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Chapter 1

THE DEVELOPMENT AND CURRENT STATE OF THE AGRICULTURAL SECTOR OF THE NATIONAL ECONOMY DUE TO THE MORE ACTIVE ACCESS TO THE GLOBAL FOOD MARKET

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ABSTRACT

The impact of global and local forces on the change in pricing policy in the food market depends on the production of agricultural crops in major producing regions that have a direct access to the world market. The latest predictions show that in the period until 2050 there will be a need to increase agricultural production by 60% worldwide, in order to meet the increasing demand from a growing population. The countries of the former Soviet Union – Kazakhstan, Russia and Ukraine in particular, have the greatest potential to increase food supply and food security in the world. Therefore, a study of the historical development of the

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agricultural sector, the current state of agricultural policy and assessment of the export potential of the countries of the former Soviet Union is very important. The paper examines the main geographical patterns of change in land productivity over the past 100 years of the development of agriculture in the south of Ukraine. It determines the spatial and temporal trends of changes in the conditions of the climate system and their impact on the dynamics of bio-productivity in the last century. The paper also considers historical and contemporary global trends in the formation of the grain market, and identifies the role and place of Ukraine in it.

Keywords: international trade, export, grain market, agricultural products, climatic change, soil fertility

1. INTRODUCTION

Influence of global and local forces upon price policy on food sale market depends on production of crops in the main agricultural regions (Davenport et al., 2016); besides, trade of wheat, maize and soy is one the most stable estimation indices of state export potential on international future markets (Jia et al., 2016). Stimulus of regional integration of stock exchange market and stock return pricing all over the world are determinants being subdivided into three categories: individual market performance, macroeconomic conditions, and agricultural trade (Valdes et al., 2016). In big countries functioning of export control and price policy formation is determined by large exporters having a direct world market entry up to 67%. This effect is transferred inside the country to other regions through interregional trade flows. In small countries regional differences of internal effects of price measures are insignificant (Götz et al., 2016). Therefore, it has been offered, first of all, to differentiate nonfunctioning links of agricultural market and links properly adjusted to unfavorable conditions in developing and emerging countries that may ensure an increased stability to external changes of price policy and growth of food security (Brosig et al., 2016). Earlier (Schindler et al., 2016) it has been emphasized that provision of stability of consequences of agriculture development measures being planned, so called upgrading strategies (UPS), for the purpose of rise in national food security can be achieved due to an approach that simultaneously considers social, economic and environmental problems. From standpoint of efficient solutions of complicated internal optimization problems, the agricultural supply chains may finally impact food security. To this end, the Canadian wheat handling system is a complex export oriented supply chain that is currently undergoing extensive changes with respect to quality control. Developing analytic and simulation models of this supply chain with the ultimate goal of identifying effective wheat quality testing strategies in a complex operational and regulatory environment (Ge et al., 2015). Y. Zhu considered interaction mechanism of international trade and food security in different aspects, on example of China, the framework of The Food and Agriculture Organization of the United Nations and represented domestic and policy implications in the context of WTO (Zhu, 2016). Owing to this H. Cai and Y. Song suggested to apply innovative network theories to study positions of countries in international agricultural trade and simulation of probable consequences after break of bilateral agricultural raw material trade relations (Cai &Song, 2016). For contribution to the promotion of sustainable rural development throughout the EU community new European Agricultural Fund for Rural Development (EAFRD) was purposely established. Stability of the multiregional model EAFRD permits to examine trade relations within the framework of entire EU regions, as well as EU relations with other world regions. Besides, the model permits to determine losses or revenues of a large range of effects. On the other hand, this framework allows a simultaneous consideration of socioeconomic and environmental fund effects to identify their causes and flows and to clarify and reallocate benefits and responsibilities across levels and regions (Monsalve et al., 2016).

