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вул. Георгія Гонґадзе, 9, м. Миколаїв, Україна, 54008
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tel.: +38(0512) 70-93-54
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PhD in Agricultural Sciences, Associate Professor, Head of the Department of Entomology, Phytopathology and Physiology, Ukrainian Order of the Badge of Honor, Research Institute of Forestry and Agroforestry named after H. V. Vysotskyi, Ukraine

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Full Doctor in Agricultural Sciences, Professor, Professor of the Department of Food Technologies, Uman National University of Horticulture, Ukraine

Olexander Zhukov

Full Doctor in Biological Sciences, Professor, Professor of the Department of Botany and Horticulture, Melitopol State Pedagogical University named after Bohdan Khmelnytskyi, Ukraine

Ihor Kovalenko

Full Doctor in Biological Sciences, Professor, Dean of the Faculty of Agrotechnology and Nature Management, Sumy National Agrarian University, Ukraine

Vitalii Pichura

Full Doctor in Agricultural Sciences, Associate Professor, Head of the Department of Ecology and Sustainable Development named after Professor Yu. V. Pilipenko Kherson State Agrarian University, Ukraine

Lidiya Mishchenko

Full Doctor in Biological Sciences, Professor, Leading Research Fellow, NSC "Institute of Biology and Medicine", Taras Shevchenko National University of Kyiv, Ukraine

Boris Boincean

Full Doctor in Agricultural Sciences, Professor, Director of the State Institution Scientific Research Institute of Field Crops "Selektisia", Republic of Moldova

Valentina Gamayunova

Full Doctor in Agricultural Sciences, Professor, Head of the Department of Agriculture, Geodesy and Land Management, Mykolaiv National Agrarian University, Ukraine

Lidia Antipova

Full Doctor in Agricultural Sciences, Professor of the Department of Plant Breeding and Horticulture, Mykolaiv National Agrarian University, Ukraine

Anatoliy Lymar

Full Doctor in Agricultural Sciences, Professor of Viticulture and Horticulture, Mykolaiv National Agrarian University, Ukraine

Mykola Samoilenko

Full Doctor in Agricultural Sciences, Professor of Viticulture and Horticulture, Mykolaiv National Agrarian University, Ukraine

Vyacheslav Sichkar	Full Doctor in Biological Sciences, Professor, Acting head of the Department of Genetics, Selection and Seed Production of Legumes, Breeding and Genetics Institute – National Center for Seed Science and Variety Research of NAAS, Ukraine
Serhiy Chornyy	Full Doctor in Agricultural Sciences, Professor Head of the Department of Soil Science and Agrochemistry, Mykolaiv National Agrarian University, Ukraine
Viktor Shcherbakov	Full Doctor in Agricultural Sciences, Professor of the Department of Field and Vegetable Crops, Odessa State Agrarian University, Ukraine
George Moraru	Full Doctor in Agricultural Sciences, Leading Researcher, Institute of Genetics, Physiology and Plant Protection of the Academy of Sciences of Moldova, Republic of Moldova
Raisa Vozhehova	Full Doctor in Agricultural Sciences, Professor, Director of the Institute of Irrigated Agriculture NAAS, Ukraine
Serhiy Kramarenko	Full Doctor in Biological Sciences, Professor, Professor of Genetics, Animal Feeding and Biotechnology, Mykolaiv National Agrarian University, Ukraine
Serhiy Ruban	Full Doctor in Agricultural Sciences, Professor, Acting Head of the Department of Genetics, Breeding and Biotechnology of Animals, National University of Life and Environmental Sciences of Ukraine, Ukraine
Olena Fedota	Full Doctor in Biological Sciences, Professor, Professor of Obstetrics and Gynecology, V. N. Karazin Kharkiv National University, Ukraine
Svitlana Kovtun	Full Doctor in Agricultural Sciences, Professor, First deputy director for scientific work, Institute of Animal Breeding and Genetics named after M. V. Zubets of NASU, Ukraine
Viktor Balatsky	Full Doctor in Agricultural Sciences, Senior Researcher, Head of the Laboratory of Genetics, Institute of Pig Breeding and Agroindustrial Production NAAS, Ukraine
Bogdan Gutyj	Full Doctor in Veterinary Sciences, Professor, Professor of Pharmacology and Toxicology, Stepan Gzhytskyi National University of Veterinary Medicine and Biotechnologies Lviv, Ukraine
Tetyana Dyman	Full Doctor in Agricultural Sciences, Professor, Vice-rector for educational, educational and international activities, Bila Tserkva National Agrarian University, Ukraine
Isaak Rashal	Full Doctor in Biological Sciences, Professor, Institute of Biology, Latvia
Mykhailo Gil	Full Doctor in Agricultural Sciences, Professor, Dean of the Faculty of TVPPTS, Mykolaiv National Agrarian University, Ukraine
Igor Gorbatenko	Full Doctor in Biological Sciences, Professor, Professor of the Department of Genetics, Animal Feeding and Biotechnology, Mykolaiv National Agrarian University, Ukraine
Valentyn Rybalko	Full Doctor in Agricultural Sciences, Professor, Chief Researcher, Institute of Pig Breeding and AP NAAS of Ukraine, Ukraine
Lyudmila Patreva	Full Doctor in Agricultural Sciences, Professor, Head of the Department of Poultry, Quality and Product Safety, Mykolaiv National Agrarian University, Ukraine
Tetiana Pidpala	Full Doctor in Agricultural Sciences, Professor, Head of the Department of Technology of Processing, Standardization and Certification of Livestock Products, Mykolaiv National Agrarian University, Ukraine
Serhiy Luhovyy	Full Doctor in Agricultural Sciences, Associate Professor, Acting Head of the Department of Genetics, Animal Feeding and Biotechnology, Mykolaiv National Agrarian University, Ukraine
Antonina Panfilova	Full Doctor in Agricultural Sciences, Associate Professor, Head of the Department of Plant Breeding and Horticulture, Mykolaiv National Agrarian University, Ukraine
Ihor Atamanyuk	Full Doctor in Technical Sciences, Professor, Professor of the Department of Applied Mathematics, Warsaw University of Life Sciences, Republic of Poland
Valerii Budak	Full Doctor in Technical Sciences, Professor, Rector, V. O. Sukhomlynskyi National University of Mykolaiv, Ukraine
Andriy Stavynsky	Full Doctor in Technical Sciences, Professor, Head of the Department of Power Engineering, Electrical Engineering and Electromechanics, Mykolaiv National Agrarian University, Ukraine
Viacheslav Prus	Full Doctor in Technical Sciences, Associate Professor, Head of the Department of Electrical Engineering, Kremenchuk Mykhailo Ostrohradskyi National University, Ukraine
Galyna Kondratenko	PhD in Technical Sciences, Associate Professor, Associate Professor of the Department of Intelligent Information Systems, Petro Mohyla Black Sea National University, Ukraine
Oleksiy Kozlov	PhD in Technical Sciences, Associate Professor of Computer Control Systems, Admiral Makarov National University of Shipbuilding, Ukraine
Antonina Kalinichenko	Full Doctor in Agricultural Sciences, Professor of the Institute of Technical Sciences, Opole University, Republic of Poland
Vijay Virendra	PhD, Professor, Head, Center for Rural Development and Technology, Delhi Indian Institute of Technology, India
Boris Butakov	Full Doctor in Technical Sciences, Professor, Mykolaiv National Agrarian University, Ukraine

ЗМІСТ / CONTENTS

В. В. Гамаюнова, Л. Г. Хоненко, О. А. Коваленко Виробництво біоетанолу із соргових культур	9
V. Gamaunova, L. Khonenko, O. Kovalenko Bioethanol Producing from Sorghum Crops	9
О. В. Шебаніна, А. І. Бурковська, Т. І. Лункіна, А. В. Бурковська Аспекти формування продовольчої безпеки в контексті епідеміологічних обмежень у США	19
O. Shebanina, A. Burkovska, T. Lunkina, A. Burkovska The Aspects of Food Security Formation in the Context of Epidemiological Restrictions in the USA.....	19
Н. М. Сіренко, К. А. Мікуляк Ринкова складова економічної безпеки суб'єктів аграрного сектору	30
N. Sirenko, K. Mikuliak Market Component of Economic Security of Agricultural Sectors.....	30
О. І. Котикова Концепція формування продовольчої безпеки на засадах сталого розвитку сільськогосподарського землекористування.....	40
Olena Kotykova The Concept of Food Security Formation on the Basis of Sustainable Development of Agricultural Land Use	40
В. С. Шебанін, І. В. Аллахвердієва Страхове шахрайство: теоретична концептуалізація та шляхи протидії	50
V. Shebanin, I. Allahverdiyeva Insurance Fraud: Theoretical Conceptualization and Countermeasures.....	50
І. В. Гончаренко, Н. О. Шишпанова Агрострахування як умова сталого розвитку сільських територій	59
I. Honcharenko, N. Shyshpanova Agricultural Insurance as a Condition for Sustainable Development of Rural Areas.....	59
Г. О. Решетілов Місцевий економічний розвиток територіальних громад	69
G. Reshetilov Local Economic Development in Territorial Communities.....	69
Н. В. Потриваєва, Л. А. Козаченко, І. І. Недбайло, І. В. Нестерчук Цифровізація обліку в управлінні бізнес-процесами підприємств агропромислового комплексу.....	79
N. Potryvaieva, L. Kozachenko, I. Nedbaylo, I. Nesterchuk Digitization of Accounting in the Management of Business Processes of Enterprises of the Agro-Industrial Complex	79

Bioethanol Producing from Sorghum Crops

Valentina Gamayunova^{*}, Lyubov Khonenko, Oleg Kovalenko

Mykolaiv National Agrarian University
54008, 9 Georgiy Gongadze Str., Mykolaiv, Ukraine

Abstract. The relevance of the article lies in a comprehensive analysis of the trend in the production of biofuels from crop products in Ukraine and other countries of the world. The purpose of the research was to justify on the basis of research by both their own and many authors that sorghum varieties are extremely important in cultivation due to changes in soil and climatic conditions. When conducting research, we used generally accepted methods, techniques and DSTU, in particular: the method of comparison, analysis and synthesis, laboratory and field. Computer methods of information processing and visualization of research results using the Microsoft Office program were also used. According to the results of research, it was found that with less favorable temperature conditions and moisture supply in 2020 yr., grain sorghum crops formed a yield depending on the hybrid in the range of 2.1-6.9 t/ha, in a more favorable year for these indicators in 2021 yr. it was at the level of 6.9-14.5 t/ha, and on average for two years it was in the range of 4.5-10.7 t/ha. Performance stability was determined in the U 60117 IG and Bianca hybrids. On average, over two years, the theoretical yield of biofuels, depending on the hybrid, ranged from 2216 up to 5199 l/ha with a starch content in the grain of more than 75%. The highest estimated alcohol yield per unit area was in the grain sorghum hybrid U 60116 IG, which combines a stable yield (10.7 t/ha) with a high starch content in the grain (75%). Treatment of sugar sorghum crops with biologics and microfertilizers had a positive effect on the yield of structural units per hectare: compared to the control, the yield of leaves during organic balance processing increased by 2.66 t/ha, the yield of panicles – by 1.56 t/ha, and stems – by 3.64 t/ha. The increase in the conditional yield of sugars relative to the control of treatment with Quantum microfertilizers was 0.354 t/ha, organic balance – 0.417 t/ha, and with their combined action – 1.143 t/ha, which was the maximum value

Keywords: grain sorghum, sugar sorghum, yield, starch yield, biofuel yield, energy efficiency

INTRODUCTION

In recent years, due to the increase in the population, the expansion of large cities and rising living standards, the demand for traditional energy resources has been growing, which in turn leads to increased global pollution, reduction of natural resources and productive areas, as well as the extinction of certain plant and animal species [1]. At the same time, the use of non-traditional and renewable energy resources, in particular bioethanol can significantly mitigate the negative effects associated with increased fossil energy production [1-3].

Bioethanol is a refined ethyl alcohol made from biomass or raw ethyl alcohol for use as biofuels. It is usually classified as a first-generation biofuel. The main advantage of bioethanol over gasoline as an energy source is its relatively low cost and the absence of harmful emissions into the atmosphere. For the production of

bioethanol, agricultural crops with a high sugar or starch content are used [4]. The addition of bioethanol to gasoline increases the oxygen content, which makes it to achieve more complete combustion of gasoline, while reducing CO₂ emissions [5].

Among the many crops which are suitable for the production of bioethanol, one of the most promising crops is sorghum, which has a high photosynthetic efficiency and it can form a powerful energy biomass in a short time [6]. Sorghum, in particular, can also be grown in meadows and pastures, where it is capable of producing high levels of yields. In addition, a small seeding rate and later sowing dates make sorghum an indispensable insurance crop.

A special feature of this crop is its high drought resistance, which is quite important for arid areas of the steppe zone, where other cereals greatly reduce the

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yield [7; 8]. The emergence of modern varieties and hybrids of sorghum with fundamentally new characteristics regarding the content of sugar-containing substances, effective use of their genetic potential require improving the system of selection and rational placement in a certain soil-climatic zone, taking into account biological characteristics, adaptability, agroecological plasticity and reaction to growing conditions [9; 10].

LITERATURE REVIEW

Biofuels are usually obtained from plant or animal biomass, which provides a viable energy source a number of studies have shown that energy plants can reduce greenhouse gas emissions [11]. According to foreign researchers [12], the most common biomass for fuel production is corn, wheat, sugar cane, sugar beet and sorghum.

These sources provide great potential for both replacing conventional fuels and reducing polluting emissions. Due to the increasing global demand for alternative energy types, the prospects for growing sorghum varieties have been increasing in recent years. In addition, sorghum crops are highly adaptable to drought, high air temperatures and soil salinity. These characteristics make the crop ideal, especially in changing climatic conditions and a suitable raw material for sustainable biofuel production [7; 13].

However, its yield varies depending on the variety or hybrid, growing conditions (soil, water, climate, pests and diseases, etc.) and elements of agricultural technology [14-16]. At the same time, compared to corn and sugar beets other agricultural crops, sorghum uses significantly less moisture and nutrients due to the favorable combination of its agrotechnical and technological characteristics [7; 10]. Sorghum requires an average of 300 parts of water per unit of dry matter, wheat – 515, barley – 545, sugar beet – 470. Sorghum consumes 300 kg of water for the formation of 1 kg of dry matter, and corn consumes 388 kg, which makes it one of the best raw materials in the production of biofuels [17].

Sorghum contains the huge share of energy (65-75%) in substances which are easily converted to ethanol. In sugar sorghum, this substance is a sugar complex in the juice of the stem, and in grain sorghum it is starch. The starch yield from grain sorghum (70-74%) is significantly higher than that of corn (67-72%). If stems and grain are used for the production of bioethanol, its volume can reach 7.000 liters per year per hectare [18].

In the United States, sorghum is one of the main crops from which bioethanol can be produced, and its yield is 25-30% higher than that of corn and wheat. As for sorghum in Ukraine, the production of this crop allowed our state to enter the top ten producing countries in the world, but in terms of export volume, according to estimates of the US Department of Agriculture, Ukraine is one of the first in the world out of five major exporters [19; 20].

Now for the production of biofuels at agricultural biogas plants, corn silage is most widely used [13; 21], the main advantage of which over other substrates is that

it guarantees stable production of biogas and methane, it greatly facilitates the dosage of the substrate into the fermentation chamber and it stabilizes the operation of the cogeneration plant.

Due to the warming climate, corn growing areas are decreasing and sorghum is becoming an alternative crop for the production of biofuels and biogas. Sorghum is more resistant to drought than corn, and its biomass yield is higher in years with low rainfall. Sorghum is more tolerant of changing environmental conditions, and its production is less energy-intensive compared to corn [22]. This is an extremely important factor, since energy crops must have a positive energy balance, that is, they are characterized not only by high biomass yields, but also by low energy costs associated with technological operations for cultivation.

According to G. Popova [23], sorghum, as an energy and fodder crop, is of significant practical interest for agriculture in general and especially for arid regions of Ukraine. It exceeds the level of yield of corn and is able to provide high yields in this zone. The positive properties of sorghum culture include the fact that it is unpretentious to soil fertility.

The introduction of innovative sorghum cultivation technologies is important not only in the agronomic aspect, but also from an economic point of view. In recent years, intensive sorghum cultivation technologies based on the use of low-molecular synthetic heterocyclic compounds derived from various classes have attracted considerable attention as effective and environmentally friendly substitutes for phytohormones and traditional plant growth regulators. The main advantages of using these compounds in agricultural practice are their wide specificity of action on various types of agricultural plants and high physiological activity at low concentrations (10^{-8M} - 10^{-12M}) compared to phytohormones or their synthetic analogues, which show physiological activity at higher concentrations – 10^{-4M} - 10^{-6M} . The use of synthetic compounds in low concentrations prevents environmental pollution in comparison with chemical mordants and existing plant growth regulators, which are used in significantly higher concentrations and have a longer half-life [24].

Now one of the directions of increasing the productivity of field crops, in particular sorghum, restoring fertility and improving the soil is mycorization. As established by studies [25], inoculation of sorghum seeds (8 g/kg) with a mycorrhizal fertilizer preparation of American production Bioarsenal contributed to an increase in grain yield by 0.6-0.8 t/ha.

In the last decade, the United States, Australia, Canada and Brazil, as well as Ukraine, have started introducing the technology of introducing biochar – activated charcoal from agro-biomass (sorghum, corn, hemp and energy perennials) into the soil since 2021. This organic substance is chemically neutral, is able to absorb and retain moisture and nutrients well, absorb and neutralize harmful chemicals, reduce the acidity of the soil (increasing pH from 3.9 to 5.1) and increase the accumulation of

carbon in it [26]. Depending on the soil and climatic conditions, the efficiency of the biochar varies [27].

Further research of the proposed technological solutions is a climate-oriented innovative agricultural technology for growing sorghum crops using biotechnological alternatives and biologically active nanomaterials.

Growing sorghum on an optimal nutritional background increases both productivity and the main indicators of economic efficiency, in particular, the growth of production and the level of profitability [8; 21; 28].

The purpose of the study is an analytical review of the world production of bioethanol and the feasibility of growing the most productive varieties and hybrids of sorghum crops in the Southern steppe of Ukraine in order to switch from traditional energy sources to renewable ones, to analyze bioenergy opportunities and prospects for their use for the effective development of the country's agricultural sector.

MATERIALS AND METHODS

Field research was conducted in 2020-2021 yrs at the experimental sites of the Educational, Scientific and Practical Center of the Mykolaiv National Agrarian University. The area of the sown area is 90 m², the accounting area is 25 m², and the repetition rate is three times. The climate is continental, it is characterized by sharp and frequent fluctuations in annual and monthly air temperatures, significant heat reserves and aridity. Soil-southern heavy loamy slightly saline chernozem.

Its predecessor is winter wheat. Agricultural cultivation techniques are generally accepted for the Southern steppe zone of Ukraine. After harvesting, the plant residues were treated with Ecostern stubble biodestructor (1.5 l/ha) with the addition of urea 5.0 kg/t of straw at a working solution consumption of 300 l/ha, they were earned with a heavy disc harrow BDT-7 to a depth of 12-14 cm. In autumn, plowing was carried out (25-27 cm). In spring, N₃₀P₃₀K₃₀ (2 centners/ha of nitroammofoski) was applied for cultivation. Sorghum was sown in the second decade of May with a row spacing of 70 cm with a domestic Klen-2.8 seed drill.

Seed treatment of Advanta Seeds sorghum hybrids was carried out before sowing with Quantum microfertilizer (4.0 l/t) and organic balance battery preparation (1.0 l/t). During the growing season (the tillering phase and the release of plants into the tube), the crops were fed with a mixture of these preparations (4.0 l/ha Quantum + 1.0 l/ha Organic balance). Sugar sorghum seeds were not processed, only top dressing of crops was carried out according to the experiment scheme in the tillering phase and the beginning of stemming with Quantum microfertilizer (4.0 l/ha), Organic balance (1.0 l/ha) both separately and together. Before the 3-5-leaf phase, crops were treated with the herbicide Pik (15-20 g/ha), and Karate Zeon insecticide (0.2 l/ha) was used against aphids if the harm threshold was exceeded. The density of plants for the harvesting period was 120 thousand/ha

for grain sorghum, 130 thousand/ha for sugar sorghum. The yield was determined from the accounting area of the plot, followed by its recalculation per hectare.

2020 yr. was a dry year with 240 mm of precipitation during the growing season, which is 89% of the long-term average. Average daily temperatures from January to July 2020 were significantly higher than the long-term average. Spring was early, but prolonged. From the second half of summer to the beginning of autumn 2020, there were prolonged droughts with little precipitation and high temperatures. For almost the entire growing season of sorghum in 2021yr., including during critical periods of crop growth and development, on the contrary, the water regime was optimal – precipitation provision was 163% of the average annual norm.

The calculation of the economic efficiency of sorghum varieties was carried out using standard technological maps developed for the Southern steppe of Ukraine. When planning and conducting research, we were guided by generally accepted guidelines and manuals [29; 30]. For detailing the object and subject of the research, theoretical and methodological generalization of the obtained results, the abstract method is applied, in particular its techniques – induction and deduction, analysis and synthesis. The main research methods were: field experiments to determine the impact of technology on the growth and development of sorghum plants; laboratory, in which the sowing qualities of seeds, the chemical composition of raw materials, the content of starch and sugars in plants were determined; mathematical and statistical, dispersive – to assess the reliability of experimental data; calculation-comparative – to establish the economic and bioenergetic efficiency of the studied factors.

RESULTS AND DISCUSSION

The global biofuel market replaces 2.32-5.0% of oil consumption, using more than 71 million hectares of arable land. The world production of biofuel in 2018 was 154 billion liters. In the context of biofuels, ethanol production is higher than biodiesel. The main producers of ethanol are the United States (2018: 54% share), the main raw material is corn, and in Brazil (2018: 30% share), the main raw material is sugar cane [31].

One of the key global levers for reducing CO₂ pollution from transport is the development of the biofuel market. However, in 2020 yr., due to the coronavirus pandemic in the United States, the production and consumption of ethanol tended to decrease. Global biofuel production fell to 151 billion liters in 2020, down 6% from 161 billion liters in 2019, according to an annual report published by the International Renewable Energy Agency (IRENA). Bioethanol production fell by 8%, while biodiesel production was relatively stable. In 2020, the US and Brazil remained the leading global producers of bioethanol, accounting for a combined 83% of global production [32].

In 2021/2022 MR, due to unfavorable weather conditions and a smaller area of plantations, the production

of ethanol from sugar cane decreased, in particular in Brazil by 10% – to 26.78 billion liters, but ethanol produced from corn increased by 15% – to 3.47 billion liters [33].

Ethanol is produced from a variety of raw materials, especially agricultural products such as corn and straw in the United States and China, sugar cane pulp and straw in Brazil, and molasses in India. About 80% of the world's ethanol production is used as fuel, while the rest (20%) is used for industrial purposes. Almost 60% of ethanol is produced from corn, 25% from sugar cane, 7% from molasses, 4% from wheat, and the rest from other cereals, such as cassava and sugar beet. The share of second-generation non-food ethanol production is insignificant (0.4%, 0.4 billion liters/year), although it is expected in the EU and US countries it is expected to increase significantly in the future and may double by 2023 yr. [34].

Raw materials for use are determined by the climatic conditions of a given country or region. It was found that the production of ethanol from sugar cane is 50-60% cheaper than from corn. In our opinion, in 2021-2022, the difference between the costs of growing these crops and the production of bioethanol from these raw materials in connection with the increase in the price of energy carriers had a growing tendency. According to [35], the cultivation of sugar cane requires less chemicals, in particular pesticides and fertilizers, and the production of bioethanol from it provides the highest energy balance and reduces the cost of fuel produced by six times compared to corn, especially in South American countries. It is expected [34] that by

2029, sugar cane production will increase by 25%, while corn production will decrease by 14%. It was also determined that in economic terms, sugar cane was the best option compared to crops such as corn or sugar beet, but significant government support could increase the competitiveness these cultures, especially in the EU and the United States, which explained why the United States became the world's largest producer of ethanol.

Pro-Consulting conducted a study of the alcohol and bioethanol market, which presented the main trends, capacity, dynamics and structure in the alcohol and bioethanol market in Ukraine and the EU [36].

The European biofuel industry is mainly limited to two separate sectors: such as bioethanol and biodiesel, which do not rely on the same raw materials for fuel production. In the EU, bioethanol is produced mainly from cereals and sugar beet derivatives. Wheat is used in Northwestern Europe, while corn is used in Central Europe and Spain. The use of sugar beet covers France, Germany and Belgium [5]. Today, in Europe and in the world, the processes of starting the production of second-generation bioethanol, which is obtained from non-food cellulose raw materials, such as wood, grass energy crops, straw, corn, etc., are becoming increasingly [37]. In 2020, the EU, according to USDA estimates, produced 25 million liters of cellulosic bioethanol. In post-Soviet countries, cereals and potatoes were traditionally used for the production of ethyl alcohol at various times. However, during this period, the production of bioethanol from sugar-containing material had the lowest cost (Table 1).

Table 1. Efficiency of bioethanol production from various raw materials in post-Soviet countries

Raw materials	Volume of production from the area 1 ha, m ³	Cost dollars/m ³
Sugar beet	2.5-3.0	300-400
Sugar cane	3.5-5.0	160
Corn	2.5	250-400
Wheat	0.5-2.0	380-400
Potatoes	1.2-2.7	800-900
Sugar sorghum	3.0-5.0	200-300

Source: [18]

A comparative analysis of various types of raw materials for the production of ethanol shows that it is the cheapest for the use of sugar cane as 160 dollars for 1 m³, for sugar sorghum it is 200-300 dollars and for corn grains it is 250-400 dollars per 1 m³.

Sorghum is a valuable biological raw material for the production of ethanol. From 1 ton of sorghum grain, you can get 650-700 kg of starch or 300-350 liters of alcohol, which is 35 liters more than from 1 ton of corn. Calculations [20] have determined that existing varieties and hybrids of sugar sorghum can provide sugar production at the level of 2.8-3.0 t/ha on non-irrigated land and 4.5-5.0 t/ha on irrigated land. Due to the fact that sugar beet is practically not grown in the south of Ukraine, sorghum can significantly replenish sugar reserves.

In Ukraine, more than 4 million hectares of land are concentrated, which, due to degradation and salinization, it is advisable to withdraw from intensive cultivation [13].

Calculations prove that [18] about 200 tons of sugar can be obtained from an area of 100 hectares of sugar sorghum (with an average green mass yield of 30.0 t/ha and 18% sugar content). In some years, it is quite possible to get up to 100 tons of green mass from 1 ha of sugar sorghum without watering. Ukraine has existing capacities and schemes for processing this biomass for feed, food and energy needs.

In Ukraine, it is most appropriate to place sugar sorghum in the southern and eastern zones of the country, since the area of sugar sorghum cultivation for syrup

production is limited by the temperature potential. The high sugar content in plants accumulates only in the southern zone of Ukraine, where the average annual sum of active temperatures exceeds 2800-3000°C. [18; 20]. When a smaller amount of temperatures is set, the rate of sugar accumulation decreases. In the years of research (2020-2021 yrs.), the sum of positive temperatures as of August 31st was in the range of 3171-3334°C.

A peculiar distribution of heat and moisture during the year and growing season was noted in 2020 yr. In ten months, only 320.2 mm of precipitation fell, which was by 60 mm less than the long-term average. In addition, the distribution of precipitation throughout the year was extremely uneven. The main part of precipitation fell by mid-summer, in the period from the second decade of May to the second decade of June (Table 2).

Table 2. Agrometeorological conditions for conducting research according to the NNPC MNAU weather station

Month	Average monthly rate air temperature, °C			Average monthly rate amount of precipitation, mm			Average monthly rate air humidity, %		
	2020 yr.	2021 yr.	Average perennial	2020 yr.	2021 yr.	Average perennial	2020 yr.	2021 yr.	Average perennial
January	0.39	-1.13	-3.6	24.2	67.0	25	85.98	92.72	84
February	2.65	-1.25	- 3.0	52.8	33.4	21	85.21	88.49	81
March	6.98	3.01	2.3	9.8	26.8	23	67.31	80.31	77
April	9.26	7.88	9.6	5.0	47.0	30	52.21	77.68	67
May	13.93	14.95	16.3	49.2	61.6	40	70.13	77.80	64
June	21.88	20.20	19.9	90.2	104.8	67	69.01	80.76	62
July	24.13	24.79	22.9	28.4	82.6	47	52.52	65.0	59
August	23.08	23.27	22.0	7.0	19.0	37	48.55	60.48	60
September	19.54	15.36	16.9	36.6	32.4	28	54.81	61.63	66
October	14.73	9.32	10.8	39.6	48.4	35	81.77	69.03	74
November	4.43	5.72	3.8	1.6	39.2	27	85.69	91.86	85
December	3.79	2.70	1.3	17.2	47.0	29	91.57	91.67	87

Source: compiled according to the author's research

Weather conditions in 2021 were more favorable in terms of temperature conditions and providing crops with moisture. Analysis of the weather conditions of the study years, as noted above, showed that they were

quite contrasting and significantly differed from the long-term average parameters, which affected the productivity of the studied hybrids of sorghum grain selection Advanta Seeds (Table 3).

Table 3. Yield of sorghum hybrids of grain selection Advanta Seeds, t/ha

Name of hybrid	Yield		Average for two years
	2020	2021	
ADV G 1329	3.2	7.3	5.3
Yankee	5.8	9.6	7.7
Sentinel	2.4	7.8	5.1
Bianca	6.1	13.3	9.7
MR Eclipse	4.3	8.5	6.4
MR Bazley	2.1	6.9	4.5
U 60116 IG	6.9	14.5	10.7
U 60117 IG	6.3	13.8	10.1
HIP ₀₅ , т/га	0.45	0.74	

Source: compiled according to the author's research

Calculations of the theoretical yield of alcohol from hybrids of sorghum grain selection Advanta Seeds, studied by us during 2020-2021 yrs. in the experimental

field of the Scientific, Educational and Practical Center of the Mykolaiv National Agrarian University, are shown in Table 4.

Table 4. Grain yield, starch content and theoretical alcohol yield from grown products of Advanta Seeds sorghum hybrids (average for 2020-2021 yrs.)

Hybrid, sample	Grain yield, t/ha	Starch content, %	Theoretical* alcohol yield from 1 ha, l
ADV G 1329	5.3	74	2541
Yankee	7.7	74	3691
Sentinel	5.1	76	2511
Bianca	9.7	75	4713
MR Eclipse	6.4	76	3151
MR Bazley	4.5	76	2216
U 60116 IG	10.7	75	5199
U 60117 IG	10.1	75	4907

Note: * – the theoretical yield of anhydrous alcohol from 1 ton of starch was 71.98 dcl.
Source: compiled according to the author's research

The hybrid of grain sorghum U 60116 IG, which combined a constant yield (10.7 t/ha) simultaneously with a high starch content in the grain (75%), was determined to be the most optimal in terms of ethanol yield per unit area (5199 l/ha). Research also found that depending on

the background of nutrition, sugar sorghum hybrids were able to accumulate sugars in the stems in different ways. The highest indicator was formed according to the variants of the experiment in the phase of milk-wax ripeness of grain by a hybrid Medoviy (Table 5).

Table 5. The content of total sugars in sugar sorghum stalks in the phase of milk-wax ripeness of grain, depending on the studied factors (average for 2020-2021 yrs), %

Foliar top dressing * (factor B)	Variety/hybrid (factor A)			Average by Factor B	Average by research
	Silo 700 D (St)	Medoviy	Troistiy		
Control	14.1	15.5	15.4	15.0	15.5
Qu	14.3	15.9	15.8	15.3	
OB	14.5	15.7	15.6	15.3	
OB + Qu	14.9	17.1	16.7	16.2	
Average by factor A	14.5	16.1	15.9	15.5	

Note: * – Qu – microfertilizer Quantum; OB – preparation Organic Balance; OB+Qu – joint use of the preparation Organic Balance and microfertilizers Quantum
Source: compiled according to the author's research

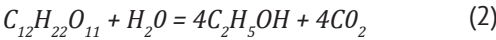
The increase in the sugar content in the stems, compared to the control, when treated separately with Quantum microfertilizer or Organic Balance preparation averaged 0.2% and 0.4% over the years of research, respectively, and the combined use of Organic Balance and Quantum microfertilizer as 0.8 %. It was found that to a greater extent this indicator depended on the genetic characteristics of the sorghum-hybrid composition.

An integral indicator which characterizes the efficiency of growing sugar sorghum for energy purposes is the yield of biofuels (bioethanol, biogas, solid biofuels) and energy yield [1; 32]. According to literature sources, as well as the results of research conducted at the Institute of Bioenergetic Crops and Sugar Beet (IBC&SB), it was found that the juice from sugar sorghum stalks contained on average about 15% dry matter, of which 13% was sucrose, 1% was monosaccharides and 1% of other dry substances (starch, minerals) [17; 31]. Thus, bioethanol from sugar sorghum juice is produced mainly from sucrose. The bioethanol yield can be calculated using the formula (1):

$$M = \frac{U \cdot n \cdot S \cdot b \cdot k}{100} \tag{1}$$

where, *M* – yield of bioethanol from 1 ha of sugar sorghum, t/ha; *U* – yield of stems, t / ha; *n* – juice yield factor, *n*=0.5; *S* – total sugar content in juice, %; *b* – the yield factor of bioethanol from sucrose, *b*=0.53; *k* – the factory yield coefficient of bioethanol, *k*=0.9.

To calculate the yield of bioethanol, it is proposed to use the formula of alcoholic fermentation:



According to the formula, the yield of bioethanol from sucrose is 53%, the remaining 47% is carbon dioxide. Therefore, the coefficient *b*, which characterizes the yield of bioethanol from sucrose, which dominates the juice of sugar sorghum stalks, is 0.53. With modern processing technologies in plants, bioethanol losses are assumed at the level of 9...15%, so the coefficient of factory yield *K* is proposed to be taken as 0.9. Juice from sugar sorghum stalks is obtained mainly using roller presses. The juice yield is about 50% (i.e., *n*=0.5)

of the stem yield, or 75% of the moisture available in the stems. According to the results of research, the indicators of conditionally calculated ethanol yield for the

cultivation of sugar sorghum against the background of joint top dressing of crops with Organic Balance and Quantum microfertilizer are shown in Table 6.

Table 6. Yield and sugar content in stem juice and theoretical alcohol yield from sugar sorghum (average for 2020-2021 yrs.)

Variety, hybrid	Yield of stems, t/ha	Sugar content in the juice of the stems, %	Alcohol yield from 1 ha, l	
			by methodology IBC&SB	Theoretical*
Silo 700 D (st)	25.0	14.9	1789	2194
Medoviy	49.3	17.1	2412	4965
Troistiy	37.9	16.7	1811	3728

Note: * – the theoretical yield of anhydrous alcohol from 1 ton of invert sugar is 58.9 dkl

Source: compiled according to the author's research

To determine the energy yield from bioethanol obtained from one hectare of sugar sorghum crops, it is necessary to multiply the calculated mass of bioethanol by its energy intensity according to Formula 3:

$$Em=M \cdot em \quad (3)$$

where, *Em* – energy output, GJ/ha; *M* – bioethanol yield from 1 ha of sugar sorghum, t/ha; *em* – energy intensity of bioethanol, GJ/t (25 GJ/t).

Thus, from 1 ha of sugar sorghum sowing with a stem yield of 25-49.3 t/ha and a juice sugar content

of 14.9-17.1%, you can get from 1.8 tons up to 5.0 tons of bioethanol, which is equivalent to 45 to 125 GJ of energy.

According to the definitions [13; 16], this indicator may be significantly higher in sugar sorghum as an energy raw material compared to other agricultural crops used for the production of alternative energy sources.

The coefficient of energy efficiency of sugar sorghum cultivation in the MNAU National Research Center also depended on the studied factors (Table 7).

Table 7. Coefficient of energy efficiency of sugar sorghum cultivation depending on the studied factors (average for 2020-2021 yrs.)

Foliar top dressing* (factor B)	Hybrid (factor A)			Average by factor B	Average by research
	Silo 700 D (St)	Medoviy	Troistiy		
Control	5.6	8.9	8.3	7.6	7.9
Qu	6.0	9.2	8.9	8.0	
OB	6.0	9.2	8.9	8.0	
OB+Qu	5.9	9.0	8.9	7.9	
Average by factor A	5.9	9.1	8.7	7.9	

Note: * – Qu – microfertilizer Quantum; OB – preparation Organic Balance; OB+Qu – application of the preparation Organic Balance and microfertilizers Quantum

Source: compiled according to the author's observations

Indicators of the energy efficiency coefficient in our studies ranged from 5.6 up to 9.2. On average, for two years of cultivation, this indicator was 2.8-3.2 units of hybrids Troistiy and Medoviy was higher compared to the Silo 700 d variety. when processing crops with microfertilizer Quantum, the energy efficiency coefficient increased by 0.4 units, with Organic Balance it increased by 0.4, and when processing both of these preparations together it increased by 0.3.

