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## MODERN TRENDS IN THE DEVELOPMENT OF PLANT PRODUCTION UNDER AGRARIAN CRISES

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**Aim.** To determine the consequences of the cyclic development in the agrarian sector and evaluate the shifts in the structure and the performance of plant production branches due to the course of the transformational and agrarian crises and inter-crisis periods, to disclose the specificities of anti-crisis regulation in the agrarian sector in the postwar time. **Methods.** Common scientific methods were applied, including historical and logical, dialectic and systemic analysis, theoretical generalization, analysis and synthesis, variation dynamics, comparison, grouping, indexing, and table methods. **Results.** The cyclic character of the development in the agrarian sector and its impact on plant production were studied, and the results demonstrated that agrarian crises are an imminent stage of this process, and their “trough” is a starting point to launch a new cycle. It was found that the prolonged nature of agrarian crises inhibited the restoration cycle so much that the temporal breaks with the cycles of previous periods decreased considerably, and the periods of their complete revolution shortened due to which the scientists distinguish just two phases of crises now instead of traditional four phases: recession and uprising. It was determined that during the transition to new forms of management, there was an obvious destruction of the material resources of plant production with the refusal to keep to the crop rotation order. Still, the redistribution of the land and their division into shares stimulated the organization of modern agrarian enterprises yet delayed the agrarian and land reforms considerably. Due to this factor and other reasons, agricultural plant production at the “trough” of the transformational crisis decreased twice. The analysis demonstrated that the restoration of plant production occurred 12 years after the institutional crisis, followed by its registered rise until the moment of the Russian aggression – up to 156 %, and the development of the industry was closely related to the cyclic character of the functioning in the agrarian sector in general. Due to military actions, the manufacture of plant products has been dropping rapidly for the past two years. It was found that the results of the basic year were achieved differently in terms of different crops: the results for grains, grain legumes, and technical crops were achieved only in 2008; for vegetables and potatoes – in 2000, the yield of sunflower constantly increased, even despite agrarian crises; the performance of sugar beet decreased more than four times in 2021; the results for fruit and berries did not match those of 1990. The main directions of restoring the agrarian resource potential and renewing the manufacture of plant products in the postwar period were suggested. **Conclusions.** Modern processes of agricultural production are subject to the cyclic character of development, the trends of which are clearly copied in the plant production development. It was proven that agriculture reached the level of 1990 by the production volumes only in 2019, and the specificity of its development lies in the fact that after a short descending trend, there was a transition to the ascending trend, improving the situation considerably, but it was often broken by the lower part (“trough”) of agrarian crises and local drops (every other year). It was found that the restoration of plant production after a deep institutional crisis was registered in 2011, and in the subsequent years, there was a clear copying of the tendencies in the development of agrarian crises, but in terms of different crops, the rises from the “trough” of the transformational crisis took place in different time periods. The evaluations confirm that in plant production, the “trough” of each subsequent agrarian crisis was higher than that of the previous one, but it was followed by the ascending trend of the

production, the exception being the peak of 2021, followed by the dramatic drop, caused by the Russian aggression. It was empirically proven that the cyclicity in the manifestation of the agrarian crises is characterized by the following time periods: from 1990 to 1999 – 10 years, from 2000 to 2010 – 10 years, and there were two crises, five years long each, during the subsequent 10-year-long period. It was rationalized that the main factors of shorter time periods in the crisis manifestation are as follows: global climate change, smart technologies, and a failure to comply with scientifically grounded requirements of crop rotations, which conditioned the domination of export-oriented crops in the structure of areas under crop, etc. The priorities of the postwar restoration of the plant production industry were substantiated; among these, the time-urgent investment into the de-mining processes in agricultural fields and the quality restoration of the latter was highlighted, including the distribution of sustainable production practices, the introduction of moisture- and resource-efficient technologies, precision agriculture, smart-technologies, the measures aimed at minimizing the losses of agricultural products in the process of producing, storing the products and managing food wastes. There is a need to establish a system of reacting to the manifestations of crisis phenomena, which should be based on analytical evaluations and scientifically grounded predicted scenarios.

**Key words:** production index, production dynamics, plant production, cyclic development, agrarian crises, military operations, postwar period.

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## INTRODUCTION

In current conditions of enhanced turbulence in the environment, extreme variability in internal economic processes, and change in natural climatic conditions in Ukraine's territory, there is a permanent transformation in the structure of agrarian production. At the same time, the cyclic development of the economic production is a cause of crisis phenomena which finds its logical completion in the evolution of different crises: economic, structural, food-related, financial, migrational, ecologic, investing, agrarian ones, etc. The reasons for their occurrence are obviously related to unexposed and apparent conflicts, disproportions, and asymmetry in the development of productive forces as well as loss of balance and incoordination of industrial relations, etc. It is known that crises do not occur all of a sudden – they develop evolutionarily within the time framework of the particular economic cycle and deform the current structure of production and its supply of resources, which, in the end, leads to the destruction of either economic system in general or its specific elements.

The cyclic nature of economic development allowed the scientists to isolate several types of economic cycles by the criterion of duration and amplitude of fluctuations as follows: the short-run cycles of J. Kitchin (named after their researcher) – 2–4 years (related to the restoration of economic balance on the consumption market) (Kitchin, 1923), medium cycles of K. Juglar – 7–12 years (related to the change in the proposition of production means, caused by a considerable vivacity of innovational restoration of the main capital) (Juglar, 1862), longer cycles of S. Kuznets – 18–25 years (related to technological progress which causes the transi-

tion to new technological orders) (Kuznets, 1925), long cycles of M. Kondratiev – 50–60 years (related to the activation of innovational activity) (Kondratiev, 1935), and also extralong cycles of J. Forrester – 200 years (related to the discovery of new sources of material and energy resources) (Forrester, 1971), and hyperlong cycles of OI. Toffler – 1000–2000 years (related to the development of civilizations) (Toffler, 1980).

As for the economic crisis, in the opinion of many well-known scientists, its indicator in modern conditions is a decrease in the gross domestic product (GDP) for six consecutive months. There is no single indicator for the occurrence, duration, and ending of agrarian crises. Still, one of the main factors is distinguished in each specific case, for instance, a reduction in agricultural production, a decrease in performance and economic efficiency of using the agrarian natural and resource potential, harvest failure, and the signs of population starvation, harvest destruction due to natural disasters or military operations, etc. (Shust O.A. et al., 2022). At the same time, a well-known agrarian economist S. Petrukha stated the following criterial features of the agrarian crisis: a more extended break between the potential and actual volume of the gross added value of the agrosector; an impairment to its balance, caused by either external or internal factors of the sectoral and general decline in agricultural production volumes and food processing industry against the background of internal demand for food products; deterioration of the quality of agricultural lands; more significant deficiency of qualified manpower and investment resources; greater negative impact of the ecologic situation on economic conditions; a decline in infrastruc-

ture and extension of depressive rural areas (Petrukha et al, 2020). The abovementioned stipulates the conclusion about a possible situational approach while isolating the features of agrarian crisis for a specific time period and territory.

