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LATEST GLOBAL CHALLENGES FOR DEVELOPMENT OF AGRO-FOOD CLUSTERS IN THE CONTEXT OF ACHIEVING THE SUSTAINABLE DEVELOPMENT GOALS

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Petrukha S. Latest Global Challenges for Development of Agro-Food Clusters in the Context of Achieving the Sustainable Development Goals

In accordance with forecasts of international organizations, the number of the population has to increase by more than 3 billion people by 2100 that, with the reduction in the amounts of natural resources and an increasingly significant impact of climate change, requires to outline the key challenges, in particular, for agro-food clusters as well. A food security problem is acute even today for 8.9% of the population that actualizes shaping scenarios of development of agro-food clusters for a timely response to the challenges associated with the worsening of the natural conditions for production of required amounts of quality food by increasing the productivity of agriculture through adaptivity to climatic changes and a more efficient usage of resources (land, water, labor, financial, informational, material resources). In accordance with set aspects, the purpose of research has become outlining the global challenges, which will determine the agro-food cluster development trends. It is substantiated that modern global challenges are associated with: orientation on the consumption of alternative proteins; critically high amounts of waste and food product losses; decrease in agricultural crop yields because of climate change; a high level of greenhouse gas emissions in the process of production of agricultural products; increase in incomes of the population; increase in investment amounts; increase in biofuel production volumes; an impact of the latest pandemics; application of alternative technologies in production of agricultural products (using a vertical farming technology that provides significantly higher yields; spreading a practice of drone use to carry out all types of agricultural production; use of digital marketing tools as technology that enables establishing a contact directly between goods producer and a consumer by using mobile applications and social media). Each of the identified challenges can subsequently cause the occurrence of a new threat or the occurrence of opportunities for more active development of agro-food clusters. An adequate response both at the agro-food cluster level and at the international level, along with the improvement of the mechanisms of meeting the priority needs of everyone for food products, will form the foundation for achieving the Sustainable Development Goals.

Key words: *challenge, agro-food cluster, agriculture, waste, food products, sustainable development*

Петруха С. Новітні глобальні виклики для розвитку агропродовольчих кластерів у контексті досягнення цілей сталого розвитку

Відповідно до прогнозів міжнародних організацій чисельність населення має зрости до 2100 року більш ніж на 3 млрд осіб, що, за зменшення обсягів природних ресурсів та все суттєвішого впливу зміни клімату, вимагає окреслення ключових викликів, зокрема і для агропродовольчих кластерів. Проблема продовольчої безпеки вже сьогодні гостро стоїть перед 8,9% населення, що актуалізує формування сценаріїв розвитку агропродовольчих кластерів для своєчасної реакції на виклики, пов'язані з погіршенням природних умов для виробництва необхідних обсягів якісної їжі, шляхом збільшення продуктивності сільського господарства через адаптивність до кліматичних змін та ефективніше використання ресурсів (земля, вода, трудові, фінансові, інформаційні, матеріальні). Згідно з визначеними аспектами метою дослідження стало окреслення глобальних викликів, які детермінуватимуть тенденції розвитку агропродовольчих кластерів. Обґрунтовано, що сучасні глобальні виклики пов'язані

із: орієнтацією на споживання альтернативних білків; критично високими обсягами відходів та втрат продуктів харчування; зменшенням урожайності сільськогосподарських культур через зміну клімату; високим рівнем викидів парникових газів у процесі виробництва сільськогосподарської продукції; зростанням доходів населення; збільшенням обсягів інвестицій; нарощуванням об'ємів виробництва біопалива; впливом новітніх пандемій; застосуванням альтернативних технологій у виробництві сільськогосподарської продукції (використання технології вертикального землеробства, що забезпечує суттєво вищий рівень урожайності; поширення практики застосування дронів для ведення всіх видів сільгоспвиробництва; використання інструментів цифрового маркетингу як технології, що дає змогу налагоджувати контакт безпосередньо між товаровиробником та споживачем застосуванням мобільних додатків та соціальних медіа). Кожен із визначених викликів у подальшому може спричинити виникнення нової загрози або ж появу можливостей для активнішого розвитку агропродовольчих кластерів. Адекватна реакція як на рівні агропродовольчих кластерів, так і на міжнародному, при удосконаленні механізмів задоволення першочергових потреб кожної особи у продуктах харчування, сформує основу для досягнення цілей сталого розвитку.