According to the results of research by G.M. Kaletnik, the domestic market of bioethanol can reach 800-1200 thousand tons per year, as provided that it replaces 10-15% of the hydrocarbon part of gasoline consumed in Ukraine [3; 19]. The European Space has even greater

potential for bioethanol exports. The export of transport ethanol may become a serious source of currency and an environmentally friendly energy commodity of Ukraine on the international fuel market in the future.

Currently, the world has the necessary production potential and developed technologies that make it possible to produce technical hydrolyzed alcohol. However, hydrolysis technologies are based on the use of sulfuric acid, which is why they are environmentally harmful. It is necessary to improve existing technologies for obtaining transport ethanol and develop modern more environmentally friendly ones. Moreover, from an energy and economic point of view, grain ethanol surpasses all types of fuel from raw materials, and ethanol obtained

from biomass is the next significant step forward. Therefore, it is necessary to search for new biologically safe raw materials sources of sucrose and starch. In this regard, interest in sorghum (grain and sugar) crops will constantly grow.

CONCLUSIONS

The duration of droughts is one of the most serious problems of the impact of climate change on agriculture, both at the regional and global levels. As one of the best solutions to this problem is the selection of crops which are characterized by high yields and drought resistance. Such a crop is sorghum, which has many advantages in terms of cultivation, storage, threshing, use for food preparation and biofuels.

According to the results of variety testing of hybrids of sorghum grain selection Advanta Seeds, it was found that on average for two years their yield of hybrids ranged from 4.5 t/ha up to 10.1 t/ha. During 2021 yr., the weather conditions were more favorable, which made it possible to form a harvest of 6.9 up to 14.5 t/ha. The maximum yield was provided by the U 60116 IG hybrid as 14.5 t/ha, it was also determined to be high in the U 60117 IG and Bianca hybrids, while the yield was lower in other hybrids studied. The best hybrid in terms of

ethanol yield per unit area (5199 l/ha) was identified as grain sorghum U 60116 IG, which combined a high yield (10.7 t/ha) with a simultaneously high starch content in the grain (75%).

Sugar sorghum, as a promising bioenergetic crop, is able to form high and stable yields of raw materials under extreme growing conditions, favorably distinguished by drought resistance, salt tolerance, and economical consumption of moisture. This crop can provide a stable base for bioenergy in the conditions of the Southern steppe of Ukraine. From 1 ha of sugar sorghum crops with a stem yield of 25-49.3 t/ha and a juice sugar content of 14.9-17.1%, you can get from 1.8 tons up to 5.0 tons of bioethanol, which is equivalent to 45 to 125 GJ of energy.

Research with sorghum culture should be continued and deepened. After all, every year there are new drugs, varieties and hybrids, as well as changes in climate and soil fertility.

You should also take into account the results of recent scientific research, including on Nanotechnologies, which were obtained in Ukraine and other countries of the world. Carry out their production verification and enter them. This will significantly increase the area of grain growing and thereby ensure Ukraine's energy independence.

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Виробництво біоетанолу із соргових культур

Валентина Василівна Гамаюнова, Любов Григорівна Хоненко, Олег Аналолійович Коваленко

Миколаївський національний аграрний університет
54008, вул. Георгія Гонґадзе, 9, м. Миколаїв, Україна

Анотація. Актуальність статті полягає в комплексному аналізі тенденцій виробництва біопалива з продукції рослинництва в Україні та інших країнах світу. Метою досліджень було на основі досліджень як власних, так і багатьох авторів обґрунтувати виняткову важливість сортів сорго у вирощуванні у зв'язку зі зміною ґрунтово-кліматичних умов. При проведенні досліджень використано загальноприйняті методи, методики та ДСТУ, зокрема: метод порівняння, аналізу та синтезу, лабораторний та польовий. Також використовувалися комп'ютерні методи обробки інформації та візуалізації результатів дослідження за допомогою програми Microsoft Office. За результатами досліджень встановлено, що за менш сприятливих температурних умов та вологозабезпеченості у 2020 р. посіви сорго зернового формували врожайність залежно від гібриду в межах 2,1–6,9 т/га, у більш сприятливий рік за цими показниками у 2021р. вона була на рівні 6,9–14,5 т/га, а в середньому за два роки – в межах 4,5–10,7 т/га. Стабільність продуктивності визначали у гібридів U 60117 IG та Б'янка. У середньому за два роки теоретична врожайність біопалива залежно від гібриду коливалася від 2216 до 5199 л/га при вмісті крохмалю в зерні понад 75%. Найвищий розрахунковий вихід спирту з одиниці площі мав гібрид зернового сорго U 60116 IG, який поєднує стабільну врожайність (10,7 т/га) з високим вмістом крохмалю в зерні (75%). Обробка посівів цукрового сорго біопрепаратами та мікродобривами позитивно вплинула на врожайність структурних одиниць з гектара: порівняно з контролем урожай листя за органобалансової обробки підвищився на 2,66 т/га, урожай волоті – на 1,56 т/га. /га, а стебла – на 3,64 т/га. Приріст умовної врожайності цукрів відносно контролю за обробки мікродобривами Квантум становив 0,354 т/га, органічного балансу – 0,417 т/га, а за їх сумісної дії – 1,143 т/га, що було максимальним значенням

Ключові слова: зернове сорго, цукрове сорго, урожайність, вихід крохмалю, вихід біопалива, енергоефективність

The Aspects of Food Security Formation in the Context of Epidemiological Restrictions in the USA

Olena Shebanina*, Anna Burkovska, Tetyana Lunkina, Alla Burkovska

Mykolaiv National Agrarian University
54008, 9 Georgiy Gongadze Str., Mykolaiv, Ukraine

Abstract. In conditions of food instability, exacerbated by environmental, political, demographic processes, the state regulation of the economy is of particular importance to maintain food security and social stability. The development of technologies (both agri-food and digital) significantly improves the process of providing the population with food through the prism of their availability, accessibility and security. The aim of this study is to thoroughly analyze the current trends under the influence of epidemiological restrictions due to the spread of COVID-19 in the United States, and to identify the main strengths and weaknesses of the food security system in the United States, which may become a model for other countries that follow similar principles of national economies due to its flexibility and sustainability. The methodological basis of the study involves thorough analysis of indicators describing the dynamics of food security and consumer behavior in a pandemic. In addition, the study used methods of synthesis, deduction, induction, generalization, systematization, benchmarking and others. The article considers the main aspects of food security formation in the context of epidemiological restrictions in the USA. The dynamics of consumer spending on food during the COVID-19 pandemic and the corresponding costs with the indicators of the years before the pandemic (since 2010 to 2019) were studied. The state of the labor market in the restaurant business was analyzed and its main tendencies were clarified. Consumer benefits for food during the pandemic and mechanisms for meeting consumer needs were analyzed. Given the significant impact of factors, such as natural disasters, military conflicts, etc., which may pose a threat to food security, in addition to the COVID-19 pandemic, an effective mechanism should be developed to counteract such risks

Keywords: food availability, food safety, COVID-19 pandemic, US food policy, governmental support, food

INTRODUCTION

The country's food security is a comprehensive definition that includes the availability of quality food in economic and logistical dimensions with minimal negative impact on the environment. As a component of national security, food security becomes a modulator of scientific and technological progress, a factor in intensifying production, a stimulus to the growth of the productive forces of society. The issue of food security has always been a priority in shaping US public policy.

Hunger prevention must be at the heart of the COVID-19 response. Providing food for everyone is essential for a medical response. With a combined population of 4.5 billion people [1] with food production for their livelihoods and those in the wage-earning sector, food systems have a critical role to play in the socio-economic response. Society now recognizes more

than ever the need to accelerate action to strengthen the resilience of food systems and make them compatible with ecosystems of the planet. The issue of food security has always been a priority in shaping US public policy. Given the epidemiological constraints caused by the spread of the COVID-19 virus, the problems of ensuring a sufficient level of food security are particularly relevant. Thus, a comprehensive assessment of food security is through the measurement of indicators of economic affordability of food, its physical accessibility and well-established distribution system, food safety for the human body and the environment. Examining aspects of the formation of US food security in the context of these four components will analyze the current state of the food security support system, assessing its strengths and weaknesses.

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The main indicators of food security, as well as the methodology of their calculation were studied by M. Babych and A. Kovalenko [1]. This study identifies priority risk areas that are the first to be affected by factors that disrupt food security. This study is purely theoretical, the empirical aspect of this study is presented in our article. General studies of environmental sustainability as an integral part of national food policy were conducted by K. Brown, N. Venkateshmurthy, C. Law, F. Harris, K. Suneetha, B. Shankar, S. Mohan, D. Prabhakaran and C. Knai [2]. The assessment by measuring the metrics of sustainable development in the space of three spheres (economic, environmental and social) in the context of quality and safety of life was performed by O. Kotykova and O. Albeshchenko [3]. The current study details the previous article and expands it on the basis of a new object of study. The relationship between economic affordability of food and the average monthly wage in the country is formulated in terms of food security regulation O. Shebanina, A. Klyuchnik, A. Burkovska and D. Caruso [4], as well as S. Sumane, M. Dionisio, T. Pinto-Correia, etc. [5]. In their work, the authors emphasize that consumer expectations shape buying behavior, which often leads to the purchase of products in the range or quantity that has never been inherent in consumers. This hypothesis is confirmed in our study on the example of increasing consumer expenditures on groups of products that they believe may be in short supply or increase in price.

S. Kugelberg, F. Bartolini, D. Kanter, A. Milford and A. Leip [6] as well as E. Shkarupa, P. Perehodov and I. Ulanova [7] researched a food system approach for policy agenda-setting design, which was used as an implication for our own research in the sphere of the governmental policy to support food security in the region. J. Sol, M. Van der Wal, P. Beers and A. Wals [8] created a paradigm of food security in the future on the basis of sustainability transitions, which induced us to conduct our research of the topic closely connected to the one discussed above. E. Totin, J.R. Butler, A. Sidib'e, S. Partey, P. Thornton and R. Tabo [9] regarded food security through the environmental issues, meanwhile, taking into account the outcomes of the research mentioned above, the research team broadened the scientific paradigm, shifting focus from environmental issues solely to the complex framework of social, demographic and economic factors that mainly predetermine the recent change in consumption. The possible solutions to the current problems regarding food security in USA were inspired by J. Rockstrom, O. Edenhofer, J. Gaertner and F. DeClerck [10] who made a huge input into modeling the global food system that would embrace available recourses and comply them with existing needs.

The purpose of this article is to identify priority areas of food security that are most vulnerable to the impact of economic, political, natural, etc. shocks to offer a model of food stability in the United States that can be replicated by other countries.

MATERIALS AND METHODS

The methodological basis of the study involves the analysis of secondary information, which provides a description of the subject of the study and confirms previous hypotheses about the reaction of consumers to fluctuations in food markets in a pandemic. Methods of theoretical generalization, analysis and synthesis were used to form a theoretical overview of the situation in the United States due to the pandemic. The obtained analytical results were presented using methods of visualization.

In the course of the research the methods of theoretical cognition were used, namely the methods of induction and deduction. The processes of analysis, conducted from specific cases to general scope allowed to scale the results of the analysis to other regions of the world, assuming that the initial factors that determine food security are stable. The method of cognition, focused on areas from general to specific ones, allowed to identify the most vulnerable areas of the food security system that needed further research.

Benchmarking was used to investigate how consumer habits change depending on gender. In addition, the comparative analysis allowed us to rank the items of expenditure, depending on how they tend to increase according to the results of subjective assessment of consumers.

Methods of systematization, classification and monographic method were used to analyze the scientific works of other scientists. Based on the analysis of scientific works on the topic, the sphere of scientific interest was formed and research areas were outlined. Secondary statistical information from international statistical databases (incl. Statista and its supplementary services) containing time series and survey databases of American respondents was used to find answers to the questions that arose during the study. Thus, in the course of work on the scientific problem, the results of surveys conducted by the research agency "Ask Statista Research" were used, which collected information on a wide range of issues of food security among the US population through telephone interviews during the period from October to November 2019 (the number of respondents comprised 2227 people within the age group of 18 years and older).

RESULTS AND DISCUSSION

Due to the limiting impact of the pandemic on the economies of many countries, the United States is developing its own policy to ensure food stability. Inspired by D. Debnath, S. Babu, P. Ghosh and M. Helmar [11] and S. Mittal, V. Hariharan, S. Subash [12] the research team decided to replicate their research of national food security policy on domestic and international markets. Thus, primarily, we need to analyze the impact of governmental measures taken in the sphere of information disclosure and maintenance of social stability by providing a strong supportive mechanism by the implication of current trends. Moreover we suggest combining previous researches with those conducted by P. Panagos,

G. Standardi, P. Borelli, E. Lugato, L. Montanarella and F. Bosello [13], A. Maysou, M. Tafadzwanashe, M. Festo [14] and E. Rajala, I. Vogel, A. Sundin, D. Kongmanila, M. Nassuna-Musoke, R. Musundire, M. Mulangala, L. Chiwina-Karlton, U. Magnusson and S. Boqvist [15] to broaden the scope by implying macroeconomic factors that often become a game changer in product markets.

Trends in the country's food security sector affect consumer demand, social stability, the structure of savings and spending. Thus, at the beginning of the COVID-19 pandemic in April 2020 [16], consumers expected their own expenditures to increase for certain groups of goods and services (Fig. 1).

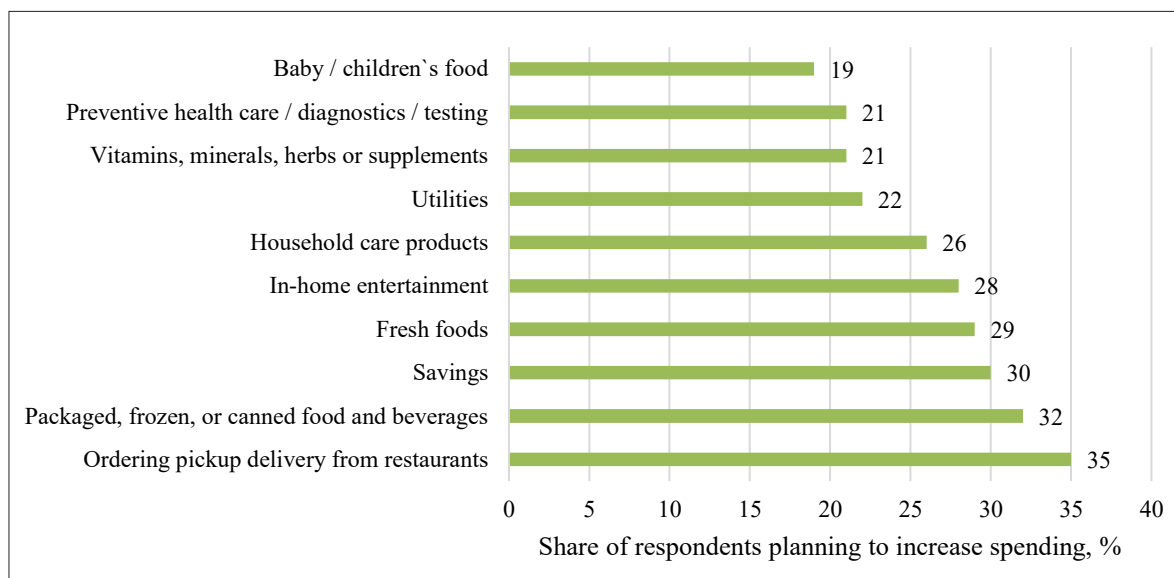


Figure 1. Increased consumer spending expectations due to the COVID-19 pandemic in the United States, by type
Source: built by the authors on the basis [16]

Thus, 35% of U.S. consumers reported that they expected to increase their spending on ordering pickup delivery from restaurants; respectively 32% of U.S. consumers reported that they expected to increase their spending on packaged, frozen, or canned food and beverages in the next six months [16]. In addition, a large proportion of consumers (33%) at the beginning of the

pandemic expected a likely increase in their own spending on savings, home entertainment, medicines and more.

During the first year of the pandemic in the United States, total household spending on food fell due to a significant reduction in food spending in catering establishments. At the same time, the cost of food at home increased compared to previous periods (Table 1).

Table 1. Average annual food expenditures of United States households (in U.S. dollars)

Years	Average annual food away from home expenditures of United States households	Average annual food at-home expenditure of United States households	Average annual household food expenditure in the United States
2010	2505	3624	6129
2011	2620	3838	6458
2012	2678	3921	6599
2013	2625	3977	6602
2014	2787	3972	6759
2015	3008	4015	7023
2016	3154	4049	7203
2017	3365	4364	7729
2018	3459	4464	7923
2019	3526	4643	8169
2020	2375	4941	7316

Source: built by the authors on the basis [17-19]

This statistic depicts the average annual household food expenditure in the United States from 2010 to 2020. In 2020, the average food away-from-home expenditure of the U.S. households amounted to about 2,375 U.S. dollars [17], which indicates a negative trend. Compared to 2019 this is a significant drop that is more

than likely a result of the COVID-19 pandemic. Thus, the COVID-19 pandemic mainly did not lead to a general reduction in food consumption, but to a reduction in the cost of food outside the home (Fig. 2). Thus, in general, the consumption of semi-finished products needed for home cooking also shows an increasing trend (Fig. 3).

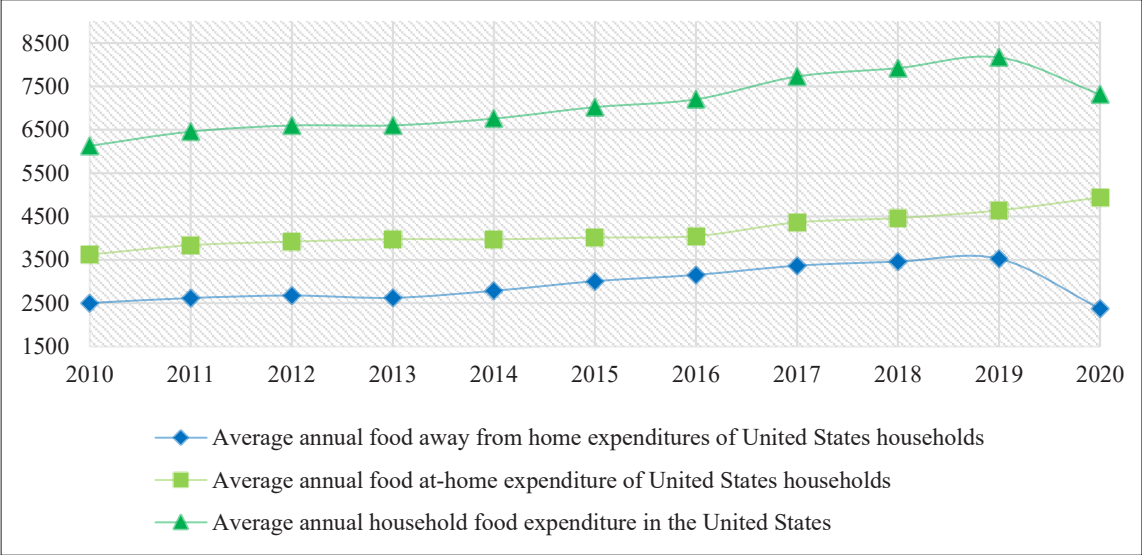


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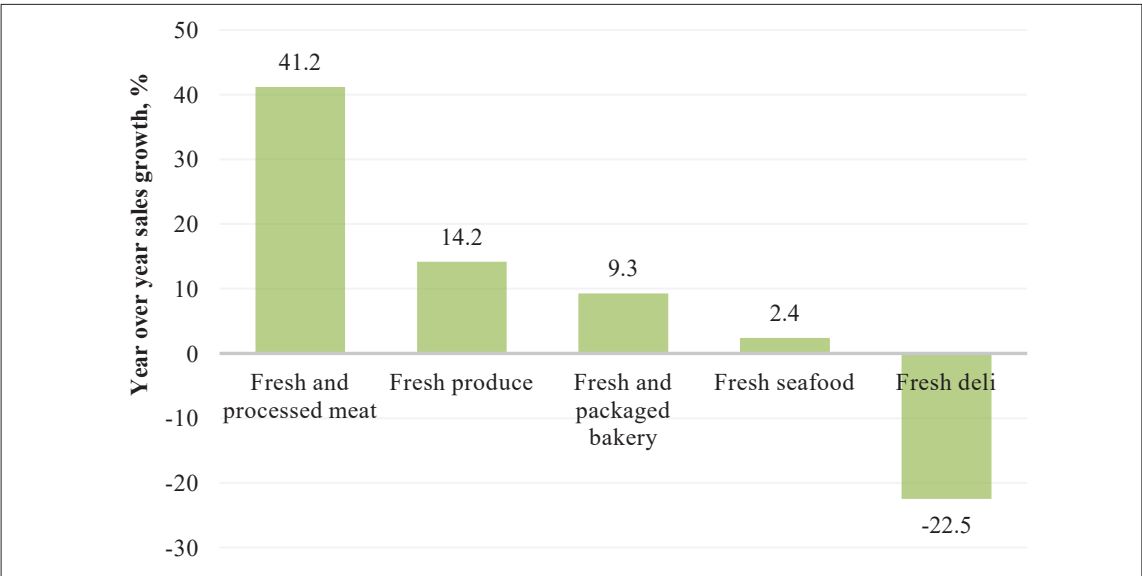


Figure 3. Sales growth of fresh foods due to Corona virus pandemic in the United States in 2020
Source: built by the authors on the basis [20]

The increase in sales of semi-finished products is due to the increase in consumption at home, in contrast to the consumption of food in catering establishments. Thus, fresh and processed meat was the fastest growing fresh food category during the Coronavirus outbreak in the United States in 2020. For example, fresh and processed meat sales grew by 41.2% compared to 2019. In addition, in contrast, fresh deli product sales declined by over 22% [20].

The trend of increasing consumption of semi-finished products did not extend to the consumption of delicacies. Thus, the consumption of delicacies in the study period decreased by 22.5% [20], due to reduced consumer incomes during the pandemic.

The US government’s food security system cares for low-income citizens by providing them with food aid (Table 2). Thus, targeted food aid is the provision of food aid to the most hard-up citizens or families, taking into

account their financial situation and average monthly total income, according to transparent registers of recipients of such assistance and confirmed by relevant documents and mechanisms (e.g. Supplemental Nutrition Assistance Program (SNAP) [21]). Transparency of the process is ensured by the involvement of non-profit public organizations (NGOs) and various forms of social entrepreneurship (including NGO's like Feed the

Future, Global Giving, Center for Food Safety and other humanitarian organizations), which is checked during the survey of the material condition of individuals, including their income. The essence of targeted food aid is to ensure full personal accessibility of everyone in need of basic food, or direct provision of the necessary set of food at minimum cost and maximum return on expenditure.

Table 2. Use of food pantries and emergency kitchens in the United States in 2020, by household food security status (in 1,000 people)

	Food pantries	Emergency kitchens
Food-secure households	3719	126
Households with low food security	2648	130
Households with very low food security	2305	195

Source: built by the authors on the basis [22]

The task of creating a transparent state of food security raises a number of agreed issues on determining consumption standards for different types of vulnerable groups, developing practices to balance regional and national needs for food aid in dynamics. Good nutrition plays a key role in maintaining the health of the nation and improving the living standards of the population.

Important factors in ensuring the safety of food for the human body are: compliance of food ingredients with the requirements established by the relevant technical documentation; ensuring food safety is possible only by enshrining the relevant conditions in the regulatory and technical documentation for each type of food product.

To ensure a healthy diet it is necessary to take into account: the quality and energy value of products, their storage conditions; the method of cooking, which should provide both taste and nutritional properties of dishes, as well as their energy value; conditions, multiplicity and time of eating; the amount and caloric content of food consumed per day; changes in diet during intense exercise.

The increase in the share of home food in the overall structure of food consumption in the United States, in addition to economic and epidemiological factors, could have other grounds. Thus, a survey of consumers about their fears of food poisoning showed that food in public institutions is often perceived as a source of potential danger by most respondents (Table 3). The survey was conducted by Ask Statista Research [23].

Table 3. U.S. adults that believed food poisoning is common due to the ways in which food is prepared at home / at restaurants as of 2019

Respondents' choice	Poisoning is common due to the ways in which food is prepared at home	Poisoning is common due to the ways in which food is prepared at restaurants
Very common, %	15	30
Sowhat common, %	40	45
Not very common, %	45	25

Source: built by the authors on the basis [23]

Against the background of the global economic crisis, when most producers are making every effort to reduce the cost of their products, there is a real threat of deteriorating food quality in general and the lower price segment in particular [14]. At the same time, there is a significant impoverishment of the population, declining solvency and an increase in the number of people who buy food in the lower price segment [24]. Economic inaccessibility of natural food products, on the

one hand, and the efforts of producers to reduce the cost of their products due to non-food ingredients, on the other — will lead to significant changes in the diet of all segments of the population [14]. The general decline in consumer demand for catering, cafes and restaurants due to the unfavorable epidemiological situation has led to a downward trend in the number of people employed in the industry in 2020 with a gradual increase in the number of employees in 2021 (Fig. 4).

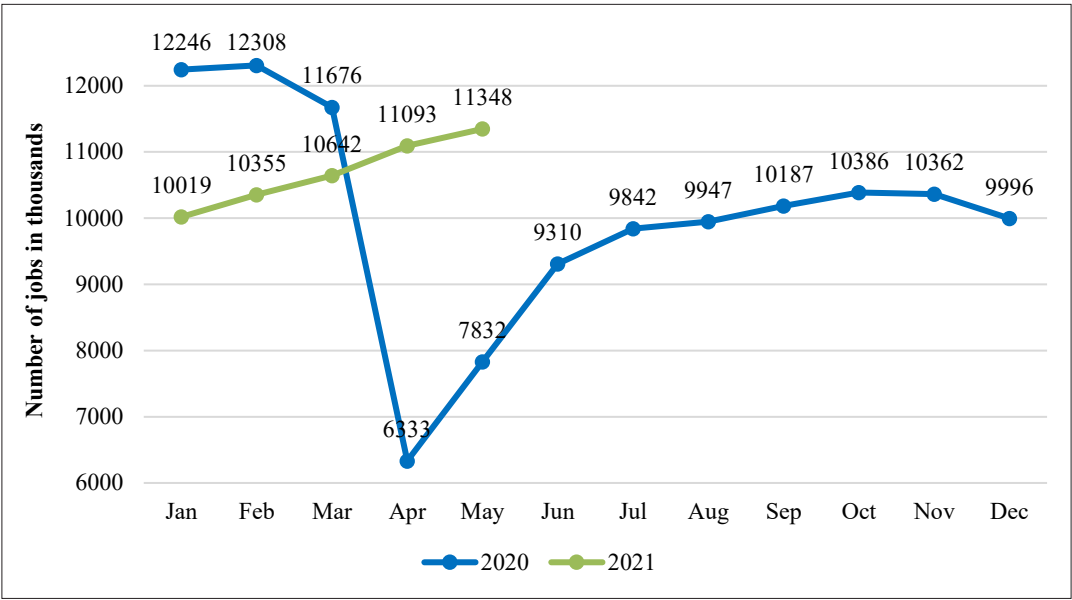


Figure 4. Number of jobs at eating and drinking places in the United States from 2020 to 2021, by month (in 1,000s)
Source: built by the authors on the basis [20]

The coronavirus (COVID-19) pandemic hit the food and drink services industry hard in 2020, which had a direct impact on changes in the labor market in the industry. Thus, during the first three months of the year (until the significant spread of infection), employment figures at eating and drinking places remained relatively stable in the United States, which illustrates the corresponding graph. However, this figure dropped significantly in April to 6.33 million as a result of the significant spread of the infection and the introduction of a ban on visiting public places. While the number of jobs

increased steadily throughout the year, it did not reach pre-coronavirus levels and ultimately saw another slight drop in December. As of September 2021, the number of food and drink service jobs in the U.S. reached approximately 11.38 million [13].

Although labor market trends in the restaurant business show declining trends, the food delivery segment is developing particularly fast. Thus, Figure 5 shows the growth of individual market leaders in food and food delivery in a highly competitive environment.

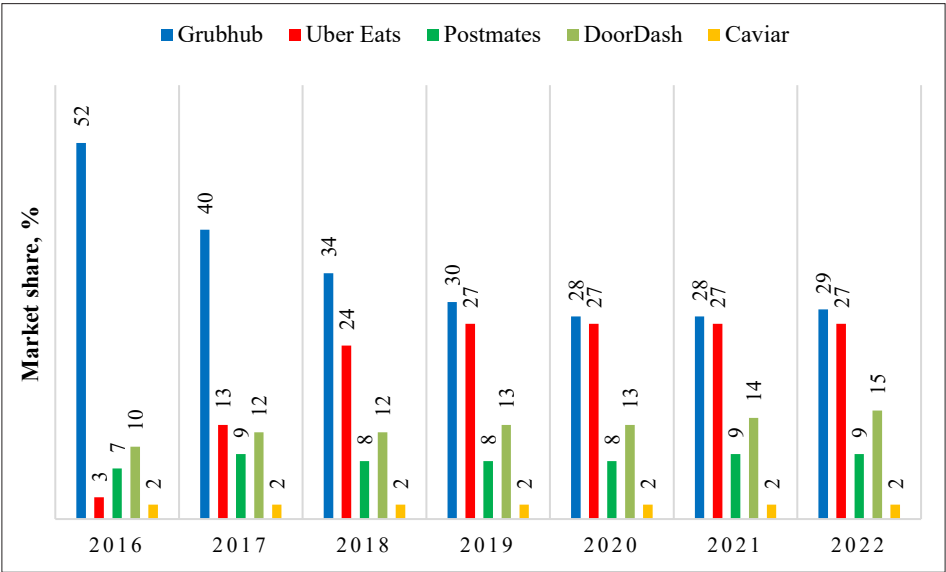


Figure 5. Market share of food delivery services in the United States from 2016 to 2022
Source: built by the authors on the basis [25]

In 2018, food delivery company Grubhub held 34% of the total food delivery market in the United States (the company's share of the market is predicted to decrease to 29% by 2022); Uber Eats held 24% of the total

food delivery market in the United States (the company's share of the market is predicted to rise to 27% by 2022); food delivery company Postmates held an eight percent of the total food delivery market in the United

States (the company's share of the market is predicted to rise to nine percent by 2022); food delivery company DoorDash held 12% of the total food delivery market in the United States (the company's share of the market is predicted to rise to 15% by 2022); food delivery service Caviar held two percent of the total food delivery market in the United States (the company's share of the market has remained the same since 2016 and is predicted to stay the same until the end of 2022, which seems quite possible due to the current trends) [25].

Fear of contact during the pandemic forced people to cut back on public places to rest and supermarkets for groceries and forced them to use home delivery services. A promising segment of the food delivery market is the delivery of products and food kits from supermarkets, which will be actively developed in the future.

One of the important factors hindering the growth of this market is the distrust of customers in the quality of products. This segment should be considered from the standpoint of a possible additional sales channel for semi-finished products or other food sets with a high degree of readiness and long shelf life.

In recent times, agriculture has begun to change rapidly from "traditional" to "industrial" and GMO production. Against the background of such technological changes in agricultural production, the demand for healthy food has appeared in society. Organic production is aimed at providing consumers with safe and high-quality food products that have a special label on the shelf and are clearly different from inorganic foods. In addition, even during the pandemic, consumers in the United States continue to prefer organic foods (Fig. 6).

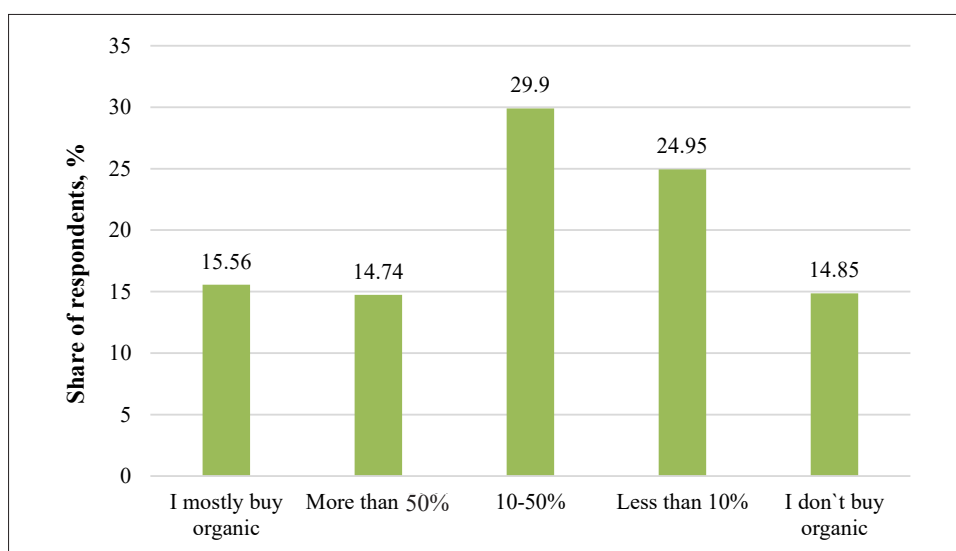


Figure 6. Organic food consumption in the USA (survey done in 2020 results presentation)

Source: built by the authors on the basis [26]

According to a poll conducted in 2020, people in the United States (U.S.) were attracted by organic products when doing grocery shopping, which indicates a high commitment of American consumers to organic products. Indeed, almost 30% of the respondents stated

that between ten and 50% of their grocery shopping consisted of organic products [26]. In addition to a conscious attitude to the formation of their own diet, consumers in the United States are prone to irrational use of food, according to a survey conducted in 2019 (Fig. 7).

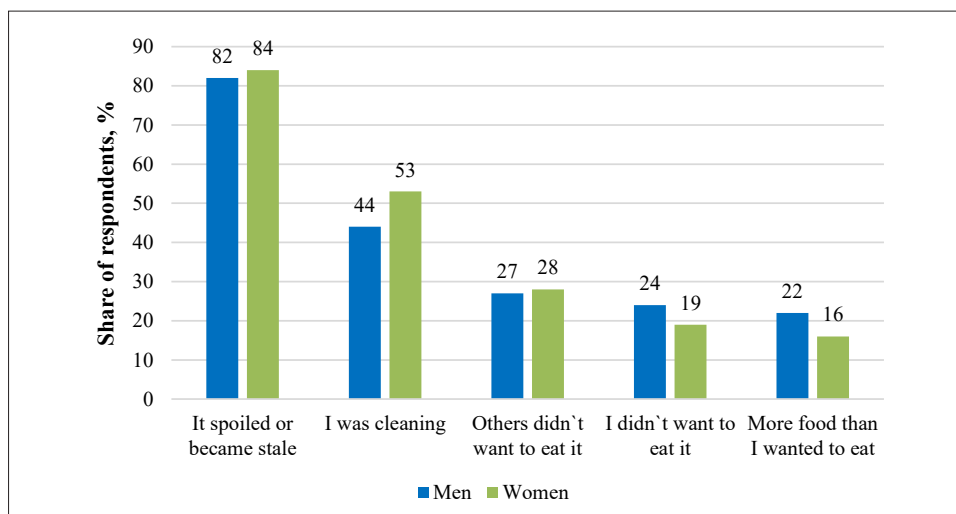


Figure 7. Reasons for discarding food in the United States in 2019, by gender

Source: built by the authors on the basis [27]

In 2019, the most frequent reason for discarding food among both male and female respondents was that the food spoiled or became stale, with approximately 82% of male respondents (among 100% of male respondents) and 84% of female respondents (among 100% of female respondents) naming this as a reason to discard food. Moreover, according to the same survey, 44% of male respondents stated that they were cleaning as a reason for discarding food, while others (56%) have never experienced such an issue. This figure was slightly higher among their female counterparts, with approximately 53% naming this as a reason to discard food, while others (47%) have never experienced such an issue. Meal leftovers were ranked as the most commonly discarded type of food among the respondents. Approximately 74% of respondents (out of 100% participants of a panel group) ranked meal leftovers among their three most frequently discarded food types (the other two types of the most frequently discarded food were naturally spoiled and expired products); while others (26%) did not

report such an issue. Least frequently thrown away were milk alternatives, with approximately 10% of respondents (out of 100% participants of a panel group) ranking them in their top three [27].