Agrarian crises are also notable for their cyclic nature; most of them occur after financial and economic crises, i.e. with some delay, with the consideration of seasonal natural and climatic specificities of certain territories and the time period of the economic cyclicality. One may assume that agrarian crises, notable for a prolonged run, affect the restoration cycle, deepening or expanding cyclic crises (Shyian, 2013). It can be explained by the fact that as compared with the cycles of previous periods, the time breaks between crises decrease considerably along with the shortening of the periods of complete revolution of economic cycles proper so much that instead of traditional four phases (crisis, depression, pickup, raising), only two are mostly used now: recession and raising (uprising) (Reviakin, 2020). The breaking point in the economy development process occurs when positive dynamics of economic development is replaced by negative dynamics, i.e. the ascending trend in the bifurcation point (change of the steady state of the system work) breaks and becomes a descending trend. The quantitative indices of development decrease and, after reaching the trough of the economic cycle, they serve as a starting point for the new cycle, i.e. symbolize the occurrence of the new bifurcation point. The recurrence of ascending and descending trends forms the wave-like mechanism of the cyclic development of the economy.

During the years of Ukraine's independence, there were several agrarian crises, but the most inconsistent, damaging, and long-term one with its destructive consequences was the systemic institutional crisis, with the agrarian crisis as its integral constituent. It was accompanied by institutional transformations and structural deformation of the agrarian sector, therefore scientists often call it a transformational crisis. The reasons for the occurrence and progress of the transformational and subsequent agrarian crises were inherited from the former Soviet Union: a systemic crisis of the agrosector, a prolonged period of its entry into actual market relations, and a fragmentary and inefficient nature of agrarian and land reforms which were slowly implemented. Thus, the specificities of the cyclicality manifestation are related not only to the length (duration) of the cycle but also to the industry branch (Shyian, 2013). Due to the abovementioned, the transition from the administrative team-oriented to the market system

of management was sporadic, without permanent scientifically grounded support for the changes, with considerable delays in the implementation of the very first steps of dividing land into shares and privatization of the material and technical resources. The indices of efficient functioning of the agrarian sector in 1990, the last year of the centrally planned economy, were the highest, thus, they are usually accepted as 100 % for comparison purposes. Further on, practically all the 1990s were notable for the decline in agrarian production, which was gradually restored only at the onset of the new century. However, the restoration of agriculture and food industry was accompanied by further transformation of their inner structure and quantitative-qualitative transformations. In this respect, it is reasonable to agree with the opinion about clarifying the notion of "agrarian crisis" as an impairment of the balance in the social-economic structure of agrarian sector of economy, conditioned by the transition to the new model of agrarian production, aimed at the intensification of food production and implementation of the Millennium Development Goals/Sustainable Development Goals (MDG/SDG) (Petrukha, 2017).

Therefore, it is reasonable to consider what an agrarian system (sector) covers and how much the agrarian crisis fits into the cyclic character of economic development. It relates to the fact that "naturally recurring crises are an indispensable phase of the cyclic development of any socio-economic system and agriculture in particular, which is at the same time a dominant element of the systems of the processing link in the chain of agricultural products and agricultural engineering, allows to form the agricultural sector as a socio-economic system, which should be understood as a set of resources, economic entities, forms of realization of their economic relations that ensure the production and processing of agricultural products, bringing it to the consumer, thus creating metabolism both in the agrosystem in general and in its specific spheres" (Petrukha, 2017). Thus, the role of cyclicality in these extremely complicated and contradictory transformations can be objectively evaluated and comprehensively disclosed only on the condition of the complex analysis of the agrarian sector structure and the dynamics of its quantitative and qualitative changes and transformations. At the same time, the nature of the agrarian crisis is closely related to the dynamics in the indices of the development of agriculture branches, including plant production and animal breeding, the manifestation of crisis features in which conditions the imbalance in the agrofood system.

## THE ANALYSIS OF RECENT STUDIES AND PUBLICATIONS.

Under high variability and ambiguity, the issue of the manifestation of agrarian crises is a separate direction of scientific studies and the elaboration of instruments for their research and monitoring in conditions of periodic imbalance in the agrofood system and its specific subsystems. These and other problems were dedicated a wide spectrum of scientific studies, the results of which were followed by complex investigations. It should be noted that during the period of Ukraine's independence, there were actually four crises, and the Russian aggression pushed the agrarian sector to the state of the early 2010s in terms of production decline, so there is a need for a deeper analysis of quantitative and qualitative changes in its structure, in plant production and animal breeding, first and foremost, and in crisis years and intercrisis periods, to find the points of postcrisis raising.

Crisis phenomena in the field of crop production are caused by numerous factors in the environment of agricultural producers, noteworthy among them being global climate change, the destruction and losses in the industry because of military operations, insufficient activity of enterprise management in the implementation of moisture and resource-saving technologies of agricultural production, etc. According to the FAO experts, the development of agriculture in the entire world is impacted by numerous dangers and threats, including floods, water deficiency, drought, decline in crop performance, loss of biological diversity, and deterioration of environment (FAO, 2023). These conditions will obviously trigger a higher incidence of crisis manifestations in agriculture branches in the absence of efficient instruments of minimization and neutralization of their negative effect on quantitative and impactful indices of development.

The war in this country will obviously enhance crisis phenomena in agriculture since agricultural producers have introduced changes to their production programs due to the limited use of fertilizers, pesticides, and seeds and have diversified their business (FAO, 2023). At the same time, agricultural producers have been suffering considerable losses due to the war which, according to preliminary evaluations of the experts, already amounted to USD 3,85 billion for the first year of the war, including USD 2.71 billion in plant production, and USD 1.13 billion in animal breeding-, or about USD 147 thousand per one enterprise on average without the consideration of temporarily occupied territories (FAO, 2023).

The generalization of scientific literature demonstrated that the notion of “a crisis” is multifaceted; it indicates the presence of imbalances in the development of any economic system. The term “a crisis” usually refers to an unpredicted and indefinite situation with the domination of sharp fluctuations in quantitative and qualitative indices in the development of a single person, a household, an economic unit, an industry, economy as a whole or an international community. Foreign researchers usually refer to a crisis as a check of the system stability (Ley et al, 2014; Maes et al, 2010; Comfort et al, 2001; Chernobrov, 2016).

According to another approach, the notion of a crisis is related to situations that are under serious threat, are notable for a high level of ambiguity, and get manifested in specific time periods (Rosenthal, 1997). There is also an interesting opinion, stating that a crisis is an unforeseen event that may have negative consequences (Okumus, 2005). Thus, crisis situations are a consequence of the impact of unforeseen events that cause an impairment of balance in any economic system and are accompanied by tangible loss, which leads to a new cycle of its development.

**The aim of the study** is to determine the consequences of impairing the equilibrium in the structure of the agricultural sector of the economy as a result of the emergence and course of agricultural crises and the transition to a new model of agricultural production and their impact on changing the structure and performance of the plant production industry and to substantiate measures and practical actions aimed at increasing agrofood production and achieving a balanced socio-ecological and economic development of the sectoral structure and the agrofood system.

## METHODS OF STUDIES

A number of general scientific and specialized methods of scientific research were used in the study (Silva, 2022; Pandey et al, 2021; Svytnous et al, 2023; Martyniuk, 2018). In particular, such standard scientific methods as dialectic and systemic analysis and theoretic generalization were used along with the special methods: the method of dynamic rows – to analyze the variability of the production index and the performance of agrarian sector, including plant production industry; analysis and synthesis – to study, summarize, and systematize isolated positive changes and immediate negative consequences, related to the primary production, including plant production, through the peaks of agrarian crises and intercrisis periods, to identify the problems, which occurred due to the aggression from

the Russian Federation; economic-statistical methods (grouping, comparison, indexing, tabular methods) – to process statistics data, visualize it and describe the phenomena and processes under investigation; variation dynamics – to determine the scale, periods, and variations in the fluctuation of the indices of gross agricultural output, including plant production in the recent decade; theoretical generalization – to systematize the results of the studies and to prepare substantiated conclusions.

