

COVID-19: crisis or new opportunities time for the agricultural sector of Ukraine

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Abstract. COVID-19 is a huge problem for the sustainability of the global economy, both short and long term. The spread of COVID-19 has led to a decline in business and economic activity, as well as a contraction in production - virtually all world economies have shown a sharp decline in GDP. World experience shows that agriculture is less vulnerable to a pandemic. In general, there is a calmer reaction to the demand for agricultural products than for industrial ones. The impact of agricultural production volume on the real GDP of Ukraine is investigated with a distributed-lag model on the data for the period 2008-2020. The effects of the impact distribute almost evenly between the four quarters of the year, which means that the lockdown effects in the agriculture sector will affect the GDP of Ukraine for a long period. The decline in production, the closure of markets and borders, the cancellation of orders led to the fact that the agricultural sector faced serious logistical problems. In addition, the economic downturn has affected farmers' access to financial resources. However, COVID-19 also opened new opportunities for the Ukrainian agricultural sector: accelerating and expanding the process of digitalization, the opportunity to expand the market for export products, and increase skilled and unskilled labor. The authors propose six steps to ensure the sustainable development of the agriculture sector of Ukraine.

Keywords: Agriculture Sector, COVID, Crisis, GDP, Model, Sustainability

1. Introduction

COVID-19 has dealt a serious blow not only to the medical systems of countries but the scale of its impact on economic systems is also huge. The spread of COVID-19 has led to a decline in business and economic activity, as well as a contraction in production – virtually all world economies have shown a sharp decline in GDP. As world experience shows, agriculture has proved more resilient to pandemics than industry. In countries where industrial exports predominate, such as Germany, exports fell by about 30 percent in the second quarter. For Ukraine, the decline in exports during this period was minimal, only imports decreased. In general, there is a calmer reaction to the demand for agricultural products than for industrial ones.

The agricultural sector plays a significant role in the development of the Ukrainian economy, which has become particularly noticeable over the past 10 years. According to the State Statistics Service of Ukraine, the share of the agricultural sector in the structure of Ukrainian real GDP has been growing steadily since 2010 (from 7% in 2010 to 12% in 2016) until 2016, then declining to 9% in



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2019, but still remains quite great. More detailed information about the real GDP of Ukraine (in billion dollars) and the fraction of agriculture in the GDP of Ukraine (in %) for the period 2007-2019 is in table 1.

Table 1. The real GDP of Ukraine (in billion dollars) and the fraction of agriculture in GDP of Ukraine (in %)

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Real GDP	150	154	131	136	143	144	144	134	121	124	127	131	136
Fraction of agriculture in GDP	7	7	7	7	8	8	9	10	12	12	10	10	9

Source: State Statistic Service of Ukraine [1], calculation of authors

The agricultural sector of Ukraine provides not only 9% of Ukraine's real GDP but also 18% in the structure of employment and 6% in the structure of tax revenues of the country. In recent years, agricultural products also account for a significant share in the structure of Ukraine's exports. Thus, in 2007 the share of agricultural products in Ukraine's exports was 13%, while in 2016 it was already 42% (the highest value), and over the last five years, it has fluctuated around 40% (and in 2019 it was 40%). More detailed information about the export of Ukraine (in billion dollars) and the fraction of agriculture in export (including the food industry, in %) for the period 2007-2019 is in table 2.

Table 2. The export of Ukraine (in billion dollars) and the fraction of agriculture in export (including the food industry, in %)

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Export	49.3	67.0	39.7	51.4	68.4	68.7	63.3	53.9	38.1	36.4	43.4	47.3	46.1
Fraction of agriculture in export	13	16	24	19	19	26	27	31	38	42	41	39	40

Source: State Statistic Service of Ukraine [1], calculation of authors

Due to the industry's resilience to crises in the economy, there is reason to expect that it will be one of the least affected during the fight against the global pandemic.