Regardless of social and economic status in society, the whole population must have access to a sufficient number of quality and safe food. A balanced diet is the basis of the normal functioning of the human body, provides it with everything necessary for cell structure, energy production and regulation of metabolism. It is extremely important that a person receives all the vital nutrients with food, the amount of which could meet the needs of the body. After all, a person's health directly depends on the quality of food and beverages he consumes. However, food may contain hazardous ingredients that can harm the human body, including nitrates, food additives, pesticides and antibiotics. That is why, according to the survey conducted by Ask Statista Research [28], consumers of restaurant menus in the United States prefer simple dishes made from local ingredients with minimal impurities (Fig. 8).

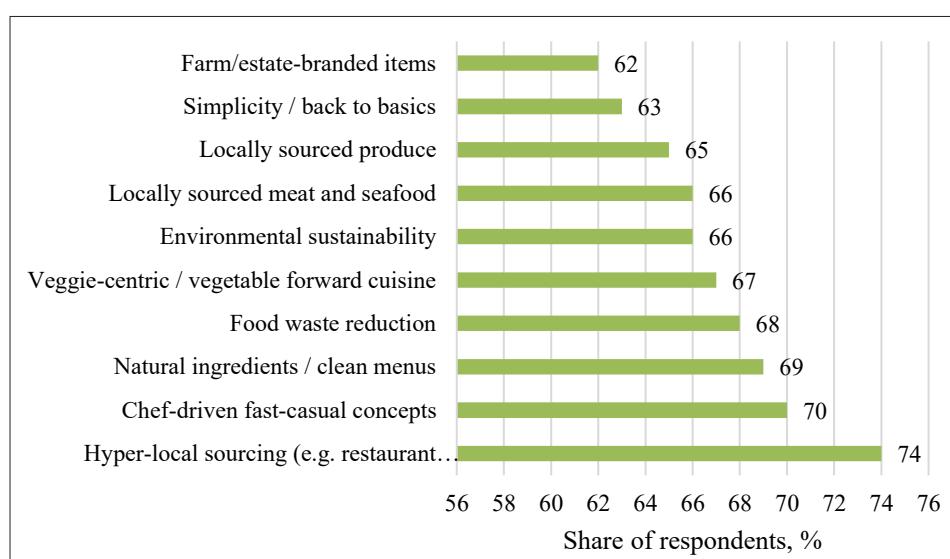


Figure 8. Leading trends in culinary themes on restaurant menus in the United States in 2018

Source: built by the authors on the basis [28]

This statistic shows the leading ten trends in culinary themes on restaurant menus in the United States as forecasted by professional chefs for 2018. During the survey, 66 percent of the respondents stated that environmental sustainability would be a "hot trend" for restaurant menus in 2018 [28].

During a pandemic, consumers try to buy more food for fear of rising prices or supply volatility, which leads to an artificial shortage of goods and provokes social tensions. In addition, the problem of many households is the creation of large amounts of food waste that is unfit for consumption due to the expiration date. To avoid this, it would be appropriate to introduce the following measures: detailed planning of food consumption for the timely adjustment of the distribution system to consumer needs; establishing communication between households that have a problem of irrational use of food and households that do not have a sufficient level of purchasing

power to purchase enough food; strengthening social support programs for vulnerable groups; providing advice and assistance in finding a job for people who lost it due to an unfavorable epidemiological situation; financing entrepreneurial initiatives aimed at creating safer business conditions during the pandemic and creating new jobs, etc.

To combat the threat to food security in the United States, it is advisable to develop not only development strategies, but also a mechanism to ensure the reform of the entire agro-industrial sector. This system should include a set of organizational, economic and legal measures to prevent economic threats, namely:

- monitoring of the economy in order to identify and forecast internal and external threats to food security;
- lending and state support to the national food producer, ensuring its competitiveness;
- partnership and cooperation of food producers;

- high level of protection of health and life of food consumers;
- balance of food products of different age and professional groups.

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- providing advice and assistance in finding a job for people who lost it due to an unfavorable epidemiological situation;
- financing entrepreneurial initiatives aimed at creating safer business conditions during the pandemic and creating new jobs, etc.

Once the pandemic is overcome around the world, modern consumption patterns will lose their relevance, but the principles that ensure food stability in crisis-free development will become relevant. Thus, in addition to providing a food reserve system and strengthening response mechanisms, associated with temporary crises in food logistics, the government should focus on the following steps to prevent quantitative hunger:

- invest in the intensification of agricultural production and development of efficient food technologies;
- support environmental projects to reduce waste and food losses, as well as the deterioration of fertile land;
- support the creation of agricultural enterprises whose activities are aimed at food production, etc.

In the post-pandemic period, the main threat to food stability in the world is likely to remain climate change, which has a negative impact on agricultural production. To combat the threats of the post-coronavirus

world, the USA should implement solutions that correlate with the major programs of leading international organizations. Thus, by focusing on the basic principles that are considered the goals of sustainable development by the United Nations, the USA will be able not only to overcome current risks, but also to ensure long-term stability, which is advised to be the subject of further research.

CONCLUSIONS

In the conditions of unfavorable epidemiological situation in the world, the issue of food security in the middle of the country becomes especially relevant. During the study period (of the second half of 2020) in the United States there were negative trends in the development of service industries (including food networks personnel redundancy, logistics chains deceleration, consumers purchasing power reduction, etc.), which is associated with limited contact between people due to the threat of infection. At the same time, the market share of food and food delivery companies continues to grow. Relevant changes are taking place in the structure of employment and consumer spending.

The pandemic has challenged the world community by forcing approaches to food production, distribution and consumption. Along with monitoring food safety, the state is trying to ensure its availability to the most vulnerable populations through free food distribution points, the organization of field kitchens, etc.

Given that the most vulnerable element of food security has been the affordability of food, it is necessary to ensure compliance with social standards and expand programs to support the population in crisis. Drawing on the successful experience of tackling the food crisis during the pandemic, other developed countries, such as North America, the European Union, Australia and others with similar economic background and resource potential can also build a high-level food security support system that will strengthen social stability and get rid of the negative effects of food shortages. The further thorough study of technological re-equipment problems for more efficient production, logistics of food supply optimization, ensuring economic stability of the state as a guarantee of food security are required.

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Аспекти формування продовольчої безпеки в контексті епідеміологічних обмежень у США

Олена В'ячеславівна Шебаніна, Анна Іванівна Бурковська,
Тетяна Іванівна Лункіна, Алла Валентинівна Бурковська

Миколаївський національний аграрний університет
54008, вул. Георгія Гонґадзе, 9, м. Миколаїв, Україна

Анотація. В умовах продовольчої нестабільності, що загострюється екологічними, політичними, демографічними процесами, державне регулювання економіки має особливе значення для підтримки продовольчої безпеки та соціальної стабільності. Розвиток технологій (як агропродовольчих, так і цифрових) значно покращує процес забезпечення населення продуктами харчування через призму їх наявності, доступності та безпеки. Метою цього дослідження є ґрунтовний аналіз сучасних тенденцій під впливом епідеміологічних обмежень через поширення COVID-19 у США, а також визначення основних сильних і слабких сторін системи продовольчої безпеки в США, яка може стати взірцем для інших країн, які дотримуються подібних принципів національної економіки завдяки своїй гнучкості та стійкості. Методологічною основою дослідження є ретельний аналіз показників, що описують динаміку продовольчої безпеки та поведінку споживачів в умовах пандемії. Крім того, у дослідженні використовувалися методи синтезу, дедукції, індукції, узагальнення, систематизації, бенчмаркінгу та інші. У статті розглянуто основні аспекти формування продовольчої безпеки в контексті епідеміологічних обмежень у США. Досліджено динаміку споживчих витрат на продукти харчування під час пандемії COVID-19 та відповідні витрати з показниками років до пандемії. Проаналізовано стан ринку праці в ресторанному бізнесі та з'ясовано його основні тенденції. Проаналізовано споживчі переваги продуктів харчування під час пандемії та механізми задоволення споживчих потреб. Враховуючи значний вплив таких факторів, як стихійні лиха, військові конфлікти тощо, які можуть становити загрозу продовольчій безпеці, окрім пандемії COVID-19, слід розробити ефективний механізм протидії таким ризикам

Ключові слова: доступність харчових продуктів, безпека харчових продуктів, пандемія COVID-19, харчова політика США, державна підтримка, продукти харчування

Market Component of Economic Security of Agricultural Sectors

Natalia Sirenko*, Kateryna Mikuliak

Mykolaiv National Agrarian University
54008, 9 Georgiy Gongadze Str., Mykolaiv, Ukraine

Abstract. Market transformations modify the development of the agricultural sector and the possibility of uninterrupted operation in a market environment. At the same time, the subjects of the agricultural sector are subject to the potential destructive impact of risks that may threaten the profitability, solvency and have negative consequences for consumers of agricultural products. Under such conditions, strengthening the economic security of the agricultural sector is the basic principle of economic development. However, in the context of market transformations, there is a need to deepen research to assess the market component of economic security, as the latter is designed to protect against market errors, shortcomings in product and sales policy, as well as incorrect choice of pricing strategy. The research used methods: monographic, logical modeling, calculation-constructive, graphic, dynamic analysis, etc. The purpose of the article is to study the level of the market component of economic security of the agricultural sector and identify areas for ensuring its optimal level. An analysis of indicators and factors influencing the market component of the economic security of subjects of the agrarian sector was carried out. It was established that the level of the market component of economic security of subjects of the agrarian sector of the national economy and subjects of the agrarian sector of the Mykolaiv region during 2016-2020 was low. It is proven that increasing the level of the market component requires the subjects of the agrarian sector to develop and implement directions for improving the mechanism of managing the market component of economic security. An assessment of the level of the market component of the economic security of the subjects of the agricultural sector was carried out using the PESTEL-analysis based on expert assessments, and it was established that in the block of threats, the greatest number of points are economic (unstable exchange rate, difficulty of entering the market, "tinization" of the economy) and legal (insufficient legal justification of the market component of economic security) factors. Such threats are successfully leveled, as the change in the characteristics of doing business, the introduction of initiatives to stimulate access to markets, as well as the development of the legal framework for the market component of economic security will contribute to the transformation of threats into opportunities for growth

Keywords: market environment, market behavior, market opportunities, market threats, development, agriculture

INTRODUCTION

Agriculture, having a pronounced seasonal nature of production, together with the constant changes in the external market environment caused by globalization processes, must adapt to new economic and technological conditions. At the same time, market modernization significantly modifies the basic conditions of agricultural reproduction and the possibility of uninterrupted operation in a market environment. At the same time, the crisis and systemic challenges caused by the COVID-19 pandemic have had a negative impact on the inability to sell products without interruption, in particular due to the breakdown of supply chains; loss of access of producers to markets; falling demand for products; the

presence of tariff and non-tariff restrictions, as well as the lack of knowledge of producers, including the organization of sales.

Protection against errors of market behavior, shortcomings in product and sales policy of the enterprise, incorrect choice of pricing strategy, designed to ensure an important component of economic security of enterprises – market, which characterizes the compliance of internal opportunities with external market environment, indicating the level of compliance of market, assessment of the coherence of production and sales, as well as the orientation of the enterprise to the needs of consumers.

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Therefore, in the context of market transformations, along with increasing globalization, the study of market opportunities of agricultural enterprises will strengthen their economic security (in the context of GDP growth, increase tax revenues, increase investment activity in the country), as well as protection from external and internal hazards arising in the market environment.

The calculation of the level of the market component of economic security is necessary to develop a set of measures to counter threats and expand opportunities to change the conditions of economic activity, education of market psychology and increase the prestige of the agricultural sector in the market environment.

Taking these factors into account is necessary in terms of developing the economic and regulatory framework for market security in order to ensure the competitive position of agricultural sector entities in the market environment.

LITERATURE REVIEW

The issues of economic security of agricultural sector entities are still well researched, which is confirmed by a significant number of publications [1-8] and methodology [9].

Methodical aspects and approaches to assessing the level of economic security of enterprises were studied by T. Oliynyk [1], T. Zubko [2], N. Pylypenko [3]. Evaluation methods and conceptual and strategic directions of economic security of agricultural enterprises were considered in the scientific works of Y. Yaremko, L. Shykova, L. Syvolap [4]. Diagnosing the level of economic security of an enterprise in conditions of limited information was carried out by T. Sak [5], the social orientation of the process of ensuring the economic security of entrepreneurship in the post-industrial paradigm is part of the scientific interests of R. Snishchenko [6]. Threats to national security were investigated by foreign scientists in their scientific works [7; 8].

In turn, market security issues are insufficiently studied and considered by scientists as a market component of economic security. The theoretical and practical aspects of evaluating the market component of an enterprise's economic security and its competitive potential as a criterion for choosing an effective competitive strategy are reflected in the scientific works of foreign scientists – J. Sheth [10], R. Sisodia [10], H. Assael [11], E. Dichtl [12], and others.

The market (domestic) component of economic security was studied by V. Tkachuk [13], M. Yarema [13], T. Melnyk [14], N. Vlasenko [14], O. Denisov [15].

The influence of the market component of economic security on the development of business entities was considered in the works of S. Ilyashenko [18], T. Voronkova, D. Melnyk and others. The work of H. Veretenikova [19] is devoted to the theoretical substantiation and improvement of methodical support for choosing a competitive strategy, taking into account the potential opportunities of enterprises and their market component

of economic security. The work of L. Filipkovska [24] and G. Savchenko [24] is devoted to the study of the market aspect of economic security, as well as its influence on the formation of strategic tasks for the development of economic entities.

According to Guidelines No. 1277 [9], economic security of the state is a state of the national economy that allows to maintain resilience to internal and external threats, ensure high competitiveness in the global economic environment and characterizes the ability of the national economy to sustainable and balanced growth.

The composition of economic security includes: industrial, demographic, energy, foreign economic, investment and innovation, macroeconomic, food, social, financial security. Market safety is absent in the methodological recommendations, which makes it impossible to interpret the essence of the legislation and determine its level on the basis of legally defined indicators. Thus, the basis for determining the essence of the market component of economic security and methodological tools for assessing its level were the scientific works of domestic scientists and practitioners.

In particular, V. Tkachuk & M. Yarema [13] reckon that the market component of economic security characterizes the compliance of internal opportunities with external ones formed by the market environment and is a protection against errors in market behavior, shortcomings in product and sales policy and wrong choices. enterprise strategy.

According to T. Melnyk & N. Vlasenko [14], the market component of economic security characterizes protection against errors of behavior in the market, shortcomings in product and sales policy of the enterprise, low level of product competitiveness, incorrect choice of pricing strategy.

O. Denisov [15] notes that the market component shows the state and level of economic security of the industry market and determines changes in the economic condition of the industry relative to the level and volume of sales of enterprises and competition between them for a common market.

The authors of the study believe that the market component of economic security is a state of protection from market dangers that may arise during the operation of enterprises.

The weakening of the market component of economic security is evidenced by:

- reduction of the market share occupied by the enterprise;
- weakening of competitive positions and ability to counteract competitive pressure;
- reduction of adaptive capabilities of the enterprise to changes in the market situation, lagging behind market requirements [16].

The purpose of the article is to determine the level of the market component of economic security and to develop directions for improving the mechanism of its management.

MATERIALS AND METHODS

During the research on the theoretical and methodological foundations of economic security and its market component, general scientific and specific methods were applied; when assessing the level of economic security and its market component – calculation-constructive, graphic and dynamic analysis.

The assessment of the level of the market component of economic security of the agricultural sector was carried out using PESTEL-analysis based on expert assessments (the subjects were economic entities of the agricultural sector; number of respondents – 80 people), the results of which are shown in Table 8.

The normative and legal basis of the study was the Methodological recommendations for calculating the level of economic security of Ukraine No.1277 [9], the Law of Ukraine “On the National Security of Ukraine” [17]. The source base of the research was made up of the data of the State Statistics Service of Ukraine, the Main Department of Statistics in the Mykolaiv region, open

sources and scientific publications of domestic and foreign authors.

The legislative basis for the definition and calculation of the market component of economic security is currently absent, so there is an objective need to deepen research on its assessment and ensure at the legislative level the definition of a list of indicators together with their normative values.

Indicators of assessment of the level of the market component of the financial and economic security of the agricultural sector were formed on the basis of information from open Internet sources.

According to the methodology of S. Ilyashenko [18], the analysis of the market component of economic security should be carried out on the basis of assessing the degree of compliance of internal development opportunities of the agricultural sector to external market environment [16]. Threats to the market component of economic security are shown in Figure 1.

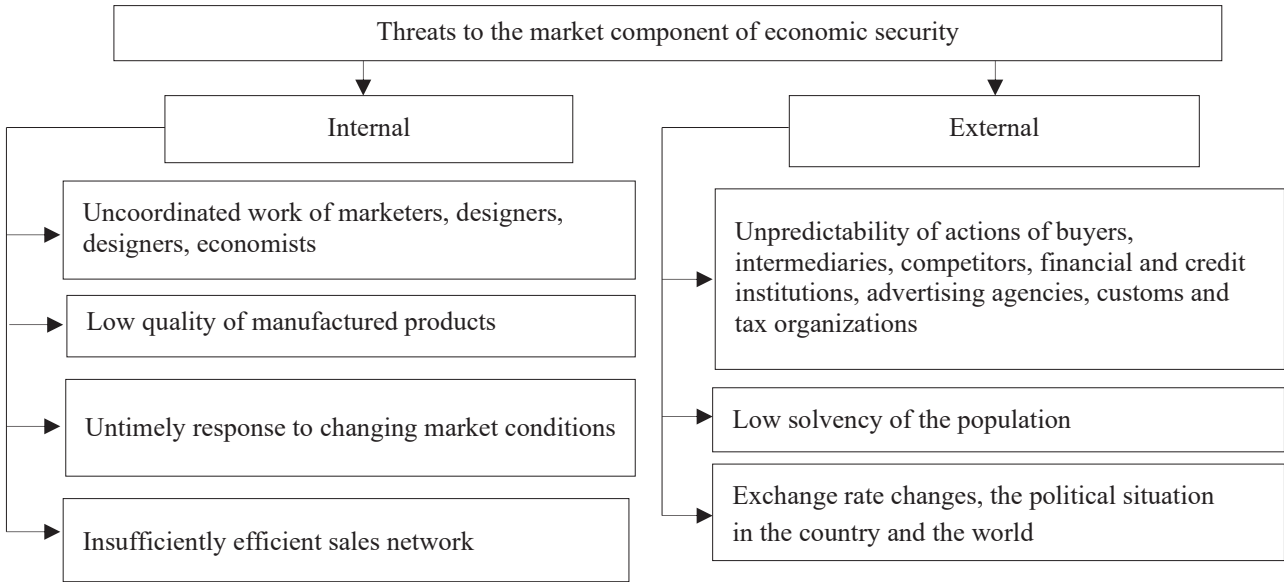


Figure 1. Threats to the market component of economic security

Source: built by the authors according to [16]

Continuous monitoring of the state of the internal environment and analysis of changes in the external market space allows agricultural sector entities to quickly anticipate danger, make better use of internal opportunities and operate more efficiently. The list of indicators recommended to be used to determine the

level of the market component of economic security was formed on the basis of the analysis of literary sources on the assessment of economic security (Table 1). Quantitative indicators for calculating the level of the market component of economic security of the agrarian sector of the national economy are given in the Table 2.

Table 1. Methods for calculating indicators for assessing the level of market component of economic security of agricultural sector entities

Indicator	Method of calculation	Significance
Market return on assets	$C_{m.r.} = \frac{P_n}{A}$, to growth, where, P_n – net profit of enterprises, UAH; A – assets of enterprises, UAH	0.12
Market share	$C_{m.sh.} = \frac{P_n}{SV_{sector}}$, to growth, where, P_n – net profit of enterprises, UAH; SV_{sector} – sales volume of the sector, UAH	0.19

Table 1, Continued

Indicator	Method of calculation	Significance
Innovation cost ratio	$C_{in.c} = \frac{C_{in}}{C_{ent}}$, to growth, where, C_{in} – innovation costs of enterprises, UAH; C_{ent} – costs of enterprises, UAH	0.17
Rhythmic sales	$D = 1 - \frac{SV_{pl} - SV_a}{SV_{pl}}$, as close as possible 1, where, SV_{pl} – planned sales volume, UAH; SV_a – actual sales volume, UAH	0.2

Source: summarized by the authors according to [16; 19]

Table 2. Quantitative indicators for calculating the assessment of the level of the market component of economic security of the agricultural sector

Indicators	Years					Abs. deviation (+, -)
	2016	2017	2018	2019	2020	
Net profit of agricultural enterprises, UAH million	90613.2	68858.5	71002.6	93255.4	81618.5	-8994.7
Assets of enterprises, UAH million	1537319.1	911614.1	983593.6	1030366.7	11303004.9	9765685.8
Sales of the sector, UAH million	414799.9	467636.1	540509.3	572748.3	624070.1	209270.2
Innovation costs of agricultural enterprises, UAH million	23229.5	9117.5	12180.1	14220.9	14406.9	-8822.6
Production costs, UAH million	326544.7	388918.7	481539.7	508633.7	512270.3	185725.6
Planned sales of the agricultural sector, UAH million	474884.1	524120.7	616094.1	636661.5	679307.6	204423.5

Source: constructed by the authors using data [20]

It is advisable to determine the level of the market component of economic security using the formula (1), [19]:

$$Y = \sum_{i=1}^n (\alpha_i * x_i)$$
 (1)

where α_i – is the significance of the partial indicator of the market component of the enterprise's economic security; x_i – is the value of the indicator of the market component of the enterprise's economic security.

To determine the qualitative level of market security of the enterprise, it is proposed use the following

ratios proposed by G. Kozachenko, V. Ponomaryov and O. Lyashenko, which offer a range of values for a low-level indicator from 0 to 0.29; medium level – from 0.3 to 0.49; high level – from 0.5 to 1.0 [19].

In order to identify the impact of the market component on the economic security of subjects of the agricultural sector of the Mykolaiv region, we will calculate it, based on the methodology of the Table 1 and using the data in Table 3.

Table 3. Quantitative indicators for calculation of a level of a market component of economic safety of subjects of agrarian sector of the Mykolaiv area

Indicators	Years					Abs. deviation (+, -)
	2016	2017	2018	2019	2020	
Net profit from operating activities, UAH million	4220.7	3352.2	3637.7	2903.2	2288.2	-1932.5
Assets of enterprises, UAH million	20574.5	25928.1	30197.5	30839.1	33276.7	12702.2
Sales volumes, UAH million	14603.4	16856.8	18134.1	19432.2	19757.5	5154.1
Production costs, UAH million	11066.2	14035.8	15568.3	17374.6	18221.1	7154.9
Planned sales, million UAH	17020.0	18915.1	20622.2	21755.2	22494.8	5474.8

Source: constructed by the authors using data [21]

Qualitative indicators of the assessment of the level of the market component of economic security of the agricultural sector of the Mykolaiv region are shown in the Table 4.

RESULTS AND DISCUSSION

When calculating the level of security of the industry market, it is important to identify and forecast possible

losses due to changes in the economic situation, the dynamics of changes within the industry and in relation to other industries and the economy as a whole [19].

Quantitative analysis of indicators for assessing the level of the market component of the economic security of subjects of the agrarian sector is based on the methodology given in the Table 1 and quantitative indicators for calculating Table 2.

Thus, the net profit of agricultural enterprises has been growing since 2018, but in 2020 compared to 2016 we see its decline. In this case, the increase in profits is possible due to: increasing production and sales; competent building of contractual relations with suppliers, intermediaries and buyers; improving the marketing system (grouping products on the basis of profitability while focusing on those products that are highly profitable); systematic research of market analysis, consumer behavior and competitors.

The assets of enterprises in the agricultural sector are growing (+9765685.8 million UAH), which shows the change in the economic potential of enterprises, their financial weight in the national [22] market. Innovation expenditures of agricultural enterprises in 2020 show

a negative absolute deviation (-8822.6 million UAH) compared to 2016, which indicates a decrease in innovation. Production costs are rising, which at current market prices affects profits [23]. However, an important aspect in the implementation of the production plan in a market environment is to take into account the range and quality of products, because in case of low quality of actual products from the planned there is a risk of customers abandoning products, leading to irregular sales.

The calculation of the level of the market component of the economic security of subjects of the agrarian sector of the national economy was carried out using the indicators of Figure 2, calculated using the method of table 1 based on the data of Table 2.

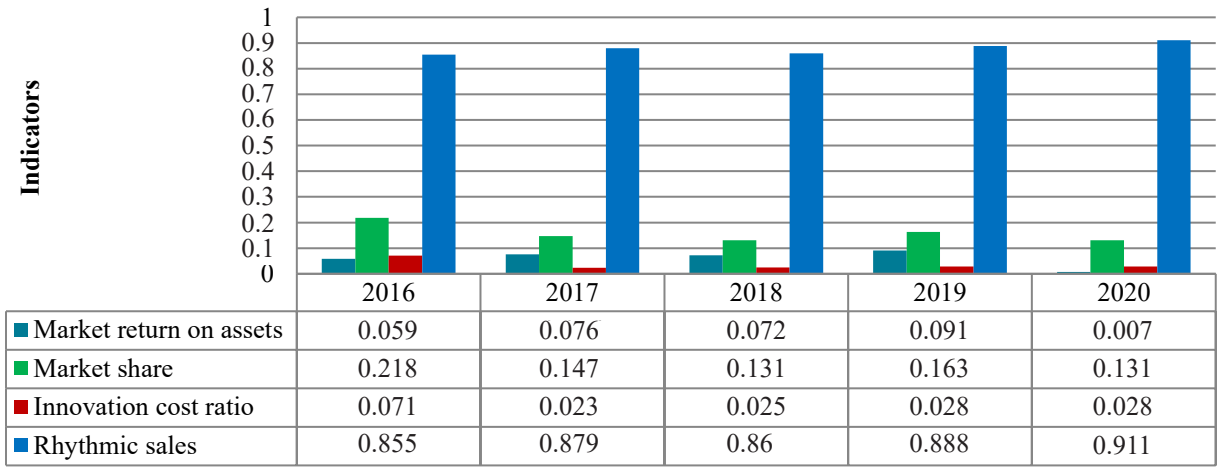


Figure 2. Qualitative indicators for assessing the level of market component of economic security of agricultural sector entities

Source: constructed by the authors using data [20]

The market return on assets has been showing growth since 2017, but in 2020 the figure is lower than in 2020, posing a threat to businesses. The share of agricultural sector entities in the market since 2016 shows a negative trend until 2018, and in 2020 compared to 2016 decreases by 0.088.

During 2016-2020, the rhythm of sales is as close as possible to 1, but values exceeding this threshold pose a threat to enterprises.

The rhythm of sales directly depends on the rhythm of its production, violation of which affects sales, leading to a violation of the rhythm of sales and reduce the efficiency of operating activities of agricultural enterprises, and at the same time negatively affects the deterioration of economic security.

Qualitative indicators for assessing the level of the market component of economic security indicate that there are challenges to the development of market relations caused by the pandemic, in terms of limiting distribution channels and export markets. Quantitative analysis of indicators for assessing the level of the market component

of economic security of the subjects of the agrarian sector of the Mykolaiv region, given in the table 3, makes it possible to determine trends in its state change.

The decrease in net profit from the operating activities of enterprises of the agricultural sector of the Mykolaiv region in 2020 is caused by a reduction in the volume of sales of the industry due to the introduction of quarantine measures (restriction of distribution channels and export markets, including tariff and non-tariff restrictions, drop in demand for products).

The assets of enterprises are growing, amounting to UAH 33,276.7 million in 2020, which exceeds the figure for 2016 by UAH 12.702.2 million, showing a change in the economic potential of enterprises. The growth of production costs at current market prices affects the increase in financial performance of enterprises [23].

The calculated indicators of the assessment of the level of the market component of the economic security of subjects of the agricultural sector of the Mykolaiv region were carried out on the basis of the quantitative data of the Table 3 and shown in Table 4.

Table 4. Qualitative indicators of an estimation of a level of a market component of economic safety of agrarian sector of the Mykolaiv area

Indicators	Years					Abs. deviation (+, -)
	2016	2017	2018	2019	2020	
Market return on assets	0.205	0.129	0.120	0.094	0.069	-0.136
Market share	0.289	0.199	0.201	0.149	0.116	-0.173
Rhythmic sales	0.142	0.109	0.121	0.107	0.122	-0.020

Source: calculated by the authors according to [21]

Analyzing the qualitative indicators of assessing the level of market component of economic security of the agricultural sector of Mykolaiv region, we see a decline in the rate of return on assets, despite the fact that the latter should tend to increase, in 2020 there was a decrease of 0.136 compared to 2016. Market share has a fluctuating trend and in 2020 there is a decrease compared to 2016 by 0.173. The value of the rhythm of sales should be as close as possible to 1, but the calculated

values are relatively low and range from 0.122 in 2016 to 0.122 in 2020.

The calculation of the level of the market component of economic security of subjects of the agrarian sector of the national economy and the Mykolaiv region, taking into account the methodology for determining the level of the market component of economic security and the significance of the indicators, is given in Table 5.

Table 5. Calculation of the level of the market component of economic security

Indicators	Significance	Years				
		2016	2017	2018	2019	2020
Subjects of the agricultural sector of the national economy						
Market return on assets	0.12	0.007	0.009	0.009	0.011	0,001
Market share	0.19	0.041	0.028	0.025	0.031	0,025
Innovation cost ratio	0.17	0.012	0.004	0.004	0.005	0,005
Rhythmic sales	0.2	0.171	0.176	0.172	0.178	0,182
The level of the market component of economic security						
y		0.231	0.217	0.21	0.225	0.213
Subjects of the agricultural sector of Mykolaiv region						
Market return on assets	0.12	0.025	0.015	0.014	0.011	0,008
Market share	0.19	0.055	0.038	0.038	0.028	0,022
Rhythmic sales	0.2	0.028	0.022	0.024	0.021	0,024
The level of the market component of economic security						
y		0.108	0.075	0.076	0.06	0.054

Source: calculated by the authors based on the methodology [16; 19]

The range of values for the calculation of indicators of the level of the market component of economic security during 2016–2020 indicate its low level both for subjects of the agrarian sector of the national economy and for subjects of the agrarian sector of the Mykolaiv

region. Increasing the level of the market component of economic security of the subjects of the agrarian sector requires the latest development and implementation of directions for improving the management mechanism of the market component of economic security (Table 6).

Table 6. Problems that need to be solved during the implementation of the market component of economic security of the agricultural sector

Problem	Measures to achieve a market component of economic security
Development of competitiveness	– monitoring and diagnosis of internal and external threats; – improving methods of managing the economic activity of agricultural enterprises and sales processes; – prevention of probable risks in the agricultural sector; – strategic planning of the process of improving the quality of the internal environment of the agricultural sector; – administration at enterprises, focused on preventing long-term negative consequences of the crisis
Improving advertising policy	– implementation of the appropriate legal and regulatory framework; – socio-psychological study of consumers of the agricultural market; – increasing the level of information support of the market; – increasing the role of product promotion in the market

Table 1, Continued

Problem	Measures to achieve a market component of economic security
Increasing the share of agricultural products in the market	– partial ban or difficulty of entering the market of imported products; – regulation of export and customs policy of the state
Slow development of innovations	– regulation of patent, budget, credit, innovation policies; – increasing the role of innovation marketing

Source: built using data [24]

Analysis of the level of market component of economic security is the basis for developing a set of measures (Table 6) to counter threats and increase the level of market component of economic security of enterprises and, accordingly, expand its adaptive capacity to change economic conditions, create conditions for stable operation and development.

Directions for improving the management mechanism of the market component of economic security of the agricultural sector are shown in Table 7.

Table 7. Directions for improving the mechanism for managing the market component of economic security of enterprises

Methods	Directions for improving the components of the economic security system of enterprises
Institutional and legal	Establishment of a market security department. Elimination of any illegal actions by the company and careful study of the actions of counterparties in order to control their legitimacy. In certain cases, the involvement of experienced and qualified is allowed lawyers from outside, if necessary. But for large companies and organizations, the availability of such staff in their staff is a vital necessity, in addition, much attention should be paid to regular training of their lawyers
Informational	Restrict access to third parties to the organization, restrict access to any information that does not relate to a particular employee, ranking and fragmentation of information, the use of new technologies to hide and store information
Organizational and technological	Renewal of fixed assets, study of innovations in technology, purchase of necessary patents
Economic	Careful strategic and tactical planning and forecasting, strengthening accounting for financial flows and reporting. Facilitating access to markets and sales. Growing competitiveness of the enterprise. Providing conditions for the renewal of the enterprise
Administrative	Personnel certification, refresher courses, measures aimed at maintaining corporate spirit, improving incentive policies, strengthening measures against employees who for some reason harmed the organization, the presence of people in the staff engaged in corporate surveillance. Introduction of a bypass system for staff and outsiders
Socio-psychological	Increasing the level of staff motivation in the security system of the enterprise
Ecological	The company needs to constantly monitor innovations in legislation related to environmental regulations. If the company is large – to have environmental staff, and if medium or small – periodically use the services of environmental services
Market and interface	This area depends entirely on the work of the marketing department. The task of management is to control their activities, fully stimulate and provide the necessary information about the internal and external environment, special attention should be paid to competitors, suppliers and buyers, as well as market conditions

Source: systematized and supplemented on the basis of data [25]

The results of the assessment of the level of the market component of the economic security of the agricultural sector, carried out using the PESTEL-analysis, are given in Table 8. The assessment experts were 80 subjects of the agricultural sector.

Thus, economic and legal factors have the highest number of points (5.0) in the block of threats. Among the economic factors, the greatest threats to the state of the market component of economic security of the agricultural sector are: unstable exchange rate, the difficulty of entering the market and the “shadowing” of the economy. Improving the stability of the exchange rate, getting out of the “shadow” of business structures and improving the possibility of easy market entry will help to improve the situation. Such threats are successfully eliminated, as changes in the peculiarities of doing business (Digital Power: Action; Action. Business without barriers; bank account for online business; SmartID; ID-card with electronic signature), as well as the introduction of initiatives to stimulate market access uninterrupted sales of agricultural products by providing producers with access to markets through distribution channels, improving access to knowledge and information on production efficiency and sales organization, and assistance in entering export markets) of the agricultural sector will facilitate the transition of threats to growth.

Table 8. Results of the PESTEL-analysis on the assessment of the level of the market component of economic security of the agricultural sector

Factors	Possibilities	Weighting factor	Score	Result	Threats	Weighting Factor	Score	Result
Political	– Improving the state of the financial system through reforms	0.5	5	2.5	– Reduction or abolition of preferential taxation and lending	0.5	4	2.0
	– Restriction of monopoly. ensuring competition	0.5	4	2.0	– Deterioration of financial and economic condition	0.5	5	2.5
	Σ	1		4.5	Σ	1		4.5
Economical	– Improving the efficiency of the use of equity and economic resources	0.5	5	2.5	– Unstable exchange rate. the difficulty of entering the market	0.5	5	2.5
	– Increasing the level of profitability	0.5	5	2.5	– “Shadowing” of the economy	0.5	5	2.5
	Σ	1		5.0	Σ	1		5.0
Social	– Increasing the motivation of staff in the system of financial and economic security	0.5	5	2.5	– Reduction of income and employment	0.6	4	2.4
	– Development of social infrastructure	0.5	4	2.0	– “Outflow” of qualified personnel. devaluation of human labor	0.4	4	1.6
	Σ	1		4.5	Σ	1		4.0
Technological	– Updating processes and means of production	0.4	4	1.6	– Preventing the renewal of all fixed assets due to their large number	0.3	4	1.2
	– Increase the efficiency of enterprise security management	0.6	5	3.0	– Rapid change of innovations. which necessitates constant updating of equipment	0.7	4	2.8
	Σ	1		4.6	Σ	1		4.0
Ecological	– Development of environmental programs to improve the external environment	0.5	4	2.0	– High level of environmental pollution	0.7	5	3.5
	– Improving the system of environmental legislation	0.5	4	2.0	– Reduction of soil fertility	0.3	3	0.9
	Σ	1		4.0	Σ	1		4.4
Legal	– Introduction of the current legal framework on the market component of the ES	0.6	5	3.0	– Insufficient legislative justification of the market component of ES	0.7	5	3.5
	– Increasing state control over financial resources and directing them to their destination	0.4	5	2.0	– Lack of strategy for the development of financial and economic security of enterprises of different levels	0.3	5	1.5
	Σ	1		5.0	Σ	1		5.0

Source: developed by the authors on the basis of expert assessments

The modern concept of open data is increasingly used by business representatives to increase the efficiency of their activities. Disclosure of data contributes to the creation of new markets in the field of business (monitoring and verification of counterparties, etc.).

