid growth of the world market for agricultural unmanned aerial vehicles confirms the effectiveness of their use. The use of agricultural technologies based on the use of unmanned aerial vehicles is becoming one of the key factors of competitiveness. This is especially important for Ukraine, which agriculture has ambitious goals for entering the world market.

It is important that the export-oriented agro-industrial complex of Ukraine creates an excellent domestic market for agricultural aircraft. Today, they are not very popular in Ukraine, but in the long run its popularity may increase significantly. The opportunities of the domestic market of Ukraine are sufficient to form on its basis one of the world leaders in the market of agri-unmanned aerial vehicles. Given the high growth rate of the market (up to 30 % per year) – it becomes a very promising area.

Thus, now the competitiveness of agricultural products is determined by the efficiency of its production and the use of advanced technologies create favorable conditions for the development of the domestic agro-industrial complex.

The use of a systematic, well-thought-out state approach for the introduction of a new generation of digital technologies and financial technologies in agriculture should become an important and promising component of

the strategy of development of the agro-industrial complex of Ukraine.

The use of protected soil farming technologies such as vertical farms can promote Ukraine's entry into the world leaders in the application of modern agricultural technologies, and through the rapid growth of this market the production of equipment for vertical farms will promote the development of domestic high-tech agro-industrial complex.

Currently, a new technological wave is unfolding in the world economy, which will be characterized by the development of robotics; biotechnologies based on modern advances in molecular biology and genetic engineering; nanotechnology; artificial intelligence systems. The urgency of flexible automation of production is increasing, the use of renewable energy sources is significantly increasing, biotechnology will become the basis for the development of agro-industrial complex.

All this creates the preconditions for the formation of a new structure of markets for means of production and products of the agro-industrial complex.

Ukraine has a significant potential for the development of agro-industrial complex at the global level. Favorable agronomic conditions, the availability of diversified infrastructure and the availability of educated able-bodied human capital are main reasons for it.

However, the main constraints on the development of the agro-industrial complex are low wages, high levels of corruption, high inflation, import dependence, the use of outdated methods and production technologies and the imperfection of the financial and credit system.

Based on the above data, we can predict two models of development of the agro-industrial complex of Ukraine, considering the general innovative trends in the world market of agricultural products.

The first model provides for the achievement of stable growth of the sector and specialization in those market segments where the products of the agro-industrial complex of Ukraine are already competitive. The second model can be implemented under the conditions of scientific and technological development of the Ukrainian agro-industrial complex [12].

The main drivers of the development of the agro-industrial complex of Ukraine under the first model will be the gradual recovery of the economy, import substitution and further development of traditional export niches. Improving investment conditions will be because of stimulating monetary and fiscal policies.

The main condition for the implementation of the second model will be the acceleration of growth of the Ukrainian economy in the medium term due to increased public investment. This involves additional investments in the development of scientific and innovative activities, support for agricultural exports and stimulation of consumer demand for domestic goods.

The main purpose of scientific and technological development of the agro-industrial complex of Ukraine is to ensure the competitiveness of Ukrainian products in foreign and domestic markets primarily through the creation, dissemination, and application of the latest advances in science and technology. The implementation of this goal is designed to ensure the transition to high-performance (accelerated selection, active substances for modern veterinary drugs and plant protection products, etc.), high-tech (synthetic biology, food biotechnology, functional foods, etc.), resource-efficient (smart agriculture, balanced unified fodder, etc.), climate-adaptive (zoned varieties and breeds, new generation irrigation complexes, vertical farms, etc.) production of agricultural raw materials and products with a high level of processing.

Mass production and export of competitive products with high added value will be possible due to the steady growth of labor productivity and resource efficiency.

Therefore, important conditions for the development of the agro-industrial complex can be: overcoming the scientific and technological lag of the domestic agro-industrial complex from the level of the world's leading countries and cost-effective reduction of its dependence on technology imports; formation in the agro-industrial complex of an innovative system that ensures the creation and development of advanced domestic developments, as well as the adaptation of imported technologies where necessary; priority development of basic and applied research in promising areas (including by attracting private investment); increasing the availability of new technologies for medium and small businesses, farms and individual producers; leveling the technological level of large and medium-sized industries; priority development of innovations in the field of resource efficiency, storage infrastructure, processing and logistics.

An important condition for Ukraine's successful integration into the innovative model of world market development is active international cooperation in this area. This will be facilitated by the interest of a number of countries with limited agri-climatic opportunities in the stable supply of agricultural products, raw materials and food, the establishment of agricultural production in other countries with favorable agri-climatic conditions, including Ukraine.

Currently, the Ukrainian economy is facing the task of finding new sources of growth, one of which should be a high-tech and globally competitive agro-industrial complex. Progress in this direction requires the improvement of scientific and technical policy in the agro-industrial complex, improving the quality of methodological, informational, and expert-analytical support of relevant management decisions. To achieve this goal, it is important to increase the efficiency of the implementation of sectoral regulatory instruments. It is also necessary to increase the scale of funding for agricultural education and agricultural science, which today is not at a high enough level [3].

The development of the agro-industrial complex of Ukraine will provide significant changes in the socio-economic sphere, will positively affect the stability of economic growth, ensuring the economic security of the country, improving employment and quality of life.