The algorithm for studying the impact of agrarian crises on structure transformation and performance in the plant production industry consists of the following stages:

Stage I envisages the analysis of the production index variability in the agrarian sector in 2009–2021, based on which the descending and ascending trends are determined along with the points of the minimal decrease (crisis trough) and maximal increase, which will help specify the period from the beginning to the end of the crisis clearly. The tempo of the change in the volumes of gross agricultural output, including plant production, in the corresponding year is evaluated against that of 1990, which is accepted as the basic one, as 100 %. It is noteworthy that in this study, 2021 was accepted as the final year, because the following year the Russian aggression started and conditioned a considerable decrease in the indicators due to which it will be impossible to detect the formed tendencies in the development of plant production and to come to substantiated conclusions.

Stage II envisages the determination of the impactful indices of agriculture development, which will help determine the impact of the crisis on the performance of the initial production.

Stage III envisages a complex study of changes in the structure and performance of plant production, conditioned by agrarian crises.

This informational component of the study was based on the data of the State Statistics Service of Ukraine for the corresponding years.

## RESULTS

It is known that over 5 % of the main production means, functioning in the domestic economy, are concentrated in the agrarian sector of Ukraine, and 10–12 % of capital investments are implemented therein. At present, it provides for about 10 % of gross domestic product (GDP) on average and about 40 % of export proceeds, and approximately every sixth em-

ployee is involved in primary production (agriculture, forestry, aquaculture) (Shust et al, 2023). It highlights the relevance of the agrarian sector to ensure the stability of the country's economic system, which requires the elaboration of functional instruments to overcome crisis phenomena, enhanced by the war in the country, in terms of restoring the industrial potential along with complying with the implementation of sustainable development principles in agriculture, food industry, and rural areas.

It should be noted that the complexity of the cyclic development in the agrarian sector is conditioned by the fact that, in addition to economic laws, according to which a complex of interrelated industries is functioning, it is affected by natural and climatic conditions of the specific region, the landscape of the specific area, higher turbulence of environment, and force majeure circumstances, including natural disasters, progressing climate change (rise in temperature), military operations on the territories with previous agricultural activity, etc.

An important indicator of transformational changes in the agrarian sector is found in critical quantitative and qualitative shifts in the ownership forms and in the structure of enterprises. For instance, in the early 1990s, there were over 12 thousand functioning enterprises (collective farms, state-run farms, inter-farm enterprises), and in 2002, there was the first publication of their structure in terms of organizational and legal forms of management (units), including commercial partnerships – 9,337, private enterprises – 4,116, production cooperatives – 2,111, farms – 42,774, state enterprises – 570, enterprises of other forms of management – 2,002, which makes up a total of 60,910 (State Statistics of Ukraine, 2008, p. 88), i.e. five times more. It demonstrated an actual transition to the model of private ownership and market forms of relations between economic entities.

However, the mentioned changes occurred under the decline of old forms of management and triggered the manifestation of *negative processes* of ruining the material and technical foundation of agricultural production, especially animal breeding farms, business parks of operating equipment and mechanisms, occurrence of uncultivated land plots, decreased introduction of mineral and organic fertilizers, mass-scale impairment of crop rotations and higher unemployment rate in rural areas, etc. The abovementioned triggered the drop in performance of almost all crops, and the impairment of the price parity between the industrial goods for the agrarian sector and the products manufactured by it,

which amounted almost five times, resulted in a two-fold production decline.

The combination of these and other drawbacks, mistakes, and troubles of the transformational period caused a great decline in agricultural production, for instance, in plant production – down to 53.1 % as compared to 1990. Actually, the trough of the agrarian crisis was noted in 1998–1999: gross agricultural output was 50.45 %, the production index of the food industry – 38.3 %, and their restoration started in 2000.

It was determined that the trough of the transformational crisis, and the agrarian one within the latter, was noted in 1999 (or wider, in 1998–2000) and the troughs of the following crises, considering the points of agricultural decline, as compared to the previous years and some delay in terms of the course of financial and economic crises, occurred in 2010, 2015, and 2020 (**Table 1**). The index of gross agricultural products in the crisis years was: 68.9 % (in plant production – 86.5 %), 88.2 % (121.0 %), 90.4 % (127.8 %).

It is noteworthy that the pre-crisis production volumes, i.e. those of 1990 (100 %) in the food industry occurred in 2005 (production index was 102.4 %), and in agriculture – in 2019 (gross production index was 100.6 %). At the same time, the pre-crisis volumes in the plant production industry were reached in 2011 (gross production index was 111.6%).

We believe that after the transformational crisis of the 1990s, the restoration of agriculture to the scales of the basic year went on for about 20 years (till 2019 inclusive), and during this period, three agrarian crises occurred, each of them being accompanied by the production decline. The presented data allow for a clear determination of the ascending trend, i.e. the restoration period for productive agricultural forces, and for a conclusion that each subsequent agrarian crisis was notable for a production decline on a higher level than the previous one, and the duration of their run shortened along with the gaps between them.

Since the catalyst of the last agrarian crisis had a non-economic source of origin (COVID-19 pandemic), some economic regularities were broken. The peaks of agrarian crises (i.e. troughs) were enhanced by the rise in prices for agrarian products; for instance, during two recent crisis years, the rise in the prices for agricultural products exceeded that for the last year more than one and a half times (166.0 % and 153.6 % as compared to the previous years, respectively, Table 1).

We believe that it was a rise in prices in 2015 that ensured a considerable increase in the quantitative values

of the main economic indices of agriculture, including the cost-effectiveness of the operational activity up to 43.0 %, the cost-effectiveness of the entire activity up to 30.4 %, the share of profitable enterprises up to 88.9 %, the income increased almost five times as compared to the previous year (UAH 101,8 billion and UAH 21,4 billion, respectively).

However, there was no positive effect on the values of the resulting indices of the development in the agrarian sector during the last crisis: the rate of the cost-effectiveness of the operational activity was 19.1 %, the cost-effectiveness of the entire activity was 14.0 %, and the share of profitable enterprises was 82.7 %. We believe this to be the effect of an artificially created crisis – due to the outbreak of the global COVID-19 pandemic. It may also be confirmed by a rapid increase in economic indices in 2021: the cost-effectiveness of the operational activity – 41.8 %, the cost-effectiveness of the entire activity – 37.8 %, the share of profitable enterprises up to 88.3 %, and the income increased by almost three times as compared to the previous year (UAH 237,6 billion in 2021, and UAH 81,5 billion in 2020).

It should be noted that even under the conditions of the war, the agriculture preserved its profitability in 2022, for instance, the cost-effectiveness of the operational activity was 20.3 %, and the cost-effectiveness of the entire activity – 13.6 %. In 2022, the share of profitable enterprises was 78.4 % or decreased only by 9.9 points as compared to the previous year (Lupenko, 2023).

Thus, the following regularity is noted: decreases (drops) and mini-declines in the output index occur but their magnitude (difference) is constantly growing. The decline index proper (the absolute difference between the indices of adjacent years) for the index of gross agricultural production is gradually increasing as compared to the pre-crisis year (by 1.1 % in 2010 as compared to 2009, respectively), by 4.4 % (2015 as compared to 2014), and by 10.2 % (2020 as compared to 2019). However, after the mini-decline (which took place after agrarian crises), there is an active increase in the production index – by 10.4 % (2013 as compared to 2012) and by 7.5 % (2018 as compared to 2017), amounting to 13.8 %. In our opinion, an insignificant increase in the index of animal breeding products is related to the fact that after the transformational decline, Ukraine's plant production managed to rise to the pre-crisis production volumes and even enlarge them 1.2–1.5 times.