Thus, a low level of the market component of economic security has been established, the increase of which requires the subjects of the agrarian sector

to develop and implement directions for improving the market component management mechanism, in particular, market and interface methods.

CONCLUSIONS

The analysis of the calculated indicators of the market component of economic security shows that there are challenges for the development of market relations

caused by quarantine restrictions, in terms of suspension of activities of agricultural sector entities due to restrictions on distribution channels and export markets.

Calculations of the level of the market component of economic security during the research period indicate its low level both for the subjects of the agrarian sector of the national economy and for the subjects of the agrarian sector of the Mykolaiv region, increasing the level of which requires the development and implementation of directions for improving the mechanism for managing the market component of economic security.

The results of the PESTEL-analysis regarding the assessment of the level of financial and economic security of the agricultural sector indicate that the greatest threat to it is economic and legal factors, namely: an unstable exchange rate, the difficulty of entering the market and the "tinization" of the economy. The threats

in the legal block are the insufficient legal justification of the market component of financial and economic security, which requires the development and implementation of a normative-legislative framework for the interpretation of the essence, definition of indicators and normative values of indicators. The improvement of the situation will be facilitated by restoring the stability of the exchange rate, getting out of the "shadow" of business structures and improving the possibility of easy entry into the market.

The strategic imperative of the market component of economic security of agricultural sector entities is to develop a legal framework to determine the essence of market security and methodological basis for assessing its level, as rapid globalization requires agricultural sector entities to quickly adapt to national and international market space.

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Ринкова складова економічної безпеки суб'єктів аграрного сектору

Наталя Миколаївна Сіренко, Катерина Анатоліївна Мікуляк

Миколаївський національний аграрний університет
54008, вул. Георгія Гонґадзе, 9, м. Миколаїв, Україна

Анотація. Ринкові трансформації модифікують розвиток аграрного сектору та можливість безперебійної роботи у ринковому середовищі. При цьому суб'єкти аграрного сектору підпадають під потенційний деструктивний вплив ризиків, які можуть загрожувати рентабельності діяльності, платоспроможності та мати негативні наслідки для споживачів аграрної продукції. Затаких умов зміцнення економічної безпеки аграрного сектору є базовою засадою розвитку господарюючих суб'єктів. Проте, в умовах ринкових трансформацій, виникає потреба поглиблення досліджень щодо оцінки ринкової складової економічної безпеки, оскільки остання покликана захищати від помилок поведінки на ринку, недоліків у товарній та збутовій політиці, а також невірному вибору стратегії ціноутворення. У дослідженні використано методи: монографічний, логічного моделювання, розрахунково-конструктивний, графічний, динамічного аналізу та ін. Метою статті є вивчення рівня ринкової складової економічної безпеки суб'єктів аграрного сектору та визначення напрямів щодо забезпечення оптимального її рівня. Здійснено аналіз показників та чинників впливу на ринкову складову економічної безпеки суб'єктів аграрного сектору. Встановлено, що рівень ринкової складової економічної безпеки суб'єктів аграрного сектору національної економіки та суб'єктів аграрного сектору Миколаївської області протягом 2016–2020 рр. був низьким. Доведено, що підвищення рівня ринкової складової вимагає від суб'єктів аграрного сектору розробки та реалізації напрямів вдосконалення механізму управління ринковою складовою економічної безпеки. Проведено оцінку рівня ринкової складової економічної безпеки суб'єктів аграрного сектору із застосуванням PESTEL-аналізу на основі експертних оцінок, та встановлено, що у блоці загроз найбільшу кількість балів мають економічні (нестабільний валютний курс, складність виходу на ринок, «тінізація» економіки) та правові (недостатнє законодавче обґрунтування ринкової складової економічної безпеки) фактори. Такі загрози вдало нівелюються, оскільки зміна особливостей ведення бізнесу, запровадження ініціатив стимулювання доступу до ринків, а також розроблення законодавчої основи ринкової складової економічної безпеки сприятимуть переходу загроз у можливості до зростання

Ключові слова: ринкове середовище, ринкова поведінка, ринкові можливості, ринкові загрози, розвиток, сільське господарство

The Concept of Food Security Formation on the Basis of Sustainable Development of Agricultural Land Use

Olena Kotykova*

Mykolaiv National Agrarian University
54008, 9 Georgiy Gongadze Str., Mykolaiv, Ukraine

Abstract. Solving the problems of food security of those that already exist and those that await us in the near future lies in the formation of a food security system on the basis of sustainable development of agricultural land use. Theoretical and practical aspects of the research problem are carried out by domestic scientists, mainly in two separate areas: food security and sustainable development of agricultural land use. The World Scientific Society pays considerable attention to this problem, but they are distinguished by a practical orientation for a particular region, which often makes it impossible to implement such scientific achievements in Ukraine. In order to develop the Food Security Program on the basis of sustainable development of agricultural land use in Ukraine, an appropriate theoretical and methodological basis is needed, which was determined by the purpose of our study. As a result of the study, the following results were obtained. First, a logical and semantic model of the methodology of food security formation on the basis of sustainable development of agricultural land use, which includes organizational, economic and environmental prerequisites for the transition of modern land use to a model of sustainable development. Secondly, the provisions and directions of implementation of the relevant Concept, based on the historical and socio-economic preconditions of food security, have been formed and includes the following components: purpose; historical and social preconditions; monitoring and evaluation system; assessment of compliance of the level of food security; mechanism for implementing the Concept; target directions and main tasks; expected results. Areas of implementation of the Concept, tools and mechanisms for implementing the model of food security on the basis of sustainable development of agricultural land use on the one hand are fully consistent with the global objectives of 2nd Sustainable Development Goals (zero hunger), and on the other – take into account national characteristics

Keywords: food system, zero hunger, the model of methodology for the formation of food security, land use in the agricultural sector

INTRODUCTION

The agriculture is necessary to ensuring food security and improving nutrition, namely: production in sufficient quantities, quality and variety of food; the agricultural sector is a driver of economic transformation and a major source of income for rural households. "Income from agriculture is the basis of livelihood for 1.3 billion people working in this sector, and directly determines their food security" [1]. Many years of world experience show that both agricultural development and economic scaling are necessary factors to improve food security, and the agricultural sector can strengthen the economy as a whole [1].

The development of agriculture "after the Second World War has led to impressive progress in food production. This is largely due to a number of factors:

economic growth, advances in technology and knowledge, and improved supply chain management" [1]. From the point of view of production factors, the increase in agricultural production was due to increased concentration and scaling of processes. However, extensive livestock farming systems on national households and small farms have also significantly contributed to the increase in food production.

"In Ukraine, unlike the member states of the European Union, households still remain the main producers of agricultural products, growing and producing food not only for their own consumption. Currently, this category of households grows much more than all types of crop products (except industrial crops) compared to farms, and the volume of potatoes, vegetables and fruits

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grown is 98% (98 in 2000 and 99 in 2020), 86% (85 in 2000 and 83 in 2020) and 82% (83 in 2000 and 82 in 2020) of their total volume, respectively. Regarding livestock products, the figures are high as well: 74% (71 in 2000 and 70 in 2020) of milk, 87% (61 in 2000 and 91 in 2020) of wool and 98% (93 in 2000 and 99 in 2020) of honey from their total number in 2016 were produced by households (the data given in parentheses are added by the authors)" [2].

"At the same time, there are well-founded arguments that call into question the fact that current and future directions of agricultural development are sustainable" [1]. In particular: the global agro-food system is unable to ensure food security for everyone – maintaining significant food security, achieving zero hunger and reducing obesity through irrational diets; insufficient social efficiency of food systems; degradation of land, fresh water and ecosystems; significant impact of agricultural sector activities on increasing greenhouse gas emissions and, consequently, climate change, which in turn have a negative impact on agriculture [28].

Given the fact that agricultural land is the main method of production, it is fair to say that solving the problems of food security of those that already exist

and those that await us in the near future, including due to significant population growth with ever-decreasing population the area of arable land suitable for growing agricultural products lies in the plane of the food supply system formation on the basis of sustainable development of agricultural land use. Theoretical and practical aspects of the researched problem are carried out by Ukrainian scientists mainly in two separate directions:

– food security – on the basis of the state of the system [3-5], on the basis of the security mechanism [6-8], on the basis of access level [9-10], on the basis of hierarchical level [11];

– sustainable development of agricultural land use [12-14] et al.

After 2015, when Ukraine joined the 2030 Agenda for Sustainable Development, the circle of scientists examining food security through the prism of sustainable agriculture has expanded. However, it should be noted that researchers do not always interpret the concept of sustainable development and use it in their own interpretation, sometimes very different from the content and objectives of 2nd Sustainable Development Goals – zero hunger (SDG2), both global and national (adapted to the conditions of Ukraine) (Fig. 1).

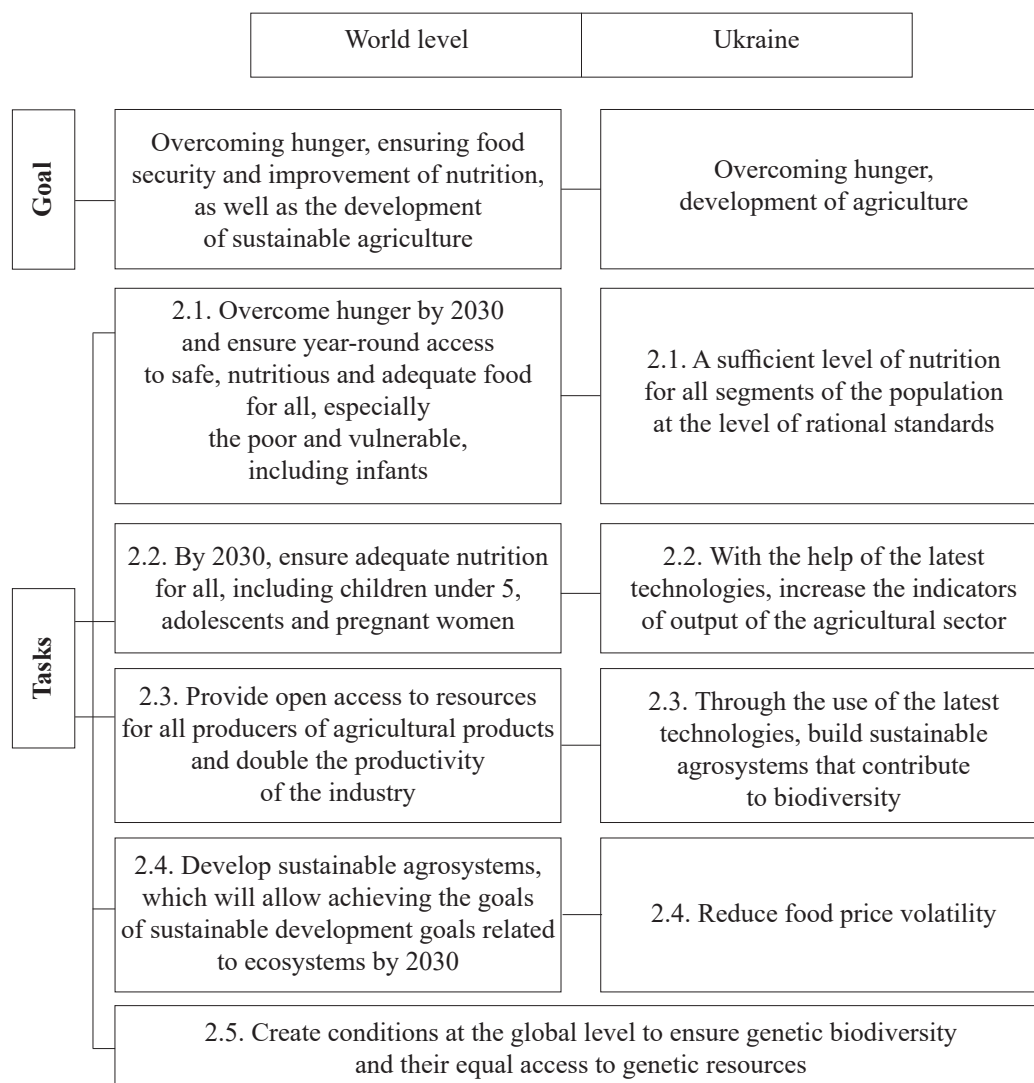


Figure 1. Tasks of SDG2 at the global and national levels

Source: made by the author according to data [24; 25]

From the perspective of finding a solution to the problem of food security through the prism of sustainable development, it is advisable to consider the food system. At the same time, there is no consensus among domestic scientists on the essential content of the category "food system". In addition, sometimes in one scientific work you can find several different terms, which the authors, apparently, use to mean "food system". Thus, in the work "Formation of the national food system: present and prospects" [15] the authors, except for the title of the article and annotation, no longer use the term "food system", using instead the concept of "food complex", "agro-industrial complex", "food subcomplex" and others, which obviously identify.

M.P. Sychevskyi [16] in one of his scientific works, uses the term "social food system", but without explaining what meaning the author puts into this concept. At the same time, the researcher identifies the main measures for the formation of the social food system: "full provision of the population with the main types of food products of domestic production; improving the quality of raw materials and finished products; energy and resource saving; introduction of innovative high-performance technologies and equipment; strengthening state influence on the process of full and high-quality food supply of all segments of the population; improving the management system and supporting the priority areas of food industry development" [16]. Thus, according to the measures identified by the author, the social food system is almost identical in content to the global food system. The research of the researcher's scientific work in general gives grounds to claim that using the term "social food system" the author is talking about the introduction of special state food aid programs for the poorest sections of the population, following the example of the United States.

It should also be noted that until recently, scientists have often replaced the concept of "food system" with the term "food security". Thus, Zelenska notes that "food security is a system that includes functional-targeted (agro-industrial complex, consumption, sales, food distribution and reserve) and providing (management, financial, information, logistics, technological, scientific support) subsystems" [17]. The author also notes that food security refers to open systems, which have the properties of dynamic equilibrium, and the mechanisms of action of the components of the system under the influence of various factors determine their stability. From the point of view of content in this case we are talking about the food system, the main task of which is to ensure food security under the influence of external and internal factors.

O.I. Goychuk [18] also in determining the content of the components of food security distinguishes 5 subsystems (provision, functional, target, controlling and regulating), which in terms of content correspond to the categories of the food system. The only difference is that the author adds a control subsystem, which includes food safety indicators, i.e., monitoring the system. The

World Scientific Society pays considerable attention to this problem.

It should be noted that the predominant focus of scientists in food safety research or on certain aspects of the problem with the development of practical recommendations, or on finding systemic solutions, including – the development of appropriate policies that have a more theoretical and methodological direction. In any case, the results of the research should be reconsidered taking into account the specifics of each country and region.

Thus, agree with M. Danse [19] and other researchers, who, in matters of food and nutrition security, emphasize the importance of transforming agriculture and food systems and the role of the private sector in this process. However, the scientists' proposals are based on the results of the study Africa, Asia and Latin America, which differ significantly from the Ukrainian ones in the construction and principles of functioning of food systems and, even partially, cannot be adapted to our realities.

According to the authors of the work "Understanding food systems drivers: A critical review of the literature" it is necessary to identify 12 defining drivers that are crucial for the formation of the dynamics of food systems [20]. The identified trends have a significant impact on the level of food security, and the situation will only get worse over time. After all, according to some indicators, the load on available resources is already beyond the limits of possible reproduction on a planetary scale [21]. In particular, irreversible processes of deterioration of soil quality are already taking place, which requires completely new approaches in the production of agricultural products, in the conditions of climate change, reduction of natural biodiversity and the impossibility of providing the planet with sufficient animal protein without significant disruption of the already unstable ecosystem [22]. These factors are generally recognized and reflected in the CSD-2030, but to eliminate their negative impact on the development of the food system for each country must develop its own policies and programs for their implementation.

F. Galli [23] and other researchers focus on the need to radically reconsider the understanding of the functioning of the food formation system in connection with the development of new policies for healthy eating and sustainable development of agriculture. The work of the researchers is focused on the study of the impact of the Common Agricultural Policy (CAP) on the development of food systems, depending on the policies and practices that were proposed as part of the implementation of the CAP, with the aim of determining the determinants of both positive and negative impact on the system and, based on established patterns, providing proposals for the introduction of strategic tools for ensuring the sustainable development of the food system.

In summary, was the following. The peculiarity of such research is their practical orientation, and thus – scientific achievements are focused on specific proposals to address a limited range of issues for a particular

region. That is why the implementation of such scientific achievements in Ukraine is not always expedient and, in general, possible. In order to develop the Food Security Program on the basis of sustainable development of agricultural land use in Ukraine, an appropriate theoretical and methodological basis is needed.

The purpose of the article. The study envisages: first, to develop a logical and semantic model of methodology for the formation of food security on the basis of sustainable development of agricultural land use, which includes organizational, economic and environmental preconditions for the transition of modern land use to sustainable development; secondly, to form the provisions and directions of implementation of the relevant Concept, based on the historical and socio-economic preconditions of food security.

MATERIALS AND METHODS

The theoretical basis of the research is the fundamental scientific provisions of food security, state land management and food security; the economic theory that determines the laws of development of land relations; scientific works of Ukrainian and foreign scientists on the evolution of food security and agricultural land use.

The study uses the following methods: an abstract-logical method (the formation of principles, theoretical generalizations and conclusions; the study of the Concept content of the sustainable land use); monographic (the study of the scientific papers on the agricultural land use sustainability issues, the study of the historical and socio-economic preconditions for food security); elementary and theoretical analysis and synthesis (the study of the relationships and the impact

of the agricultural land use development on the level of food security); the direct synthesis and analysis (the analysis of the environmental, agricultural and land legislation of Ukraine and the EU countries); modelling (modelling of the food security system).

The research is based on open data, reports, protocols, program documents, etc. official and authorized bodies of Ukraine and EU countries; open research results of scientists; open global sources of information, such as analytical reports and statistics, were used in the research State Statistics Service of Ukraine, Food and Agricultural Organization, United Nation.

RESULTS AND DISCUSSION

The model of food security methodology based on sustainable development of agricultural land use, should include: principles of food security formation; levels of food security; levels of food security management; mechanism for achieving food security; tools for food security management.

Taking into account the fact that the content of food security determines everyone's access to quality food in sufficient quantity, we have laid the basis of the principles of food security on the basis of the sustainable development of agricultural land use, we were guided by Right to Food Guidelines [26]. Since the achievement of food security should be based on sustainable development of agriculture in general and agricultural land use as a basis for agricultural business, the principles of sustainable food development based on sustainable development of agricultural land use, we also include the principles of sustainable bioeconomy. The main content of the Voluntary guidelines is shown in Figure 2.

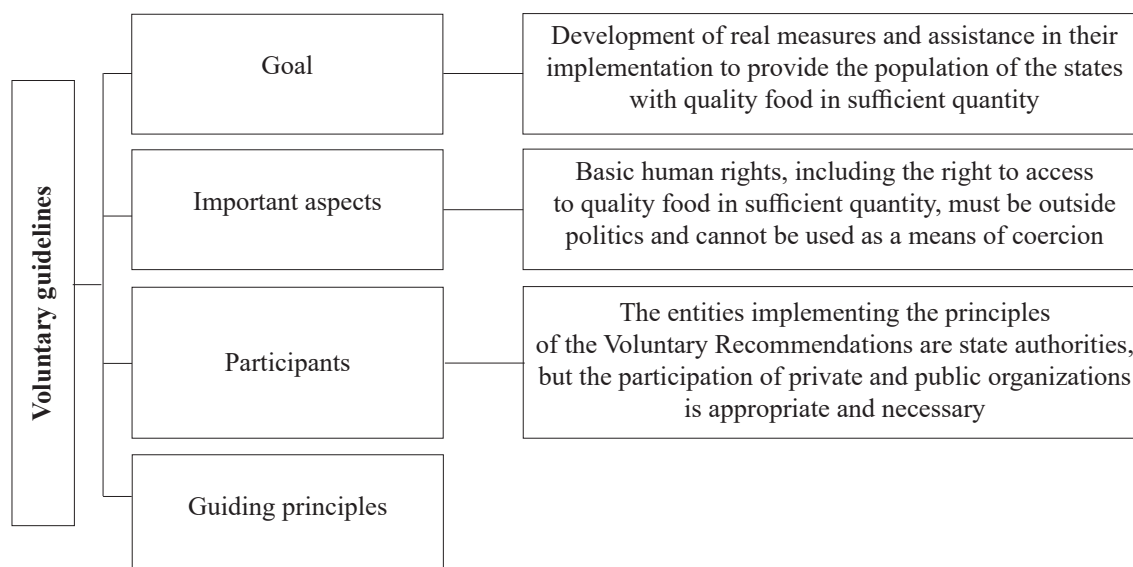


Figure 2. Contents of the Voluntary guidelines to support the progressive realization of the right to adequate food in the context of national food security

Source: made by the author according to data [26]

In 2016, the International Working Group on Sustainable Bioeconomy (ISBWG) was established, the purpose of which is to help in the development of programs

and strategies for the introduction of zero-waste bioeconomy [27]. ISBWG is also an advisory body to FAO on the technical work of the Organization for sustainable

bioeconomy of closed cycle [28]. FAO's extensive experience in biomass production and technology, processing and consumption complements other global bioeconomic initiatives, focusing primarily on the sustainable transformation of agri-food systems [28]. For example, new products based on the use of biological technologies instead of the use of traditional chemical compounds aimed at both the producer and the consumer; deployment of new technologies that contribute to sustainability without reducing the level of productivity; virtually waste-free production due to the use of all biomass through repeated processing for both production needs and consumption; focus on technologies that are natural; application of

technologies aimed at restoration and protection of natural resources involved in the production process, etc. [29]. Bioeconomic strategies are multi-sectoral and face greater challenges than sector-oriented sustainable development strategies, as the implementation of a sustainable bioeconomy compromises between different sustainable development goals, on the one hand, and sectors, on the other. Through enhanced dialogue between international partners, the ISBWG raises awareness of potential synergies and trade-offs related to the implementation of the bioeconomy, as well as opportunities for sustainable development and non-waste [28]. The content of the principles of sustainable bioeconomy is presented in Figure 3.

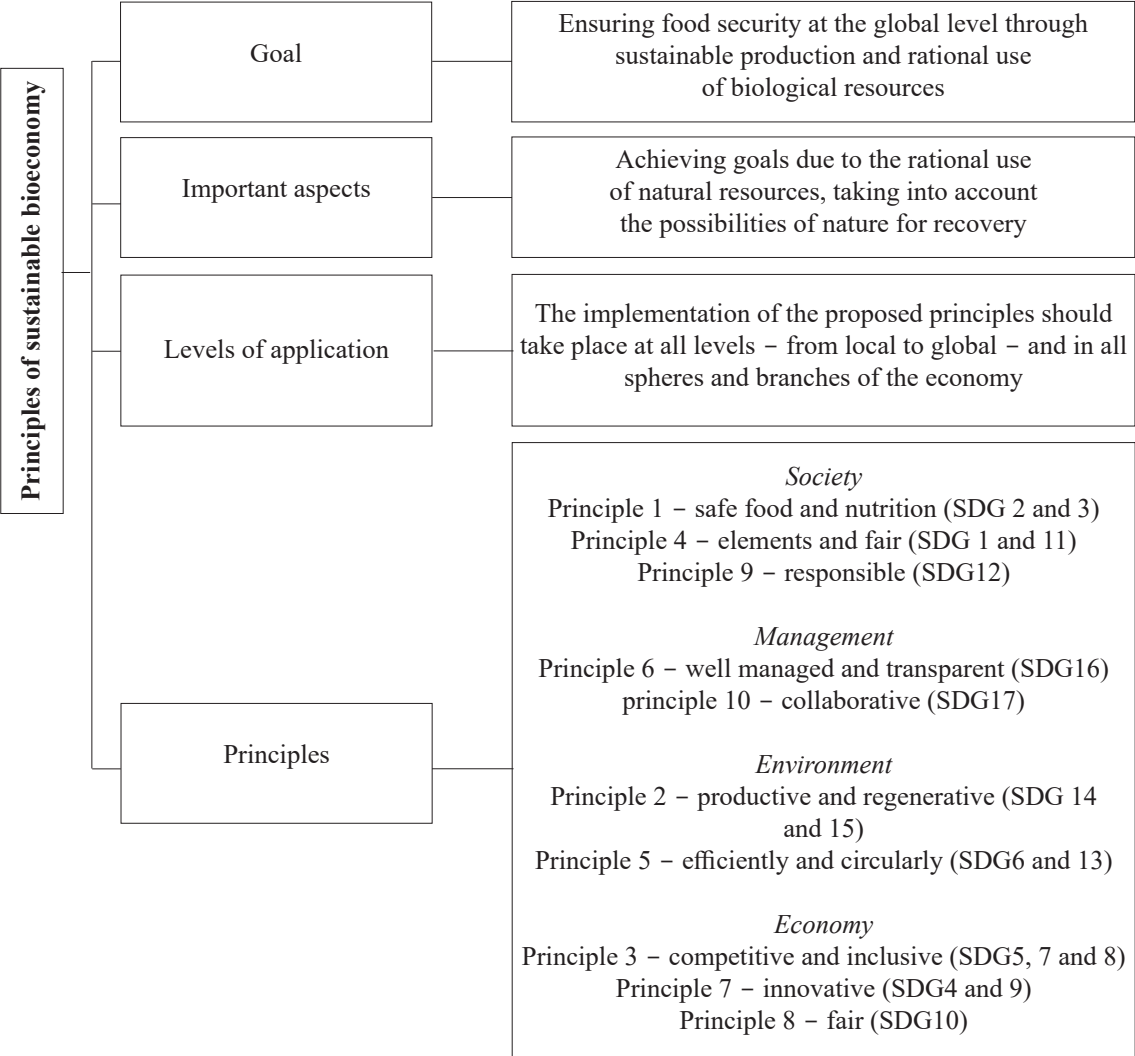


Figure 3. The content of the principles of sustainable bioeconomy

Source: made by the author according to data [28]

The levels of management of the food security system are determined by the levels of its provision. Thus, to ensure food security at the national level, tools, means and mechanisms of state regulation are used, at the regional level – local government, at the household level – internal government, and at the individual level – it is necessary to use joint initiatives.

Full organizational and economic mechanisms to reduce food losses and food waste are described in

the work of M.M. Babych [2]. It is important that the proposals are presented in terms of stages (from production to consumption) in the food chain. In particular, the organizational mechanisms include the following [2]:

- at the stage of production – donation of crops unsuitable for sale; conversion of unsuitable agricultural crops into value-added products; use of the latest technologies and modern equipment in the production process and during the collection of products; improving access to infrastructure and markets;

– at the storage stage – improvement of food storage technologies; introduction of energy-efficient equipment for storage of products with low carbon content; use of equipment and technologies that protect products from the penetration and reproduction of non-specific microflora; improving infrastructure (e.g. roads, access to electricity);

– at the stage of processing and packaging – reengineering of technological processes of products' processing and packaging; improving the supply chain management system; use of packaging that will ensure longer storage of food without losing its quality, taking into account the optimal volume of packaging; reprocessing or repackaging of products that have not lost their nutritional properties and quality;

– at the stage of delivery and sale – donation of unfit for sale food (for example, damage to packaging); clear guidelines for food storage and strict adherence; improving the rules of food labeling; extensive use of promotions;

– at the stage of consumption – donation of unfit for

sale food in catering establishments; reduction of portion size or the possibility of ordering different portion sizes; conducting campaigns on consumer education (the general public, especially schoolchildren); consumption of "imperfect" in appearance products.

Regarding economic mechanisms, we support the position of M.M. Babych [2]. Among the technological mechanisms for achieving food security on the basis of sustainable development of agricultural land use, include rational, adaptive and alternative land use systems. Forms of sustainable agricultural land use and farming systems are closely interrelated, as the former determine the latter [30]. System management tools include a fairly wide spectrum of measures, means, mechanisms and methods of both economic and legal, administrative, agro-technological and ecological direction [30].

In general, the author's vision of the methodological requirements for the formation of food security on the basis of sustainable development of agricultural land use is presented in Figure 4.

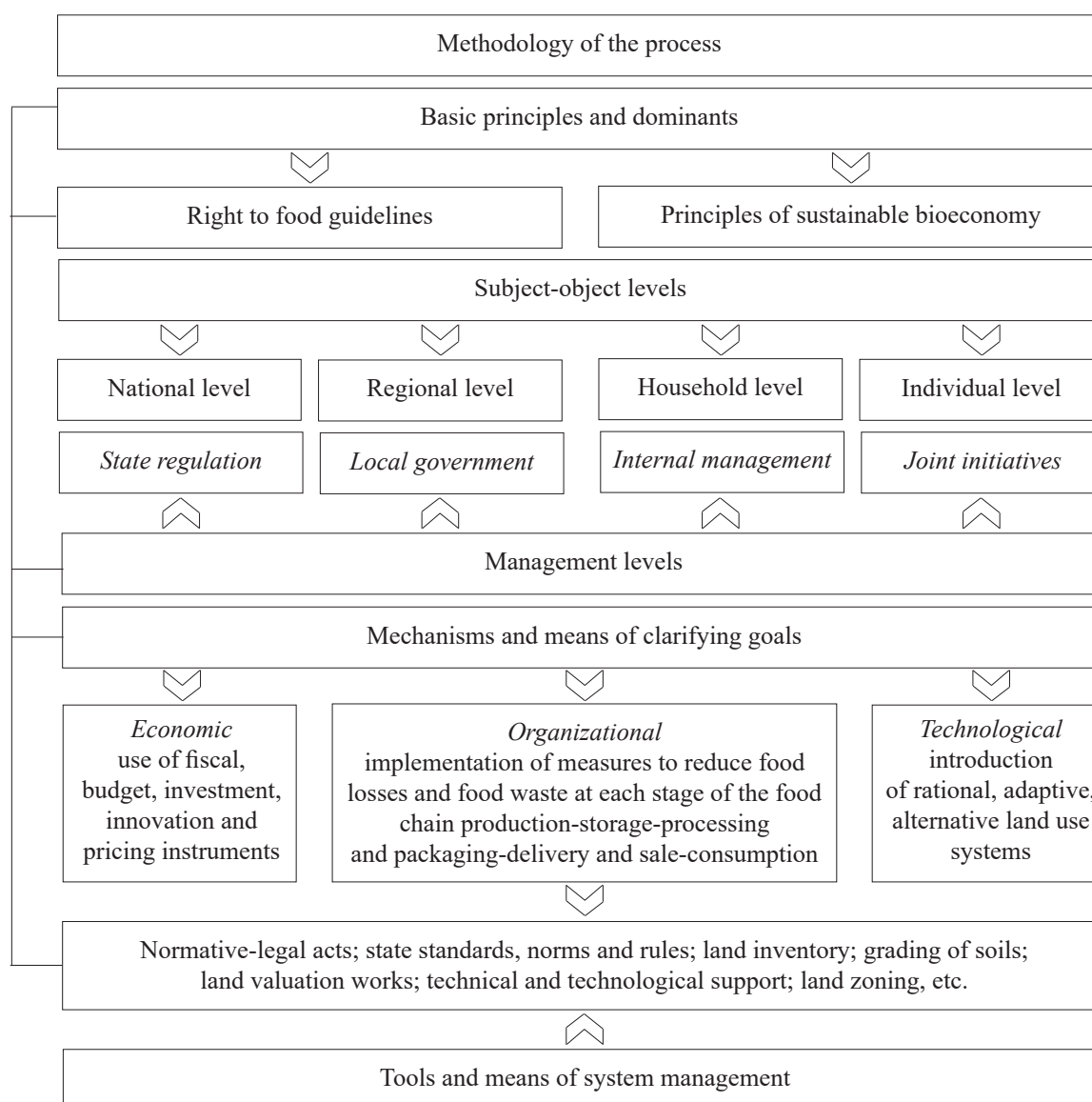


Figure 4. Logical and semantic model of methodology for the formation of food security on the basis of sustainable development of agricultural land use

Source: made by the author

The proposed model of the methodology of food security formation on the basis of sustainable development of agricultural land use allows to form the provisions and directions of implementation of the relevant Concept (Fig. 5).

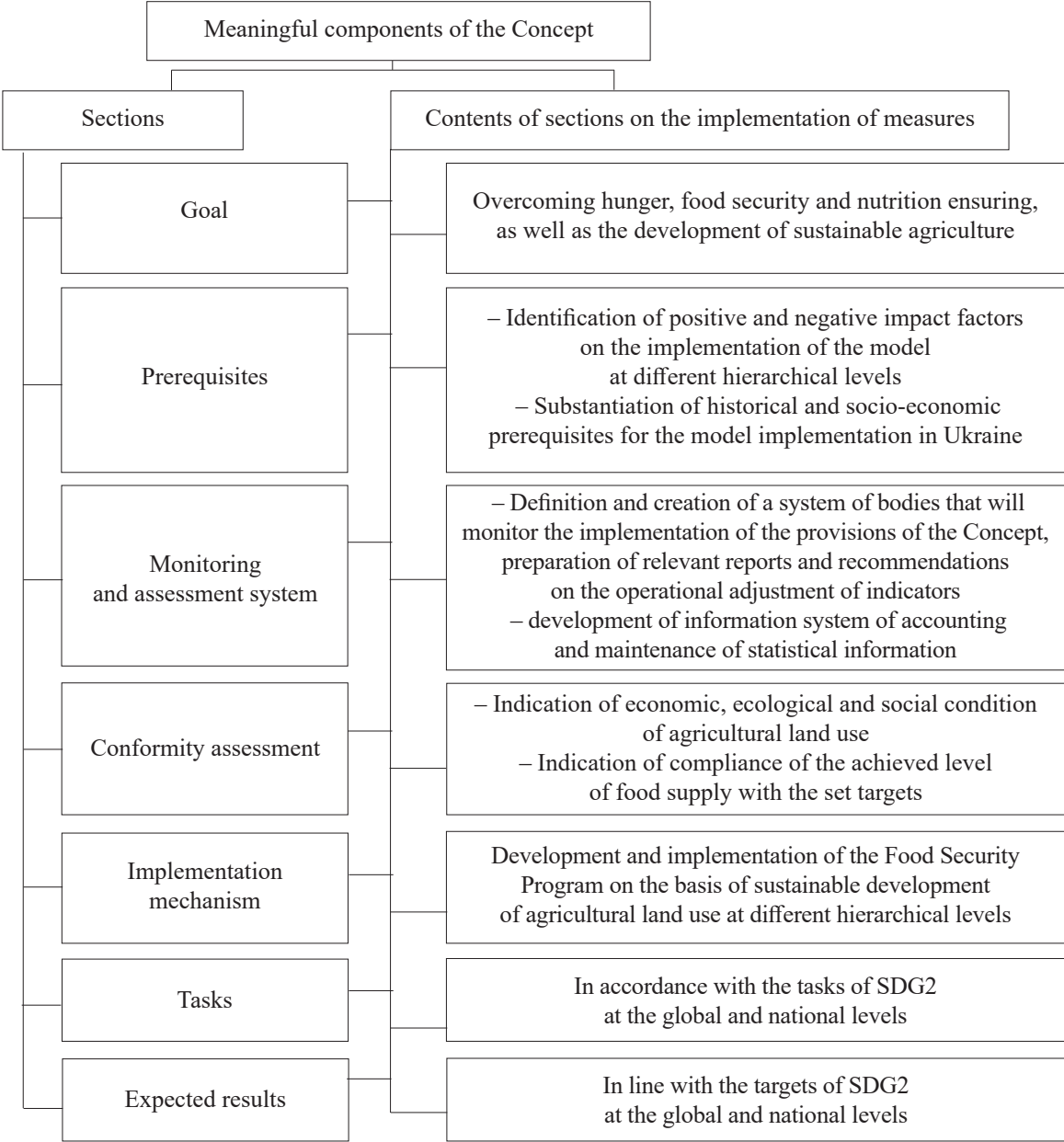


Figure 5. The main provisions and directions of implementation of the Concept of food security on the basis of sustainable development of agricultural land use

Source: made by the author

Components of the Concept of food security on the basis of sustainable development of agricultural land use (hereinafter – the Concept) are based on the approach proposed earlier in the construction of the Concept of sustainable development of agricultural land use in Ukraine [23].

The goal of the Concept is the global goal of sustainable development – this approach ensures the

achievement of the defined goals of the Sustainable Development Goals. It is also necessary to take into account the peculiarities of Ukraine, which have both a negative and a positive impact on the process of introducing a food security model based on the principles of sustainable development of agricultural land use (Fig. 6).