As a key sector of the real sector of the Ukrainian economy, agriculture is a guarantee of the food and environmental security of the country in a pandemic condition. Sustainable agricultural development is mandatory for many Sustainable Development Goals and it is therefore important to strengthen the sector's participation in national development strategies.

2. Impact of COVID-19 on global agriculture

Consider how the manifestation of the COVID-19 shock in the agricultural commodities segment is presented. S-Network ITG Agriculture IndexSM can be used as a basic illustration. This index was designed to serve as a fair, impartial, and transparent measure of the performance of the Global Agriculture Industry [2]. The graph for this index, which characterizes the dynamics of the shock deployment, is shown in Fig. 1.



Figure 1. S-Net ITG Agriculture Index

Source: investing.com [2]

As can be seen from the graph, the dynamics, in a generalized form, includes a shock fall, and then a relatively slow recovery. There is increased volatility during the recovery. On this basis, it is logical to present the manifestation of shock with two parameters:

- 1) The depth of the fall in relation to the pre-shock period.
- 2) Percentage recovery over a certain time horizon.

In terms of these parameters, we estimated the agricultural ETF within a certain sample.

Technically, for the calculation, three-time stages were allocated: - 07/01/2019 - 01/15/2020 - the pre-shock period; 01/16/2020 - 03/31/2020 - the shock period; and 04/01/2020 - 09/22/2020 - the post-shock period.

Within the first stage, the average value was calculated, within the second - the minimum value, and within the third - the average value.

The depth of the fall was calculated as the percentage drop of the first parameter to the second. Recovery was calculated as the ratio of the third parameter to the first.

COVID-19 -induced shock is presented in figure 2.

Despite some voluntary statements and memoranda by WTO members on ensuring and protecting sustainable supply chains, reducing or eliminating tariffs on basic necessities and agricultural products, many countries have introduced restrictive trade measures mainly on basic food products such as sugar, cereals, buckwheat, meslin, rice, vegetables, soybeans, sunflower seeds, ready meals, and oil to ensure local food supplies and food security [3].

For example, the Eurasian Economic Union banned the export of onions, garlic, turnips, rye, rice, buckwheat, cereals, sunflower seeds, and so on. From April 3 to July 3, 2020, Belarus introduced a temporary restriction on exports of some basic foodstuffs (buckwheat, onions, garlic). Egypt has banned the export of some legumes (beans and lentils are still banned for export). China has temporarily reduced import tariffs not only on medical goods, but also on certain categories of raw materials, agricultural products, and meat. The Republic of El Salvador and Honduras have banned the export of some dried legumes. Indonesia has temporarily abolished the requirement for import certification of onions and garlic. Kyrgyzstan has temporarily banned the export of certain foods (eg wheat and meslin, wheat flour, edible oil, rice, pasta, chicken eggs, sugar, iodized salt, feed, hay, straw, feed, bran, and grain feed). Saint Kitts and Nevis Federation lifted import tariffs on certain products, such as vegetables, fruits, fruit juices, and vitamins, and Thailand banned the export of chicken eggs.