**Table 1.** The dynamics of products and plant production effectiveness in Ukraine's agriculture in 2010-2021, gross products and production index in 1990 – 100 %

Indices	Years											
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
<i>Agriculture, hunting, and related services</i>												
Gross output, %	68.9	82.6	79.0	89.4	92.6	88.2	93.8	91.7	99.2	100.6	90.4	103.4
including plant production	85.6	111.6	102.6	120.9	127.6	121.0	133.0	129.0	142.8	145.4	127.8	156.6
Change in the tempo, as compared to the previous year, %	98.6	120.2	96.1	113.6	102.2	95.2	106.3	97.8	108.2	101.4	89.9	116.4
plant production	96.4	128.7	93.3	117.1	103.1	94.8	109.1	97.1	110.2	101.8	87.9	122.6
Cost-effectiveness of operational activity, %	24.4	24.7	22.8	11.7	21.4	43.0	33.6	23.2	18.9	19.8	19.1	41.8
Cost-effectiveness of the entire activity, %	17.4	19.3	16.3	8.3	9.2	30.4	25.6	16.5	14.2	16.6	14.0	37.8
Share of profitable enterprises, %	69.6	83.5	76.8	80.3	84.9	88.9	88.4	86.7	86.7	83.4	82.7	88.3
Index of prices for the sale of agricultural products (against the previous period of the year), %	n/s	n/s	n/s	91.3	145.1	166.0	107.6	111.8	104.4	86.6	153.6	116.7
Amount of profit, million, UAH	17,238	25,253	26,718	14,811	21,391	101,854	89,799	68,240	70,420	92,840	81,465	237,606

Note. Source: composed using the data of the State Statistics Service of Ukraine for the corresponding years.

Thus, one may state that after the insignificant descending trend, there is a transition to the ascending trend, which improves the situation considerably. In our opinion, it is explained by the general (global) ascending trend which has gone on since the early 2000s and lasted till reaching the value of the gross agricultural index at the level of the basic year.

Land resources are the main production means in plant production. The changes in their quantity in the crisis and ascending/descending years in terms of their being used in agriculture, comparing them to the basic year as the foundation, and the shifts in their structure or their utilization in terms of the main crops in 1990–2021 are presented in **Table 2**.

The presented statistical data can be used to characterize the dynamics of the changes in the structure of the area under crop and the lands used to cultivate 24–26 crops.

The entire structure of Ukraine's area under crop is divided into four groups: grains and grain legumes; technical crops; potatoes, vegetables and cucurbits; and forage crops. Prior to the analysis of each group, let us specify that the total area under crop decreased by 1/6: from 32.4 million ha in 1990 to 26.9 million ha in 2015, and then expanded to almost 28.6 million ha. The shifts in land utilization, triggered by different circumstances, occurred along with the structural transformation of land utilization with the purpose of cultivating different crops. Regardless of a total decrease in agricultural land by almost 12 %, the area under grains and grain legumes expanded by 9.7 % (up to 16 million ha) in the period under investigation. On the one hand, it occurred due to the 2.15-fold expansion of area under winter barley (up to 1,139 thousand ha) and the 4.5-fold expansion of that under grain corn (up to 5,522 thousand ha), and on the other hand, a reduction in the area under winter wheat by 8.7 % (down to 6.9 million ha), a reduction of area under spring barley by almost 40 % (down to 1,337 thousand ha), the 5-fold reduction of area under peas (down to 243 thousand ha), the 4-fold reduction of the area under buckwheat (down to 90 thousand ha), the 3-fold reduction of the area under winter rye (down to 171 thousand ha) and almost 3-fold reduction of the area under oats (down to 178 thousand ha). As a result, there was a *structural transformation of land utilization* due to the reduction of the areas under low-profit crops and the expansion of fields under high-margin crops, mainly used for export, including wheat, corn, and barley. Thus, the area under the abovementioned crops expanded by almost 30 % in 31 years – up to 14.9 million ha.

Similar but more considerable changes occurred in the *structure of technical crops*. The total area under them increased 2.5 times – up to 9,244 thousand ha, and it also occurred due to contradictory changes, including the almost 6-fold reduction in the area under traditional crops – down to 305 thousand ha (the 7-fold reduction for industrial sugar beet – down to 227 thousand ha, the 2-fold reduction for linen flax – down to 78 thousand ha). This fact can be explained by the decline of these industries: sugar beet cultivation and flax-processing industry. On the other hand, there was an almost 5-fold expansion of the area under oil crops – up to 8,939 thousand ha, including the 4-fold expansion for sunflower – up to 6.6 million ha, the almost 11-fold expansion for soybeans – up to 1 million ha, and more than 14-fold expansion for rape – up to 1.3 million ha. These great changes took place because Ukraine has taken the first or second place in the world in the production of plant oil, the prices for which rose considerably, and it ensures the replenishment of the state's currency resources.

Some changes took place in the structure of the plant group of *potatoes, vegetables, and cucurbits*. For instance, the area under these crops decreased by 1/8 – down to 1.8 million ha, including the area under potatoes, which decreased by 1/10 – down to 1.3 million ha, the open area under vegetables remained stable – over 450 thousand ha, and the area under other vegetables and cucurbits decreased 2.7 times – down to 70 thousand ha. The insignificant changes are explained by the fact that the products are mainly used to meet the needs of the local population and are only partially used by city residents.

At the same time, there were considerable shifts in the group of *forage crops*. The total area under the latter was reduced almost eight times – down to 1,535 thousand ha, including corn for silos and green fodder – almost 22 times, down to 214 thousand ha, annual grasses – almost by one order, down to 269 thousand ha, perennial grasses – almost five times, down to 819 thousand ha, fodder roots – 3.5 times, down to 177 thousand ha, other forage crops – three times, down to 56 thousand ha. It is explained by the considerable decrease in the number of livestock.

Against the background of structural transformation of plant production, noteworthy are the changes in the dynamics of crop production (**Table 3**).

The data, presented in Table 2, demonstrated considerable shifts in the structure of plant products, especially in the dynamics. Let us indicate that the output of