In 21st century the world demand for agricultural products is going to rise, recent forecasts show a need to increase agricultural production globally by 60% from 2005 to 2050, in order to meet a rising demand from a growing population. It requires scientific grounding of drivers for increase of foodstuffs production with simultaneous keeping social and environmental balance in use of water and land resources, preservation of biological diversity and satisfaction of population needs for foodstuffs. Production rise in agriculture significantly depends on strengthening of existing agricultural systems (Levers et al., 2016) against situational forecasting of world economy using the model Global Trade Analysis Project (GTAP) for the purpose of simulation of a move to global free trade (the maximum benefit from a multilateral trade reform) with endogenous and counterfactual modes of farmers' aid policy in economic development of states (Anderson et al., 2016). To meet growing demand for agricultural foodstuffs and ecosystem service further expansion of plough-lands can't be avoided. Estimation of compromises between social and ecological consequences and advantages of transformation of available land reserve into cultivated lands are crucial. In the former Soviet Union countries (in European Russia, western Siberia, Ukraine and Kazakhstan), where the transition from state-command to market-driven economies resulted in widespread agricultural land abandonment, cropland expansion may incur relatively low costs, especially compared with tropical regions. Restoration of potentially available cropland in such regions may make a serious contribution to world cereals production with relatively low compromises with environment compared to the tropics, but it mustn't be a panacea for solution of global food security problems or reduction of pressure of land tenure on tropical ecosystems (Meyfroic et al., 2016). It's considered that main former members of Soviet Union, in particular, Kazakhstan, Russia and Ukraine (KRU-region) have the highest potential for increase of food supplies and food security strengthening in the world (Schmitz et al., 2015) and recently are becoming of key importance in establishment of world agricultural market (Liefert et al., 2010). It's confirmed by restriction of grain export (bans, quotas, taxes) for KRU-region on both national and international levels, which resulted into a significant rise of prices on the world market. Influence of climate on production and risks of demonstrations of lean years for cereals also predetermine price policy inside countries of export and on the world market (Dronin et al., 2011). Repetition of scenario of temporary export restriction from KRU-region may seriously worsen the situation on the grain world markets in future, especially with unfavorable consequences for grain net importing countries. At the same time, results show that for a country like Ukraine, i.e., a country usually exporting large shares of its total grain production, the introduction of export restrictions could potentially result in decreases of domestic consumer prices to a level even below a situation with normal weather conditions (Fellmann et al., 2014). Interference of export and import on formation of price policy for agricultural products in Ukraine is shown in the work (Ivaniuk, 2014). T. Melnyk and O. Golovachova made a complex analysis of regulations of foreign trade in agriculture and integration of state-of-the-art experience of governmental support to increase management efficiency of agricultural production (Melnyk &Golovachova et al., 2015). Detailed examination of dynamics of agricultural price and trade interventions in Bulgaria, Poland, Romania, Russia, and Ukraine was examined in works (Agricultural support…, 2000; Pall et al., 2013; et al.).