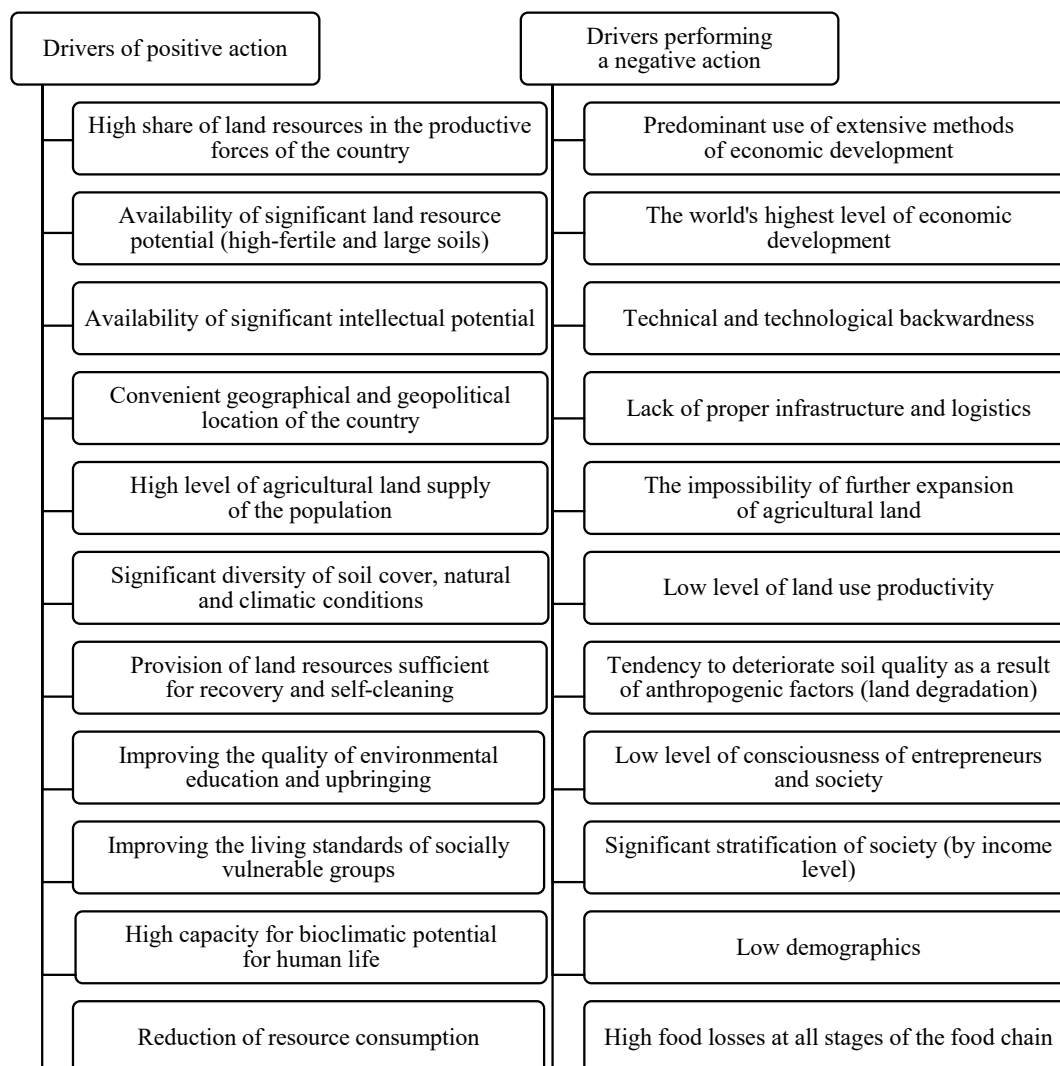


Figure 6. Influencing factors and preconditions for the implementation of the Concept of food security on the basis of sustainable development of agricultural land use

Source: made by the author according to data [23]

In order to obtain data on the implementation of the Concept, it is advisable to conduct ongoing monitoring. It is proposed to indicate the economic, environmental and social status of agricultural land use according to the proposed method [30]. It is advisable to assess the compliance of the achieved level of food security with the established targets according to the indicators defined by the State Statistics Service of Ukraine and FAO, comparing them with the defined targets (paragraph 7 of the Concept "Expected Results").

Implementation of the Concept involves the development of an appropriate Program, which includes a financial unit for the implementation of certain tasks (paragraph 6 of the Concept "Tasks").

CONCLUSIONS

The investigated problem is complex and multifaceted, which requires a combination of knowledge and efforts in various spheres of life: from political-economic to natural-climatic. Taking into account the fact that in Ukraine the development of the food system on the basis of sustainable development is at the stage of its

formation, the results of the study are concentrated in the theoretical and methodological plane, in particular:

- methodologies of food security formation on the basis of sustainable development of agricultural land use – the application of Voluntary guidelines and principles of sustainable bioeconomy is substantiated; the expediency of application of certain hierarchical and managerial levels is proved; the use of specific mechanisms and tools of economic, organizational and technological direction is proposed;

- the main provisions and directions of implementation of the Concept of food security on the basis of sustainable development of agricultural land use, which includes 7 sections necessary for the development of the program and agreed with the Sustainable Development Goals in terms of achieving zero hunger and sustainable agriculture.

Further research should focus on the development of the Food Security Program on the basis of sustainable development of agricultural land use and regulatory support of this issue in Ukraine, taking into account European standards and norms.

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Концепція формування продовольчої безпеки на засадах сталого розвитку сільськогосподарського землекористування

Олена Іванівна Котикова

Миколаївський національний аграрний університет
54008, вул. Георгія Гонґадзе, 9, м. Миколаїв, Україна

Анотація. Вирішення проблем продовольчого забезпечення тих, які вже наявні, та тих, які очікують нас у найближчій перспективі, лежить у площині формування системи продовольчого забезпечення на засадах сталого розвитку сільськогосподарського землекористування. Світове наукове товариство приділяє значну увагу визначеній проблемі, проте їх відрізняє практична спрямованість для певного регіону, що часто унеможлиблює імплементацію таких наукових здобутків в Україні. Для вироблення Програми продовольчої безпеки на засадах сталого розвитку сільськогосподарського землекористування в Україні необхідним є відповідне теоретико-методологічне підґрунтя, що було визначено метою нашого дослідження. В результаті проведеного дослідження отримано наступні результати. По-перше, розроблено логічно-смыслову модель методології формування продовольчої безпеки на засадах сталого розвитку сільськогосподарського землекористування, що включає організаційно-економічні та екологічні передумови переходу сучасного землекористування на модель стійкого розвитку. По-друге, сформовано положення і напрями реалізації відповідної Концепції, що базується на історичних та соціально-економічних передумовах продовольчого забезпечення та включає наступні складові: мету; історичні та соціальні передумови; систему моніторингу та оцінки; оцінку відповідності рівня продовольчого забезпечення встановленим цільовим показникам; механізм реалізації Концепції; цільові напрями та основні завдання; очікувані результати. Напрями реалізації Концепції, інструменти та механізми реалізації моделі продовольчої безпеки на засадах сталого розвитку сільськогосподарського землекористування, з одного боку, повністю узгоджуються із глобальними завданнями 2-ї Цілі сталого розвитку (подолання голоду), а з іншого – враховують національні властивості

Ключові слова: продовольча система, нульовий голод, модель методології формування продовольчої безпеки, використання земель в аграрному секторі

Insurance Fraud: Theoretical Conceptualization and Countermeasures

Vyacheslav Shebanin*, Irina Allahverdiyeva

Mykolaiv National Agrarian University
54008, 9 Georgiy Gongadze Str., Mykolaiv, Ukraine

Abstract. Ensuring the effective functioning of insurance companies and the proper level of their financial security is impossible without the formation and implementation of an effective system for detecting and countering insurance fraud, which causes negative consequences for the companies themselves, their clients and counterparties, and the country's insurance market in general. The purpose of the article is to generalize the theoretical foundations of insurance fraud and substantiate practical recommendations for combating insurance fraud in the modern conditions of the functioning of insurance companies of Ukraine using the best experience of organizing the fight against fraud in the insurance systems of the leading countries of the world. In the process of carrying out a scientific search, in order to achieve the specified goal, the following general scientific methods were used, which ensure the reliability of the obtained results and conclusions, such as: the method of theoretical generalization; monographic and comparative; method of comparative analysis; graphic; abstract logical method. For the success of the fight against fraud, it is justified to build a hierarchical structure for combating insurance fraud, which will cover the entire market and will be carried out at the state level and at the level of the insurance company. The main goal of the proposed system is to prevent cases of insurance fraud, exchange information on the facts of falsification of insurance events and control compliance with the law. The insurance fraud prevention system at the level of insurance companies is proposed to be segmented into the following groups: financial investigations; building a fraud prevention mechanism; search and return of assets, support in disputes and handling of cases. It has been determined that the very segmentation of a company's anti-fraud efforts is necessary in order to cover all the areas of risk associated with causing losses to companies as a result of fraud. Therefore, the proposed ways of combating insurance fraud are based on a systemic approach, and their complex application can give its synergistic effect and make it possible to cover all risk areas associated with causing damage to companies as a result of fraud, abuse, employee negligence and other frauds as both within the company and in relations with counterparties, and will also contribute to safety in the insurance market

Keywords: insurance fraud, insurance market, insurance companies, insurance market regulation

INTRODUCTION

Ensuring the effective functioning of insurance companies and the proper level of their financial security is impossible without the formation and implementation of an effective system for detecting and countering insurance fraud, which causes large-scale negative consequences for companies, their stakeholders and the insurance market in general. In the countries of Western Europe and the USA, 15% of payments from insurance cases go to fraudsters [1]. Similar statistics are not known in Ukraine. It is worth noting that even the National Bank of Ukraine, which, in particular, supervises domestic insurance companies, does not have similar statistics. However, according to the Report of the General Prosecutor's Office

of Ukraine "On Criminal Offenses Committed at Enterprises, Institutions, Organizations by Types of Economic Activity", it follows that the share of crimes committed in the field of insurance, reinsurance of non-state pension provision, in addition to mandatory social insurance, from the total number of crimes committed in the field of financial activity in 2020 ranges from 7.2% to 10.6%, in 2021 – from 9.8% to 16.0% [2].

Despite the efforts made by the insurance community, the authorities and law enforcement agencies to combat insurance fraudsters, in particular with regard to market segmentation, licensing and prudential supervision, reporting, inspections, corporate governance

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and protection of consumer rights, the involvement of international and Ukrainian experts to develop concepts, development proposals for legislative and regulatory changes and preparation of drafts of relevant acts [3], the problem of insurance fraud continues to remain relevant and cause great economic losses. Therefore, it is advisable to consider the justification of ways to combat insurance fraud systematically, and only a comprehensive application can give its synergistic effect and make it possible to cover all risk areas associated with causing damage to companies as a result of fraud, abuse, employee negligence and other frauds both within the company, as well as in relations with counterparties, and will also contribute to security in the insurance market.

Various scientists have made a significant contribution to the study of insurance fraud problems and the study of ways to regulate insurance fraud prevention. Ya.V. Mykytenko, V.S. Fomina proposed a system of measures for the prevention of insurance fraud, which should be based on the automation of the fight against fraud, the use of artificial intelligence, the culture of combating fraud and the prompt exchange of information [4].

In the studies of V. Andrienko, R. Kobko [5], it is proven that the level of economic security of the insurance market is determined by how effectively the subjects of the insurance market can effectively resist existing and potential threats and eliminate negative factors affecting the functioning of the insurance market.

Studying the motives for its implementation is important when developing ways to combat insurance fraud. Thus, researchers B. Loveday, J. Jung [6] indicate that fraud, like any crime, is a product of three factors: motivated offenders; the presence of a potential victim or target; lack of an effective supervisory body. This general rule applies regardless of whether it is fraud against government assistance programs, against the elderly, or misappropriation of corporate assets by a company director.

J. Jung [7] provides a characterization of insurance fraud, including its nature, the Scholar argues that insurance fraud is highly fragmented and each offense is not significant enough to cause active public interest or police intervention. Scientists identified and diagnosed three problems: lack of awareness, lack of national leadership, and limited attention of investigative bodies to insurance fraud. Based on these, three recommendations were proposed: (1) the initiation and development of a national initiative by the central government, (2) the use of a dynamic concentration approach to send deterrence threats to potential fraudsters, and (3) the use of big data technologies to identify the clandestine activities of organized groups.

In their research, P. Grabosky, G. Duffield emphasize that the most common motivation for fraud is economic. Another motivation is moral satisfaction. Scientists believe that those caught at the scene of fraud get joy from their own skill, which increases their prestige, causes pride and a desire for revenge [8, p. 2].

A similar opinion is held by L. Shirinyan [9, p. 337], who believes that economic incentives for fraud

are due to the existence of information asymmetry. You can agree with this, because according to the Law of Ukraine "On Insurance" [10], all parties to an insurance contract at any time are obliged to act with maximum conscientiousness, honesty to each other, which obliges the parties to mutually disclose all information known to them. Access to relevant information is usually limited to one of the parties to the agreement. A participant who possesses certain information has an advantage, which often serves as an incentive to commit fraud. Asymmetric information leaves participants with no other option but to trust each other for the duration of the agreement. The many opportunities that naturally arise for one or more interested parties due to the lack of complete information provide clear economic incentives to commit fraud.

Without diminishing the importance of scientific intelligence in this area, it is worth paying more attention to the definition of problems related to the spread of insurance fraud in Ukraine and the justification of the anti-fraud structure at the state level and at the level of the insurance company.

The purpose of the article is to generalize the theoretical foundations of insurance fraud and substantiate practical recommendations for combating insurance fraud in the modern conditions of the functioning of insurance companies of Ukraine using the best experience of organizing the fight against fraud in the insurance systems of the leading countries of the world.

MATERIALS AND METHODS

This article is aimed at consolidating and conducting a literature review with the aim of generalizing the theoretical foundations of insurance fraud and substantiating practical recommendations for combating insurance fraud in the modern conditions of the functioning of insurance companies of Ukraine using the best experience of organizing the fight against fraud in the insurance systems of the leading countries of the world.

In the process of carrying out a scientific search, in order to achieve the specified goal, the following general scientific methods were used, which ensure the reliability of the results and conclusions obtained, such as: the method of theoretical generalization – to formulate one's own approach to understanding the essence of insurance fraud; monographic and comparative – to systematize the scientific approaches of scientists to the theoretical aspects of insurance fraud and expand the methodological basis for justifying the creation of a system for combating insurance fraud; the method of comparative analysis – to compare the actual data of the activity of insurance companies of different periods; graphic – for visual display of research results; abstract-logical method – in the process of forming theoretical generalizations and conclusions.

The information base of the research was served by normative legal acts, in particular the Law of Ukraine "On Insurance", the Criminal Code of Ukraine; consolidated statistical data of the State Statistics Service of Ukraine,

reports “On Criminal Offenses Committed at Enterprises, institutions, organizations by types of economic activity” of the General Prosecutor’s Office of Ukraine for 2020-2021, Internet resources; monographic, periodical and reference publications; reporting materials of specialized organizations of various countries (National Insurance Crime Bureau, Insurance Bureau of Canada, Gesamtverband der Deutschen Versicherungswirtschaft, Association of British Insurers, Federation of Finnish Financial Services), the main task of which is to ensure control of the insurance market and combat fraud on it, and data from their official websites; reports of the international auditing company Price Waterhouse Coopers; results of own research and calculations.

In accordance with the formulated goal, the stages of the research were: the study of the theoretical foundations of insurance fraud, the definition of its main types; analysis of the performance indicators of insurance companies in the modern conditions of the spread of insurance fraud; substantiation of ways to combat insurance fraud in the modern conditions of operation of insurance companies of Ukraine. The used methodology contributed to the solution of the task and the justification of practical recommendations for combating insurance fraud in the modern conditions of the functioning of insurance companies of Ukraine using the best experience of organizing the fight against fraud in the insurance systems of the leading countries of the world.

RESULTS AND DISCUSSION

In Article 190 of the Criminal Code of Ukraine [11], fraud is interpreted as a crime against property, which is carried out through “... seizing someone else’s property or acquiring the right to property by deception or abuse of trust...” [11]. The International Association of Insurance Supervisors (IAIS) defines fraud as an act or deliberate concealment of information with the aim of obtaining an unfair advantage for the fraudster himself or for a third party [12].

International auditing company Price waterhouse Coopers interprets fraud as deliberate deception with the aim of stealing money, property or legal rights [13, p. 15]. The Association of Certified Fraud Examiners (Association of Certified Fraud Examiners) defines fraud in organizations (or so-called “corporate” fraud) as “...the use of official position for the purpose of personal enrichment through the intentional misuse or abuse of the resources and assets of the employer organization...” [14, p. 9].

The most discursive questions remain the definition of insurance fraud. It should be noted that there are no unified approaches to the interpretation of the content of insurance fraud in the Ukrainian financial literature. In many cases, the term “insurance fraud” is interpreted as deception, illegal behavior. Various definitions of insurance fraud, which can be the basis for understanding the concept itself, are presented in Table 1.

Table 1. The range of interpretations of the definition “insurance fraud”

Author	Definition
V.L. Plastup [15]	Insurance fraud is the illegal behavior of the subjects of the insurance contract, as a result of which the subjects of the insurance contract get the opportunity to illegally and free of charge rotate capital to their advantage
A.V. Tkachuk [16, p. 21]	Insurance fraud is a cunning and clever deception; seizing individual property of citizens or acquiring the right to property by deception or abuse of trust.
O.I. Baranovsky [17]	Insurance fraud is the obtaining of insurance compensation by the insured by deception or abuse of trust, or by paying less than necessary, with a normal assessment of risks, insurance premium, as well as hiding important information at the conclusion or during the period of validity of the insurance contract
L.V. Shirinyan [9, p. 343]	Insurance fraud is a conspiracy or deliberately illegal behavior of certain subjects of insurance relations, intentionally incorrect display (presentation) of data regarding the terms of the insurance contract, as a result of which such subjects get the opportunity to illegally change (use) the terms of the insurance contract to their advantage or receive compensation without proper grounds arising from the legislation, to take possession of someone else’s property or acquire rights to property by deception, abuse of trust
O.R. Kryvytska [18, p. 149]	Insurance fraud is an illegal action by the subjects of the insurance contract, or third parties, as a result of which the subjects of the contract get the opportunity to turn capital to their advantage on an illegal and free basis

Source: systematized by the author

The review of works reveals that the conceptual apparatus regarding insurance fraud, which would cover all subjects of the insurance market, remains undeveloped, which necessitates the formulation and definition of the concept of “insurance fraud” taking into account the role of the main subjects of the insurance market. So, based on the key characteristics of insurance fraud and taking into account the interpretation of this definition by scientists, an author’s approach to defining the essence of this concept was formed. Insur-

ance fraud can be considered as intentional actions of the subjects of the insurance contract, aimed at obtaining illegal benefits by deception or abuse of trust.

Insurance fraud can be classified depending on the subjects whose rights are violated; purposes of criminal acts, fraudulent acts; areas of insurance in which fraud is most widespread [4]. The indicated classification features are of significant importance in identifying possible threats to subjects of insurance relations. Yes, according to Y.V. Mykytenko, V.S. Fomin. the goals

of criminal actions for the insurers or insurance intermediaries themselves are the illegal appropriation of insurance premiums in the absence of the intention to fulfill their obligations to pay insurance compensation; for policyholders – illegal obtaining of insurance compensation or security; for employees of an insurance company – illegal obtaining of benefits by causing property damage to insurers and policyholders [4]. According to the identified motives for committing insurance fraud, it is possible to distinguish certain groups of fraudsters with characteristic psychological features (Fig. 1). Fraud can be divided into two groups: planned and situational. A key feature of planned fraud is extensive training,

sometimes involving a group of people and with the assistance of insurance company employees. This can be insurance of duplicate cars, insurance of damaged cars followed by the announcement of an insurance event, insurance of property in several different insurance companies to receive several insurance payments at once, staging of insurance events (accidents, thefts, arson and flooding, robbery). Situational fraud usually concerns insurers who have entered into a contract for the purpose of classic insurance protection. However, in the event of an insured event, they may take measures, as a rule, to hide the true causes and circumstances of the event, in order to avoid payment refusal or artificial overestimation of the loss [19].

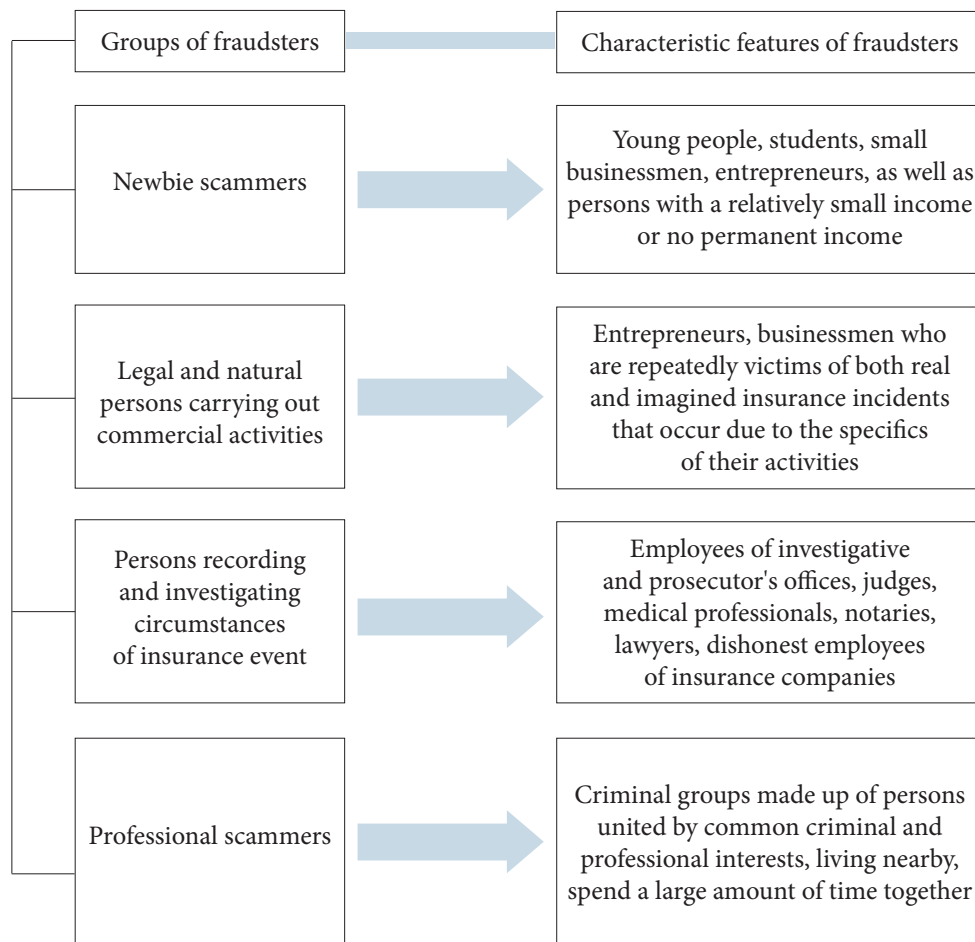


Figure 1. Groups of fraudsters in the insurance sector

Source: compiled by the author using [9; 15; 20]

The scale of insurance fraud varies from country to country. According to estimates by Insurance Europe [21, p. 9], fraud accounts for up to 10% of all claims costs in Europe. However, this number varies between countries and insurance classes depending on the functioning of the market and the distribution of a particular type of insurance. The approach to detecting insurance fraud also differs in European countries. Some countries (UK, Germany, Sweden, France, Finland) place great importance on establishing an accurate estimate of detected and undetected fraud, while others (USA, Canada, France) focus on reducing the number of known fraud cases.

However, the objective remains the same: to determine the extent to which anti-fraud initiatives are successful and whether further action is needed.

The insurance industry loses huge sums due to criminals. Figures from the Association of British Insurers (ABI) [21; 22] show that approximately £1.9 billion (€2.2 billion) of fraud goes undetected each year, with the value of detected fraud increasing by 7% to £983 million in 2020 sterling (1148 million euros). Figures from Insurance Sweden (Larmtjänst) [23] in Sweden show that insurance fraud investigators set up by insurance companies conducted 6,200 suspected fraud investigations

in 2020 and detected fraud totaling €40 million. Research has shown [21] that 10-20% of all fraudulent claims are claims for damages arising from events that never happened (ie false statements) and 80-90% of all fraudulent claims are exaggerated. In France, 35,042 fraudulent insurance claims were recorded in 2020, resulting in 168 million euros not being paid.

A study conducted by the Insurance Association (FFI) in Finland showed that 27% of policyholders indicated that they knew someone "...who defrauded their insurance company" [21].

In Ukraine, the situation is a little calmer. This is due to the fact that the insurance market is not as developed as in Europe and the USA, so there are fewer fraudsters. The share of insurance cases with signs of insurance fraud is about 1.5-2% of all registered losses [19]. The main field of activity of insurance fraudsters was and remains auto insurance – CASCO and OSCPV [24]. In some European countries, 80% of insurance fraud cases are related to motor insurance. At the same time, attempts to make a profit from insurers take place in real

estate insurance (both for individuals and for businesses) and in personal insurance (from accidents, civil liability insurance, etc.).

The number of insurance companies in Ukraine has a tendency to decrease, mainly due to the introduction by the National Bank of Ukraine of new requirements for their activities: updating mandatory standards for insurers, aimed at ensuring the appropriate level of solvency and liquidity of insurance companies, reducing the level of riskiness of operations, improving the quality assets and strengthening financial stability in the market of insurance services. A significant reduction in the number of insurance companies on the insurance market of Ukraine is also caused by the annual increase in the number of frauds in this area. Thus, in 2020, compared to the same period in 2017, the number of companies decreased by 84 SC [25]. For a more detailed analysis of the insurance market, the dynamics of the number of insurance companies and the level of their concentration were determined (Table 2). This will help to assess the overall potential of these financial institutions for insurance services.

Table 2. Dynamics of the number of insurance companies and their concentration in Ukraine

Number of insurance companies	2017	2018	2019	2020	The first half of 2021
Total quantity, units	294	281	233	210	181
Including IC "non-Life"	261	251	210	190	162
Including IC "Life"	33	30	23	20	19
Top 100 IC "non-Life", %	97.6	97.9	98.1	98.9	99.1
Top 150 IC "non-Life", %	99.5	99.7	99.8	99.9	99.9
Top 10 IC "Life", %	95.9	96.9	96.7	97.1	97.4
Top 20 IC "Life", %	99.9	100.0	100.0	100.0	100.0

Source: built on materials [25]

It should be noted that the peculiarity of the development of the Ukrainian insurance market is that 89.5% of it consists of "non-life" insurance companies (insurance companies dealing with risk types). The reason for the low level of development of life insurance is that the population of Ukraine does not have free funds and trust in the insurance system as a whole. The indicator of the number of insurance companies should be considered together with the indicator of the concentration of the insurance market. Thus, as of the end of 2020, only 150 "non-Life" insurers out of 210 (71.4%) accumulate 99.9% of all collected insurance premiums [25]. That is, we can talk about the existence of "pseudo insurance" on the insurance market, since 0.1% of insurance premiums are collected by 60 out of 210 insurers. A similar trend is observed in the life insurance market. During 2017-2021 10 ICs (50.0% of the total number of Life ICs) accumulated 97.1% of insurance premiums. All this confirms the low level of social security of the population of Ukraine, because the receipt of life insurance premiums and the number of insurers of this type are too small to ensure sustainable development. The study of the dynamics of the number of insurance companies and

their concentration in Ukraine is limited to data for the first half of 2021 due to the lack of published official statistical information on the number of insurance companies as of the beginning of 2022.

Insurance fraud in the market of insurance services has significant consequences, causing significant losses for all subjects of the insurance market. Fraudulent lawsuits and the costs of investigating suspected fraud lead to higher insurance premiums for honest customers [26]. Fraud investigations also affect insurers and their ability to process genuine claims quickly.

Sufficiently complex systems of prevention, detection and management are required for the success of the fight against fraud. For this, it is necessary to create an environment against fraud.

The fight against fraud in the field of insurance forces insurers to unite and create unions, and the state to take effective measures to solve this problem. Thus, in almost all developed countries, where insurance plays an important role for the effective functioning of the national economy, there are specialized organizations whose main task is to ensure the control of the insurance market and to oppose the manifestations of fraud on

it. Thus, in the USA there is a National Insurance Crime Bureau (National Insurance Crime Bureau), founded in 1992 [27]; in Canada, the Insurance Bureau of Canada was established in 1964 [28]; in Germany – the German Association of Insurers (Gesamtverband der Deutschen Versicherungswirtschaft) [29]; the Association of British Insurers has been operating in Great Britain since 1985 [22]; the Federation of Finnish Financial Services (Federation of Finnish Financial Services) has been operating in Finland since 2009 [30]. Analyzing the activities of the presented organizations, it was established that in order to reduce the negative impact of fraudulent actions on the subjects of the insurance system, the countries keep registers of insurance losses, and therefore of cases of insurance crimes, as well as organizations that fight against insurance fraud in order to detect insurance fraud. Actively use the latest technologies, such as electronic devices to identify the authenticity of documents submitted to support claims, as well as verify available information from social networks and other websites, hotlines and other methods, involving a wide range of the public in the fight against insurance fraud, etc. Thus, it can be stated that the association of its participants plays an important role in activating and improving the functioning of the insurance market. The level and potential of market development is determined by the presence of various types of such associations and the consolidation of their members' activities. Each such association has its own purpose and task and plays an important role in the intensive development of the insurance market. The main reason for the creation of such associations is the

inability of individual insurance companies to independently solve problems that constantly arise in the insurance market, inhibit its further development, and hinder the development of insurers' business [31, p. 248]. As of the beginning of 2022, the National Association of Insurers of Ukraine, the League of Insurance Organizations of Ukraine, the Insurance Business Association, the Motor Transport Insurance Bureau of Ukraine and others operate in Ukraine, whose activities are primarily aimed at activating the development of the insurance market of Ukraine, but it is necessary to form a new model of combating fraud [32].

Taking into account all participants of the insurance market, it is advisable to propose different hierarchical levels of the structure of combating insurance fraud. There will be a market-wide response structure that will take place at the state level and at the insurance company level. State regulation of insurance activity in the field of combating insurance fraud involves the use of a number of methods of direct and indirect influence, forms of regulation and tools (Fig. 2). The introduction of a system to combat insurance fraud at the state level is not only important, but also necessary. According to V. Andrienko and R. Kobko, state regulation of the insurance market remains the most effective and important mechanism for controlling the effectiveness of the functioning of insurance companies and ensuring the economic security of the insurance market [5, p. 9]. The authors support the opinion of scientists, since state regulation can significantly affect the safety of the insurance market and the growth of trust in it on the part of citizens and enterprises.

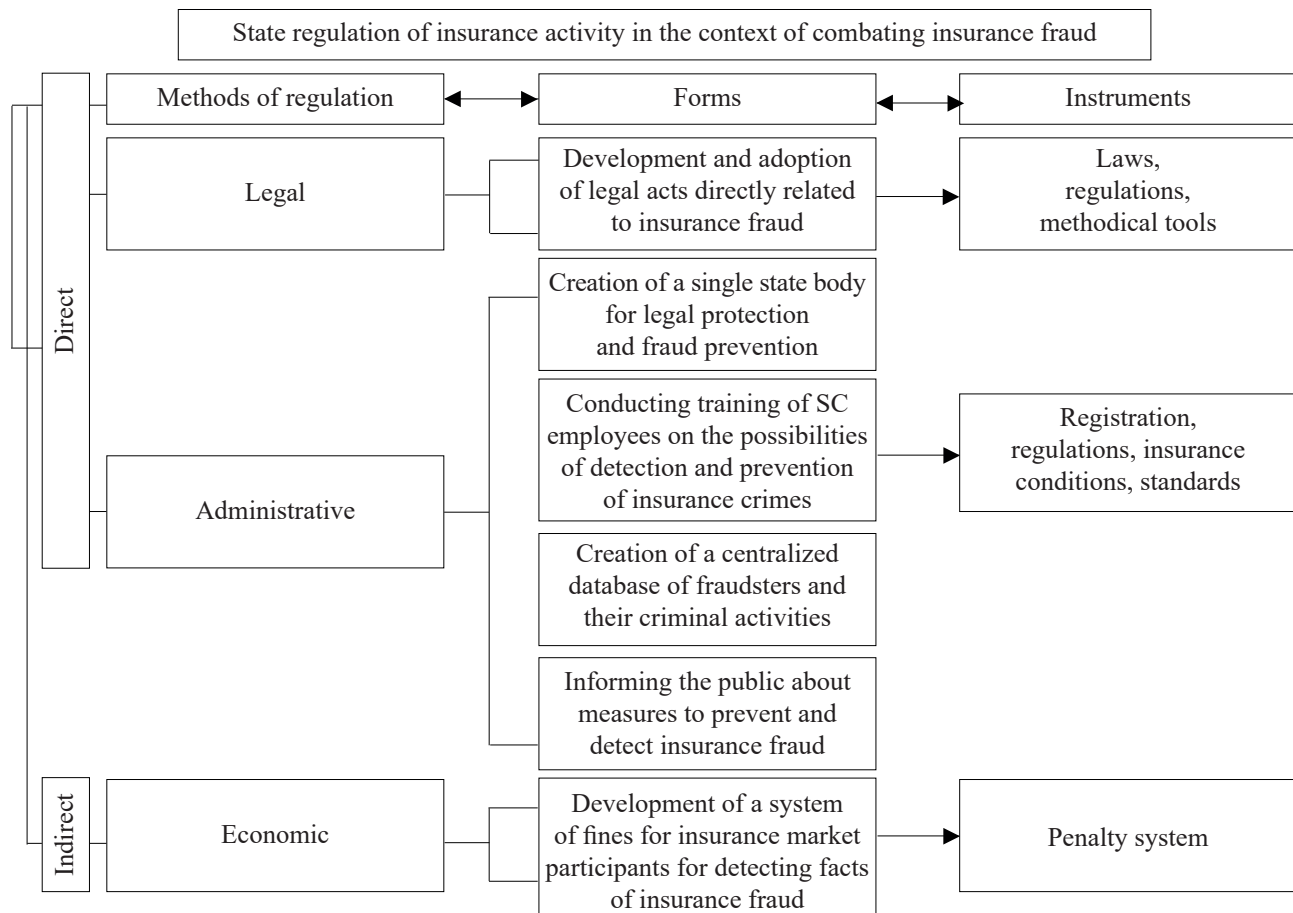


Figure 2. The system of combating insurance fraud at the state level

Source: developed by the author

The main purpose of the proposed system of combating insurance fraud at the state level is to prevent cases of insurance fraud, exchange information about the facts of falsification of insurance events and control compliance with the relevant legislation [9, p. 354]. Therefore, the system will contribute to the protection of the rights and economic interests of the subjects of the insurance market and the growth of trust in it.

The insurance fraud prevention system at the level of insurance companies is recommended to be segmented into the following groups: financial investigations (analysis of the current security system in the company; evaluation of procedures and internal policies); building a fraud prevention mechanism (preparation of a plan of anti-fraud measures; organization of the work of a corporate hotline; preparation of an online application form; organization of the work of the security service and internal control); search and recovery of assets, assistance in disputes and case proceedings (identification of lost profits and opportunities; collection of hidden information about the parties to the dispute; evaluation of the dispute and development of a strategy; assistance in negotiations; pre-trial recovery of assets; court assistance, provision of expert testimony). The very segmentation of a company's anti-fraud efforts is necessary in order to cover all areas of risk associated with causing losses to companies as a result of fraud, abuse, employee malpractice and other manipulations both within the company and in relations with counterparties.

Realizing the scale of losses in the insurance market for insurance companies, the construction of a fraud prevention mechanism should be focused on the following components:

1. *Automation of the fight against fraud.* It is important to develop fraud detection capabilities with technical support. Many industries and sectors are actively using big data technologies to suit their needs. Similarly, big data technology can be a useful tool for detecting cases of insurance fraud, as the number of claims for insurance benefits increases over time. Big data technologies can benefit key stakeholders as they will be able to detect cases of organized fraud in the first place.

2. *Use of artificial intelligence.* Artificial intelligence can be used to analyze images while checking for fraud. Insurance companies can use these technologies to improve and streamline their risk analysis and fraud detection processes.