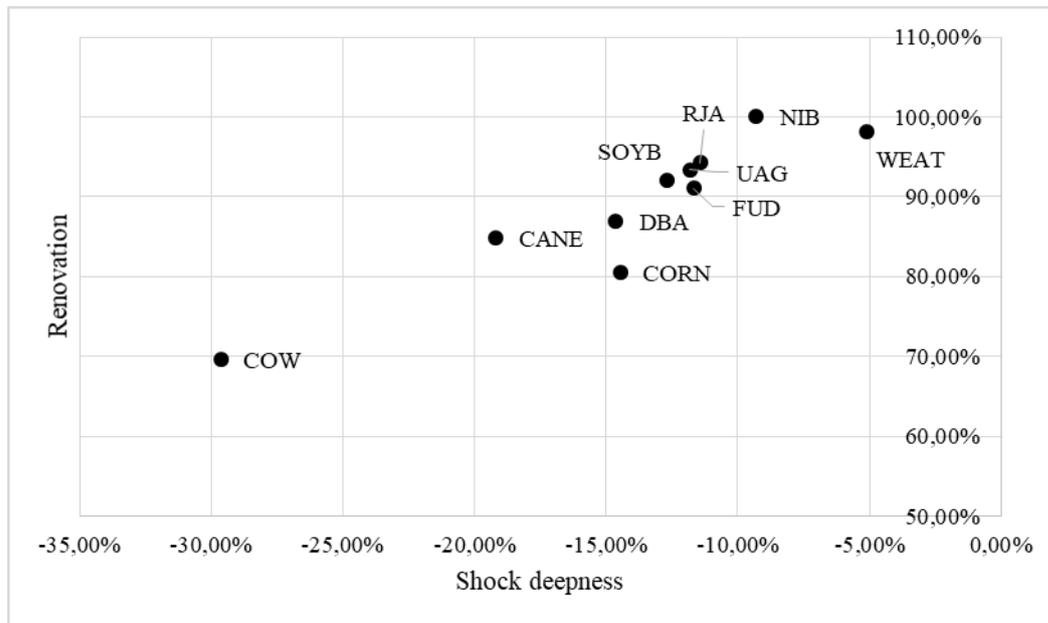


Figure 2. Shock characteristics for agriculture ETFs
Source: investing.com [2]

On April 22, 2020, 23 WTO members, including Ukraine, signed the Joint Statement on responding to the COVID-19 pandemic with open and predictable trade in agricultural and food products [4].

Siche [5] investigate how different pandemics impact economics, especially in agriculture on the basis of data from the Food Agriculture Organization and the World Health Organization and concludes that the Covid19 pandemic has a great impact on economics and agriculture, especially on groups vulnerable to a food crisis. Authors from different countries discover the pandemic impact on agriculture production and the agricultural sector at all, for example Kumar, Padhee and Kumar [6] in India, Zhang et al. [7] in China, Gray [8] in Canada, Kaminskyi, Nehrey, and Rizun [9] and Hryhoruk, Khrushch, and Grygoruk [10] in Ukraine, Oliskevych [11], Davydenko [12] and Elleby et al. [13] and in global agricultural market and others.

The unprecedented health crisis and its economic and social consequences make it even more difficult to achieve the goals of sustainable development. The world community is already off schedule for the 2030 Sustainable Development Goals, and the COVID-19 pandemic has made it even more difficult to achieve both the goals and track the results already achieved. While the overall situation is assessed as worrying, it is important to note positive trends, such as increased water efficiency in South Asia, intensified efforts to conserve plant genetic resources in North Africa, progress towards sustainable forest management and some progress in combating illegal, unreported and unregulated fishing.

The agro sector and the food industry are central to the world economy, of particular importance to developing countries. That is why investing in agriculture has one of the best effects, contributing to economic growth, food security, and the fight against poverty, what are the sustainable development goals. Certain commitments in the new plan for sustainable development are divided into some areas: accelerating innovation for farmers and nature; striving for carbon-neutral agriculture; ensuring human safety and health and significant partnership.

3. Ukrainian agriculture during a pandemic

The situation in Ukraine is different from the situation in other countries, because they're the cause of the crisis is COVID-19 and measures to combat it, and in Ukraine, it is primarily systemic problems of the agricultural sector: the land market, which is still not working, a large share public sector and a

number of state enterprises; slowing down privatization; low performance. Therefore, to get out of the crisis, it is not enough for Ukraine, like other countries, to simply provide business support, and it is important to support macro stability.