**Table 2.** Structure and dynamics of area under crops, thousand, ha

Crops	1990: note	1998	1999: trough	2000: peak	2009	2010: trough	2011: peak	2014	2015: trough	2016: peak	2019	2020: trough	2021: peak	1999 in % till: 1990	2020 in % till 1999	2020 in % till 1999
Total area under crop	32,406	28,780	28,313	27,173	27,133	26,592	27,670	27,239	26,902	27,026	28,001	28,147	28,581	87.4	99.4	99.4
Grains and grain legumes	14,583	13,718	13,154	13,646	15,837	15,090	15,724	14,801	14,739	14,401	15,318	15,392	15,995	90.2	117.0	117.0
– winter grains	8,614	6,501	6,705	6,324	8,308	7,904	7,987	7,174	7,904	7,178	7,836	7,600	8,226	77.8	113.3	113.3
wheat	7,568	5,543	5,766	5,316	6,518	6,137	6,499	5,898	6,696	6,028	6,650	6,429	6,908	76.2	111.5	111.5
rye	518	736	638	668	468	286	263	185	150	144	115	137	171	123.2	21.5	21.5
barley	528	222	300	340	1,322	1,481	1,205	1,091	1,058	1,006	1,058	1,025	1,139	56.8	341.7	341.7
– spring grains	5,969	7,217	6,449	7,322	7,529	7,186	7,737	7,627	6,835	7,223	7,482	7,792	7,769	108.0	120.8	120.8
wheat	9	250	281	303	334	314	282	163	171	190	167	167	188	3,122	59.4	59.4
barley	2,201	3,677	3,318	3,645	3,800	3,024	2,582	1,950	1,768	1,861	1,555	1,370	1,337	150.7	41.3	41.3
oats	492	614	575	521	433	326	288	247	213	209	183	200	178	116.9	34.8	34.8
grain corn	1,234	1,030	793	1,364	2,149	2,709	3,620	4,691	4,123	4,286	5,005	5,432	5,522	64.3	685.0	685.0
millet	205	368	337	437	119	95	169	103	112	109	92	159	83	164.4	47.2	47.2
buckwheat	350	586	573	574	273	225	311	140	133	154	69	84	90	163.7	14.7	14.7
rice	28	22	22	26	25	29	30	10	12	12	11	11	10	78.6	50.0	50.0
grain legumes	1,424	631	514	408	371	429	374	227	250	324	348	315	314	36.1	58.7	58.7
peas among them	1,287	522	407	307	286	305	275	154	170	240	254	239	243	31.6	58.7	58.7
vetch and vetch mixtures	79	60	61	54	28	32	22	12	14	13	65	63	55	77.2	103.3	103.3
Technical	3,751	3,770	4,340	4,187	6,545	7,296	7,441	8,437	8,350	8,852	9,130	9,224	9,244	115.7	212.5	212.5
sugar beet	1,607	1,017	1,022	856	322	501	532	331	237	292	222	220	227	63.6	21.5	21.5
sunflower	1,636	2,531	2,889	2,943	4,232	4,572	4,739	5,257	5,105	6,073	5,928	6,457	6,622	176.6	223.5	223.5
soy	93	34	49	65	644	1,076	1,134	882	2,158	1,869	1,609	1,351	1,006	52.7	2,757	2,757
rape	90	96	270	214	1,060	907	870	1,806	682	455	1,282	1,127	1,311	300.0	417.4	417.4
linen flax	172	31	27	23	2	1	2	2	2	2	89	69	78	15.7	255.6	255.6
Potatoes, vegetables and cucurbits	2,073	2,066	2,166	2,277	1,950	1,967	2,028	1,900	1,823	1,841	1,828	1,854	1,807	104.5	85.6	85.6
potatoes	1,429	1,513	1,552	1,629	1,409	1,408	1,439	1,348	1,291	1,312	1,309	1,325	1,283	108.6	85.4	85.4
field vegetables	456	459	497	538	451	462	498	463	440	442	446	457	454	109.0	92.0	92.0
other vegetables and cucurbits	188	94	117	110	90	97	91	85	92	87	72	73	70	62.2	62.4	62.4
Forage crops	11,999	9,236	8,653	7,063	2,658	2,599	2,477	2,101	1,990	1,932	1,725	1,677	1,535	72.1	19.4	19.4

Continuation of Table 1

Crops	1990: note	1998	1999: trough	2000: peak	2009	2010: trough	2011: peak	2014	2015: trough	2016: peak	2019	2020: trough	2021: peak	1999 in % till: 1990	2020 in % till 1999	2020 in % till 1999
root vegetables	624	394	2393	285	247	244	236	216	213	211	192	191	177	63.0	48.6	48.6
corn for grain and green fodder	4,637	2,849	2,799	1,920	485	473	445	346	309	284	243	262	214	60.4	9.4	9.4
annual grasses	2,583	2,176	2,087	1,765	585	583	531	408	393	374	312	302	269	80.8	14.5	14.5
perennial grasses	3,986	3,752	3,320	2,985	1,289	1,238	1,252	1,119	1,027	995	921	869	819	83.3	26.2	26.2
other fodder crops	169	65	54	108	120	61	13	12	48	68	57	53	56	32.0	98.1	98.1
Area of black fallow	1,427	3,022	2,990	3,213	1,523	1,465	1,211	830	n/s	n/s	n/s	n/s	n/s	209.5	n/s	n/s
<i>Note: gross plant production (1990 for 100 %)</i>																
%	100.0	59.4	53.1	65.5	92.5	88.2	111.6	127.6	121.0	133.0	145.4	127.8	156.6	-46.9	74.7	28.8

Note. Source: composed and estimated according to the data of the State Statistics Service of Ukraine for the corresponding years.

plant production on the trough of the transformational crisis was only 53.1 %, that of the first agrarian crisis – 88.2 %, the second agrarian crisis – 121.0 %, the third agrarian crisis – 127.8 %, on the rise in 2021 – 156.6%. The renaissance of plant production occurred only 21 years after the basic 1990 – in 2011, it was 116.1 %. The presented data demonstrated that in plant production, the trough of each subsequent agrarian crisis was higher than that of the previous one, but it was followed by the ascending trend of the production output. However, the rise of 2021 was followed by a dramatic drop, triggered by the unprovoked Russian aggression. It caused considerable ruination of the resource potential of the agrarian sector and a decrease in the index of agricultural products down to 77 % (State Statistics Service, 2023).

Six summarized indices of agricultural crop output, presented in Table 2, demonstrate that the consequences of the transformational decline were overcome only by four crops, except for sunflower, and fruit and berries failed to overcome it after almost 4-fold decrease – the production index in 2021 was only 77.0 % (2,235 thousand tons). There was a simultaneous drop in the production of industrial sugar beet – more than 4-fold, down to 10.8 million tons.

There were considerable positive changes in the structure of grains and grain legumes: after a two-fold reduction in their production on the trough of the transformational crisis, there was a gradual restoration. It was manifested especially in 2021: the volume of grain intake of the new harvest increased almost 1.7 times (up to 86 million tons), and it provided for a considerable increase in its export. For instance, at the end of the period under investigation, almost 50.8 million tons of grains were exported (0.8 % less than in the previous year – almost 51.2 million tons), and USD 12,342 million were obtained in currency (31.3 % more than in the previous year – USD 9,400.5 million). The main components of the grain export were corn – 24,675.9 thousand tons, wheat – 20,071.3 thousand tons, barley – 5,656.3 thousand tons (Prabhat et al, 2015). It was 99.3 % of all grains.

The most considerable success was registered in the sector of sunflower cultivation: the volume of its harvest increased 6.3 times – up to 16.4 million tons, i.e. a quarter more than in the previous year. This made it possible to take the global leading positions in the export of plant oils: in 2021, 5,090.0 thousand tons of sunflower oil were sold abroad for the amount of USD 6,334.4 million. Although in 2020, the export of

oil increased by one-third (6,795.4 thousand tons), the income in currency was 20 % smaller – USD 5,271.3 million (Prabhat et al, 2015). In this situation, the decisive part was played by the increase in prices by almost 161.4 % as compared to the previous year (State Statistics of Ukraine, 2022).

After the reduction in potato production by almost one quarter on the trough of the transformational crisis, there was a rapid restoration in 2000, with some fluctuations in the subsequent years. As of the end of the investigated period, the harvest of potatoes increased by more than one quarter as compared to the basic year – up to almost 21.4 million tons. It demonstrates that a share of potatoes, which is subject to industrial processing, increased considerably.

After a reduction in the production of vegetables by 30 % at the peak of the transformational crisis down to 5.5 million tons, the restoration of the harvest volumes occurred at the rise of the first agrarian crisis in 2011 with the 1.5-fold increase. Later, there was an insignificant fluctuation within the mentioned volume – in 2021, it was over 9.9 million tons (149 % as compared to the basic year). This powerful rise in the production of vegetables demonstrates that a considerable part of these products is subject to industrial processing.