3. *Anti-fraud culture.* Such a culture requires structured communication between departments, senior management involvement, fraud awareness training and agreed performance standards for staff. There are many examples of positive world experience in this aspect. For example, in Germany, Denmark, Finland, annual training is held for claims handling specialists to teach them how to detect and fight fraud. The training is conducted by practitioners of the insurance industry, legal advisers, technical specialists, police experts and medical scientists. Participants can take an exam to earn a Certificate of Expertise in Insurance Fraud Detection. In Finland, the

insurance federation has been organizing seminars and training with the police, other authorities and the media for 30 years. In the UK, bodies such as the IFB and IFED run specialist anti-fraud workshops for staff, and many insurance companies additionally run early and career-long training programs for staff and appoint "fraud advocates" who highlight and remind colleagues about the possibility of fraud in all areas of business [21].

4. *Exchange of information.* All insurance companies would benefit from joining forces and sharing information on the origins of fraud. It is worth noting the existing foreign experience regarding the exchange of information about fraudsters in the field of insurance. In particular, in Croatia, Estonia, Finland, Germany, Ireland, Malta, the Netherlands, Norway, Portugal, Slovenia, Spain, Sweden and Great Britain, there is an exchange of information about fraudsters in the field of insurance between insurance companies. Insurance companies are transparent about this and act in accordance with data protection and privacy requirements. There is also cross-border cooperation. Insurance companies of the Scandinavian countries meet regularly to discuss trends and problems in combating insurance fraud. And in France, Sweden and Great Britain, insurance companies have created formalized groups to investigate insurance fraud [21].

In France, insurers created a national body (Agence pour la lutte contre la fraude à l'assurance, ALFA) in 1989 to investigate suspicious claims. ALFA aims to contribute to the fight against fraud by developing appropriate tools to help the industry fight fraud. These include: training and certification of fraud investigation agents, advice on handling fraud cases that target multiple insurers at the same time, and advice on managing relationships with law enforcement [32].

In Sweden, insurance companies have created special investigative units that are responsible for detecting insurance fraud. Insurance Sweden encourages these units to report detected or suspected fraud to the police [33].

In the UK, the Insurance Fraud Bureau (IFB) focuses on detecting and preventing organized and cross-industry insurance fraud. The IFB leads or coordinates the industry's response to the detection of criminal fraud networks and works closely with the police and other law enforcement agencies [33]. It encourages and helps people to report suspected or known fraud anonymously through the insurance hotline.

Without the active response of all market participants, in particular the state, and the insurance companies themselves, positive changes in the context of minimizing the risks of insurance fraud are impossible. That is why the proposed ways of combating insurance fraud are based on a systemic approach, and their complex application can have a synergistic effect in combating fraud and contribute to security in the insurance market.

CONCLUSIONS

It stands to reason that detecting and reducing insurance fraud is a key priority for insurers. Honest customers should

not have to pay the price for fraudsters through higher premiums. The insurance industry continues to improve its systems and controls to ensure that all types of fraud are detected and prevented.

Insurers' methods are constantly evolving to deal with changes in the behavior of fraudsters. It has been proven that it is necessary to build a hierarchical structure to combat insurance fraud, which will cover the entire market and will be carried out at the state level and at the level of the insurance company. The proposed system of combating insurance fraud at the state level, which involves the use of a number of methods of direct and indirect influence, forms of regulation and tools. The main purpose of the proposed system is to prevent cases of

insurance fraud, exchange information on the facts of falsification of insurance events and control compliance with the relevant legislation. The expediency of segmenting the company's anti-fraud efforts is substantiated.

Thus, it is proposed to segment the insurance fraud prevention system at the level of insurance companies into the following groups: financial investigations; building a fraud prevention mechanism; search and return of assets, support in disputes and handling of cases. Such a system will make it possible to cover all risk zones associated with causing damage to companies as a result of fraud, abuse, employee malpractice and other frauds both within the company and in relations with counterparties.

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Страхове шахрайство: теоретична концептуалізація та шляхи протидії

В'ячеслав Сергійович Шибанін, Ірина Валеріївна Аллахвердієва

Миколаївський національний аграрний університет
54008, вул. Георгія Гонґадзе, 9, м. Миколаїв, Україна

Анотація. Забезпечення ефективного функціонування страхових компаній, належного рівня їх фінансової безпеки неможливе без формування і впровадження дієвої системи виявлення і протидії страховому шахрайству, що спричиняє негативні наслідки як для самих компаній, їх клієнтів і контрагентів, так і страхового ринку країни загалом. Метою статті є узагальнення теоретичних засад страхового шахрайства та обґрунтування практичних рекомендацій щодо протидії страховому шахрайству у сучасних умовах функціонування страхових компаній України з використанням передового досвіду організації боротьби з шахрайством у страхових системах провідних країн світу. У процесі здійснення наукового пошуку, для досягнення визначеної мети було використано такі загальнонаукові методи, що забезпечують достовірність отриманих результатів і висновків, як: метод теоретичного узагальнення; монографічний та порівняльний; метод порівняльного аналізу; графічний; абстрактно-логічний метод. Для успіху боротьби з шахрайством обґрунтована побудова ієрархічної структури протидії страховому шахрайству, яка охоплюватиме весь ринок і буде провадитися на державному рівні та на рівні страхової компанії. Основною метою запропонованої системи є запобігання випадкам страхового шахрайства, обмін інформацією про факти фальсифікації страхових подій та контроль за дотриманням законодавства. Систему протидії страховому шахрайству на рівні страхових компаній запропоновано сегментувати на такі групи: фінансові розслідування; побудова механізму протидії шахрайству; пошук і повернення активів, супровід в справах і розгляді справ. Визначено, що саме сегментування зусиль компанії з протидії шахрайству є необхідним для того, щоб охопити всі зони ризику, пов'язаних з нанесенням компаніям збитку в результаті шахрайства. Отже, запропоновані шляхи боротьби зі страховим шахрайством базуються на системному підході, а їх комплексне застосування може дати свій синергетичний ефект та дасть змогу охопити всі зони ризику, пов'язані з нанесенням компаніям збитку в результаті шахрайства, зловживання, службовою халатністю співробітників та інших махінацій як всередині компанії, так і у відносинах з контрагентами, а також сприятиме безпеці на страховому ринку

Ключові слова: шахрайство у страхуванні, страховий ринок, страхові компанії, регулювання страхового ринку

Agricultural Insurance as a Condition for Sustainable Development of Rural Areas

Iryna Honcharenko*, Nataliia Shyshpanova

Mykolaiv National Agrarian University
54008, 9 Georgiy Gongadze Str., Mykolaiv, Ukraine

Abstract. The agricultural sector is currently the leading link in the Ukraine economy, which largely determines the socio-economic development of rural areas. Agricultural insurance is an effective tool to reduce financial losses in the course of economic activity in agriculture. The aim of the article is to identify trends in the agricultural insurance market in Ukraine, highlight the factors influencing its functioning and on this basis substantiate the directions and prospects for further development of this segment of the insurance market as a condition for sustainable rural development. The following methods were used to implement the tasks: abstract-logical; system analysis; structural and functional; graphic; monograph; comprehensive analysis. In the study of the relationship between insurance premiums and 7 factors of influence, the method of regression analysis was used. According to the simulation results, it is established that by 53.6% the variation in the volume of agricultural insurance premiums depends on the volume of crop production by agricultural enterprises, by 52.5% – on the share of insured area and 92.1% on the average insurance rate. The value of the coefficient of determination according to this model indicates that the variation in the volume of insurance payments for agricultural insurance by 96.4% is determined by the variation of these factors. Factors of low level of distribution of agroinsurance in Ukraine are revealed, which are combined into blocks: factors connected with branch specificity of enterprises; factors related to the activities of insurance companies; natural and climatic factors; institutional factors. The directions of development of the agricultural insurance market in Ukraine are substantiated: first, the creation of mutual insurance companies and cooperatives, which will allow to take into account the specific needs of members of the company; secondly, the resumption of public-private partnerships, which will help the insurance company's customers to develop a variety of sources of insurance costs, restore confidence in insurance as a tool for risk localization and increase the reliability of insurance compensation in the event of an insured event

Keywords: insurance, insurance of agricultural enterprises, insurance companies, agricultural territory

INTRODUCTION

The agricultural sector of Ukraine's economy is currently the key block of the national economy, which largely determines the socio-economic development of rural areas, employing the rural population, forming 14% of gross value added and over 40% of exports [1]. However, the existing Ukrainian agricultural potential is not fully used. This is primarily due to the lack of adequate financial support for agriculture, unfavorable lending conditions for agro enterprises, as well as the lack of government subsidies and investment in the agricultural sector. In addition, there are force majeure factors that do not depend on agricultural enterprises and often lead to the complete cessation of their activities.

It is possible to solve the existing problem and ensure the proper functioning of the agricultural market, in particular by reducing market risks for farmers through the diversification of market instruments. An effective tool to reduce financial losses connected with adverse weather conditions during economic activities in agriculture is agricultural insurance. Insurance protection of agricultural production is the best way to ensure continuity, balance, and stability of the agricultural market [2, p. 157].

In recent years, the agricultural insurance market of Ukraine has had positive dynamics: the number of concluded insurance contracts, the number of collected

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insurance premiums in hryvnia, the total sum insured are growing. But the share of insured areas in the total amount of crops remains within 3-5% [3, p. 176]. Under such conditions, the potential of agricultural insurance as a component of ensuring the conditions for sustainable development of the agricultural sector is not realized. Therefore, to ensure further growth of the agricultural sector of Ukraine, the study of agricultural insurance as a tool of risk management from the standpoint of identifying and solving problems is an important component that will improve insurance protection, risk management and ensure maximum profitability of the sector.

Various aspects of the functioning of such an important financial instrument as agricultural insurance have been studied by several Ukrainian and foreign scholars and practitioners. O. Slobodyanyuk specifies that agricultural insurance is the primary mechanism for agricultural risk management, which provides a balance of interests of all parties or participants: farmers – protection of profits in case of crop loss, creditors – repayment of loans taken for agricultural purposes, the state – food security [4, p. 28]. This definition is incomplete, as it does not reflect the role of insurance companies in ensuring the insurance process.

There is a view that agricultural insurance is an effective tool to compensate for financial losses from weather and climatic factors and other adverse events in the course of economic activity in agriculture [5, p. 176].

Among scientists dominated the scientific position that the design of agricultural insurance systems should be such to ensure the transparency of decisions with the involvement of government agencies, insurance companies, and agricultural producers [6, p. 215].

Given the expediency of agricultural insurance, O. Panchenko, A. Sholomiy note that the organization of insurance protection of agricultural enterprises will protect them from the possible risk of loss of crops and hence their income [7, p. 119]. The same opinion is supported by V. Shebanin and I. Kormishkin [8]. Scientists attribute agricultural insurance to the main components of infrastructural support for the development of agricultural entrepreneurship [8, p. 9]. They emphasize that insurance is one of the effective means of protecting agricultural formations from weather and climate risks, which farms are unable to avoid, but which negative consequences they can minimize by choosing the appropriate insurance program.

An assessment of the causal links between index insurance and the welfare of farmers is presented in the works of K. Tafere, C. Barrett, E. Lentz [9]. The need for index insurance is emphasized by S. Janzen, N. Magnan, C. Mullally and others [10]. Index insurance is also considered by N. Jensen, C. Barrett, A. Mude [11]. However, researchers in their research emphasize the need for caution in promoting index insurance as a tool to reduce risk, as well as the importance of assessing product quality.

P. Zhang, M.A. Palma compare compulsory, voluntary and mixed insurance in terms of unfavorable selection and moral hazard and found unfavorable selection

in purely voluntary insurance, but profitable in mixed insurance [12]. Y.L. Kevin, C. Ruth, V. Hill in their research, they study the impact of delayed premium payments on the use of insurance services and subsequent investment decisions among small farmers [13].

Proposals on ways to build an effective system of agricultural insurance with the active participation of the state are formulated in studies by O. Panchenko, A. Sholomiy [7], O. Yatsukh [14], L. Tulush and O. Prokopychuk [15], N. Bondarenko and S. Vlasjuk [5]. The issue of state participation is also considered in the framework of the project “Development of financing the agricultural sector in Europe and Central Asia” [16], revealed in an analytical study of the International Finance Corporation IFC (World Bank Group) in cooperation with the Ministry of Agrarian Policy and Food of Ukraine [17].

However, there are still many debatable and unresolved issues in the agricultural insurance sector of Ukraine, especially the need to scientifically substantiate the potential of the agricultural insurance market, taking into account the interests of all stakeholders in the insurance process to ensure effective neutralization of various risks generated in rural areas, which require in-depth study and analysis, as well as the development of a system of measures aimed at improving the insurance protection of agricultural businesses.

The aim of the article is to identify trends in the agricultural insurance market in Ukraine, highlight the factors influencing its functioning and on this basis substantiate the directions for further development of this segment of the insurance market as a condition for sustainable rural development.

MATERIALS AND METHODS

The theoretical and methodological basis of the study are the fundamental provisions and basic principles of economic theory on the formation of insurance relations in agriculture. The following methods were used to implement the tasks: abstract-logical to substantiate the research methodology and determine theoretical generalizations; system analysis in the formation of conceptual provisions for the coordination of structural and infrastructural participants in the agricultural insurance market; structural and functional to explain the processes of formation of the institutional environment in the agricultural insurance market; graphic to identify and illustrate current trends in the functioning of processes related to agricultural insurance; monograph to study the experience of successful business process management in the agricultural insurance market; comprehensive analysis to identify trends in agricultural insurance.

In accordance with the stated goal, the stages of the study were: identification of problems in the development of the agricultural insurance market of Ukraine; substantiation of the reasons for the low level of prevalence of agricultural insurance in Ukraine and identification of factors influencing the formation and development of agricultural insurance; analysis of the impact of factors on the total amount of agricultural insurance

premiums; substantiation of directions and prospects of further development of the mentioned segment of the insurance market as a condition of sustainable development of rural areas.

Studied the influence of factors (crop production, the share of insured area, level of crop profitability, number of agricultural insurance suppliers, average tariff rate, number of agricultural insurance contracts and level of payments) on the total amount of agricultural insurance premiums (found that the variation in the volume of insurance payments for agricultural insurance by 96.4% is determined by the variation of these factors) and used methods of regression analysis – in the study of the relationship between random values of target Y (insurance premiums) and non-random values of 7 factors of influence X. The initial data for building an economic and mathematical model were data on the development of the insurance market in 2007-2020 [18; 19] chose the target insurance premiums for agricultural insurance (million UAH, Y), and the factors were the relevant market indicators, namely: crop production (UAH billion, X1), the share of insured area (% X2), level of crop profitability (% X3), number of agricultural insurance suppliers (X4), average tariff rate (X5), number of agricultural insurance contracts (% X6) and level of payments (% X7). At the stage of analysis of the influence of factors on the total amount of insurance premiums for agricultural insurance, the factors of influence were selected and a correlation matrix has been constructed to identify the factors that have the greatest impact on the volume of insurance premiums for agricultural insurance.

The information base of the study was the relevant legal documents, including the Law of Ukraine "On Insurance", Resolution of the National Bank of Ukraine "On Approval of the Regulations on Insurance of agricultural products with state support" from 10/20/2021 No. 108, official materials of the State Statistics Service of Ukraine, Ministry of Agrarian Policy and Food of Ukraine, statistical information from the site "Forenschurer" for 2007-2020, data from the Project "Development of financing the agricultural sector in Europe and Central Asia", implemented with the support of the World Bank and International Finance Corporation (IFC), data from the official website of the Agrarian Insurance Pool, data from the Global Mutual Market Share (International Cooperative and Mutual Insurance Federation) report, primary documentation of individual insurance companies, scientific publications of foreign and domestic scientists, Internet resources; monographic, periodical and reference publications, as well as the results of personal observations of the author.

RESULTS AND DISCUSSION

The agricultural sector plays a key role in Ukraine's economy, providing 9% of GDP, 18% of employment and 6% of tax revenues [18]. The development of the agricultural sector in Ukraine is largely a consequence of favorable natural conditions. At the same time, climate change is creating new challenges for the industry and

necessitating investment inefficiency. The agricultural sector plays a key role not only in the Ukrainian economy. Ukraine is one of the leaders in the production and export of many types of agricultural and food products in the world. Although Ukraine is a leader in the export of low-margin products, the country has cases of successful development of the processing industry (sunflower oil, chicken) [20].

However, having relatively favorable climatic conditions for agricultural development, the state of this industry is quite low. This situation in agriculture is a consequence of the lack of real support for Ukrainian agricultural enterprises by the state, lack of investment in agricultural development, failure to use new high-tech tools in the operation of enterprises, and failure to take into account the experience of developed countries in solving existing problems [7, p. 119].

Recognizing the importance of insurance for agricultural businesses, it was decided at the state level to promote its development. Ukraine has twice tried to launch a system of assistance to farmers, namely to insure crops from the effects of weather risks, first in 2005-2008 [21] and then in 2012 [22]. In the first wave, the state allocated funds and partially compensated the cost of insurance for farmers. But the insurance market was not technically ready to provide the appropriate level of service. In addition, according to the law of Ukraine "On the Basic Principles of State Agricultural Policy for the Period up to 2015" [23], first wave insurance (in 2005-2008) was mandatory for agricultural producers. Thus, the Law of Ukraine "On the Basic Principles of State Agricultural Policy for the Period up to 2015" has identified a favorable insurance policy as one of the priority areas of state agricultural policy [23].

At the end of 2012, the Agrarian Insurance Pool was established, an association of insurers that is a non-profit organization. The main activity of this pool is related to the implementation of risk insurance in the field of production, storage, and circulation of agricultural products. The main task of the latter was to coordinate the development of agricultural insurance in terms of its state support program [23]. However, due to the lack of necessary budgetary resources, the Agrarian Insurance Pool coordinated the insurance programs of state forward purchases of the Agrarian Fund of Ukraine and the State Food and Grain Corporation of Ukraine, ensuring stable implementation of agricultural insurance under these programs. However, in recent years its activity in the agricultural insurance market has been minimized [24].

The scale of the agricultural insurance market is characterized by a set of interrelated indicators that highlight the current level and provide opportunities to determine the dynamics of the insurance system in rural areas in the future. It should be noted that currently agricultural insurance in Ukraine is mostly carried out in the field of crop production: weather risks account for 58% of negative cases, plant deaths and diseases – 17%, weeds – 14%, pests – 10% [19, p. 157].

Ukrainian agricultural enterprises traditionally prefer insurance of winter cereals and winter oilseed rape for the overwintering period, which is 76.0% by the number of contracts and 84.5% in the insured area [19].

The largest share of contracts concluded for the spring-summer period are contracts for future harvest insurance against many risks (multi-risk) – 57.7%. Insurance contracts against these risks account for 34.2% of the total number of contracts [19]. The largest number of contracts for agricultural crops was concluded for insurance of winter wheat (614 contracts, or 50.9%), winter rape (307 contracts, or 25.4%), corn (114 contracts, or 9.4%), sunflower (77 contracts (or 6.4%), winter barley (40 contracts, or 3.3%), winter rye (13 contracts, or 1.1%) and spring wheat (8 contracts, or 0.7%) [19].

Against the background of volumes of insurance for crops, insurance for farm animals in Ukraine is not widespread. Thus, according to [19] licensed insurance companies of Ukraine, in the 2019 underwriting year, animal insurance was provided by 7 insurance companies: Oranta-Sich, UPSK, AXA, Ingo Ukraine, Universalna,

TAS, and Mega-Garant. 5,997 animal insurance contracts were concluded, of which: 5,994 – cattle (10,960 insured heads), 2 – pig insurance (26,609 insured heads), and 1 – poultry insurance (61,304 insured heads). The total sum insured was UAH 329 million, and the insurance premium paid was UAH 2.5 million [19]. Insurance indemnities were made only under cattle insurance contracts. The average rate of insurance premiums under concluded contracts has hardly changed compared to the previous year and amounted to 0.8%. In 2018, a sharp increase in the number of contracts compared to last year (from 23 to 5,997 contracts) was mainly due to the conclusion of insurance contracts with individuals, and not just the provision of animals as collateral for a loan [19].

Summarizing the above, currently, only a small number of Ukrainian farmers are ready and able to pay insurance premiums to insure their business against possible losses. In recent years the share of insured areas has varied between 3-4% in Ukraine [19]. The reasons for the low level of prevalence of agricultural insurance in Ukraine are shown in Figure 1.

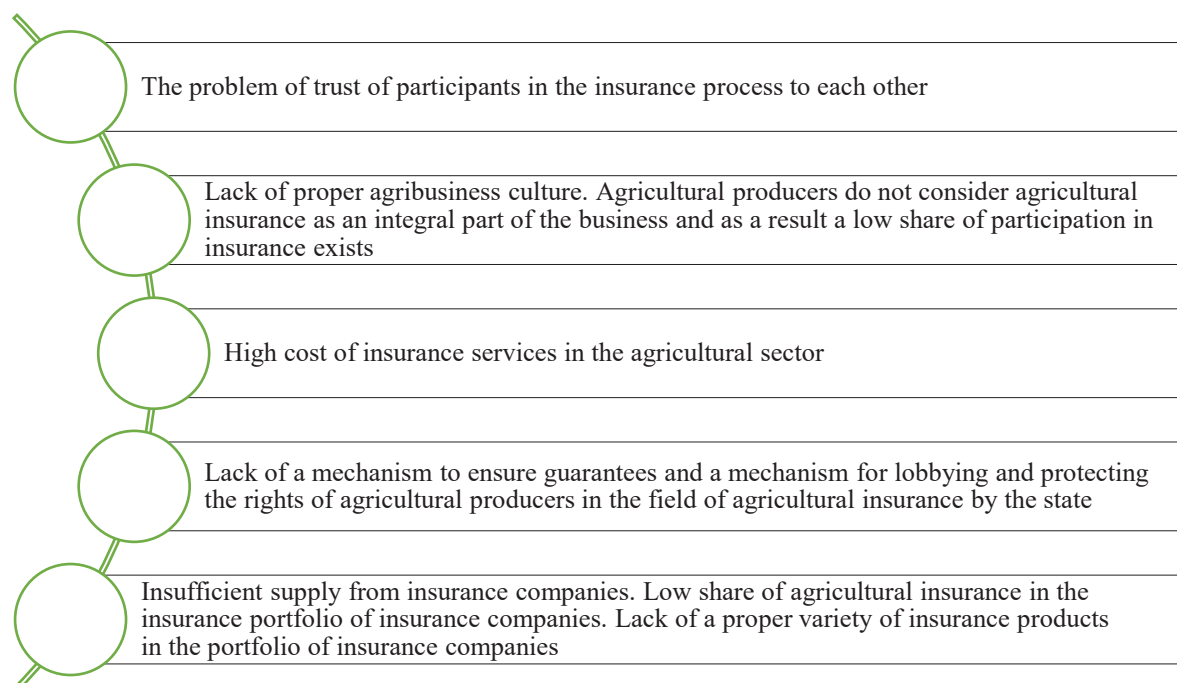


Figure 1. Problems of agricultural insurance market development in Ukraine

Source: own research

Regardless of the chosen model of relations in the agricultural insurance market, the issues of developing insurance programs, on the basis of which insurance products are formed for sale to potential policyholders, are of paramount importance. In the world theory and practice of agricultural insurance, the whole set of insurance programs is divided into three main groups: classic, index insurance programs, as well as programs aimed at protecting the income (profits) of farmers (Fig. 2). Diversification of insurance programs in accordance with the needs of farmers in insurance protection is a necessary condition for the development of the global market of agricultural insurance.

Thus, the Ukrainian agricultural insurance market is represented by classic insurance products for mono- and multi-risk insurance with an extensive product line. Instead, index insurance products (based on indices – yield, weather, vegetation) in the Ukrainian agricultural insurance market are still considered innovative and little used. Currently in Ukraine weather index products are under development and implementation. They are a fairly new type of insurance product that allows you to relatively easily determine the losses from the effects of adverse weather events in the cultivation of crops. In their research Prokopchuk O., Kolotukha S. [26] prove that in contrast to classical insurance, parametric (index)

insurance, from a theoretical point of view, is more attractive to agricultural producers in the agricultural insurance market due to its lower cost, transparency, clarity, elimination of the factor of subjectivity in determining the occurrence of the insured event and determining the insurance indemnity, standardization of conditions.

Determinants of the choice of insurance programs are:

- 1. The level of solvency of farmers to cover insurance costs.
- 2. Conditions of the attractiveness of the insurance environment (insurance rates, amount of insurance coverage,

insurance risks, insurance period, term), amount of deductible, payment of insurance indemnity) for concluding (re-concluding) insurance contracts (reinsurance).

- 3. Insurer's policy on accepting insurance risks, as well as the possibility of sharing responsibilities among other insurers (reinsurance mechanism).

The above analysis gives grounds to form a list of the main factors influencing the formation and development of agricultural insurance in Ukraine (Fig. 3).

To identify the factors that most affect the amount of insurance premiums for agricultural insurance, a correlation matrix was built (Fig. 4).

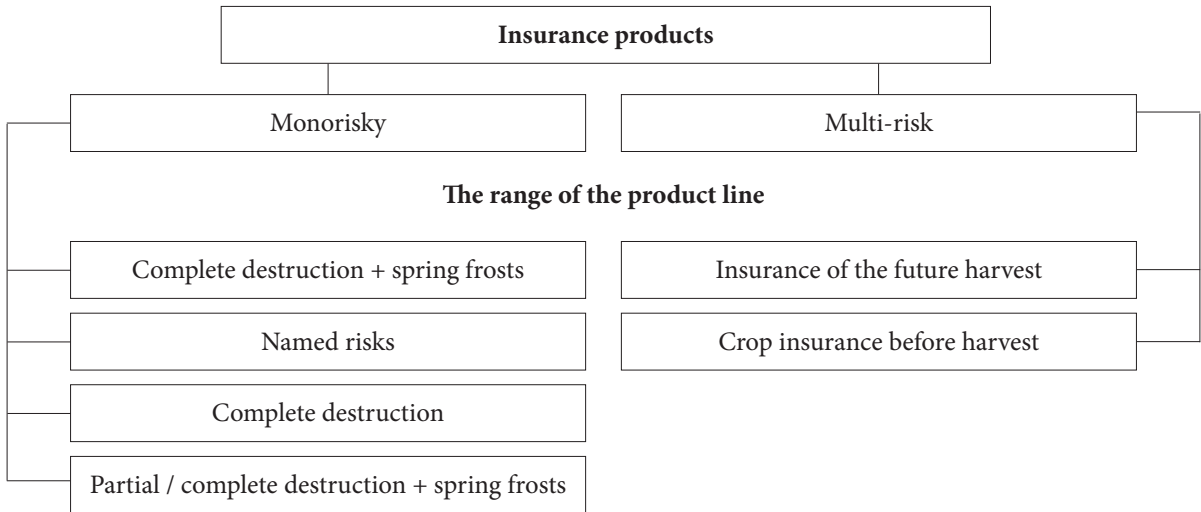


Figure 2. Classification of insurance products in the agricultural insurance market of Ukraine
Source: grouped by authors according to data [7; 14; 25]

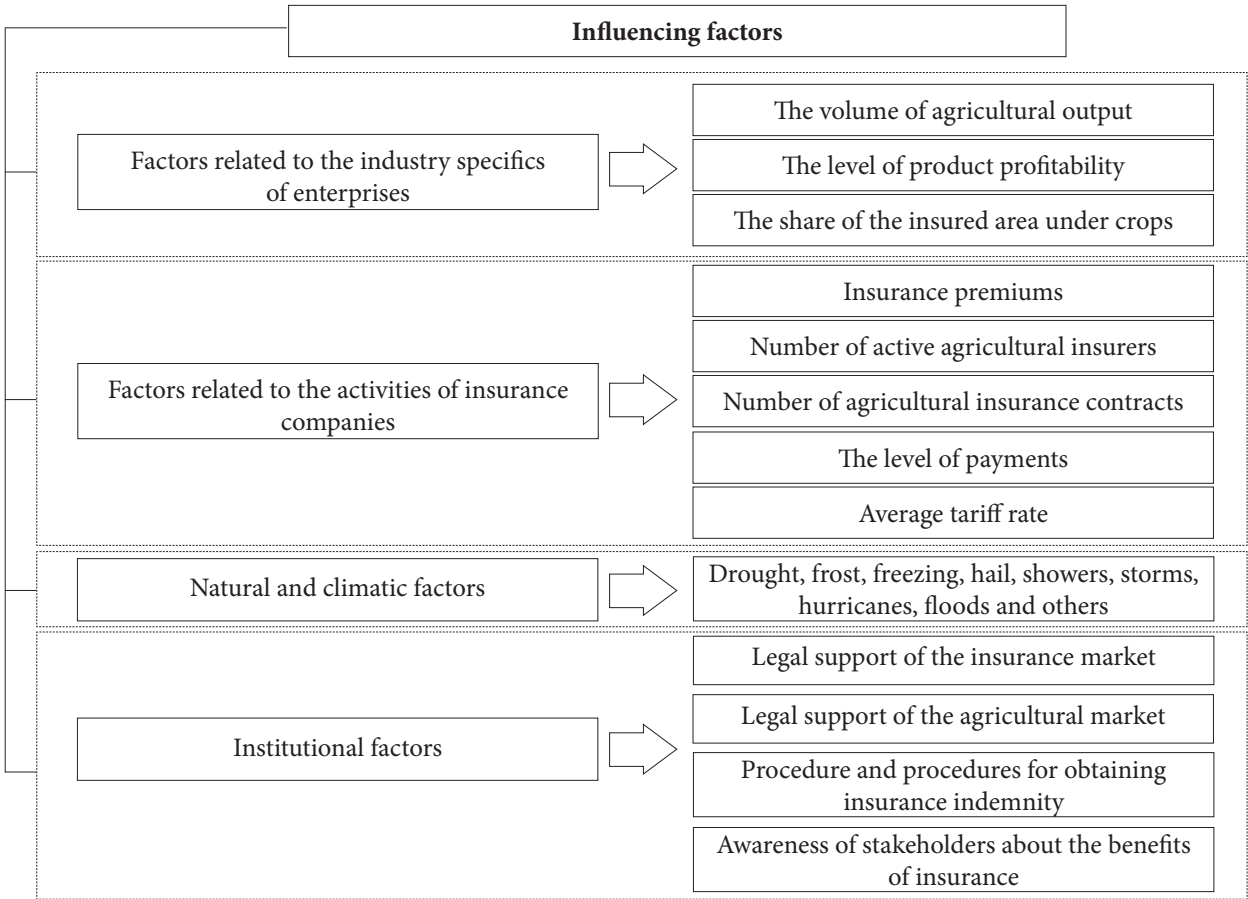


Figure 3. Factors influencing the functioning of the agricultural insurance market
Source: grouped by authors according to data [3; 8; 27]

	y	X1	X2	X3	X4	X5	X6	X7
y	1							
X1	0.73208	1						
X2	0.724791	0.239345	1					
X3	-0.21731	0.142662	-0.7057	1				
X4	0.621096	0.741905	0.311842	0.15966	1			
X5	0.961934	0.768155	0.604243	-0.11274	0.605192	1		
X6	-0.43423	-0.63063	0.2506	-0.65832	-0.29629	-0.4937	1	
X7	0.174136	0.254435	0.00662	0.293097	0.530155	0.300349	-0.04447	1

Figure 4. Matrix of paired correlation coefficients to identify factors influencing the amount of insurance premiums for agricultural insurance

Source: sources of information were insurance market statistics [17-19], which were processed using the method of correlation and regression analysis

According to the constructed matrix, there is a very high relationship between y and x_5 , $r_{y5}=0.961$, a high correlation between the productive trait and the factor trait x_1 , $r_{yx1}=0.732$, and x_2 , $r_{yx2}=0.724$ between y and x_3 no connection (-0.217) and (-0.434) respectively. Between y and the connection is noticeable (0.621), between y and the connection is weak (0.174). Therefore, it is necessary to evaluate the forms of dependence between endogenous variable and exogenous – x_1 , x_2 and x_5 .

According to the simulation results it is established, it was found that by 53.59% variation in the volume of insurance premiums for agricultural insurance depends on the volume of crop production by agricultural enterprises (by 46.41% of other factors (Fig. 3). The value of the coefficient of determination for this model is 96.4, which indicates the high quality of the model.

A linear multifactor model of the dependence of the volume of insurance premiums on agricultural insurance on certain indicators x_1 , x_2 and x_5 has the following form (1):

$$y=0.55x_1+43.62x_2+88.96x_5-376.581 \tag{1}$$

The multiple correlation coefficient is a measure of the linear relationship of the dependent variable y with the independent variables x_1, x_2, x_5 and for this model it has the following level $R=0.9816$, which characterizes a strong enough relationship between the relevant indicators. The value of the coefficient of determination according to this model indicates that the variation in the volume of insurance payments for agricultural insurance by 96.4% is determined by the variation in the volume of crop production by agricultural enterprises, the share of insured area and the average insurance rate.

According to calculations, it can be predicted that the level of insurance premiums on agricultural insurance will have a positive trend with increasing output of crop products, the share of insured area and the tariff rate under agricultural insurance contracts.

We support the scientific position of L. Tulush, O. Prokopchuk that the key role in the agricultural insurance system belongs to the state, which must provide conditions for reconciling the interests of other participants

in the system, and, accordingly, the consolidation of their efforts [15, p. 62]. Thus, the IFC International Project “Development of Agricultural Financing in Europe and Central Asia” is aimed at studying and researching agricultural insurance models in countries such as the USA, Canada, Spain, and Turkey to help adapt and ensure the functioning of the best world achievements in the agricultural insurance market in Ukraine [16]. Together with the Ministry of Agrarian Policy and Food of Ukraine, IFC is working to build a reliable agricultural insurance system that would become a reliable support for the development of agriculture in the country. To this end, IFC project experts proposed to the Ministry the concept of creating a new model of agricultural insurance in Ukraine [28]. The Regulatory Authority adopted the Resolution “On Approval of the Regulations on Insurance of Agricultural Products with State Support” of October 20, 2021 No. 108 [29], according to which the organizational and legal framework for insurance activities of insurers of agricultural insurance with state support. The prototype of the new model was the structure of the US Agricultural Risk Management Agency (RMA) [30].

The state-supported agro-insurance system needs to be improved, with the key issues being the balance of interests of insurance participants, affordability of insurance services, improving the quality of services, forming an effective insurance market infrastructure, developing a system of state control and supervision of insurance market participants. There is no doubt that the mission of public-private partnerships in the insurance market is growing. Yes, small farmers could pay only a part of the value of the insurance premium, the rest to be paid by the state through a special fund (with the participation of the Agricultural Insurance Pool) [31].