Small and medium-sized farms suffer the greatest losses. The closure of the markets, restaurants, and cafes with which they cooperated in March-May 2020 closed the opportunities for such farms to sell their products. All food could be purchased only in supermarkets and shops, where sanitary conditions are 100% observed. Not every small farmer can meet the requirements for standards of packaging, safety, volume, and quality of products, as in supermarkets. Small farmers are inconvenient suppliers for supermarkets, chain stores are easier to have one large supplier. This caused problems with the sale of grown products deprived consumers of food supplies and put small farmers and peasants in a difficult financial position. This process has also resulted in the bartering of relations in rural areas, which is one of the signs of the crisis in the industry. Large retail chains and large purchasing firms, during quarantine, increased prices for agricultural products, which in turn led to a decrease in demand from the population, as well as a gradual change in the structure of the industry, due to a decrease in agricultural production. As a result, prices for agricultural products in Ukraine increased in April-May. The situation resulting from quarantine restrictions includes threats related to the deterioration of food security in Ukraine, the destruction of small agricultural businesses, exacerbation of social tensions, the shadowing of the agricultural market, which provokes rising prices for agricultural products in retail chains, stimulates its imports.

The pandemic has hit the country's economy, and as a result, investment in agriculture is declining significantly. According to scientists of the Institute of Agrarian Economics, under the current conditions of investment activity in 2020, the total amount of capital investment in agricultural production in 2019 prices will be about 51 billion UAH or 2.0 billion USD. This is 5% less than in 2019 and 17-20% less than in 2017 and 2018. In case of a deterioration of the situation and conditions of the synergy of existing and new negative factors, in particular: deterioration of the financial condition of enterprises, reduction of investment projects in agro-industrial production, as well as the global economic crisis associated with the COVID-19 pandemic, the investment can be expected additionally by 15-20% - up to 1.6-1.7 billion dollars [14].

Agricultural export one of the two main sources of foreign exchange earnings in the country. In general, agricultural exports provide Ukraine with up to 40% of foreign exchange earnings. In 2019, agricultural exports amounted to \$ 20 billion.

In the first seven months of 2020, exports of crop products fell to \$ 5.73 billion (by 11%) [15]. The largest share of crop exports is corn, whose exports amounted to 18.9 million tons, which is 14% less than the same period last year. However, wheat exports increased by 7% and amounted to 6.8 million tons. There is also a positive trend in barley exports: an increase of 53% to 2.1 million tons. Soybeans export decreased by 52% and amounted to 0.83 million tons. The other plant products export increased by 39% to 0.52 million tons.

For seven months of 2020, exports of livestock products amounted to \$ 667 million, which is 13% less than the corresponding period of 2019. Among the export goods of livestock, the first place is occupied by poultry meat, 254.2 tons were exported, which is 4% more than in 2019. Eggs export amounted to 71.9 thousand tons, which is 15% less than the corresponding period of the previous year. The exports of honey increased by 25% and amounted to 35.5 thousand tons. Exports of dairy products decreased, milk and cream by 38% - up to 16.5 thousand tons, dairy whey at 9% - up to 15.3 thousand tons.

Exports of fats and oils in January-July 2020 increased by 22% to \$ 3.43 billion. The first place here is occupied by sunflower oil, whose exports amounted to 4.35 million tons, which is 15% more than in the corresponding period of 2019. Exports of soybean oil decreased by 12% to 209 thousand tons, exports of rapeseed, mustard, and colza oils increased by 609% to 40.3 thousand tons. There is also a positive trend in margarine exports - an increase of 18% to 30, 5 thousand tons

Finished products export increased by 2% and as of July 2020 amounted to \$ 1.89 billion.

The pandemic was an additional impetus for the Ministry of Economy along the way for preparation the first Voluntary National Review on the implementation of the Sustainable Development Goals in Ukraine. The review of the SDG on 15.07.2020 was presented during the High-Level Political Forum on Sustainable Development under the auspices of ECOSOC (UN Economic and Social Council). The SDG 2020 Review presents the results of the first stage of systematic work with SDG since 2015, which covers the adaptation of SDG in Ukraine, monitoring the state of Ukraine's achievement of SDG and analysis of key trends. The SDG 2020 Review provides a vision of the achievements and challenges on the way to achieving each of the 17 SDGs in accordance with the benchmarking benchmarks established based on calculation and forecasting work and summarizes the results of the assessment of national development under the SDG. The Ministry of Economy also prepared a draft of the first Voluntary National Review of Ukraine's progress in achieving the Sustainable Development Goals.