Continuing climate fluctuation results into increasing uncertainties in yield for main consumer agricultural products. Authors (Bren D'Amour et al., 2016) find that the Middle East is most sensitive to connected supply shocks in wheat, Central America to supply shocks in maize, and Western Africa to supply shocks in rice. Weighing with poverty levels, Sub-Saharan Africa is most affected. Altogether, a simultaneous 10% reduction in exports of wheat, rice, and maize would reduce caloric intake of 55 million people living in poverty by about 5%. Export bans in major producing regions would put up to 200 million people below the poverty line at risk, 90% of which live in Sub-Saharan Africa. Results suggest that a region-specific combination of national increases in agricultural productivity and diversification of trade partners and diets can effectively decrease future food security risks. For this reason, season climate forecasts are becoming the most important element in some decision making policy systems, particularly, in the context of adaptation to climate fluctuation, first of all, for agriculture (Troccoli, 2010). Results of climate forecasting, which are used in development of different adaptation variants in agriculture, should have an opportunity to influence decisions taken by interested parties so that to improve agricultural production results and to increase competitive positions on the world market. Agriculture adaptation variants can be developed with the help of forecasts of climate genetic properties on a number of time scales, from several days up to several decades against five headings: relevance, reliability, stakeholder engagement, holism and accuracy (Challinor, 2009). At present problems of climate fluctuation, possibility to develop situational models of forecasting climatic conditions are disclosed in a great deal of works, including possibility to improve quality of Gaussian models of forecasting various scenarios of cyclic climate fluctuation (Gershgorin et al., 2012), use of physics ensemble approach for regional climate forecasting (Liang et al., 2012), the possibility of using normalized difference vegetation index (NDVI), which is based on satellite data, using effective climatic signals and artificial neural network (ANN)for agricultural drought forecasting based (Marj et al., 2011), use of models of multivariate linear regression (MLR) or a standard linear state-space (LSS) approach for short-term temporary forecasting of seasonal fluctuations of temperature and precipitations (Kokic et al., 2010) etc. All over the world a lot of attention is paid to prediction of yield of agricultural crops, for this purpose many different methodological approaches based upon neural networks were developed, including for crop yield estimation from normalized difference vegetation index image time series (Bose et al., 2016), prediction of yield of agricultural crops depending on climate and soil variables (De Paepe et al., 2016), for space clustering and temporary prediction of wheat yield (Bijanzadeh et al., 2016; Pantazi et al., 2016), prediction of barley yield against total of 10563 data from 17 features (Mokarram et al., 2016), use of Water production functions (WPFs) for space-time modeling of yield from irrigation that are useful tools for control of irrigation and economic analysis of yield decrease because of deficit of irrigation (Haghverdi et al., 2016) etc.

Water resources availability has a significant impact on agricultural land-use planning, especially in a water shortage area. The random nature of available water resources and other uncertainties in an agricultural system present risk for land-use planning and may lead to undesirable decisions or potential economic loss. Owing to this an inexact risk management model (IRM) was developed for supporting agricultural land-use planning and risk analysis under water shortage. The model ensures possibility to take decisions on risks minimization and assistance in search of the economically efficient strategy of agricultural land-use planning with complicated uncertainties (Li et al., 2016). Nevertheless, understanding of determination of space regularities of agricultural intensity and changes in them is restricted. In modern conditions sub-national variation of levels of agricultural intensity of cultivation of different groups of crops to a great extent depends on quality and potential of land fertility and less on labor productivity. So the challenge for policy formation on future land use is how to move from an unmanaged combination scenario towards a managed combination scenario, in which the soil functions are purposefully managed to meet current and future agronomic and environmental targets, through a targeted combination of intensification, expansion and land drainage. (Valujeva et al., 2016). Such purposeful space-time management requires grounding of particular efficiency conditions for land and water use by optimization of land fund structure proceeding from basin, position-dynamic and adaptive-landscape principles (Lisetskii et al., 2014, 2015; Pichura, 2015).

2. Major Geographical Regularities of Land Productivity Changes over the Past 100 Years of Agricultural Development in Southern Ukraine

Objective difficulties in integration partial soil fertility indices for estimation of soil quality (SQ) determine a permanent interest to use of comparable fertility of agricultural crops, which collectively reflects efficient fertility of soils. An approach based upon comparative analysis of variation of dynamic yield rows of this crop depending on regional peculiarities of the territory, in fact is indicative A. A. Zhuchenko (Zhuchenko, 1990, p. 280) named it the summative agroecological regional assignment.

Idea of territorial differences in natural capacity of soils in Northern Black Sea region started forming in 19th century in the course of accumulation of data of agricultural crops yield within steady administrative and economic units (district country cottages and volosts, i.e., districts).