The format of public-private partnership in the agricultural insurance market is used in the conditions of the initiative of the state, local authorities, and/or united territorial communities on their participation with the private sector in the segment of agricultural insurance. In world practice (experience of North America (USA, Canada) and Europe (Austria, Spain, Germany, Switzerland, etc.), various mechanisms of state support for insurance of agricultural products are used in the form

of subsidies for insurance premiums, insurance payments, and reinsurance; financing the development of insurance products, as well as educational and information activities, training, certification, and payment for the services of experts in claims settlement; compensation of administrative costs to insurance companies [32, p. 252]. Until now, only one of the listed mechanisms of state

support has been used in Ukraine – it is subsidizing insurance premiums [25]. It is clear that these measures will be effectively implemented only with a sufficient level of resources from the state budget, the full return of the agricultural sector and Ukrainian insurance companies, which must be grouped together to overcome these problems. (Fig. 5)

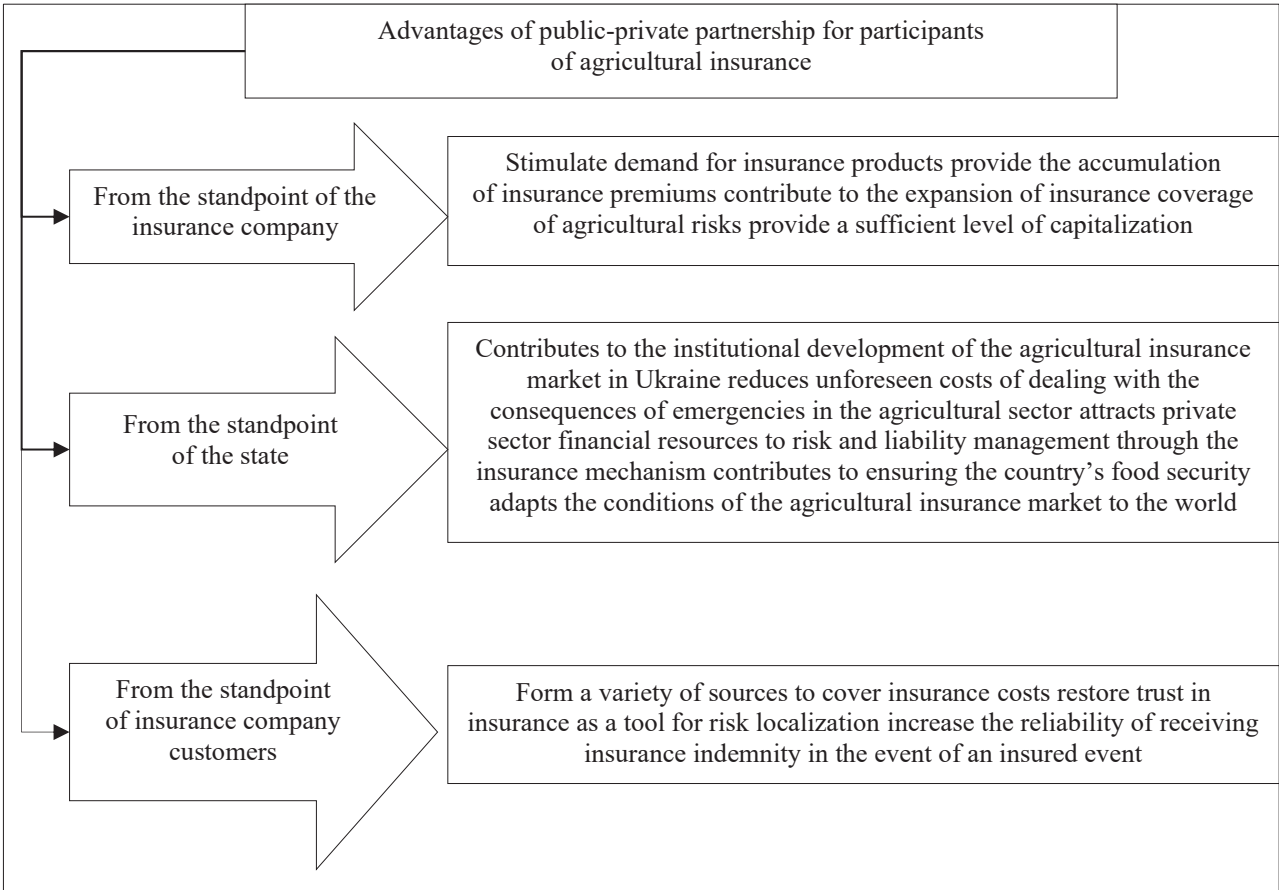


Figure 5. Advantages of public-private partnership for participants in agricultural insurance
Source: own research

Given the economic difficulties of our country today and the inability of the state to immediately provide serious financial assistance to Ukrainian farmers, it is worth proposing another effective mechanism, the effectiveness of which, like state aid – mutual insurance companies.

Cooperative and mutual insurers are among the world's oldest insurance companies and this longevity has helped to build their reputations as sustainable and reliable. The cooperative/mutual model is nonetheless highly relevant to the socio-economic needs of new and emerging insurance markets. According to the International Cooperative and Mutual Insurance Federation (ICMIF) [33], mutual insurers account for approximately 27% of the global insurance industry market share.

In the United States the main aim of all mutual insurance companies is to provide insurance coverage for its members (policyholders). Any policyholder has the right to select the management of the company. The core idea behind a mutual insurance fund is about people

coming together to protect themselves in a common financial need. In the United States, National Association of Mutual Insurance Companies (NAMIC) [34] is the organization that serves the interests of small and largest mutual insurance companies. For more than 120 years NAMIC operates across the United States as well as in Canada. They are the largest property/casualty insurance trade association that serves more than 170 million auto, home, and business policyholders.

According to Global Mutual Market Share [35], mutual insurers occupy more than a quarter of their national markets in 20 countries. The 10 largest mutual market markets were from Europe, including France – 51.8% and Germany 47.3%, Austria – 59.9%, Finland 56.2%, the Netherlands – 55.9%. Mutual insurance companies also have a significant presence in the two largest insurance markets in the world: the United States (39.9%) and Japan (42.2%).

Such associations are an alternative to state-supported insurance for agricultural enterprises. These

societies unite agricultural enterprises that want to collectively eliminate the consequences of adverse events through collective efforts.

The world infrastructure of agricultural insurance is focused on the creation and active functioning of mutual insurance companies and insurance cooperatives. Current research in the field of non-profit insurance shows that insurance services on a cooperative basis are provided in 73 countries. In 2015, the world's mutual and cooperative insurance companies raised \$ 1.21 trillion, which is 26.7% of total world insurance premiums. The gross assets of these financial institutions amount to \$ 7.9 trillion dollars [36].

Mutual insurance companies and insurance cooperatives are active participants in the insurance process in almost all market economies. The advantages of mutual insurance companies are:

- greater efficiency, as the company is not managed by investors seeking to maximize profits, and the insurers themselves;
- greater reliability, as insurers act in their own interests;
- provision of a wide range of insurance services, which is formed depending on the needs of agricultural holdings that form this group;
- joint ownership, which encourages each member of the company to take an active part in the management of the insurance company;
- lower fees for the use of insurance services due to the lack of administrative costs, advertising costs and finding new customers;
- guaranteeing the payment of insurance sums in the event of insured events in the required (full) amount, despite the fact that this amount of losses was not provided for in the contract;
- takes full account of the specific insurance needs of members, as insurance conditions are developed and approved by them [37].

CONCLUSIONS

Factors of low level of distribution of agroinsurance in Ukraine are revealed. They are combined into blocks: factors related to sectoral specifics of enterprises (volume of agricultural output, level of profitability, share of insured area under crops); factors related to the activities of insurance companies (insurance premiums, number of active agricultural insurers, number of agricultural insurance contracts, level of payments, average tariff rate); natural and climatic factors (drought, frost, freezing, hail, showers, storms, flood hurricanes and

others); institutional factors (legal support of the insurance and agricultural market, the procedure and procedures for obtaining insurance indemnity, awareness of stakeholders about the benefits of insurance).

The analysis of the impact of factors on the total amount of agricultural insurance premiums showed that 53.6% variation in the volume of agricultural insurance premiums depends on the volume of crop production by agricultural enterprises, 52.5% variation in the volume of agricultural insurance premiums depends on the share of insured area and 92.1% of the average level of the insurance rate. The value of the coefficient of determination according to this model indicates that the variation in the volume of insurance payments for agricultural insurance by 96.4% is determined by the variation of these factors.

It is clarified that the key role in the agricultural insurance system belongs to the state, which can provide conditions for reconciling the interests of other participants in the system and, consequently, consolidate their efforts, which is a necessary condition for sustainable rural development.

Thus, the practical significance of the results is to justify the development of the agricultural insurance market in Ukraine: first, the creation of mutual insurance companies and cooperatives, which will allow to take into account the specific needs of members of the company; secondly, the resumption of public-private partnerships, which will help the insurance company's customers to develop a variety of sources of insurance costs, restore confidence in insurance as a tool for risk localization and increase the reliability of insurance compensation in the event of an insured event.

The formulated author's conclusions and recommendations are characterized by a positive impact on the development of the Ukrainian agricultural insurance market, as they provide an opportunity to expand the range of products for agricultural producers, promote development and build trust between agricultural insurance market participants, motivate strategic planning. Further study of trends in the development of agricultural insurance in Ukraine is the need for scientific substantiation of potential opportunities for the development of the agricultural insurance market, taking into account the socio-economic interests of all stakeholders in the insurance process. It will be important to study the possibility of introducing insurance of crops, machinery, farm animals against military risks and its impact on sustainable development of rural areas.

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Агροстрахування як умова сталого розвитку сільських територій

Ірина Василівна Гончаренко, Наталія Олександрівна Шишпанова

Миколаївський національний аграрний університет

54008, вул. Георгія Гонґадзе, 9, м. Миколаїв, Україна

Анотація. Аграрний сектор економіки України нині є провідною ланкою національної економіки, що значною мірою визначає соціально-економічний розвиток сільських територій. Дієвим інструментом, який дозволяє зменшити фінансові втрати під час здійснення економічної діяльності в сільському господарстві, є агострахування. Метою статті є виявлення тенденцій ринку агострахування в Україні, виділення факторів, що впливають на його функціонування та на цій базі обґрунтування напрямів і перспектив подальшого розвитку згаданого сегменту страхового ринку як умови сталого розвитку сільських територій. При дослідженні зв'язку між страховими внесками та 6 факторами впливу використано метод регресійного аналізу. За результатами моделювання встановлено, що коливання обсягу страхових премій агострахування на 53,6 % залежить від обсягу виробництва продукції рослинництва сільськогосподарськими підприємствами, на 52,5 % — від частки застрахованої площі та на 92,1 % від середнього ріння страхового тарифу. Значення коефіцієнта детермінації за даною моделлю свідчить про те, що варіація обсягу страхових платежів з агострахування на 96,4 % визначається варіацією цих факторів. Виявлено фактори низького рівня поширення агострахування в Україні, які поєднано у блоки: фактори, що пов'язані з галузевою специфікою підприємств; фактори, що пов'язані з діяльністю страхових компаній; природно-кліматичні чинники; інституційні фактори. Обґрунтовано напрями розвитку ринку аграрного страхування в Україні: по-перше, створення товариств взаємного страхування та кооперативів, що дозволить врахувати специфічні потреби учасників товариства; по-друге, відновлення державно-приватного партнерства, що сприятиме для клієнтів страхової компанії формуванню різноманітних джерел покриття витрат на страхування, відновленні довіри до страхування як інструменту локалізації ризиків та підвищенні надійності отримання страхового відшкодування у разі настання страхової події

Ключові слова: страхування, агострахування, страхові компанії, сільські території

Local Economic Development in Territorial Communities

Georgiy Reshetilov*

Mykolaiv National Agrarian University
54008, 9 Georgiy Gongadze Str., Mykolaiv, Ukraine

Abstract. As a result of the reforms of decentralization and local self-government, territorial communities have received more resources and powers to dispose of them, in this sense, the issue of local development has become especially relevant for communities. The purpose of the article is to study the processes of local economic development of Olshanske village council. In accordance with the set goal, the following tasks were set and solved: to investigate the meaning of the concept of “local economic development” and the factors influencing; at the theoretical level to investigate the actors of local economic development and their place in the management process; to analyze the socio-economic development of Olshanske village council and identify the main problems of its local economic development; to explore the possibility of implementing forms of community cooperation in Olshanske village council. To achieve this goal, the article uses general and special research methods: method of theoretical generalization and comparison; hermeneutic; comparative and graphic; analysis and synthesis. The article forms one's own vision of the concept of local economic development. It is established that decision-making procedures in local development management depend on the task performed. The local economic development of Olsha village council is characterized. In the course of the research, the authors determined that the LED of the village council is based on creative principles. The article substantiates that the use of community cooperation will be a promising tool for local development. It is established that for Olshanske settlement council the potential subject of cooperation is the Koblevsky village council of the Nikolaev area. The task of the cooperation will be to ensure the provision of services in the field of urban planning and architecture on the territory of Olsha village council in accordance with the requirements of current legislation and increase the efficiency of the use of local budgets

Keywords: local self-government, goals and factors of local economic development, authorities, community cooperation, grant, creative activities

INTRODUCTION

The issue of local economic development is becoming increasingly important for local communities. Thanks to budget decentralization and local government reform, they have been given more resources and authority to dispose of them and have the opportunity to take seriously the issue of their further development, identify opportunities and main directions. After all, communities will be able to provide proper services, jobs, social assistance, amenities and good roads for residents.

Many studies by leading scholars have focused on various aspects of local economic development. Thus, the essence and basic principles of local economic development in their works revealed such scientists as A. Ammari [1], Yu. Borysenko [2], V. Vorobei [3], A. Klyuchnik, N. Galunets [4], S. Slava, H. Hrin [5], D. Treller [6], D. Serebryanska, R. Stasiuk [7] et al. Theoretical and practical issues

of planning the local economic development of territorial communities are studied by E. Bleikli [8], G. Vasilchenko [9], V. Nudelman, I. Sanzharovskyi [10], V. Parkhomenko, V. Proshka, P. Mavko [11]. A number of international organizations have developed their own definitions to stimulate LED and promote appropriate approaches. For example, the World Bank proposes the following definition: “Local economic development is a process in which the public, business and non-governmental partners work collectively to create the best conditions for economic growth and job creation; the goal of local economic development is to improve the quality of life for all” [12].

The United Nations Human Settlements Program (UN-Habitat) uses the following definition: “Local economic development is a process of cooperation between the local community and all sectors, aimed at

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stimulating local entrepreneurship to ensure the viability and sustainability of the local economy; it is a tool to promote the creation of new jobs and improve the quality of life of all, including the poor and marginalized" [13].

The study of theory and practice, mechanisms and tools for financing local economic development, financing various projects and initiatives in the field of local economic development, as well as a review of current international experience has been the subject of research by scholars such as N. Baldych, N. Khodko [14], K. Blishchuk [15], V. Mamonova [16], K. Kravchuk, L. Mocharska [17]. The principles of organization and practical aspects of cooperation of territorial communities to ensure local economic development were the subject of consideration of the following scholars: V. Vakulenko, A. Tkachuk [18], O. Vrublevskiy [19], V. Zasadko [20], T. Zhurav, O. Ignatenko, G. Borsch, O. Kurt, F. Tedick [21]. Such researchers as V. Tolkovanov [22], M. Shkilniak [23], M. Dziupyn, O. Kalashnikova, O. Kolesnikov [24], paid a lot of attention to the creation of methodological and methodological basis for cooperation of territorial communities. However, it should be noted that currently there is no comprehensive approach to assessing local economic development. In the conditions of financial and economic crisis there is a need to provide theoretical and methodical bases of local economic development of territorial communities.

The purpose of the article is a theoretical substantiation of scientific principles and development of practical recommendations for local economic development of the territorial community.

The scientific novelty of the article is to highlight the theoretical and practical principles of local economic development, as the topic is quite relevant. Formed his own vision the concept of local economic development are permanent synergy of actions of the business community, government, civil society and academia, which aims to improve the quality of life and economic potential of a particular community.

MATERIALS AND METHODS

To achieve this goal, the article uses general and special research methods: method of theoretical generalization and comparison — to determine the essence of the concept of local economic development; hermeneutic — in the study of legal aspects of local community development; comparative and graphic — to study the dynamics and structural changes in the development of Olshanske city council; SWOT-analysis to analyze internal and external factors that may affect the local development of the community; analysis and synthesis — in outlining the priority areas of local development. The main stages of work on the scientific article were: the preparatory stage at which the topic of the article was chosen, its comprehension and substantiation of relevance; the stage of work on the content involved drawing up a plan and structure of a scientific article, conducting research and summarizing its results; at the

final stage the formation of conclusions and registration of the list of the literature was provided.

The information base of the study was: laws and regulations of Ukraine on the reform of decentralization, local self-government and cooperation of territorial communities; scientific monographic literature on strategic planning of territorial communities and local economic development; scientific articles of domestic and foreign authors in periodicals; materials of scientific conferences, etc. The source of data from this study is the Ministry of Development of Communities and Territories of Ukraine; Olshanske village council; Internet.

RESULTS AND DISCUSSION

However, despite the significant amount of scientific work in this area of research, some aspects of this multifaceted problem remain controversial and require further research. It is important to consider research on best practices, available opportunities and tools that the local community can use for local economic development to ensure greater competitiveness of their communities in today's complex world of new conditions and realities. At present, the tools of local economic development that can be used by the community are not sufficiently studied for territorial communities. Among the debatable issues of local economic development of territorial communities that need to be addressed is the effective management of local resources, creating comfortable conditions for the operation of businesses that already exist in the community, what budgetary resources of the territorial community can be the main source of funding for local economic development, how to involve various stakeholders, stakeholders, groups in discussing local economic development issues in communities and what tools to use to involve them in decision-making, etc. All these unresolved issues at the theoretical level are reflected in practice, in the inefficient implementation of the process of local economic development of territorial communities. The analysis of scientific sources allowed us to conclude that the problem of local economic development is currently the number one issue on the agenda of local government.

The concept of local development is defined as a special form of regional development, in which the central place is occupied by endogenous factors. Different variations of the concept of "local economic development" (further LED) are given in the economic literature.

Local economic development is the process by which a local government and/or community, based on groups, manages available resources and makes new commitments to partnerships, either with the private sector or among themselves, to create new jobs, employment and stimulation of economic activity in a clearly defined economic zone [2].

In the process of studying the scientific literature, the authors found that the definitions of "local economic development" are different, but they all have the following common components [25; 9; 7]:

1. LED is participatory. It is based on partnerships

between local authorities, the private sector, other public sector agents and civil society to promote local business. LED initiatives are community-led and locally owned.

2. Local governments provide leadership and coordination in planning and implementing LED initiatives directly or through delegation to public agencies.

3. The LED plans combine efforts in different sectors, developing both formal and informal economies, to achieve community goals such as better quality jobs, poverty reduction, environmental sustainability and the inclusion of marginalized groups, including women, youth, and people with disabilities and indigenous peoples.

4. LED initiatives vary significantly depending on local needs and conditions. These may include infrastructure development, research and innovation, vocational training, attracting new investment, technical and financial services to new and existing businesses, favorable procurement policies and marketing support.

5. LED is a long-term process aimed at developing inclusive, sustainable communities.

Having studied different approaches, the authors formed their own vision of local economic development — a constant synergy of business community, government, civil society and academia, which aims to improve the quality of life and economic potential of a particular community. Considering successful practices of local economic development and a series of practical manuals developed by PROMIS Project experts, the authors determined that the main factors influencing local economic development include [7; 14; 26]:

Demographic information:

- information on the demographic situation in the community, which will be the basis: to compile the demographic profile of the territorial community, to determine social needs and future trends in local economic development;

- availability of various demographic information (on the state of implementation of gender policy at the local level, employment of local people, features of their education and characteristics of human resources, etc.) is necessary for a more detailed understanding of the impact of factors on local economic development;

- knowledge of the demographic characteristics of the community will influence the determination of the effectiveness of the implementation of local economic development programs and projects.

Economic information:

- will give us the general characteristic of local economy (structure, features, its influence on environment);

- breaking down the information on the local economy by sectorial sector can give an idea of the efficiency of the local economy, how the sectors are interconnected, which sectors are prospering and which are declining, where there are opportunities for business development, and the total value of local production chains;

- having information about the labor market will help to develop a carefully thought-out profile of the workforce, which will highlight the level of skills, shortages, skills that are declining, and trends in local economic

development. It can be used to identify labor market shortages, barriers to entry and employment and programs for potential labor, as well as to identify industrial sectors that can be helped and encouraged to locate in the area. It can identify specific groups of unemployed people, which will help suggest what LED actions are needed.

- understanding the nature and scale of the informal sector's economy is fundamental to understanding how the local economy actually works. It is important to know how the informal sector supports and works with the formal sector, as well as how to maintain and improve the productive quality of this activity.

Information about a business-friendly environment:

- reveals to us the state of affairs of municipal bodies in supporting or hindering the development of business in the formal (including economic activities carried out in the framework of state accounting and control and reflected in official statistics) and informal sectors (economic activity carried out outside the state accounting and control, and therefore not reflected in official statistics);

- explains to us why the business projects were successful or failed; the number and specialization of enterprises located in the area; the attitude of enterprises to the activities of the municipality; existing business environment infrastructure that supports the development of small and medium-sized businesses and enterprises, its role in supporting new business and business development; description of labor relations in the area; regarding the existing small and medium business development programs in the area; diversity of local norms in local councils, which provide a simplified and accelerated procedure for the creation and state registration of enterprises (reducing the time and cost of starting a new business at the local level or establishing them at a level no higher than in other communities);

- initiating a business-friendly study can help determine the satisfaction of local businesses and their perspectives, helping the municipality's management to improve actions and activities that affect the business-friendly environment.

Physical infrastructure:

- it will provide information on the state of transport, telecommunications, gas, water, electricity and wastewater treatment services. Such data can highlight current and future infrastructure shortcomings and needs and help prioritize infrastructure investment for local economic development.

Regional, national and international information:

- studying information on regional, national and international economies helps to identify new markets and opportunities for business development (ie increasing exports, expanding remittance flows, diversifying industry links, additional opportunities to promote tourism);

- understanding these economic links can also identify activities that need to be strengthened to embrace value realized outside the local economy. This will increase the amount of money circulating in the local economy, help create jobs and grow businesses (for example, residents

spend money in stores in other cities because they cannot find produce locally);

- with information on existing economic zones and existing economic ties between large cities and regions of other countries, we will be able to design it to provide links between towns and secondary cities of other countries in the context of local economic development.

The main goals of LED are to promote economic prosperity and social well-being by creating a business-friendly environment together with the integration of vulnerable groups (individuals / families who are in difficult life circumstances and cannot overcome them on their own, their needs for social services) into communities and promoting a dynamic and positive attitude of the population to the development of their region [25].

The actors of local economic development include "government and government bodies (local, regional and central) responsible for sectorial policies (industry, environment, labor, public works, transport, etc.), representatives of economic activity and public services (business, banks, unions, etc.), educational institutions, public organizations, mass media, etc".

Development actors work at the local, district, national, international and transnational (global) levels. At each of these levels, they can be from the public (government) sector, the private (business) sector or from civil society (ordinary citizens) [27].

It is common to call different groups of actors stakeholders (stakeholders), and interactions between them to call meetings with several stakeholders (stakeholders). This poses enormous challenges for communication and consensus building.

A stakeholder is any individual, group, or organization that may influence or believe that a program may be affected by the program [18].

A key aspect of local development management is the effective management of stakeholders. This is an important component for the successful implementation of any project, program or activity.

Stakeholders can influence projects in a variety of ways, both positively and negatively, and need to be actively managed. Risk management and further risk reduction depends to some extent on the effective management of stakeholders.

The process of local economic development management includes: definition of strategic and tactical goals, tasks of local development; collection, processing and analysis of information from primary sources; choice of forms, methods, levers, tools, measures, methods of local development management; making managerial decisions; development of a road map for clarification of stages and updating of management decisions; control and monitoring of the implementation of management decisions and their consequences.

Management technology, as a process of managerial decision-making, can be presented as a consistent set of actions of the subject, which are aimed at obtaining the expected results in the process of local development. Management decisions are made on the basis of

collecting, processing and analyzing information from primary sources, the quality of which depends on the results of decisions. On the basis of the analysis of the initial information the choice of forms, methods, levers, tools, actions and receptions of management becomes. Management decisions involve the development of an action program and organization of the process of their implementation.

The main actors in local development management are local authorities, local governments and communities. In the context of decentralization, other institutions, such as regional and local development agencies, community development resource centers, local government associations, local project bureaus, consultation centers, business centers, play a key role in the community-based approach to local development, associations and others. Executive power in the region, districts and Kyiv is exercised by local state administrations. The local state administration is a local executive body and is part of the system of executive bodies [2].

The experience of developed countries shows that under the influence of changes in the world over the past 50 years, there have been changes in the practice of local economic development planning, in particular changes in the methodology of local development management [3]. Note that the process of managing local economic development is carried out by central authorities, local state executive bodies and local governments. Decision-making procedures in local development management depend on the task at hand. For example, the procedures for developing, approving and implementing local economic development programs include various bodies responsible: executive bodies of village, locality, city councils; standing commissions of village, locality, city councils; Executive Committee; village, locality, city councils; executive bodies of village, locality, city councils; standing commissions of village, locality, city councils.

Local economic development was studied on the example of Olshanske village council.

Olshanske village council was formed in accordance with the Law of Ukraine "On Voluntary Association of Territorial Communities" by the decision of the twelfth session of the village council of the seventh convocation of August 25, 2016 No. 1 "On Voluntary Association of Territorial Communities". The community included 13 localities: Olshanske, the village of Yasna Zorya and the villages of Yasna Polyana, Shostakove, Trikhaty, Kovalivka, Sapetnya, Ternuvate, Andriyivka, Novoadriyivka, Sukha Balka, Korchyne and Novoyurivka.

Administrative center — town Olshanske [28]. The territory of Olshanske village council is inseparable, its boundaries are determined by the external boundaries of the jurisdiction of the united territorial communities. The minimum distance of localities to the administrative center is 1 km, the maximum — 5 km. The area of access to the potential administrative center is determined at a distance of not more than 7 km. paved roads. The territory of Olshanske village council is 24658.9368 hectares, namely: Olshanske village council — 1567.3789 hectares;

Trikhatsky Starostynsky District No. 1 — 4138.1379 ha; Shostakovsky Starostynsky District No. 2 — 6033.94 ha; Kovalivsky Starostynsky District No. 3 — 6807.18 hectares; Yasnaya Polyana Starostynsky District No. 4 — 6112.3 hectares [28]. On the territory of Olshanske village

council industrial development prevails for the most part, but also the agro-industrial complex functions. The vast majority of the population is employed in business. Information on the demographic situation and the labor market of Olshanske village council is concentrated in Table 1.

Table 1. Demographic situation and labor market of Olshanske village council, 2020

No.	Name of the locality	Number of households	Number of inhabitants
1	Olshanske urban-type settlement	2634	3958
2	Trikhatsky Starostynsky District No. 1	370	1110
3	Shostakovsky Starostynsky District No. 2	305	1105
4	Kovalivsky Starostynsky District No. 3	685	2031
5	Yasnaya Polyana Starostynsky District No. 4	295	861
Total		4289	9065

Source: [28]

Significant economic potential of Mykolaiv district and region is concentrated on the territory of Olshanske territorial community. Local businesses play an important role in community life: job creation, cooperation in building infrastructure, participation in important community events. Among the largest enterprises are such as [28]:

1) Yugcement PJSC (former Olshanske cement plant) Dyckerhoff Cement Ukraine cement production and sales

(Director Marco Cartouran);

2) PJSC "Olshanske ATP-14865", transport services (Director Sklyar Sergey Vadimovich);

3) Olshanske branch of PJSC Kyiv-Dniprovske MPPZT, railway transport services; etc.

The area of agricultural land of Olshanske territorial community is 18506.7413 ha, arable land 15231.7858 ha (Table 2).

Table 2. Land structure of Olshanske territorial community

Land category	Land area, ha
Agricultural land	18506,7413
Arable	15231,7858
Pastures	2423,5875
Perennial plantings	452,031
Afforestation	1960,5153
Ponds and reservoirs	1102,94

Source: [28]

The area of personal farms is 1049.5492 hectares. The number of personal farms — 1660, the number of persons entitled to land share (share) — 1311 people. The area of agricultural land designated for allotment is 11765.1357 ha (arable land). Lands are leased to legal entities — 8428.8690 ha (arable land). Number of agricultural legal entities established on the territory of the community — 4. Number of farms — 39, with 4295.8368 hectares of land. Limited liability companies — 11, they leased land — 5673.46 hectares [27].

Sources of formation of the revenue part of the special fund of the city budget are determined in accordance with Art. 69 (note 1) of the Budget Code of Ukraine (as amended) [29]. According to the special fund of the local budget, the figures for 2021 are UAH 851,474 thousand.

The main sources of filling the special fund are the own revenues of budgetary institutions, the planned amount for 2022 of which is 455,000 thousand UAH, which is 53.4% in the structure of revenues of the special fund of the city budget [26].

The estimated amount of environmental tax revenues is calculated taking into account the latest changes in budget legislation, revenues of this tax for 2022 is 396,474 thousand UAH, which is 46.6% in the structure of revenues of the special fund of the village budget.

Expenditures of the local budget for the implementation of local/regional programs in 2022 include expenditures in the amount of UAH 3,303.084 thousand, including:

- program of reforming and development of housing and communal services on the territory of Olshanske village council (extended by the decision of 01/04/17 No. 11 until 2020 (until the adoption of new programs) Decision No. 10 of 12/11/2020, on the program of Olshanske village council and extended until 2023, which extends to the territory of village councils that have joined the Olshanske village council) — UAH 300,000 thousand;

- the program of social and economic development of Olshanske village council for 2017-2020 was extended

by the decision from 02/24/17 No. 1 to 2020 (inclusive) Decision No. 10 from 12/11/2020 and extended until 2023 until the adoption of new programs validity The programs of the Olshanske settlement council extend also in the territory of the village councils which have joined the Olshanske settlement council) — 2 235,158 thousand UAH;

- The program “Environmental Protection” for 2019-2022 (Decision No. 1 of 04/18/2019, Decision No. 10 of 12/11/2020. Extended until 2023 until the adoption of new programs (validity of subsequent settlement programs) — 396,474 thousand UAH;

- The program of social and economic development of Olshanske village council for 2017-2020 was extended by the decision of 02/24/17 No. 1 until 2020 (inclusive) Decision No. 10 of 12/11/2020 on the program of Olshanske village council, extended until 2023 year, which extends to the territory of village councils that joined the Olshanske village council) — 371,452 thousand UAH [10].

The study with the help of SWOT-analysis analyzed the social, environmental and economic spheres of Olshanske village council. SWOT-analysis of the social sphere is given in table 3 [10].

As a result of the SWOT analysis, the following conclusions can be drawn:

- 1) lack of investment in the community and the Small and Medium Business Support Program;

- 2) there is a need to attract investors to implement projects to create modern enterprises for processing agricultural products, road infrastructure, green tourism, etc.;

- 3) the dominant part of the working population is unemployed or has left Ukraine;

- 4) long-term operation of roads without major/current repairs complicates the full-fledged connection between the settlements of territorial community (hereinafter TC), has a negative impact on meeting the needs of the population in goods and services.

Table 3. SWOT — analysis of the social sphere of Olshanske village council

Strengths:	Weaknesses:
1. Existing infrastructure of administrative, educational, medical services provided to the local community. 2. High level of development of the social and educational network of institutions. 3. Cultural and historical heritage. 4. Improvement of settlements and recreation areas. 5. Developed network of water supply and lighting.	1. Provision of health care personnel. 2. Weak material base and level of energy saving in TC utilities 3. Insufficient arrangement of sports grounds. 4. Low level of security for citizens. 5. Insufficient legal and educational work among the population of all ages. 6. Lack of effective communication between TC settlements
1. Development and improvement of the material base of educational, medical and cultural institutions. 2. Development of tourist infrastructure in natural recreation areas and near architectural and historical sites. 3. Improving the quality of medical care. 4. Development of out-of-school and sports institutions.	1. Outflow of young people in search of work. 2. Lack of opportunities for self-realization. 3. Deterioration of the criminogenic situation.

Source: [28]

Having investigated the sites of territorial communities of Mykolaiv region, the authors also note that no community has such a significant number of master plans as in Olshanske village council — 8 [28].

The master plan is a long-term strategy that is developed and approved in the interests of the respective territorial community, taking into account public and private interests. In other words, the master plan is a comprehensive document that reflects the current state of construction, infrastructure, restrictions, etc., but is also aimed at local community development.

It should also be noted that Olshanske village council ranks seventh [30] in the rating of institutional capacity and sustainable development of small and medium-sized communities in Ukraine.

Local development Olshanske village council is based on creative principles, in particular, in the village of Trykhaty Olshanske territorial community on the banks of the Southern Bug River is an international festival of kites “Tryhutty International Kite Festival-2021”. There are no analogues to this show in Ukraine yet, that Mykolaiv region is the center of this special sport. In addition to

participants of the festival from Mykolaiv, Dnipropetrovsk, Zaporizhia, Kherson, Luhansk and Odessa regions, there are representatives from India, Germany, Turkey, Switzerland, Poland, Brazil, Italy and the Netherlands. The increase in the number of both domestic and foreign representatives at the festival each year testifies to the effective promotional activities of the Olshanske village council. The festival is also held at a high international level thanks to the coordinated cooperation of public activists, in particular the NGO “Unity Force”, which operates in Olshanske, local authorities and community residents.

Having conducted a study of local development and the results of SWOT-analysis of Olshanske territorial community, the authors identified its main problems [28]:

1. Lack of proper communication between local governments and local businesses.

2. Difficulty for the community to provide appropriate business proposals due to lack of qualified specialists, lack of proper infrastructure, limited resources.

3. Problems of institutional support of local development (institutions of local / regional development exist,

but their activities are not coordinated; they inefficiently use available resources, formally cooperate with the community).

4. Lack of proper planning in the community (development programs are mostly formal or ineffective, because they are developed without public and business involvement; there is no monitoring of these programs), including formalism in the preparation of planning documents, application of program-target method.

5. Providing information support to business (providing information about property and land that can be used by business, potential investment objects in the community, a list of current regulations, etc.).

6. Inability to effectively use the community's own resource potential to fill the budget and ensure community capacity.

7. Low human resources in the field of LED and lack of specialists in strategic planning.

8. Lack of integrated approaches to the implementation of local economic development strategy (ensuring the implementation of regional and interregional local economic development projects).

9. Lack of cooperation processes.

Cooperation can become an effective tool for local economic development of Olshanske village council. The possibility of cooperation of territorial communities is provided by the Constitution of Ukraine, which states that "territorial communities of villages, settlements and cities may unite on a contractual basis objects of communal property, as well as budget funds for joint projects or for joint financing (maintenance) of communal enterprises, organizations and institutions, to create appropriate bodies and services for this purpose" (Part 2 of Article 142) [31]. The main principles of cooperation of territorial communities are defined by the Law of Ukraine "On Cooperation of Territorial Communities" (hereinafter the Law) of June 17, 2014 [32].

Cooperation of territorial communities (hereinafter cooperation) is considered as a relationship between two or more territorial communities, carried out on a contractual basis in the forms prescribed by law to ensure socio-economic, cultural development of territories, improving the quality of services based on common interests and goals. fulfillment by local self-government bodies of the powers specified by law. The aim of such cooperation should be to improve the quality of services to the population, the development of territories and the well-being of communities on the basis of common interests and goals. The mentioned Law envisages state stimulation of cooperation by providing subventions, transfer of objects of state property to communal ownership, methodological, organizational and other support of the activity of subjects of cooperation [21; 33].

Cooperation enables communities to jointly and mutually beneficially address important issues of local importance, to influence the development of territories without uniting communities. Proposals for cooperation can be made by village, settlement, city mayors, deputies

of local councils, as well as members of the territorial community as a local initiative [34; 19; 20].

Article 3 of the Law of Ukraine "On Cooperation of Territorial Communities" stipulates that the subjects of cooperation are territorial communities of villages, settlements, cities, which cooperate through village, settlement and city councils [32]. The list of subjects of cooperation is exhaustive and cannot be interpreted in detail. This means that no one but the territorial communities of villages, towns and cities can be the subjects of cooperation. Part 1 of Article 4 of the Law defines 5 forms in which such cooperation can be developed [32].

Based on the study of successful practices of cooperation between communities [28; 35; 23] and the dialogue between Olshanske village council and Koblivka rural territorial community, given the understanding of both communities, the benefits of inter-municipal cooperation and community willingness to transparency and long-term cooperation, we identified a potential cooperation for Olshanske settlement.

The purpose of cooperation will be to provide in the territory of Olshanske settlement council of the Nikolaev area rendering of services in the field of town-planning and architecture according to requirements of the current legislation and increase of efficiency of use of means of local budgets.

In the course of the research the expediency of cooperation is substantiated exercising the powers of the executive committee of Olshanske village council in the field of construction, urban planning and architecture and improving the efficiency of local budgets by delegating the Department of housing and communal services, landscaping, environmental protection, infrastructure, urban planning, architecture and capital construction of the Koblivka rural territorial community of the Mykolaiv district of the Mykolaiv region with the transfer of relevant resources to the following individual tasks:

- providing urban planning conditions and restrictions for the design of construction sites, landscaping in the manner prescribed by the Law of Ukraine "On Regulation of Urban Development" in Olshanske village council of Mykolaiv district of Mykolaiv region;

- granting to builders of passports of binding of temporary constructions for carrying out business activity in the settlements of Olshanske settlement council of the Nikolaev area;

- granting in accordance with the current legislation to customers of construction of the passport of building of land plots in the territory of Olshanske settlement council of the Mykolaiv area;

- issuance of initial data for design on the territory of Olshanske village council;

- maintenance of the town-planning cadastre on the territory of Olshanske settlement council;

- control over observance of the legislation, the approved town-planning documentation at planning and building of the territory;

- approval of land management documents;
- exercise of other powers in the field of urban planning and architecture in accordance with the requirements of current legislation.

Areas of cooperation: construction, urban planning and architecture.

The form of cooperation is determined by as delegation of separate tasks of department of housing and communal services, accomplishment, environmental protection, infrastructure, town-planning, architecture and capital construction of the Koblivka rural territorial community of the Mykolaiv region with transfer it of corresponding resources.

The expected financial results from the cooperation expected minimizing the amount of own financial resources aimed at ensuring cooperation organized by local communities. Other conditions of cooperation: recalculation of the subvention for reimbursement for services rendered, department of housing and communal services, landscaping, environmental protection, infrastructure, urban planning, architecture and capital construction of Koblivka rural territorial community of Mykolaiv district of Mykolaiv region from the budget of Olshanske village council according to the calculation.