4. The impact of climate change on the agricultural sector of Ukraine

In 2019, Ukraine produced a record grain harvest - 75 million tons, the forecast for 2020 is much lower, about 68 million tons. The main reason for this is not COVID-19 but adverse weather conditions. Farmers in the Vinnytsia region estimate the loss of the crop at 30%, in Mykolayiv region up to 50%. For some crops, such losses can reach 70-80%. In the Odessa region due to the drought are on the verge of bankruptcy more than 1 thousand farms [16].

Currently, the issues of high degree of ruined lands, suboptimal crop rotations, extensive use of pesticides and plant protection products are critical for the agriculture of Ukraine. The climate is changing so fast that farmers simply do not have time to adapt to them. In addition, the high level of emissions from agricultural production further complicates the situation, addressing the negative impact on the climate. Agriculture needs to adapt as much as possible to climatic conditions, especially to optimize the sowing campaign and crop rotation, improve soil structure, use the land fund and invest in technology.

5. The distributed-lag model of agricultural products volume impact on GDP in Ukraine

The relationship between the elements of socio-economic systems is not known to be instantaneous; there is usually a lag between cause and effect. In the study of processes related to agriculture, lag dependencies often occur also because the processes in agriculture are seasonal.

The effects of COVID19 and lockdown, in particular, are likely to affect the economies of both countries and individual households for some time to come.

Although the agricultural sector is not one of the sectors most affected by the corona crisis, considering its share in Ukraine's economy, it is interesting to investigate the impact of agriculture on GDP. A reduction in agricultural production (for various reasons) was recorded in Ukraine during the last periods and according to the seasonality of agriculture, the country's economy will feel the effects of contraction for some time to come.

For the analysis, we use the quarterly real GDP of Ukraine and the monthly volume of agricultural products, cumulative since the beginning of the year (in actual prices, billion UAH). All data are collected for the period from 1/01/2008 to 1/07/2020 from the State Statistic Service of Ukraine and the National Bank of Ukraine [17]. This period includes at least three crisis period in economics: the global financial crisis in 2008, the socio-economic crisis in 2014 caused by the military conflict in the East of Ukraine and the annexation of Crimea, and the 2020 economic crisis, the consequences of which we will still feel. All these crises were reflected in some way in the main economic indicators of the country.

The econometric models can be useful for investigating the impact of agriculture on GDP. Al-Mulali [18] used panel data to investigation, how biofuel energy impacts economic growth, ecological situation in the country, and agriculture production. The model is realized for 16 countries with the highest level of consumption of the biofuel energy on the data for 2000-2010. He discovered that biofuel energy increases both GDP and agriculture production. Shu-hai [19] used the VAR model for

investigating interdependencies between agricultural loans and GDP. Izuchukwu [20] used multiple regression and ANOVA analysis for discovering how agriculture impacts Nigerian GDP and concludes that the agricultural sector of Nigeria needs improvements. Matviychuk and Velykoivanenko [21] propose an approach to constructing the mathematical models of scenario forecasting of economic development and determining the time delay when the effect of changes in influencing factors can appear. A similar approach can be used, among other things, to predict the consequences of COVID-19, but the article uses only standard statistical modeling methods. Kadir and Tunggal [22] discovered long-run macroeconomic variable's impact on agricultural production (on the example of Malaysia) using the Autoregressive-Distributed Lag approach (ARDL). Davydenko et al. [23] propose a methodology for GDP modeling based on dynamic programming which takes into account the peculiarities of social processes in Ukraine and the tendencies of world economic development. Agricultural data are characterized by seasonality, which is taken into account in the study [24], where seasonal ARIMA is constructed. Awan and Aslam [25] also used the ARDL model for estimating the economic growth of Pakistan impacted by agricultural productivity.