The dynamics of performance of the main crops in the investigated period of 1990–2021 is of particular interest (**Table 4**).

The data presented in Table 4 demonstrate that practically all the main crops underwent the pathway of a

**Table 3.** Structure and dynamics of crop production, thousand, tons

Crops	1990: note	1998	1999: trough	2000: peak	2009	2010: trough	2011: peak
Grains and grain legumes	51,000.9	26,470.7	24,580.6	24,459.0	46,028.3	39,270.9	56,746.8
Industrial sugar beet	44,264.5	15,522.6	14,063.8	13,198.8	10,067.5	13,749.2	18,740.5
Sunflower	2,570.8	2,266.3	2,794.4	3,457.4	6,364.9	6,771.5	8,670.5
Potatoes	16,732.4	15,405.2	12,722.8	19,838.1	19,666.1	18,704.8	24,247.7
Vegetables	6,666.4	5,492.2	5,323.9	5,821.3	8,341.0	8,122.4	9,832.9
Fruit and berries	2,901.7	1,178.0	766.0	1,452.6	1,618.1	1,746.5	1,896.3
<i>Note: gross plant production</i>							
%	100.0	59.4	53.1	65.5	92.5	88.2	111.6

Note. Source: composed and estimated according to the data of the State Statistics Service of Ukraine for the corresponding

**Table 4.** Performance of crops at farms of all categories, centner per 1 ha of the harvested fields

Crops	1990: note	1998	1999: trough	2000: peak	2009	2010: trough	2011: peak
Grains and grain legumes	35.1	20.8	19.7	19.4	29.8	26.9	37.0
Industrial sugar beet	275.7	173.8	156.3	176.7	314.9	279.5	363.3
Sunflower	15.8	9.3	10.0	12.2	15.2	15.0	18.4
Potatoes	116.8	101.8	82.0	121.6	139.3	132.5	168.0
Vegetables	149.0	123.2	110.6	112.3	182.8	173.6	195.0
Fruit and berries	42.7	28.6	19.2	38.4	70.7	78.2	84.9
<i>Note: gross plant production</i>							
%	100.0	59.4	53.1	65.5	92.5	88.2	111.6

Note. Source: composed and estimated according to the data of the State Statistics Service of Ukraine for the corresponding y

considerable decrease in their harvest at the peak of the transformational crisis and its gradual increase in the subsequent years. During the transformation years, the performance of crops decreased by 20–40 and even 60 %. For instance, the performance of grains and grain legumes dropped from 35.1 to 19.7 centner/ha, industrial sugar beet – from 275.7 to 156.3 centner/ha, sunflower – from 15.8 to 10.0 centner/ha, potatoes – from 116.8 to 82.0 centner/ha, vegetables – from 149.0 to 110.6 centner/ha, fruit and berries – from 42.7 to 19.2 centner/ha. It happened due to the transformation in the organization structure of agriculture, i.e. the transition from the “collective farm – state-run farm” system to the market system, the ruination of old production forms, and a gradual establishment of new ones. It impaired the crop rotations and consecution in crop cultivation, the number of independent households in-

creased several times, and a considerable drop in the number of livestock was accompanied by a significant reduction in the volumes of introduced organic fertilizers. There was an increase in performance in the subsequent years, namely, grains and grain legumes – up to 53.9 centner/ha in 2021 (273.6 % to 1999 and 153.5 % to 1990), industrial sugar beet – up to 479.1 centner/ha (306.5/173.8 %), sunflower – up to 24.6 centner/ha (246.0/155.7 %), potatoes – up to 166.4 centner/ha (202.9/142.4 %), vegetables – up to 215.4 centner/ha (194.7/144.5 %), fruit and berries – up to 117.3 centner/ha (610.9/274.7 %). Considering some reduction in the area of the utilized land in the investigated period, the gain in the plant production output took place due to the increase in performance which should be deemed a positive moment in the plant production development.

2014	2015: trough	2016: peak	2019	2020: trough	2021: peak	1999 in % till 1990	2020 in % till 1999	2021 in % till 202
63,859.3	60,125.8	66,088.0	75,143.2	64,933.4	86,010.4	48.2	264.2	132.4
15,734.1	10,330.8	14,011.3	10,204.5	9,150.2	10,853.8	31.8	65.1	118.6
10,133.8	11,181.1	13,626.9	15,254.1	13,110.4	16,392.4	108.7	469.1	125.0
23,693.4	20,839.3	21,750.3	20,269.2	20,838.0	21,356.3	76.0	163.8	102.5
9,637.5	9,214.0	9,414.5	9,687.6	9,652.8	9,935.2	79.9	181.3	102.9
1,999.1	2,152.8	2,007.3	2,118.9	2,023.9	2,235.1	26.4	264.2	110.4

(1990 for 100 %)

127.6	121.0	133.0	145.4	127.8	156.6	-46.9	74.7	28.8
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years.

2014	2015: trough	2016: peak	2019	2020: trough	2021: peak	1999 in % till 1990	2020 in % till 1999	2021 in % till 202
43.7	41.1	46.1	49.1	42.5	53.9	56.1	215.7	126.8
476.5	435.8	481.5	461.1	416.2	479.1	56.7	266.3	115.1
19.4	21.6	22.4	25.6	20.2	24.6	63.3	202.0	121.8
176.4	161.4	165.8	154.8	157.2	166.4	70.2	191.7	105.8
207.8	206.1	210.5	214.0	207.4	215.4	74.2	187.5	103.9
95.2	104.9	101.9	108.1	105.6	117.3	45.0	550.0	111.1

(1990 for 100 %)

127.6	121.0	133.0	145.4	127.8	156.6	-46.9	74.7	28.8
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years.

**Table 5.** Grouping of agricultural enterprises by the size of area under crops

	2011: peak		2015: trough		2015 in % till 2011
	Enterprises				
	units	%	units	%	%
Enterprises with the area under crop – total of these, had area, ha	44,919	100.0	42,224	100.0	94.0
till 50.00	24,464	54.5	22,238	52.6	90.9
50.01–100	4,236	9.4	4,461	10.6	105.3
100.01–250.00	4,582	10.2	4,286	10.3	93.5
250.01–500.00	3,199	7.1	3,165	7.5	98.9
500.01–1000.00	2,901	6.5	2,836	6.7	97.7
1,000.01–2,000.00	2,777	6.2	2,704	6.4	97.4
2,000.01–3,000.00	1,322	2.9	1,149	2.7	86.9
over 3,000.00	1,438	3.2	1,345	3.2	93.5

Note. Source: composed and estimated according to the data of the State Statistics Service of Ukraine for the corresponding years

It is important to identify the changes in the number of agricultural enterprises in terms of the size of the area under crop during the period from the ascending to the descending trend in the development of plant production. For this reason, it is reasonable to investigate the number of agricultural enterprises by the size of the area under crop in the year, when the ascension started, and in the year, when the trough was reached, which would provide for the conclusion on the changes among agricultural producers. We chose 2011–2015 for our analysis, and made an assumption that the detected tendency had a similar manifestation in the cycles of agrarian crises (**Table 5**).