CONCLUSIONS

After researching different approaches, was formed our own vision of the concept of local economic development. It is established that the main factors influencing the local economic development of territorial communities,

of course, are demographic and economic information, physical infrastructure and information about business-friendly environment, regional, national and international economy. With the help of SWOT-analysis, the local development of Olshanske village council was studied and relevant conclusions were made, in particular, that the local development of Olshanske territorial community is based on creative principles, which include holding the international kite festival "Tryhutti International Kite Festival-2021".

At the same time, given the presence of creative approaches in local community development, the study identified its main problems. It is argued that the use of cooperation will be a promising tool for local economic development of Olshanske village council. It is proposed to conclude a cooperation agreement based on the dialogue between Olshanske village council and Koblivka village council, the main form of which will be the delegation of certain tasks of the department of housing and communal services, landscaping, environmental protection, infrastructure, urban planning, architecture and capital construction of Koblivka village council with the transfer of relevant resources. The effectiveness of such cooperation will be to minimize the amount of own financial resources aimed at ensuring cooperation organized by local communities.

Further research in this area may focus on the study of the impact of individual instruments of local economic development, which will help local communities in their successful application.

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Місцевий економічний розвиток територіальних громад

Георгій Олександрович Решетілов

Миколаївський національний аграрний університет
54008, вул. Георгія Гонґадзе, 9, м. Миколаїв, Україна

Анотація. В результаті реформ децентралізації і місцевого самоврядування територіальні громади отримали більше ресурсів та повноважень розпоряджатися ними, у цьому сенсі питання місцевого розвитку стало для громад особливо актуальним. Мета статті полягає у вивченні процесів місцевого економічного розвитку Ольшанської сільської ради. Відповідно до поставленої мети, були сформульовані та вирішені такі завдання: дослідити значення поняття «місцевий економічний розвиток» і фактори впливу; на теоретичному рівні визначити суб'єкти місцевого економічного розвитку і їхнє місце в процесі управління; проаналізувати соціально-економічний розвиток Ольшанської сільської ради і виявити основні проблеми її місцевого економічного розвитку; дослідити можливість впровадження форм співробітництва громад Ольшанської сільської ради. Для досягнення мети у статті застосовуються загальні і спеціальні методи: метод теоретичного узагальнення і порівняння; герменевтичний; порівняльно-графічний; аналізу і синтезу. У статті сформоване власне бачення концепції місцевого економічного розвитку. Встановлено, що процедура прийняття рішення в управлінні місцевим розвитком залежить від поставленої задачі. Охарактеризовано місцевий економічний розвиток Ольшанської сільської ради. В ході дослідження автори визначили, що місцевий економічний розвиток сільської ради базується на творчих засадах. У статті обґрунтовано, що використання кооперації громад буде перспективним інструментом місцевого розвитку. Встановлено, що для Ольшанської селищної ради потенційним суб'єктом співпраці є Коблевська сільська радаю Миколаївської області. Завданням співпраці буде забезпечення надання послуг у сфері містобудування і архітектури на території Ольшанської селищної ради згідно вимог чинного законодавства і збільшення ефективності використання коштів місцевих бюджетів

Ключові слова: місцеве самоврядування, цілі і фактори місцевого економічного розвитку, органи влади, співпраця громади, грант, творча діяльність

Digitization of Accounting in the Management of Business Processes of Enterprises of the Agro-Industrial Complex

Natalia Potryvaieva^{*}, Liliia Kozachenko, Iryna Nedbaylo, Iryna Nesterchuk

Mykolaiv National Agrarian University
54008, 9 Georgiy Gongadze Str., Mykolaiv, Ukraine

Abstract. The article is devoted to the problems of digitalization of accounting in the agricultural sector of Ukraine as the main element of modernization of business processes in the conditions of digitalization. Accordingly, the issue of using modern accounting tools for agricultural enterprises, which largely depends on the implementation of the scenario of digital development of rural areas of Ukraine, in particular, the development of digital infrastructure, is gaining relevance. The purpose of the article is to investigate the current trends in the digitisation of the accounting of agricultural enterprises and their impact on the management of business processes in today's conditions. The research uses the dialectical method of cognition and general scientific techniques and principles of complex research, which include empirical, theoretical-cognitive and general logical methods, in particular: observation, comparison, description, generalization; analysis, synthesis, analogy and abstraction; systematic approach; monographic; comparative analysis. The article examines the benefits of using information technologies in the activities of enterprises in the agrarian sector and identifies factors that slow down the process of its transformation. It was established that the development of an agricultural enterprise based on the digitalization of management processes requires a significant amount of time for implementation, which is associated with making significant investments in the acquisition and support of technologies, as well as training employees in new professional skills. The innovations of the modern information space that can be used in the business environment for the digital transformation of business, in particular for the purpose of productive organization of accounting processes, are considered. The generalized results and formulated conclusions can be applied in the practical activities of Ukrainian agricultural enterprises in the context of the use of the formed information base of technologies, online services, specialized applications for the digitalization of accounting processes, reporting, taxation, as well as the determination of critical factors for slowing down the use of digital technologies, which will contribute to the overall transformation business processes of economic entities of the agro-industrial complex

Keywords: digitalization, digital transformations, accounting, agricultural sphere, information technologies

INTRODUCTION

The modern development of agricultural production depends on the modernization of business process management, which slows down in the conditions of digitalization due to the insufficient use of new modern information technologies. Digitization of accounting processes is the basis for the successful implementation of management decisions of stakeholders, as a single information platform is created for registration, accumulation, summarization and storage of information, reporting, analysis, and control of business processes of the enterprise.

Modernization, optimization and development of an agricultural enterprise based on the digitization of management processes require a significant amount of

time for implementation, which is associated with making significant investments in the acquisition and maintenance of technologies, as well as training employees in new professional competencies.

Agricultural enterprises currently choose the purchase of agricultural machinery and technologies for production and its maintenance, energy carriers, agricultural materials, labour costs and land rent as a priority direction of investment, as this will allow them to produce more products and maximize economic benefits [1]. In particular, according to statistical data, in 2020, the volume of capital investments in agricultural enterprises amounted to UAH 50,679.7 million, of which

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about UAH 48.0 million was directed to software and databases for economic activity. In comparison with the total amount of capital investments in financing software and databases in all branches of the economy of Ukraine, this is 0.4%, while the industry invested 11.7% [1].

When introducing digital technologies into accounting processes in the agricultural sector, a number of other problems arise, in particular: at the micro level – the reluctance of the owners themselves to carry out digital transformations of their own business; insufficient funds for digitalization of accounting; accountants' fear of layoffs and unwillingness to gain additional knowledge; at the macro level – provision of rural areas with access to high-speed Internet and digitalization of the agricultural sector in general. Therefore, the productive integration of digital technologies in the development of the Ukrainian agricultural sector is impossible without state and public support.

The work of many Ukrainian scientists was devoted to the issue of accounting transformation in the agrarian sphere of production, in particular, the following were studied: the impact of digital transformations on the functioning of agricultural enterprises; problems of innovative development of agribusiness; applied aspects of digitization of accounting in Ukraine and others.

In their work, researchers L. Vodyanka and T. Yuriy revealed the modern significance of digitization and digital platforms, which is progressive for the economic development of economic entities in the agrarian sector of the economy. As a result of research, the authors offered a model of a digital platform for the agricultural sector, the implementation of which will significantly speed up the process of digital transformation of agricultural production on domestic and global markets [2].

A group of researchers M. Demchyshak, O. Radux and V. Gryb believe that during the years 2014–2019, the agrarian sector in the post-crisis period ensured the inflow of currency, and employment in rural areas and the restoration of economic growth in Ukraine. The authors claim that the agricultural sector in Ukraine has established prerequisites for further qualitative transformations and the application of innovations and modernization. Justifying the opinion, the researchers believe that digitalization contributes to the emergence of new industries and developed innovative entrepreneurship in the agricultural sector [3].

When studying the use of modern information technologies in the agro-industrial complex, O. Zelinska and S. Suxoczka proved that the use of information technologies increases labour productivity, taking into account that many tasks are solved. In turn, the use of artificial intelligence will make it possible to significantly improve the information support system of the agro-industrial complex, which will be accompanied by an increase in the competitiveness of Ukrainian agricultural production [4].

When studying the issue of accounting in the conditions of the digital economy, scientists determined that despite the dynamic development of digital

technologies in the economy, including the growth of trade volumes via the Internet, their segmentation is evident. It was also found that a holistic scientific approach to the digitalization of accounting and taxation has not been formed. The researchers noted the current trends that should be developed by scientists and practitioners [5].

Modern technologies in the process of digital transformation of agricultural enterprises are key in M. Rudenko research. In his work, the author notes that the main obstacles that prevent technological innovations from entering agro-industrial enterprises are a lack of understanding of the values of technology and a lack of desire to change. The author claims that the expediency of using digitization technologies in each individual enterprise of the agrarian sector is the survival of commodity producers in modern conditions of conducting agrarian business [6].

So, the issue of the transformation of accounting of the agricultural sector in Ukraine is quite widely represented in scientific circles. However, scientific explorations of digitalization of accounting must be continued in order to support the modernization and development of the agrarian sector of the economy. Thus, the paper formulates the advantages of digitization of accounting processes for agribusiness, summarizes the proposals of the IT industry for the accounting of Ukrainian enterprises in the agrarian sector, represented by both ready-made smart technologies and project products, and also reveals the content and areas of application of modern accounting tools with an emphasis on the problems of the accountant's professional activity and the science of accounting.

The purpose of the article is to study the trends of digitalization of the agricultural sector of the economy, in particular, the possibilities of the latest digital accounting technologies in the management of business processes.

MATERIALS AND METHODS

In the research process, the dialectical method of cognition and general scientific methods and principles of complex research, which include empirical, theoretical-cognitive and general logical methods, were used. Thus, the authors used the following methodological tools: observation, comparison, description, and generalization in the study of the essence and features of digital accounting; analysis, synthesis, analogy and abstraction to reveal the trends of digitalization of accounting in the management of business processes of the agrarian sector, as well as the transformation of the social and economic environment in the conditions of the digitalization of the information space of Ukraine; a systematic approach to identifying methodological problems that arise during the implementation of digital technologies in the accounting process of agrarian enterprises and their impact on the management of business processes; monographic to clarify the essence of the relevant categories; comparative analysis to study the features of technologies used

for digitization of accounting; other methods in the field of economic research.

In order to interpret the results, the following stages of the research process were carried out:

- exploratory research, which included the search and selection of problematic aspects of digitalization of the agricultural sector of the economy in general, as well as accounting processes in particular; study of regulatory and legal support, already published scientific works, publications of specialists in the field of accounting and the IT industry, in order to clarify the current state of proposals and the practical use of digital technologies in the implementation of business processes of agricultural enterprises; existing theories of Ukrainian and foreign practice of digital transformation of accounting were identified, which became useful in finding answers to the questions of this study;

- research design, on which the action plan was built, in particular: a set of scientific research methods was selected, including empirical, theoretical-cognitive and general logical methods, in particular, a combination of case studies and action research; the strategy of forming a sample was formed, which involved the study of the problem of the availability of IT products that have an industry focus and are offered for use in the agrar sector;

- conducting a study, which consisted of the pilot testing to identify potential problems in conducting a study of the Ukrainian market of IT products for accounting; data collection, their analysis and interpretation regarding regulatory support, the practice of using digital technologies in the accounting of agricultural enterprises, the presence of digital literacy of accounting personnel, the creation of digital infrastructure at the state level with an emphasis on rural areas, for the purpose of formulating a conclusion, as well as preparing a scientific article.

The information base for the study was: legislative and normative acts regulating digitalization processes in Ukraine, as well as accounting and taxation of economic activities of enterprises, in particular: Decree of the President of Ukraine dated 05/15/2017 No. 133/2017 "On the Decision of the National Security and Defense Council of Ukraine" dated April 28, 2017 "On the Application of Personal Special Economic and Other Restrictive Measures (Sanctions)"; Law of Ukraine dated December 2, 2010 No. 2755-VI "Tax Code of Ukraine"; Law of Ukraine dated July 16, 1999, No. 996-XIV "On Accounting and Financial Reporting in Ukraine"; theoretical and methodological developments of Ukrainian and foreign scientists; statistical and analytical materials of the State Statistics Committee of Ukraine and the Ministry of Agrarian Policy and Food of Ukraine.

The work used data from publications of official websites of software developers and online accounting and reporting services (InfoTAX, iFin, Fair, Taxer, Reportax, BookKeeper, Dilovod, Master: Accounting, Litachok, others), as well as Ukrainian information agencies (Information Agency "AgroNews.ua", "Economic Truth" Project, "Agravery" Agrarian Information Agency, DOU: Community of Programmers).

RESULTS AND DISCUSSION

The agrarian sphere in economic development

The agrarian sphere of Ukraine plays a leading role in the development of the world economy, which requires the intensification of the general production of agricultural products and the maximum creation of modern working and living conditions for the rural population. The food security of the world depends on the export of agricultural products because Ukraine supplies 10% of the annual consumption of wheat for 15 countries of the world and is a granary for almost 400 million people [7; 8]. Agricultural products traditionally occupy the first place in Ukrainian exports, in particular, the main share is made up of grain and oil crops, which were exported for 18.6 billion dollars in 2021 [7; 8].

Due to the constant dynamics of the development of global markets, as well as changes occurring in their structure, agrarian business, including in Ukraine, is constantly affected. Also, the demand for food in the world is constantly growing, taking into account the challenges in recent years that affect the decrease in the production of agricultural products in the world. Thus, the 2019 outbreak of the novel coronavirus disease (COVID-19) became a public health emergency of international importance. And the destruction in Ukraine caused by the Russian aggressor since February 2022 has already affected about 25% of the world trade in grain, in particular, wheat and sunflower oil. However, despite the critical economic conditions in Ukraine, in January-April 2022, agro-food products were exported for 7.420 billion dollars, which is 3% higher than in January-April 2021 [7]. At present, 90% of agricultural producers have started working in the liberated territories of Ukraine, namely Chernihiv, Sumy, and Kyiv regions, about 50% are near the battle lines, and more than 95% are working in the rest of the free territory of Ukraine [7].

Digitization of business processes of agricultural enterprises

In such crisis times, the state and enterprises face the task of ensuring the operation of all industries in order to preserve the economic stability of Ukraine. At the same time, there is an urgent need to create the safest conditions for the life and health of employees during the performance of their duties, movement in the territory of settlements, etc. Therefore, the maximum provision of digitalization of economic processes makes it possible, where possible, to combine work in a safe place and on the employer's territory, in general, to continue working to support the country's economy, including in the agricultural sector.

Agriculture as an industry has a number of specific opportunities, in each of which you can find your own application of digital technologies [2; 3]:

- the sphere of life of living organisms, plants and animals, in which the breakthrough of technological machines, geo-information systems and equipment took place, can be widely used to control and manage agriculture and minimize human errors;

- reducing the labour intensity of production processes for the employee with the help of digital technologies;

- the possibility of controlling and covering large territories with IT technologies;

- application of new promising digital technologies in the process of collection, processing, production and sale of various agricultural crops.

However, there is a tendency to increase the dependence of agrarian businesses on various types of information, the speed of obtaining it, the possibility of conducting an operational analysis of its own activity indicators and an overview of the agrarian market. Agricultural enterprises are increasingly implementing digital technologies for the digitalization of accounting and its management segment.

In the work of R. Bruxanskyj and I. Spilnyk, the description of digital accounting or, as the authors synonymize it, electronic accounting, consists of the presentation of accounting information in a digital format, which is then processed and transmitted electronically [9].

Since every year more and more developments for digital accounting are released, it is necessary to systematically update the skills of accounting personnel through various formal and informal measures, in particular: obtaining professional and/or higher education, professional development, participation in professional seminars, taking courses; self-education, participation in professional associations, communication with specialist colleagues, etc.

Currently, the digitalization of accounting processes allows employees of the accounting service to perform functional tasks as quickly and with the least errors as possible, to effectively interpret and prepare financial statements, which allows owners to more effectively manage the business processes of the enterprise and achieve the defined strategic goals.

Online accounting implements a full cycle of necessary operations for working with suppliers and contractors, operational accounting of purchased goods and services, calculations for employee payments, electronic tax administration, pricing and control over calculations, use of cloud computing in the accounting process, and more.

To the main technologies that are currently actively used in the business environment for the digital transformation of business, in particular, for the purpose of productive organization of accounting processes, researchers include the following [10-12]:

- BigData – for use in calculations in order to increase efficiency, accuracy and speed when processing extremely large data sets;

- Blockchain – for data systematization and effective control;

- Internet of Things – a complex process of information analysis and operational decision-making to support important business processes;

- Microsoft product – “Microsoft Office 365” – a single economic system of services and programs that are

integrated with each other and provide a single platform for the work of all employees;

- RTA – for performing accounting operations in real-time;

- EDI – for free and fast exchange of electronic data;

- XBRL – extended language of financial, management, and tax reporting of various business areas;

- cloud technologies – for distributed data processing, in which computer resources and capacities are provided to the user as an Internet service;

- RPA and AI – for the use of software robots and artificial intelligence to automate mostly standardized operations, in particular, related to the collection and processing of primary data, preparation of financial statements, etc.

Big Data provides tangible advantages for the digital transformation of business processes. The technology is intended for the organization and structuring of large volumes of information, database management and “Business Intelligence” decision-making, although it was not created directly for accounting. Big Data performs three main operations: processing data with a larger volume; the processing of data that is constantly arriving with an ever-increasing volume; the ability to work with various types of data [12].

Researchers propose to adapt the capabilities of Big Data to the field of accounting, taking into account the following features of this technology [11]:

- horizontal scalability – as the differentiation and detailing of data on accounting objects lead to an increase in the number of computing nodes on which these data are distributed;

- fault tolerance – due to the fact that the number of computing nodes in the information system is incomparably limited, therefore, in the event of computer equipment failure, it is necessary to implement preventive measures;

- data locality – accounting data is distributed among numerous computing nodes, while physically located on one server, and processing takes place on another [11].

Blockchain (Blockchain or Block Chain translated from English – a chain of blocks) is a sequential chain of blocks with information that are stored on different computers and are connected to each other. Many companies are studying the possibilities of applying blockchain technologies everywhere – from accounting, auditing, finance and production [12]. So, blockchain technology involves the creation of a register or account book of events in a digital environment. This technology provides protection of information recorded for the first time from corrections or destruction since each new operation is confirmed by the history of previous records. Such a high level of protection allows you to have a business database that is protected from unauthorized destruction of records or falsification and therefore is an effective prerequisite for obtaining timely and unbiased information by managers [11]. The Internet of Things technology is effective in the organization of primary accounting, which

is a rather labour-intensive part of production. The technology makes it possible not to use the traditional approach to the preparation and transmission of primary documents due to the automatic formation of a database on production processes, the state of equipment, etc. For this, the main nodes, mechanisms of machines and machines are equipped with special sensors, executive and control devices and processors, which will collect analytical data directly during the production process. Therefore, the necessary database for accounting needs is formed automatically after the processes of processing information and placing it in the accounting system [9; 11].

Incidentally, we note that for accounting needs, the use of technology such as Blockchain will allow reducing product losses by 30 million tons; The Internet of Things, which can be used to monitor supply chains, is 35 million tons [13].

One of the well-known and widely used corporate tools that can replace most of the third-party programs accompanying the business processes of the enterprise is the Microsoft product – “Microsoft Office 365”. In the modern program, along with the usual Word, Excel, PowerPoint and other tools for the work of accounting departments of private users, corporations and businesses, there are conditions for working with documents, computing devices, planners and calendars, a service for data exchange, the ability to organize and hold video conferences [14].

Digitization as a vector of accounting

The decision of the National Security and Defense Council of Ukraine dated April 28, 2017 “On the Application of Personal Special Economic and Other Restrictive Measures (sanctions)”, which was put into effect by the Decree of the President of Ukraine dated May 15, became a significant impetus in the development of software products for the digitization of accounting in Ukraine 2017 No. 133/2017 [15].

Currently, the services offered on the market of special technologies for the digitization of accounting are services that to one degree or another solve the problems of Ukrainian enterprises, in particular: InfoTAX, iFin, Fairo, Taxer, Reportax, BookKeeper, Dilovod, Master: Accounting, Litachok, others [16-18]. So, in order to obtain information about the state of settlements with the budget, registration and accounting data, the results of document processing, the occurrence of tax debt, the terms of reporting and payment of taxes, it is possible with the help of the InfoTAX chatbot offered by the State Tax Service of Ukraine [16]. In parallel with the launch of chatbots, the Ukrainian company iFin offers the functioning of electronic, legally significant document flow with controlling bodies and submission of reports in electronic format for various fields of activity [19].

The Fairo tax application for individual entrepreneurs also allows users to create and send tax reports and reports on the amounts of the accrued income of insured persons, the amounts of the accrued single contribution, as well as automate accounting processes, and it is additionally suggested to use banking [17].

The Taxer service provides the following opportunities for entrepreneurs, both for free and with paid packages: creation and sending of electronic reports; online tax payment; interactive calendar with current tax events for the entrepreneur; online accounting; use of information of the current knowledge base; consultations of professional lawyers and accountants [20].

With the help of the Reportax telegram bot service, it is possible to calculate and pay taxes, as well as submit reports to the relevant state structures, the function of reminding entrepreneurs about the deadlines for submitting reports and tax payments is fixed [16].

Another representative that provides the possibilities of modern online accounting for agribusiness in Ukraine is the BookKeeper service, which has created conditions for keeping records of activities, compiling and submitting reports by enterprises and individuals, entrepreneurs of all taxation systems, as well as non-profit organizations using any device [18].

It should be noted that most of the mentioned services operate with the advantage of submission of reports by users who are taxpayers in electronic form, which not only saves time and labour resources but also fully complies with the norms of the Tax Code of Ukraine, which provides for the submission of reports in electronic form [21]. Of course, the digital technologies used by the developers make it possible to constantly update the software in accordance with the current changes in tax legislation, to perform arithmetical control of tax reporting indicators, automatically archive electronic copies of reports and other documents, and most importantly, they are able to protect information from unauthorized viewing and interference [22].

In more detail, we will pay attention to digital solutions Dilovod, MASTER: Accounting, Litachok [23-25], which can be used to digitalize the accounting of agricultural producers, as these products take into account the peculiarities of management in the agricultural sector.

In 2014, the Ukrainian online accounting and reporting service Dilovod began to implement software that allows you to optimize the accounting process and carry out timely control over all business processes [23]. So, among the proposed software products, which are equipped with full functionality for the organization of accounting of natural persons, entrepreneurs and legal entities, there are solutions for enterprises in the agro-industrial sphere, in particular: crop production, harvest production, animal husbandry. The program allows you to automate and control: time-consuming processes of accounting, management and tax accounting; compilation of electronic reporting; calculation, maintenance and payment of wages; production accounting; management of labour resources; supply process management and others. The Dilovod program provides two interfaces, for an entrepreneur and an accountant, and the work of several users at the same time is ensured. It is convenient that the program is used online as a service and there is no need to buy configurations, licenses, and rent or purchase a server. It is also important that all segments of the program are updated in accordance

with changes in the legislation of Ukraine, in particular, the terms of reporting, forms of reports, and primary documents are updated [23]. The first software product from the MASTER line – the software product MASTER: Accounting for small and medium-sized businesses were presented to the Ukrainian market in September 2017. MasterBukh offers the MASTER: Agro software product for comprehensive accounting to agricultural enterprises on the Ukrainian market, which can be available in the cloud and stationary solutions [24].

The accounting program provides accounting and tax accounting, accounting of salaries and personnel, specialized accounting of crop production, animal husbandry, transport and land lease [24].

In order to expand the functional boundaries of the MASTER: Agro software product, applications are provided [24]:

- MASTER: TEP (technological and economic indicators) allows you to plan the production load of sowing areas for the next year according to the specified parameters with the possibility of creating several planning scenarios;

- MASTER: The flow is designed for the operational management of quantitative and qualitative accounting of grain on the flow;

- MASTER: Agronomy is designed to record the work of an agronomist in the system and to account for the actual costs of fieldwork, accounting for work performed in the field;

- MASTER: The operative warehouse is designed for keeping quantitative records of goods and material values, in which each storekeeper has the opportunity to display the arrival and departure of material values, compare their balances, and print orders without using accounting data.

- MASTER: The elevator is designed for keeping quantitative and qualitative records of the grain elevator and for keeping contractual and contractual records at the elevator.

The special Ukrainian software designed for the accountant's work on smartphones, tablets or other mobile devices is the "Airplane" mobile application. The developers of the Mykolaiv National Agrarian University, led by Yu. Volosyuk, provided a significant amount of useful reference and application information for users, which is designed to facilitate users' access to the necessary information, which will always be relevant due to its constant updating by editors [25]. So, the practical functionality of the application includes a chart of accounts; a catalogue of accounting transactions; balance calculation; calculators for calculating value-added tax, personal income tax, income tax, real estate tax, wages, vacation, sick leave, depreciation; catalogue of regulatory documents [25].

Robotic process automation (RPA) is becoming increasingly important in the digitization of accounting processes. The essence of RPA is to use a software robot that is configured to run and control other software. At the same time, studying the features of RPA as software that is programmed to perform basic repetitive tasks

in all applications, researchers point out that ensuring the technical capabilities of the user is only part of the RPA implementation process [26]. It is necessary to standardize and optimize business processes and to create tools such as a scorecard for ranking tasks. It will also be advisable, when including a software bot in certain processes, structured, repetitive, based on rules and with digital inputs, to change the structure of units and the responsibilities of executors in order to avoid duplication of functions and to adjust internal control procedures [26].

The implementation of RPA in the business processes of the enterprise will definitely change the work of accounting employees, which is confirmed by research results [27]. The authors distinguish five roles of accounting employees in the digital transformation of accounting, in particular: identifier, explainer, instructor, supporter, and analyzer of the organization's automation initiatives. Undoubtedly, in order to be competitive in the conditions of digital transformations of business processes of an agricultural enterprise, an accountant needs to acquire new special technical skills [27]. Therefore, an agrarian business that transforms the accounting process with the help of digital technologies will undoubtedly minimize the cost of accountants' working time, accelerate the implementation of accounting functions, have an improved document flow process, a lower level of errors, better quality of reports, which will save financial resources and meet the needs of internal and external stakeholders in information.

We can assert that thanks to the initiatives and with the support of the state regarding the digitization of economic processes in Ukraine, Ukrainian business, in particular agrarian, receives greater competitive advantages, increases profits, has the opportunity to receive investments and pay more taxes, and thus make its contribution to the socio-economic development of the country [28].

As early as 2020, the Project of Conceptual Foundations "Digital Agenda of Ukraine – 2020" set out goals designed to lay the foundation for the transformation of sectors of the Ukrainian economy into competitive and efficient ones due to the formation of a "digital" economy, "digitalization" of business and industry [29].

For the agricultural sector, the technology "Digital" agriculture (e-farming) was provided, which is a new management strategy in agronomy, the fundamental foundations of which are the use of not only "digital" technologies by agricultural enterprises, but also new technical means [29]. The developers of the project proposed to use in combination: management and executive mechanisms; geo-information systems, global positioning, and on-board computers that differentiate methods of cultivation, application rates of fertilizers, chemical meliorates and plant protection agents. According to the given data, such measures will contribute to the economic efficiency of production, increase the yield from 1 ha of land, provide soil protection, reduce crop losses in the fields, and make work in the agricultural sector safe and attractive [29].

Taking into account the fact that according to the level of use of agrochemicals, Ukrainian agricultural production is set aside for 30-40 years due to careless use of soils, the concentration of inefficient production of only cheap raw materials, etc., the introduction of the technology of "Digital" agriculture should have a positive effect on the structural and technological reforming of the agricultural sector and will contribute to the social economic revival of rural areas. An important factor for revitalizing the economy of Ukraine is the "Digitalization" of the socio-economic sphere, which involves the modernization of the "Electronic Payments and Settlements" system, the purpose of which is to facilitate the commercial cooperation of the stakeholders of the economy, as well as to combat the "shadow" circulation of funds [29]. The section "Electronic commerce, cross-border e-commerce", set out in the project of the Conceptual Principles "Digital Agenda of Ukraine – 2020" [29], highlights the changes regarding accounting in the conditions of digital transformation, which provide for amendments to the Law of Ukraine "On Accounting and financial reporting" [30]. Thus, primary documents are the confirmation of business transactions and the basis of their display in accounting, then at the legislative level, it is necessary to recognize electronic documents and notifications made by primary accounting documents [19].

Also, for Ukrainian agrarian business, the Ministry of Agrarian Policy and Food of Ukraine plans to implement a digital transformation, which will allow the use of digital solutions not only in the management of land resources but also in the management of agricultural producers in general [31].

At the first level, the organization of relations between the state and participants of the agrarian sector, who are the main stakeholders of the process, is foreseen. Thus, all relations and services that will arise between agricultural enterprises and the state will have the opportunity to take place on the basis of a digital omnichannel platform. At the second level, the digital transformation of agricultural enterprises will already be carried out directly. It is assumed that such an initiative will be effective in the introduction and systematic updating of information and technological support for the collection of information about the big data industry, the spread of data-driven decision-making methodologies, and the involvement of united territorial communities in the process of digital development of territories [31].

Currently, the All-Ukrainian project "Vkursi Zemli Ukraine – Digitization of the Land Bank of Ukraine" has been launched in Ukraine as part of the system of digital transformation in the field of land use. The service will serve to obtain information about land plots, their owners and tenants, and lease terms on the territory of Ukraine. Also, the online platform "Vkursi Zemli" will help representatives of agrarian businesses effectively manage their land resources, as well as promote the attraction of financial resources by popularizing their

business reputation in front of service and financial companies [32]. Digital developments minimize labour and time costs for accounting operations. Thanks to the latest software, the use of land resources is becoming more and more efficient, because with the increase in the area of cultivation, the volume of produced products and their sale on both domestic and international markets increases. Thus, using the possibilities of precision agriculture will allow to reduce the producer's costs by 100 billion dollars, reduce water consumption by 180 billion m³, and at the same time increase the production of agricultural products by 300 million tons [13].

In the process of research, scientists conclude that objectively digital accounting ensures the systematic implementation of accounting functions, as a rule, it is the implementation of standardized operations (collection and processing of primary data, preparation of various types of reports, data analysis, etc.), as quickly as the technical capabilities of the enterprise allow and accountants' awareness of accounting tools using computer equipment and digital technologies, specialized Internet resources, international and Ukrainian regulatory materials, web links, accounting software and applications [33].

In general, in order to determine the needs of farmers for sowing, the Ministry of Agrarian Policy and Food launched access to the resources necessary for the sowing campaign, created an agricultural platform for collecting the actual needs of farmers for sowing in real-time, and an online platform for improving the logistics routes of farmers in conditions of martial law [34].

The main problems of the widespread implementation of digital accounting by agricultural enterprises, along with limited financial resources and lack of familiarity of accountants with modern accounting technologies, include the problems of information provision outlined by a group of researchers in scientific work, in particular: "insufficient level of information flows for all key users; the use of paper technologies in the collection, processing and analysis of information; lack of statistical indicators at the sectoral, regional and state levels" [35].

It is worth noting that the qualitative transformation of the management component of enterprises of the agro-industrial complex due to the organization of digital accounting depends, first of all, on the solution of the main tasks of the complex normative-legal and organizational approaches to the sphere of "digitalization" of the economic sectors, which consists in the joint efforts of the authorities, the public and business [28; 29; 36]:

- to increase the efficiency of management in the agro-industrial complex through the introduction of end-to-end digital technologies;
- to create technologies for obtaining, checking, structuring, synthesizing and analyzing reliable and up-to-date data on the state of the agro-industrial complex, necessary for making reasonable and timely management decisions;
- to create technologies and services that facilitate

the access of agro-industrial enterprises to credit and insurance products;

- to implement the principles of a unified system of identification and authentication, maintaining a digital profile of enterprises of the agro-industrial complex;

- to increase the effectiveness of state support measures by reducing costs and time in providing this support;

- to encourage the implementation of digital technologies in the production processes of agricultural enterprises, including through state support;

- to increase the effectiveness of the inter-economic interaction of enterprises of the agro-industrial complex with the state.

The fundamental transformation of the agrarian sector continues to gradually grow and contributes to the effective functioning of Ukrainian agrarian business, the modernization of the infrastructure of rural areas in general, and therefore is an effective tool in ensuring the socio-economic effect for the development and stability of the life of the rural community.

CONCLUSIONS

The introduction of digitization of accounting determines the harmonious use of technologies, accounting programs, applications and other business tools, which allows ensuring the recording of business transactions, changes in business processes, prompt response to deviations, as well as the implementation of the unhindered exchange of information in real-time, its updating and synchronization. In the current economic conditions during the martial law

in Ukraine, the digitization of business processes, including the accounting component, becomes an effective form of work organization, enabling safe conditions for employees as much as possible, contributes to the further functioning of agricultural enterprises, which solves the problem of employment of the population, preservation of economic stability countries.

The effectiveness of the digitalization of accounting processes in the activities of agro-industrial enterprises depends on the amount of technology financing, the qualifications and competence of accounting employees, as well as digital transformations of rural areas, in particular, ensuring unhindered access to high-speed Internet.

The methodology and organization of the digitization of accounting processes in the enterprises of the agro-industrial complex, where the practice of using information technologies is not active, and the issue of choosing online services is difficult due to the limited number of software products in the Ukrainian IT market that take into account the sectoral features of business processes, require further scientific research. agricultural sector. A thorough study of the above-mentioned aspects will allow solving the problems of digitalization of accounting in the management of business processes of enterprises of the agro-industrial complex and will contribute to the effective use of their financial resources, the improvement of technologies for obtaining, storing and transmitting analytical information to stakeholders, the methodology of systematization of information, increasing the competence of accounting employees and increasing the prestige of the accounting profession.

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Цифровізація обліку в управлінні бізнес-процесами підприємств агропромислового комплексу

Наталя Володимирівна Потриваєва, Лілія Анатоліївна Козаченко,
Ірина Іванівна Недбайло, Ірина Василівна Нестерчук

Миколаївський національний аграрний університет
54008, вул. Георгія Гонґадзе, 9, м. Миколаїв, Україна

Анотація. Статтю присвячено проблемам цифровізації бухгалтерського обліку в аграрному секторі України як основного елемента модернізації бізнес-процесів в умовах діджиталізації. Відповідно набувають актуальності питання використання сучасного інструментарію бухгалтерського обліку аграрних підприємств, що в більшій мірі залежить від реалізації сценарію цифрового розвитку сільських територій України, зокрема розвитку цифрової інфраструктури. Мета статті – дослідити сучасні тенденції цифровізації обліку підприємств аграрної галузі та їх вплив на управління бізнес-процесами в умовах сьогодення. У дослідженні використано діалектичний метод пізнання та загальнонаукові прийоми і принципи комплексних досліджень, які включають емпіричні, теоретико-когнітивні та загальні логічні методи, зокрема: спостереження, порівняння, опис, узагальнення; аналіз, синтез, аналогію і абстрагування; системний підхід; монографічний; порівняльного аналізу. У статті досліджено вигоди від використання інформаційних технологій у діяльності підприємств аграрного сектору та визначено чинники, які уповільнюють процес його трансформації. Встановлено, що розвиток аграрного підприємства на основі цифровізації управлінських процесів потребує значної кількості часу для впровадження, що пов'язано з вкладенням суттєвих інвестицій у придбання та супровід технологій, а також навчання співробітників новим професійним навичкам. Розглянуто новації сучасного інформаційного простору, що можуть бути використані у бізнес-середовищі задля цифрової трансформації бізнесу, зокрема з метою продуктивної організації облікових процесів. Узагальнені результати та сформульовані висновки можуть застосовуватися у практичній діяльності українських аграрних підприємств у контексті використання сформованої інформаційної бази технологій, онлайн сервісів, спеціалізованих додатків для цифровізації процесів обліку, складання звітності, оподаткування, а також визначення критичних чинників уповільнення використання цифрових технологій, що сприятиме загальній трансформації бізнес-процесів суб'єктів господарювання агропромислового комплексу

Ключові слова: діджиталізація, цифрові трансформації, бухгалтерський облік, аграрна сфера, інформаційні технології

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Миколаївський національний аграрний університет
вул. Георгія Гонґадзе, 9, м. Миколаїв, Україна, 54008

тел.: +38(0512) 70-93-54

E-mail: info@bsagriculture.com.ua

www: <https://bsagriculture.com.ua/uk>

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