Because in our case data are collected with a different frequency (GDP is published only with quarterly frequency), we had to choose a method for data processing. One of the easiest ways is reduction all data to one higher frequency (in our case quarterly). One more problem with the volume of agricultural products is a cumulative method of data collection, that's why first we had to transform them into uncumulative forms. In the next step monthly volume of agricultural products was transformed into a quarterly one by adding monthly data within the quarter. Since a significant part of Ukraine's GDP is agricultural products, it is obvious that the formation of GDP is influenced by the agricultural sector. Let's test this hypothesis by constructing a simple pair regression-correlation model of Ukraine's GDP dependence on agricultural output:

$$y_t = 4,82 + 4,11x_t,$$

where y_t is quarterly real GDP of Ukraine, x_t is quarterly volume of agricultural products.

The model is adequate and all parameters are significant, but coefficient of determination is 0.26 that means 26% of variance can be explained with the independent variable.

The distributed-lag model contains not only current but also previous (lag) values of independent variables and thus takes into account the effect of the factor variable, distributed over several time periods.

The distributed-lag model with one factor variable can be written in the form:

$$y_t = \alpha + \beta_0 x_t + \beta_1 x_{t-1} + \beta_2 x_{t-2} + \dots + \varepsilon_t$$

where y_t is dependent variable, x_t independent variable.

Because simple pair model is not useful for analysis, let's evaluate the parameters of the model with lag. With the method of sequential evaluation of parameters in the fifth step revealed statistically insignificant estimate of the first parameter of the model, which indicates the correctness of the model from the previous step:

$$y_t = \alpha^{(4)} + \beta_0^{(4)} x_t + \beta_1^{(4)} x_{t-1} + \beta_2^{(4)} x_{t-2} + \beta_3^{(4)} x_{t-3} + \varepsilon_t$$

or explicitly

$$\tilde{y}_t = -88327,3 + 1046,58 x_t + 1076,36 x_{t-1} + 904,1 x_{t-2} + 1111,04 x_{t-3}$$

The coefficient of determination for this model is 0,78, that is three times more, than for the first model. The values of the Student's t-test for the regression coefficients $b_0^{(4)}$, $b_1^{(4)}$, $b_2^{(4)}$ and $b_3^{(4)}$ of this model are:

$$t_{b_0^{(4)}}^{EM} = 4,13; t_{b_1^{(4)}}^{EM} = 4,32; t_{b_2^{(4)}}^{EM} = 3,55; t_{b_3^{(4)}}^{EM} = 4,26.$$

The tabular value of the Student's distribution with $v=40$ degrees of freedom and a given level of significance $\alpha = 0.05$ is equal to $t_{0,05}^{CF} = 2,02$.

Short-term or influential multiplier shows the impact of agricultural production on GDP change in the current period and is equal to 1046.58, i.e. in the current period with each increase in agricultural production by UAH 1, GDP increases by UAH 1,047.

Long-term or total multiplier shows the effect of the agricultural production on GDP over four periods of time and is equal to $\beta = 1046,58 + 1076,36 + 904,1 + 1111,04 = 4138$, i.e. for four periods of time with each increase in the agricultural production by 1 UAH, GDP increase by 4.14 UAH.

The standardized values of the intermediate multipliers are:

$$\beta_1^* = \frac{1046,58}{4138,07} = 0,27; \beta_2^* = \frac{1076,36}{4138,07} = 0,22; \beta_3^* = \frac{904,01}{4138,07} = 0,26; \beta_4^* = \frac{1111,04}{4138,07} = 0,25.$$

That is, during the current period we have 27% of the total impact of a single change in the volume of agricultural production on GDP, and for the second period - 0.22% and so on. Note that the effects of the impact were distributed almost evenly between the four quarters of the year. This means that the consequences of the reduction in agricultural production (either under the influence of the crisis of 2020, or in connection with the decline in yields) will significantly affect the GDP of Ukraine during the year.