To estimate soil fertility for the last 100 years' materials of the end of 19th century in the part of Black Sea region, where Kherson province was located, were used as comparative basis. This is the territory in – between the Dnieper and Dniester Rivers within the limits of southern part of forest-steppe, steppe and dry steppe landscape zones. The territory had an access to the Black Sea through ports Odessa, Nikolaev, Kherson. The steppes on Earth cover more than 6% of the land area and are one of the main biomes, accumulating energy resources in humus-rich Chernozems, which ruthless exploitation leads to a widespread degradation (Lisetskii et al., 2016). Kherson province was created in 1803 and its territory was being separated into counties up to 1835. As a result of military survey of 1850-1852 Kherson province comprised of six counties (Ananiev, Tiraspol, Odessa, Yelisavetgrad, Alexandria, Kherson) and covered land fund area of 7.19 mln. ha (for reference – this is larger than area of Ireland) which at that time was ploughed up by 45.4%. By the late 19th century due to ploughing up in Kherson province pastures area reduced from 80 (in the beginning of the century) to 20% (Lisetskii et al., 2010). According to our estimations presently (i.e., after 130 years of development) pastures area within comparable limits is 68.3%.

Peculiarity of nature of land regions having high soil fertility and profitability of pastures reflects results of agricultural activity analysis for 1900-1908, which was mapped in the work (Shif, 1925, p.25). Map "Estimation of level of soils effective fertility" based upon data of average many-years (1953-1962) cereals yield (ignoring expenses) holds an intermediate position among estimation maps of the end of 19th century and the last third of 20th century (Kuz'michov, 1970).

Appraisal of Ukrainian soils in 1970-1980th was made proceeding from many-years data of yield of agricultural crops and in 1993-1995by natural peculiarities of soils (content of humus and physical clay in ploughing horizon, depth of humus horizon, depth of location of gleyic horizon, agrophysical condition index). Nevertheless, obtained estimations of soils did not always meet their actual productivity level.

In statistical and economic reviews district country cottages or their groups were used territorial units. It shall be noted that on the contrary from many posterior administrative territorial unit's advantages of district country cottages in geographical analysis was their relative uniformity by natural conditions and comparable area (about 33,000 ha). By land tenure private landowner lands prevailed: in 1896 they made up 61.2% of the province land fund as peasant holdings covered only 38.8% (Statistical and economic review…, 1897). In Kherson province the majority of peasants (former state-owned serfs) received on average from 7.3 up to 10.6 ha of land each and landowners-owned peasants – 3.7 ha each.

In every land tenure (256 territorial units in total) yield rows of spring wheat in private landowners' lands for 1892-1900 had been registered (Materials…, 1902). Selection of spring wheat yield registration on private landowners' lands permits to reduce impact of land tenure area on its productivity. In sowing structure of the province spring wheat prevailed: in 1892-1902 it covered 40% of area with variations in counties from 35 up to 43%. Alongside with spring wheat high sensitivity to soil fertility factors this circumstance determines possibility of reflection of almost undistorted influence of natural conditions with insignificant effect of manmade means of plant cultivation intensification. Analysis of yield row showed that 1892, 1899, 1900 could be regarded as lean years, as territorial differences in productivity were characterized by the largest variability (variation coefficient reached up to 43-94%). The remaining five years were characterized by more favorable conditions by production process, at that they showed themselves as three- and two-years periods (1893-1895, 1897-1898). Herewith average yield in 256 land tenures in the most favorable year did not exceed 12c/ha.

Territories within the limits of former Kherson province conform to 50 administrative regions of Odessa, Kirovograd, Nikolaev, Kherson and Dnepropetrovsk regions. For analysis 15-years-long yield rows of spring wheat from 1971 until 1986 in section of selected districts were used. In these years share of spring wheat in sown areas structure increased up to 50%. Variation coefficient of yield data reflecting variability of space non-uniformity varies within 11-20%. Whereas by many-years data of experimental stations variation coefficient of spring wheat yield in regions with precipitations lower than 500 mm per year is within 21-39%.