Conclusion. Innovations in the agro-industrial complex are experiencing an explosive growth. In the medium term, they will determine the new leaders of the agricultural market. In recent years, the volume of innovations in startups specializing in new agricultural technologies has increased more than ten times.

The use of a systematic, well-thought-out state approach to the introduction of a new generation of digital and financial technologies in agriculture should become an important and promising component of the development strategy of Ukraine's agro-industrial complex.

The use of protected land technologies such as vertical farms can promote Ukraine's entry into the world leaders in the application of modern agricultural technologies, as well as due to the rapid growth of this market, the production of equipment for vertical farms will contribute to the development of domestic high-tech agro-industrial complex. Another new direction of technological development of the agro-industrial complex is the market of agricultural.

Ukraine has excellent prospects for successful integration into the world market of agricultural products, considering a fairly high level of innovation in the field of agriculture, as well as significant potential for the development and production of high-tech innovative products.

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ІННОВАЦІЙНИЙ ХАРАКТЕР РОЗВИТКУ СВІТОВОГО ТА ВІТЧИЗНЯНОГО РИНКУ СІЛЬСЬКОГОСПОДАРСЬКОЇ ПРОДУКЦІЇ

Досліджено місце та роль агроінновацій як основної рушійної сили розвитку вітчизняного ринку сільськогосподарської продукції та формування конкурентних переваг його учасників на світовому ринку. Прискорене впровадження цифрових технологій нового покоління в аграрно-промисловому комплексі визначено як ефективне використання організаційних переваг української моделі розвитку сільського господарства. Органічне виробництво є новітнім трендом світового ринку сільськогосподарської продукції. Однак, передовими технологіями, що активно використовуються фермерами з усього світу, стали на сьогодні вертикальні ферми, аквапоніка, безпілотні літальні апарати, досягнення у сфері робототехніки тощо. Такий активний попит на технологічні новації та їх активне використання у сфері сільського господарства сприяє як розвитку самої агрогалузі, так і сфер, що забезпечують розробку та виробництво інноваційної продукції. Актуальним питанням залишається державне сприяння та підтримка цікавості фермерів до технологічних новинок, що реалізується в різноманітних заходах грошово-кредитної та бюджетної політики.

Ключові слова: інновації, технології, агропромисловий комплекс, конкурентні переваги.

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ИННОВАЦИОННЫЙ ХАРАКТЕР РАЗВИТИЯ МИРОВОГО И ОТЕЧЕСТВЕННОГО РЫНКА СЕЛЬСКОХОЗЯЙСТВЕННОЙ ПРОДУКЦИИ

Проведено исследование места и роли агроинноваций как основной движущей силы развития отечественного рынка сельскохозяйственной продукции и формирования конкурентных преимуществ его участников на мировом рынке. Ускоренное внедрение цифровых технологий нового поколения в аграрно-промышленном комплексе определено как эффективное использование организационных преимуществ украинских моделей развития сельского хозяйства. Органическое производство является новым трендом мирового рынка сельскохозяйственной продукции. Однако передовыми технологиями, которые активно используются фермерами со всего мира, стали на современном этапе вертикальные фермы, аквапоника, безпилотные летательные аппараты, достижения в сфере робототехники и т. п. Такой активный спрос на технологические новации и их активное использование в сфере сельского хозяйства способствует как развитию самой агросферы, так и сфер, которые обеспечивают разработку и производство инновационной продукции. Актуальным вопросом остается государственное содействие и поддержка интереса фермеров к технологическим новинкам, которые реализуются в разнообразных мероприятиях денежно-кредитной и бюджетной политики.

Ключевые слова: инновации, технологии, агропромышленный комплекс, конкурентные преимущества.

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ВПЛИВ ШТУЧНОГО ІНТЕЛЕКТУ НА РОЗВИТОК МІЖНАРОДНОГО ОСВІТНЬОГО СЕРЕДОВИЩА

Проаналізовано передумови виникнення штучного інтелекту, розглянуто світові практики його впровадження у життєдіяльність суспільства. Наведено приклади стратегій успішного використання технологій штучного інтелекту в освітньому середовищі країн Близького Сходу, США, у Китаї, Індії, Японії, Німеччині, Канаді. Обґрунтовано необхідність створення єдиних стандартів розроблення алгоритмів штучного інтелекту.

Ключові слова: штучний інтелект, освітнє середовище, робототехніка, цифровізація, нейронні мережі, машинне навчання.

Постановка проблеми. Наприкінці грудня 2019 року Стенфордський університет оприлюднив результати дослідження, згідно з яким обчислювальна потужність штучного інтелекту вже понад сім років випереджає закон Мура. Цей закон говорить, що швидкість процесора подвоюється кожні 18 місяців, а отже, розробники можуть очікувати подвоєння продуктивності додатків в ці строки за тією самою вартістю обладнання. Але звіт групи дослідників зі Стенфордського університету, підготовлений у співпраці з McKinsey & Company, Google, PwC, OpenAI, Genpact і AI21Labs, показав, що обчислювальна потужність ШІ зростає швидше, ніж потужність традиційних процесорів. Переломним моментом, коли швидкість розвитку штучного інтелекту стала ви-