The data, presented in Table 5, demonstrate that during the investigated period the number of agricultural enterprises with areas under crop decreased almost by 2.7 thousand units, or 6 % enterprises, including large ones (by 173 units) with the area of 2–3 thousand ha (by 13.1 %). In addition, there was a considerable increase in the number (by 2.3 thousand units), and a relative share (by 5.3 %) of small business structures with the area of 50–100 ha, and the rest of enterprise groups had insignificant changes. Thus, during the “raising-trough” periods, there was a decrease in the group of the smallest structures with the area of up to 50 ha, but there was a considerable increase in small farms with the area of 50–100 ha. Actually, there was consolidation of used land plots in the groups of enterprises with the area of 100–2,000 ha, but the number

of larger ones decreased. It allows for the conclusion about the highest vulnerability of the smallest agricultural producers to the crisis which should be taken into consideration while forming the instruments of state support for small economic entities to minimize and mitigate the negative impact of crisis phenomena in the plant production industry.

## DISCUSSION

The results of the study demonstrate the key researchers’ priorities in the issues of agrarian crises in national economies, the incidence of which is manifested in shorter time periods and impacted by numerous global challenges, including climate change, digitalization, etc. The results of our study correlate with the conclusions made by domestic researchers (Petrukha et al, 2022; Balian et al, 2019; Shust et al, 2023), in the aspect of the manifestation of crisis phenomena, the methodological approaches to their study and duration, etc. It is evident that the changes in the characteristics of crises in the agrarian sector of the economy and the main industries of agriculture, including plant production, are caused by the turbulence in the world economy in two recent decades. It can be explained by the fact that plant production as an agrarian system is rather complex, since it covers environment, industrial production, auxiliary and maintenance structures, social sphere as a source of labour force, economic and financial fields of the society. Their extreme complex-

ity is conditioned by the combination of three radically different subsystems: natural and biological; industrial and implementational; and financial and banking (Varchenko, 2023; Calicioglu et al, 2019). The occurrence of destructive phenomena and processes, force majeure circumstances, violation of normative rules, requirements, and warnings, long delays in the implementation of technological processes and the course of industrial, trade, and banking operations may not only induce the expenses in the initial period, but also cause considerable losses and even bankruptcy of market operators on the final stages of the technological chain. The impossibility to forecast them is an indicator of permanent turbulence of complicated systems and a non-alternative requirement for economic entities – to always consider a high probability of possible chaotic changes in any link of the supply chain for plant production output.

The works of domestic and international researchers, dedicated to the issues of agrarian crises and problems of food supply, clearly define the factors which triggered them. For instance, one of these drivers was COVID-19, which created chaos in financial markets (Ezeaku et al, 2021; Tian, 2016; Rathod, 2022; Salisu, 2020) and is expected to have a negative impact on the global economy in the future. It should be noted that its negative impact on the agrofood sector can be traced and characterized by the change in prices: during the recession, caused by COVID-19, the prices for goods decreased at first, but due to quarantine measures, low efficiency of proposition management, the proposition was limited, and the excessive demand was created which triggered the boom of the goods market (Miklesh, 2023).

Further crisis phenomena in the development of the agrarian sphere, including plant production, were undoubtedly aggravated by the Russian invasion of our country. At present, this factor has the most serious effect on the possibilities of agricultural production and food manufacture as well as the possibilities of delivering the finished goods to the end consumers since our country is one of the largest exporters of agrofood to foreign markets. The war in Ukraine has a considerable impact on the aggravation of the crisis in the agrarian sector and its branches and will have a prolonged negative effect even when the war is over (Adekoya, 2022; Bereziuk et al; 2023; Vakulenko, 2022). It is proven by the fact that researchers conduct active studies of war consequences in our country and their impact on the macroeconomic indices and especially the possibilities of ensuring food safety of specific countries (Mhlanga

et al, 2023; Duho et al, 2022; Ali et al, 2023; Arnd et al, 2023).

If the factors, affecting the manifestation of crisis phenomena, are to be considered, first of all, one should take into account *the changes in temperature regimes*, which have the greatest effect on the impactful indices of the plant production industry. The results of the study on the manifestation of climate change in domestic conditions were proven by Ukrainian scientists (Balabukh et al, 2021; Balabukh, 2023), especially in terms of their impact on biological processes of development of specific crops and the formation of their performance are in clear agreement with our conclusions on the significance of this factor for crisis manifestation in plant production. We find similar thoughts in foreign studies, in which considerable attention is paid to high risks for plant production due to the manifestation of climate changes that prove the decrease in the performance of crops due to a reduction in precipitation and an increase in temperature, which demands flexible adaptation of the cultivation conditions to changes in order to at least maintain current performance indices, not considering the need to enhance them to the level, required by 2050 (Hochman et al, 2017; Mirón et al, 2023). It is obvious that an increase in the incidence of severe weather conditions (waves of hot weather, pouring rains, droughts, etc.) may have a negative impact on the magnitude of crop performance and the production volume for food products that is confirmed by numerous study results (Yılmaz et al, 2023; Semeraro, 2023).

We believe that the stability of the development of agriculture and its branches, as well as the reduction in crisis duration, is affected by innovation technologies and the elaboration of resistant species of crops, pesticides, herbicides, and, in current conditions, the digitalization instruments (Schwab et al, 2018; Goel et al, 2021). For instance, Agriculture 4.0, the fourth design of agrotechnologies, envisages the creation of *climate-resistant agriculture*, which would ensure long-term stable performance of plant production based on rational management of technological processes and nutrients with the purpose of promoting the increase in organic carbon and the growth of plants in soil and minimization of exhausts in the production processes (Prause, 2021; Navulur et al, 2017). Both domestic and foreign researchers state that this is a novel way of enlarging the volumes and quality of agricultural products via the economy of such resources as labour, seeds, fertilizers, and water (Navulur, 2017; Lins et al, 2020; Manushkina et al, 2020; Kucher et al, 2014). Obviously, the strategic development of plant production

in the period of postwar rebuilding will be oriented on the implementation of smart technologies, which reduce dependence on non-renewable or ecologically harmful resources and are based on *ecoagriculture*, *permaculture*, *low expenses*, *resource- and moisture-efficient* technologies (El Bilali et al, 2018; Quintero-Angel et al, 2018; Schnebelin et al, 2021).

A relevant direction in crisis mitigation is the reduction of expenses during the collection and storing of the harvest, especially perishable products, as well as the promotion of best practices for sustainable food consumption (Shipman et al, 2021; Fabi et al, 2021). On the other hand, under conditions of the increase in temperature regimes, the output of plant production requires the creation of irrigation possibilities, since global warming will trigger a shortening of the harvest season, photosynthesis change, and active spreading of diseases and pests. In addition, there are changes in nutrients – from organic to inorganic ones, and there is an impact on the efficiency of the use of fertilizers which enhances soil evaporation that results in the exhaustion of natural resources. So, the orientation of domestic agroproducers on the principles of climate-efficient agriculture (Levkovska et al, 2021; Ivaniuta et al, 2020) will provide for the effective distribution of industrial resources, reduction of industrial expenses, and an increase in crop performance.

## CONCLUSIONS

It was found that the output of agricultural production is subject to cyclic development of the agrarian sector, including plant production, and its greatest decline was noted in the crisis years of 1999, 2010, 2015, and 2020. Agriculture managed to reach the level of the basic 1990 only in 2019 (the production index was 100.6 %). The restoration of productive forces in agriculture occurred after the trough of the decline, but there was a local decline prior to reaching the peaks of these ascending trends, which was followed by greater progress. Thus, a short descending trend is followed by the transition to the ascending one that improves the situation considerably, which is explained by the “run” of a more powerful global ascending trend due to a positive impact of the innovation factor that promotes a considerable increase in the performance of crops.