6. Opportunities for agriculture sector of Ukraine

COVID-19 not only revealed the weaknesses of the agricultural sector. The pandemic situation has forced farmers to look for new opportunities and approaches to production, marketing, and management. The possibility of using modern technologies plays a significant role here. Until 2020, agriculture focused on digitalization in the framework of production processes: automation and robotics, the use of drones and satellites, artificial intelligence, the Internet of Things, and others. During the pandemic, the weak point was primarily access to the consumer through closed markets. The digitalization of the sales process has become an urgent issue. Farmers started creating online stores, selling through groups on Facebook and Viber, and thinking about developing applications. In Ukraine, this process has just begun, but there are great prospects and opportunities.

Another area of active digitalization has become management processes. These processes were particularly active in large agricultural holdings, as restrictions on movement forced management to change management approaches. Thus, the digitalization of management has reduced management costs and saved time.

Amid the pandemic, governments in many countries have begun to reconsider their approaches to food security. An active process of creating domestic stocks of agricultural products, especially products that are traditionally exported, has begun. In this situation, favorable conditions are created for Ukraine as a country-exporter of agricultural products. This is an opportunity to expand markets, enter the international market with new products, and promote not only raw materials but also finished agricultural products.

The situation with the coronavirus pandemic has forced many people to reconsider their views on daily spending, health, and nutrition. Now everyone is trying to consume environmentally friendly products, read labels more carefully, and consciously approach such criteria as quality and safety. Now the culture of conscious consumption is becoming higher, people are thinking more about what products they buy and how safe they are. Products must be fresh, natural, and necessarily safe in a secure package. Farmers who feel these market needs, adjust their production to the new requirements, can gain significant competitive advantages. After all, healthy food is now becoming very important.

Among the positive factors in the development of the industry associated with the coronavirus is the return to Ukraine of workers - both skilled and unskilled workers, who can be involved in seasonal agricultural work and compensate for the traditional shortage of farms.

7. Conclusion

The main problem of the agricultural sector of Ukraine is not COVID-19, not the crisis caused by it, but systemic macroeconomics problems, in particular, the lack of a real strategy for agricultural development in the country.

To ensure the sustainable development of agriculture, in our opinion, it is necessary to do the following:

1. Restore the Ministry of Agrarian Policy, which would focus exclusively on the country's agricultural activities. And the priority task of the restored ministry should be to develop and implement a strategy for agricultural development in Ukraine.

2. Provide access to cheap medium-term and long-term financing. The development of the agricultural sector is impossible without investment. Today, farmers have virtually no access to loans for 5 years or more. To improve production processes, create a modern farm, digitalize the agricultural sector, it is necessary to create favorable financial conditions for farmers.

3. Integrate the agricultural sector of Ukraine into global agriculture. In order to function effectively on foreign markets, the agricultural sector of Ukraine must, first of all, meet European and world quality standards, obtain the appropriate European quality certificates for its own products. This will significantly expand markets and increase exports in cash by increasing product prices. It is necessary to move from the export of raw materials to the export of finished products.

4. Develop a system of adaptation to climate change. Farmers need not only to learn to adapt quickly to climate change but also to change their products in such a way as to reduce its impact on climate change. This requires the development of a program for sustainable agricultural development.

5. Improve fiscal policy towards the agricultural sector. The same tax burden is unacceptable for agricultural holdings with political protectionism and financial overcapacity, and medium and small farms. Small businesses should receive the most support from the state. It is necessary to optimize the model of taxation and state support of enterprises in the agricultural sector.

6. Improve the management system in the agricultural sector.

First of all, it is necessary to simplify the management system and start the process of digitalization: to provide open access to information, to open databases, including the land bank, to create the possibility of remote access, etc. The availability of accessible and timely information will allow farmers to effectively manage and quickly adapt to certain changes.

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