Agroclimatic conditions of two mentioned chronological intervals can be compared by data of instrument observations. Materials from meteorological station in Odessa showed that in the period from 1894 until 1900 the average temperature rise was 0.1°C compared to the previous (1882-1893) cycle of the same century (with average temperature 9.5°C) and by moistening conditions the period of 1884-1899 was characterized by average annual amount of precipitations – 394 mm. Period from 1971 until 1986 was characterized by higher moistening (precipitations amount increased up to 448 mm per year, but average annual temperature increased up to 10°C). Available estimations of reaction of cereals productivity (Kotljakov, Glazovskij, Nikolaeva, 1992) show that climatic fluctuations of such amplitude do not exceed the level of significant yield variations (±10% from average many-years one). It promotes more unambiguous interpretation of space regularities in distribution of soil fertility.

For relative estimation of lands productivity for *i*-th land tenure we used productivity index (I_i) showing the share of yield range averaged for period m and realized in particular years:

$$I_i = \frac{1}{m}\sum_{j=1}^{m}\frac{X_{ij} - X_{\min j}}{X_{\max j} - X_{\min j}}, \qquad (1)$$

where X_{ij} – is yield in the territory of *i*-th land tenure in *j*-th year; $X_{\max j}$, $X_{\min j}$ – are maximum and minimum yield of *j*-th year respectively. Formula (1) is one methods of standardization of characteristic that is widespread in statistics, has already been used in appraisal of soils (Saharov, Hamzin, 1965) and is preferred due to possibility of content-related interpretation of resulting standardized values.

Distribution of productivity index (in more convenient expression–$I_i \cdot 10^3$) over the territory allows to express space regularities of variation of efficient yield level. Analysis of paired correlation coefficients between space yield rows of spring wheat showed that space regularities in yield distribution were becoming most stable in dry years (1892, 1896, 1899, except for 1890) and years with average yield (1894 and 1897). With introduction of the threshold value of correlation coefficient – 0.53 the group of years (1893, 1895, 1897, 1898) was distinguished, when with sufficient precipitations amount effect of edaphic environmental factors on lands fertility was being revealed more actively; it results into absence of conjunctions between space yield rows. Using correlation – independent fruitful years the productivity indices were calculated, geographical regularities in distribution of which clearly reflected differences in efficient fertility level acquired for 100-130 years and in particular districts–for even longer period of land tenure of Black Sea region area (Figure 1). Twenty-versts – and an-inch map of Kherson province (1:840 000) of late 19th century with indication of county cottages and volosts was base material (Materials…, 1902). It's expedient to compare the map "Average many-years profitability of field land of 1900-1908" (Shif, 1925, p.

25), which was mapped against data of land lease prices at the beginning of 20 c., with these results.

For analysis of productivity agro-landscapes in second half of 19th century in precious data were found in records of annual yields of southern Russian German colonists. According to data published at the end of 19th century (Postnikov, 1891) materials for two adjacent volosts of Berdiansk country of Tavria province were used. Nowadays this territory conforms to Tokmak and Chernigov districts of Zaporozhye region, Ukraine. In respect of physics and geography this is Priazov lowland with 400-450 mm rainfall per year and dominating conventional minor humus-poor Chernozems and partially southern humus-poor forester Chernozems. At the end of 19th century in land tenure history of this territory there was a remarkable period of 1870-1879, when many sowings turned out to be on new lands – firstly ploughed virgin soil-due to lands active ploughing up. It permits to estimate losses of efficient fertility in extensive agriculture with minimum fertilization of fields (Table 1). Productivity of old-arable lands summarized by four kinds of cereals was lower than of the firstly ploughed lands by average yields by 19% and by maximum ones – by 21%. Sensitivity of particular agricultural crops to high exhaustion of soil fertility is shown the following row: barley >winter rye = spring wheat > oats. In 10 years after ploughing up virgin soil decrease in productivity by average and maximum yields was 6-7% only.

Consequently, in extensive agriculture average annual reduction rate of soil fertility is estimated to be 0.6-0.7%. Therefore, at the beginning of 20th century old-arable lands reclaimed at the beginning of 18th century and earlier could have reached its critical exhaustion level of soil fertility resources.