In its turn, the global ascending trend of agricultural production, the starting point of which is the trough of the transformational crisis of 1999 (the production indices were 48.7 % in agriculture, 53.1 % in plant production), and the peak of 2021 (the correspond-

ing production indices were 103.4 and 156.6 %), was broken many times by both the lower part (trough) of agrarian crises and local (every other year) declines. At the same time, the sharp drop of 2022 did not result from the cyclic development of agrarian sector; on the contrary – its origin was absolutely artificial: it was a consequence of unprovoked full-scale russian aggression.

We believe that the dramatic drop in 2022 is not a result of the cyclic development of the agrarian sector, on the contrary, it has an absolutely artificial origin: it is a consequence of unprovoked full-scale russian aggression.

The restoration of plant production after a deep institutional crisis was registered in 2011 (as compared to the basic year, the production index was 111.6 %), and in the subsequent years, there was clear copying of tendencies in the development of agrarian crises as follows: a starting point – the trough of the agrarian crisis, a rise, a local decline, a rise to reach the peak of the trend, and another decline to the trough of the next agrarian crisis, etc. Several crops overcame the trough of the transformational crisis in different time periods. For instance, the results of the basic year in terms of grains, grain legumes, and technical crops were reached only in 2008, and those of vegetables and potatoes – in 2000. At the same time, the harvest of sunflower seeds increased constantly regardless of the agrarian crises, but the collected harvest of industrial sugar beet decreased more than four times in 2021. During the entire period after the transformational crisis, the harvests of fruit and berries did not reach the level of the basic year.

Agrarian crises are a part of the economic cycle. Their foundation lies in the technological transformation of agriculture as well as modern tendencies of agrofood market globalization, climate changes, national specificities of natural and geographic specialization and technological modernization, the efficiency of state support instruments, and management of economic entities in terms of flexible minimization and neutralization of the risks for agrofood production. It is clear that the restoration of agrarian sector will become possible in the post-war period after the actual powerful expansion of humanitarian mine-clearing of polluted territories, filling the notion of “restoration of agrarian resource potential” with modern inner sense in the liberated regions, modernization of the material and technical basis of plant production in the regions, not covered by military operations. The solution to the

mentioned tasks requires the accumulation of financial resources from different sources. Still, the key role will be played by the sanctioned active capital of the Russian Federation, both private and state.

In addition, a relevant task is the creation of a system of responding to the crisis, which should be based on reliable data, modern digital instruments, analytic reviews and evaluations, and forecast scenarios developed by domestic research organizations and networks, as well as foreign ones, including FAO, the International Food Policy Research Institute (IFPRI) and Science for Humanity's Greatest Challenges (CGIAR). We believe that this approach will help create transparent conditions for foreign investors, state institutions, and management of agricultural enterprises regarding investments, the substantiation of preventive measures and actions to overcome crisis phenomena, and flexible adjustment thereto.

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#### Сучасні тренди розвитку рослинництва в умовах аграрних криз

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**Мета.** Виявити наслідки циклічного розвитку аграрного сектора й оцінити зрушення в структурі та результативність галузей рослинництва внаслідок перебігу трансформаційної й аграрних криз і міжкризових періодів, розкрити особливості антикризового регулювання в аграрному секторі у повоєнний час. **Методи.** Застосовано загальнонаукові методи, зокрема, історико-

логічний, діалектичного й системного аналізу, теоретичного узагальнення, аналізу й синтезу, а також варіативної динаміки, порівняння, групування, індексний, табличний. **Результати.** Досліджено циклічний характер розвитку аграрного сектора та його вплив на рослинництво, на основі чого встановлено, що аграрні кризи є неодмінним етапом цього процесу, а їх «дно» є відправною точкою для започаткування нового циклу. Встановлено, що затяжний характер аграрних криз гальмує відтворювальний цикл настільки, що часові розриви з циклами попередніх періодів помітно зменшилися та скоротилися періоди їх повного кругообігу унаслідок чого замість традиційних чотирьох фаз криз нині оперують лише двома: рецесія та піднесення. Виявлено, що при переході до нових форм господарювання було відчутно зруйновано матеріальну базу рослинництва, відмовились від дотримання порядку сівозмін, однак переділ і розпаювання земель стимулювали організацію сучасних аграрних підприємств, але надзвичайно затягнули аграрну та земельну реформи. Внаслідок цього й інших причин виробництво продукції рослинництва на «дні» трансформаційної кризи зменшилося вдвічі. Проаналізовано та виявлено, що відновлення рослинництва відбулося за 12 років після інституційної кризи, а в подальшому зафіксовано його піднесення до моменту російської агресії – до 156 %, а розвиток галузі чітко пов'язаний із циклічним характером функціонування аграрного сектора загалом. Унаслідок військових дій обвальний спад виробництва продукції рослинництва продовжується другий рік поспіль. Установлено, що досягнення результатів базового року було відмінним у розрізі сільськогосподарських культур: по зернових і зернобобових та технічних культурах відбулося лише у 2008 р.; овочевих і картоплі – у 2000 р.; соняшнику – збори насіння постійно зростали, навіть незважаючи на аграрні кризи; цукрові буряки – урожайність зменшилася у 2021 р. більш як учетверо; плодкових і ягідних культурах – не досягнуто показників 1990 року. Запропоновано основні напрями відродження аграрного ресурсного потенціалу та відновлення виробництва рослинницької продукції у післявоєнний період. **Висновки.** Сучасні процеси виробництва аграрної продукції підпорядковуються циклічному характеру розвитку, тренди якого чітко копіюються у розвитку рослинництва. Доведено, що сільське господарство досягло рівня 1990 р. за обсягами виробництва продукції лише у 2019 р., а особливостями його розвитку є те, що після короткого низхідного тренду відбувається перехід на висхідний, який суттєво покращує ситуацію, однак неодноразово розривався як нижньою частиною («дном») аграрних криз, так і локальними (через рік) спадами. Виявлено, що відновлення рослинництва після глибокої інституційної кризи було зафіксовано у 2011 р., а у наступні роки спостерігалось чітке копіювання тенденцій розвитку аграрних криз, однак у розрізі різ-



них сільськогосподарських культур подолання «дна» трансформаційної кризи відбувалося у різних часових періодах. Розрахунки підтверджують, що у рослинництві «дно» кожної чергової аграрної кризи перебуває вище, ніж попередньої, але за цим слідує висхідний тренд виробництва продукції, винятком є підйом 2021 р. після якого має місце обвальний спад, зумовлений російської агресією. Емпірично доведено, що циклічність прояву аграрних криз характеризується такими часовими періодами: починаючи з 1990 р. по 1999 р. – 10 років, з 2000 по 2010 р. – 10 років, а впродовж наступного 10 річного періоду відбулися дві кризи тривалістю 5 років кожна. Аргументовано, що основними чинниками скорочення часових періодів прояву кризи є: глобальні кліматичні зміни, смарттехнології, недотримання науково обґрунтованих вимог сівозмін, що зумовило домінування експорторієнтованих культур у структурі посівних площ, тощо. Обґрунтовано пріоритети повоєнного відновлення галузі рослинництва, серед яких виділено першочергове інвестування процесів розмінування сільськогосподарських угідь та їх якісного відновлення, що включає в себе поширення практик сталого ведення виробництва, впровадження волого- та ресурсоощадних технологій, точного землеробства, smart-технологій, запровадження заходів щодо мінімізації втрат рослинницької продукції у процесі виробництва та зберігання продовольчих відходів. Існує необхідність побудови системи реагування на прояви кризових явищ, яка повинна базуватися на аналітичних оцінках і прогнозних науково обґрунтованих сценаріях.

**Ключові слова:** індекс продукції, динаміка виробництва, рослинництво, циклічний розвиток, аграрні кризи, військові дії, повоєнний період.

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