Ключові слова: *виклик, агропродовольчий кластер, сільське господарство, відходи, продукти харчування, сталий розвиток.*

Problem setting. According to the World Bank's data (The World Bank, 2020), in 2018, an agriculture's share of GDP was in total 4%, and, for the specific countries, reached even 25%. In addition, in the countries with low incomes per capita, 65% of adult population are employed in this sector of the economy that allows them to earn a living. The report for 2020 contains the information on 690 million people that is 8,9% of the population of our planet, that experience undernourishment. It is important that within the last five years, the number of such population has increased almost by 60 million. To the largest extent, this problem concerns Sub-Saharan Africa, where, in 2019, undernourishment was experienced by 22,0% of the population, i.e., 235 million people. The FAO further gives the information on a problem such as an increase in a portion of people over 18 years of age who suffer from obesity: in 1997 – 8,3%, in 2007 – 10,1%; in 2017 – 13,2% (FAO, 2019, p. 15) that is a consequence of an unbalanced daily ration and an active usage of harmful chemical additives by goods producers.

The presented data actualizes, even today, the formation of scenarios of development of agro-food clusters for a timely response to challenges associated with the worsening of the natural conditions for the production of the required amount of quality food by increasing the productivity of agriculture through adaptivity to climatic changes and a more efficient usage of resources (land, water, labor, financial, informational, material resources).

Recent research and publications analysis. Formation and development of clusters was defined by M. Porter (Porter, 2003), and was contributed by other foreign and Ukrainian scientists, for example (Holian, Petrukha and Roshkevych, 2018; Kuchiki, Mizobe and Gokan, 2017; Ryzhakova, Petrukha, and Kunytskyi, 2019; Skogstad, & Verdun, 2013; Wardhana, Ihle, and Heijman, 2017). It makes sense to note also the absence of fairly thorough research of the trend of the agro-food clusters development in the mid- and long-term, proceeding from a change in the need for and conditions of the production of agricultural products.

Task setting. The purpose of the research is to outline the global challenges, which will determine the trends of the agro-food clusters development.

Research methods and materials. To identify the set of key global challenges for the agro-food clusters development, the following methods are applied, namely synthesis and analysis – to identify the dynamics and capacity of the production of agricultural products; morphological analysis – to define the content of challenges for the development of agro-food clusters more precisely; a graphical method – for visual presentation of the theoretical and methodical material; an abstract-logical method – for theoretical generalizations and conclusions of research.

The research is based on a thorough work with materials of international organizations

such as the FAO, the UN Department of Economic and Social Affairs etc.

Presentation of basic material. In accordance with formed forecasts of the UN Department of Economic and Social Affairs, the number of the population on the Earth will increase to 8,5 billion people in 2030, to 9,7 billion people – in 2050 and to 10.9 billion people – in 2100 (UN Department of Economic and Social Affairs, 2019) that will cause, in economic terms, increased demand for food products, will increase the level of urbanization and income growth that, in its turn, will provoke increase of the burden on the environment, in particular, in terms of climate change and the functioning of the agro-food sector of the world economy.

The specified circumstances actualize outlining the key challenges, which will determine the trends of the development of agro-food clusters over the next several decades:
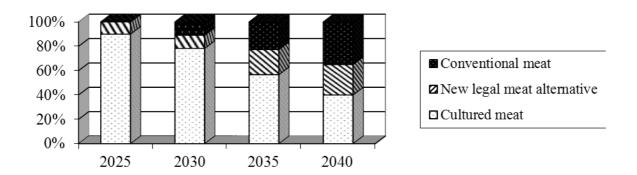
- *orientation on the consumption of alternative proteins*. Under the conditions of the increasing demand for food products, in particular, meat, which even today is difficult to meet because of the need for a larger amount of resources under the real conditions of their decrease because of the worsening of climatic conditions, there is a real risk associated with the orientation on meeting the needs of the population for food by alternative proteins (Fig. 1).
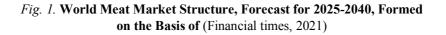
In the forecast for a change in a world meat market structure, the three trends are clearly distinct: decrease in a share of conventional meat, i.e., such meat that is received as a result of animal growing from 90% in 2025 to 40% in 2040, with an expected world market gain by 3%; increase in the vegan meat alternative, which even today is popularized through consumption of tofu and tempeh, texturized vegetable protein, seitan, mushrooms, jackfruit, kidney bean and beans etc.; it is forecasted that high rates of the scientific-technical progress will enable satisfying the top-priority needs of the mankind through creating the cultured meat, or «test-tube meat».

For agro-food clusters, such a challenge can lead to occurrence of new market opportunities in the form of meeting the demand for new vegan meat alternatives or occurrence of a real threat to the economic development because of losing positions in the world meat market;

- *critically high amounts of waste and food product losses*. In accordance with the data (Unneccesary food waste reaches 40%, 2021), the population annually throws as waste nearly 1.3 billon t of food that, in relative terms, is nearly 40%. The figures are impressive against the background of a forecasted increase in the demand and complications of the production of food products. The analytical information on such losses by specific groups of countries shapes an idea of the phasing of food losses (Fig. 2). For the countries with the developed economy, the largest share of losses falls on the consumption stage, i.e., is associated with conscious behavior of each person.