Apart from biological removal and yield, water soil erosion was a significant factor of soils degradation. If in these bioclimatic conditions soil formation rate is estimated to be 1-2 t/ha per year (Lisetskii, Stolba & Goleusov, 2016), after ploughing lands on slopes annual erosion losses increased from 0.45 up to 8 t/ha. With acceleration of soil degradation processes, climate fluctuation and under influence of socio-economic reasons it has become clear just recently that land tenure and water use problems shall be settled (Lisetskii et al., 2014) and ways for their settlement shall be offered (Yermolaev et al., 2015).

Earlier (Tjutjunnik, Korotkova, Nadol'naja, 1988) it was noted that particular physical and geographical regularities were reflected in distribution of spring wheat yield over regions and its time variability. With a favorable combination of meteorological factors, they are significantly leveled off. With an unfavorable combination of agroclimatic conditions the pattern of productivity space distribution is especially informative for non-correlated years, when soil fertility is shown most clearly. Proceeding from correlation table 1972, 1976, 1983, 1985, 1986 years turned out to be independent with average yield 24.9 (19.7÷27.9) c/ha that is by 15% less than average yield for the last decade.

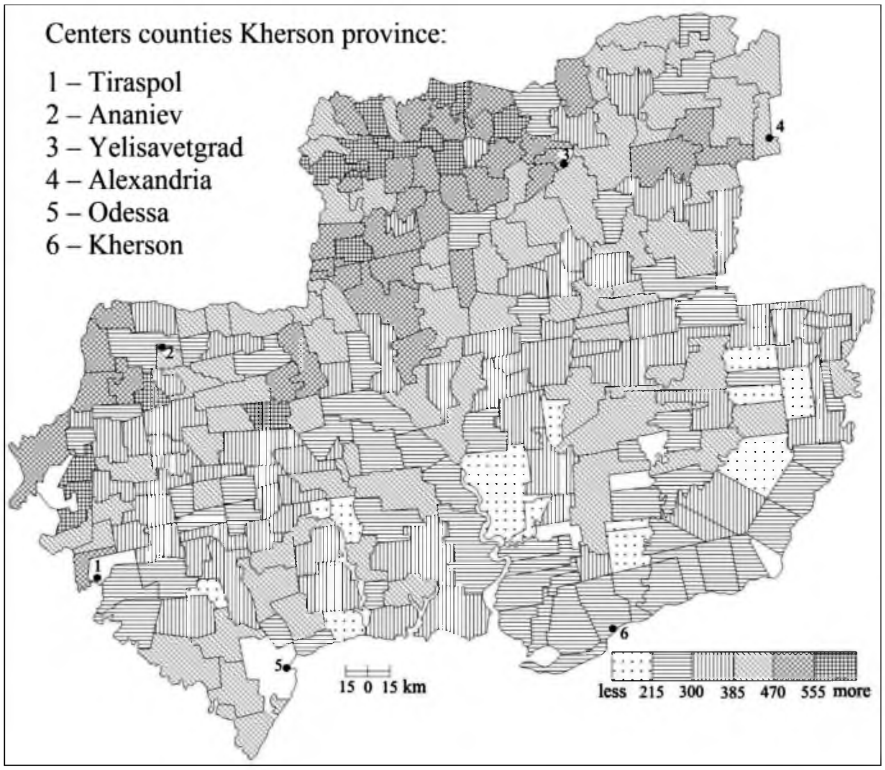


Figure 1. Estimation of efficient soil fertility level at the beginning of 20th century in Black Sea region (by spring wheat productivity index – $I_i \cdot 10^3$).

Paradoxical ness of the result consisting in non-correlativity of space yield rows favorable for fertility of years at the end of 19th century and unfavorable at the end of 20th century, in our opinion, can be explained as follows. At the beginning of agricultural period the territory under consideration was characterized by large zonal differences of potential fertility. For example, in the map of isohumic belts of south-western Russia (Nabokih, 1911, p. 119) humus content in soils from the south to the north was increasing from 2 up to 10%, but presently the range of conforming soils reduced from 2 down to 6%.

Initial genetic differences of ploughing horizon were substantially leveled off under the influence of general zonal soil degradation processes, on the one had, and under the influence of manmade factors of land tenure intensification (treatment, fertility etc.), on the other hand. Therefore, at current stage of land tenure the previously existing large differences in potential fertility are displayed less clearly in years with favorable agroclimatic criteria. Besides, much more powerful root age of winter wheat compared to spring one in years with favorable climate can use fertility resources, moisture content of ploughing and lower horizons (up to 50-60% of necessity in soil moisture is to be filled up from the second and third meter layers) more efficiently.

Comparison of space distribution of efficient fertility in three chronological sections (beginning, middle and end of 20th century) allows distinguishing the following main peculiarities. Permanently highest productivity level in Black Sea region is marked at the boundary of forest-steppe and steppe areas, where at the beginning of the century typical and conventional Chernozems contained 7-10% of humus.

In distribution of soil fertility natural zonal-provincial regularities are most objectively displayed in estimation of lands according to data of 19th century. To the south from the isoline restricting soils with humus content less than 5% (Nabokih, 1911, p. 119), and approximately coinciding with the northern boundary of southern Chernozems, there are only around 10% of county cottages with productivity index exceeding the average level (above 385) – see Figure 1. Using generalized data from counties of Kherson province (The collection…, 1904) we calculated yield classes by three criteria: land productivity (yields of main cereals in 1892-1900), monetary price of land and rentals are an unambiguous evidence of excess of average province estimations (84-86 scores) in north-eastern part of the territory under consideration (Alexandria, Yelisavetgrad counties and northern part of Kherson province). Areas with the lowest values of productivity index (<215) are completely concentrated in the southern boundary of Steppe dry zone (under scheme of natural and agricultural regional assignment of Ukraine (1985)), i.e., within the limits of sub-zone of southern Chernozems. In general view this peculiarity is confirmed on the map of field land profitability (Shif, 1925). For 100 years of land tenure of southern Chernozems the most significant reduction of their productivity took place.

Table 1. Variation of productivity of argoecosystems in extensive agriculture (against records of annual yields of southern Russian German colonists in Berdiansk county (by: Postnikov, 1891)

Periods*	Years	Yields crops, c/ha							
		Winter rye		Spring wheat		Barley		Oats	
		average	maximum	average	maximum	average	maximum	average	maximum
I	1840-1869	6.0	16.8	5.4	12.9	9.2	22.1	6.1	16.2
II	1870-1879	7.3	21.6	6.0	18.9	10.8	24.4	8.9	20.3
III	1880-1889	7.0	22.7	5.3	16.5	10.8	22.1	8.1	18.2
Comparison of efficient fertility levels by periods									
I by II		82	78	90	68	85	91	69	80
III by II		96	105	88	87	100	91	91	90

* Periods: I – use of old-arable lands; II – ploughing up virgin soil; III – use of newly reclaimed lands.

At the end of 20th century high level of efficient productivity (I > 450) was typical for districts with irrigation amelioration (Ovidiopol, Beliaevka, Belozerka, Novovorontsovka), where 11-35% of arable lands were being irrigated at that time. If according to data of 1953-1962 lands of average quality (of yield class 59-66) were represented by the narrow band on the south of Black Sea region, irrigation development in 70th-80th changed regularities in efficient fertility distribution over the territory. Proceeding from the productivity index value the worst conditions for realization of potential fertility of soils were marked in districts of Odessa without irrigation (Velikomikhailovka, Razdelnaia, Ivanovka). Consequently, productivity of lands in south-western forest steppe and steppe of Black Sea region decreased most significantly.

Initial (before agricultural period) space in homogeneity of soil fertility conditioned by soil and geographical zoning determined naturally conditioned differentiation of soil fertility. As far as lands were being used for agricultural purpose and soil-degradation processes were being developed both leveling of differences in lands quality and fertility reduction at different rate depending on differences of primary fertility level took place. Complex comparable estimation of lands quality should become one of the most important improvement mechanisms in new economic conditions. It permits to assess added profit in agriculture arising in labor productivity with equivalent expenses on lands with highest fertility and to create an objective basis for establishment of the fair land tax.