Fig. 1. **World Meat Market Structure, Forecast for 2025-2040, Formed on the Basis of** (Financial times, 2021)
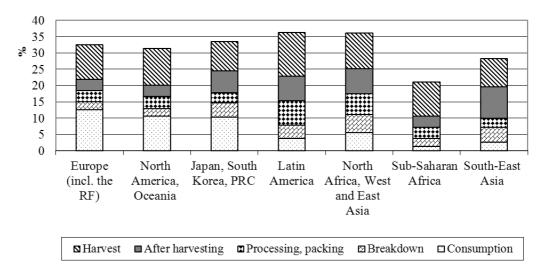
Fig. 2. **Breakdown of Food Losses by Production and Consumption Stages,**
formed on the basis of (Castellano, 2020).

A different situation is in the developing countries where losses are quite high at all stages, beginning from harvesting that, accordingly, actualizes a problem of enhancing the efficiency of the agro-food clusters functioning by applying more perfect technologies;

- *reduction in grain yields because of the climate change*. In accordance with forecasts (Financial times, 2021), without required crop adaptation, an average yield can reduce by more than 5% until 2050, in particular, in Africa it can reach more than 20%. For comparison, by a provisional 10% reduction in yields, 45% of arable lands will require additional processing.

The specified forecast is based on the statement of the fact that, since 1970s, an average temperature rise has been from 0,16 ^{0}C to 0,18 ^{0}C within the decade. According to the results of conducted modelling of the global warming impact on a growing season of grains (barley, maize, rice, palm oil, rape, soya, wheat etc.), it was identified that yields have changed even today, in particular, from (-13,4%) for palm oil to 3,5% for soya. Climatic changes have had a negative impact on grain yields in Europe, South Africa and Australia, but a positive one in Latin America. The other aspect is identifying a reduction in caloricity, which was in Germany (-11%), Spain – (-4%), Italy - (-4%), Ukraine (-4,71%) (Ray, West, Clark and Gerber, 2019).

The provided analytical data and made forecasts require reviewing modern grain growing technologies, with activation of work on their adaptation to climatic changes;
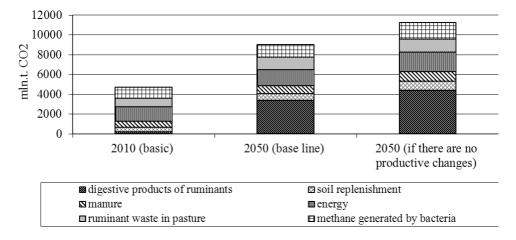
- *a high level of greenhouse gas emissions in the process of the production of agricultural products*. Basis sources of the generation of greenhouse gases are animal husbandry, application of nitrogen fertilizers, growing of rice and usage of energy at all stages of the production of agricultural products (Fig. 3).

According to the specified problems, orientation on achieving the Sustainable Development Goals requires: a technological improvement of animal husbandry by using chemical substances, which would reduce in the level of the environmental contamination; use of fertilizers, having an improved composition in terms of increase in the rate of nitrogen absorption; reduction in the length of field floods in order to save water and reduce in methane emissions for rice growing; a more active use of renewable energy sources;

- *increased incomes of the population*. In accordance with forecasts developed by the FAO's specialists, if moderate world economy gain rates of 2,7% are taken as a basis, then the world GDP will increase from $50T in 2005–2007 to $126T in 2050. Higher per capita income gain rates will be characteristic of the countries with low and medium incomes at the

level of 2,7% (increase from \$2,400 to \$7,500) compared to the countries with high incomes – 1,2%. Despite the difference in the gain rates, in absolute terms, a gap between GDP indicator per capita will only increase from \$25,500 to \$40,000 (FAO, 2016).

Fig 3. **Change in Amounts of Greenhouse Gases in Production of Agricultural Products,** *formed on the basis of* (World resources institute, 2021)

The provided actual data and forecasts of the FAO for GDP growth per capita point at an eventual change in the demand, price and structure of agricultural products. To the largest extent, the above concerns the countries with low and medium incomes where, affected by the increase in the income level, the demand for meat and dairy products will grow.

- *increase of investment levels.* Researches, conducted by a number of international organizations (FAO, 2017, p. 450) show that, in order to prevent hunger for 650 million people in 2030, additional investments in the production of agricultural products must be at least \$265B annually. These forecast data point at the existence of the prospect for development of agro-food clusters by means of the significant growth of financing to achieve the Sustainable Development Goals;

- *increase of biofuel production volumes.* In 2007 60 billion liters of biofuel were produced, whereas in 2015, this indicator reached a level of 130 billion liters and in 2020 – came close to 140 billion liters (Alexandratos and Bruinsma, 2012, p. 24). The biofuel production raised at the highest rates in the USA. For comparison, world grain consumption was increasing, in the same period, on the average, by 1,8% annually. The other indicator shows that the vegetable oil consumption for the production of food products increases annually by 5,1%, whereas for the biofuel production – by 23%. According to FAO's forecasts, by 2024, the one fourth of sugar cane will be used for the ethanol production (UNECE (United Nations Economic Commission for Europe) & FAO, 2016). Specialists also note that today a biofuel production gain is characteristic, to the largest extent, of the countries with high incomes but, further increase in the demand and in the gap between per capita incomes will provoke the reprofiling of the production of agricultural products in the countries both with medium and low incomes. According to the World Economic Forum's data, a world potential for the biofuel production is estimated, as of 2020, at \$295B (UNECE (United Nations Economic Commission for Europe) & FAO, 2016) that can definitely make a significant effect on the process of the further functioning of most agro-food clusters, regardless of their geographic location;

- *effect and consequences of latest pandemics.* COVID-19 has significantly affected all socio-economic processes in the world. Analytical data on the number of the dead and losses suffered by each national economy, cannot yet be generalized today as the struggle continues. Each country fixes getting over a wave of rise in diseases, concurrently preparing for the next one. However,

in the context of researching a problem of the functioning of agro-food clusters, it is important to state the facts that even after a victory over COVID-19, there is a high probability of occurrence of a new pandemic, which will exacerbate problems concerning the production of agricultural products. A current pandemic has revealed a problem of implementing restrictions for the activities of the whole sectors of national economies in order to reduce in the rates of the spread of a lethal virus. This circumstance has adversely affected, to the largest extent, a part of the population with low incomes as the specifics of encountering the impact of COVID-19 on a human body is associated with their possibility to systematically consume sufficient amounts of food products rich in micro elements to support and strengthen immunity. The other circumstance is that agro-food clusters, with a fair 2020 yield, have suffered losses through failures in the process of the collection, transportation and sale of products. The specified is associated with a failure to engage a required number of seasonal workers because of the restriction for movement of, in particular, migrant workers, whose labor force is used in harvesting. In addition, further problems arise as for complying with the sanitary conditions of stay of a significant number of workers, their permit to work and treatment.

- *latest technologies in the production of agricultural products*. It makes sense to draw attention to the three technologies, which will be determinant for the functioning of agro-food clusters until 2050. The first technology is associated with application of vertical farming providing growing crops in vertically stacked layers located in greenhouses with controlled climate. At this moment, the number of farms using such technology is limited, but the results of experiments point at the maximally wide use of gained experience within quite short periods of time. So, according to data provided in the publication (Neubauer, 2021), on the Costa Group's experience, an average tomato yield of 70 kg per square meter is specified, that is six times as much as the best Australian farms following traditional technologies. Vertical farming allows achieving the two of the Sustainable Development Goals at the same time: significantly decrease the consumption of resources (land and water) and to produce the large amount of agricultural products forming a required basis to provide 10 billion people with food products in 2050.

The other technology provides a more active application of drones for running all types of agriculture, i.e., beginning from the presence of stock numbers in pastures to the surveillance over remote water supply points and survey of large agricultural land plots to identify problems with soils, weeds and agricultural crop yields. Using drones is just the tip of the iceberg, oriented on collecting the maximum amount of data with further development of forecasts and carrying out of operational intervention in the process of growing of agricultural products.

Application of the third technology is associated with a complication to meet consumers' need for agricultural products because of disruption of internal chains, the attention to which was drawn above. A solution to this complicated problem is the application of digital marketing as the technology that enables establishing a contact directly between a goods producer and a consumer by using mobile applications and social media such as Facebook and WhatsApp. In France, Belgium and Netherlands, the first Internet platforms for the promotion of products of local agro-food clusters have already been created. However, the first results confirmed the fact that such platforms work better for agricultural products having no strict expiration dates. Meanwhile, combining goods producers into agro-food clusters enables using the digital technologies more actively to stabilize the situation and to restore internal chains of the production and sale of agricultural products.

Conclusions. Drawing conclusions, it makes sense to stress once more that even today orientation on achieving the sustainable development goals requires introducing changes in the functioning of agro-food clusters in order to respond, in an adequate and timely manner, to key challenges, which can subsequently cause both new threats and additional opportunities, in particular, in terms of development at a micro level and a decrease in a part of the population experiencing difficulties with getting quality and safe food in required amounts at a macro level.

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