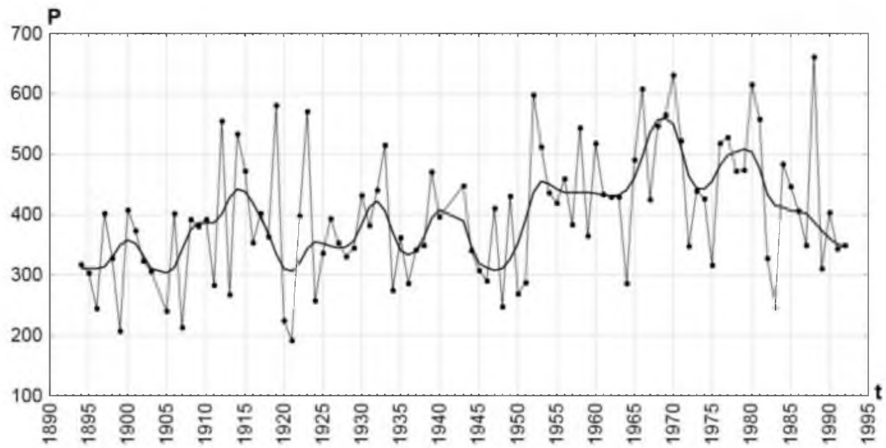
3. Trends of Variations of Moistening Conditions in Regional Climatic System for the Last Century

Rational use of land resources and introduction of adaptive agrotechnologies in terms of changing climate is a guarantee of high stable yields and provision of competitive position s of agricultural producers of regions of Eastern-European plain. For the last seventy years warming during 10 first months of the year in average by 2°C (from 10.4 up to 12.4°C), increase of precipitations amount by 90 mm (from 314 up to 404 mm) (Lisetskii, Pichura, 2016) is being observed.

In dry conditions of steppe zone a strong dependency of yield of agricultural crops from moistening conditions is observed. It's confirmed by facts known from sources of literature before the beginning of regular meteorological observations (from the end of 19th century). During 19th century droughts in southern Ukraine were registered in 1833, 1834, 1840, 1847, 1848, 1862, 1873, 1874, 1882, dust devils – in 1824,1848, 1876, 1885, 1886, 1891, 1892, 1898, 1899. At the end of 19th century, when reliable statistical data appeared, low yields were registered in 1880, 1885, 1886, 1889, 1891, 1892, 1896, 1899 and 1900. Average value of annual amounts of precipitations for the period of 1892-1900 made up 352 mm that was by 21.2% less than 447 mm (standard). In this period spring wheat yields of 5.0-5.8 c/ha were actually provided. Years with the most unfavorable climate in this period were actually 1894 and 1900 with precipitations amount 251.5 mm and 229.7 mm respectively. Decrease in annual amount of precipitations by 46 mm resulted into reduction of yield relative to average value for the period by 40-48% (by 1 c/ha).

When estimating influence of changes on conditions of lands productivity potential using data of three basic meteorological stations (MS) in the south of Eastern European plain (Odessa, Simferopol, Kherson) the trend-cyclic rise of annual amounts of precipitations was established from the end of 19th century until the beginning of 21st century in average by 0.9-1.7 mm per year and, consequently, for the last 130 years (Figure 2, 3) annual amount of precipitations in average increased by 117–221 mm. In 20th century – at the beginning of 21st century the variation coefficient of annual amount of precipitations is estimated by values 25-28% (Table 2). With intensive progress in development of agricultural technologies since the end of 19th century until now it ensured increase of land productivity potential by 4.5 times.

From 1887 until 2014 two qualitative periods of orientation of changes of annual precipitations (Figure 4) were distinguished. Besides, there is no relationship between temperature variation and annual precipitations amount in century dynamics.



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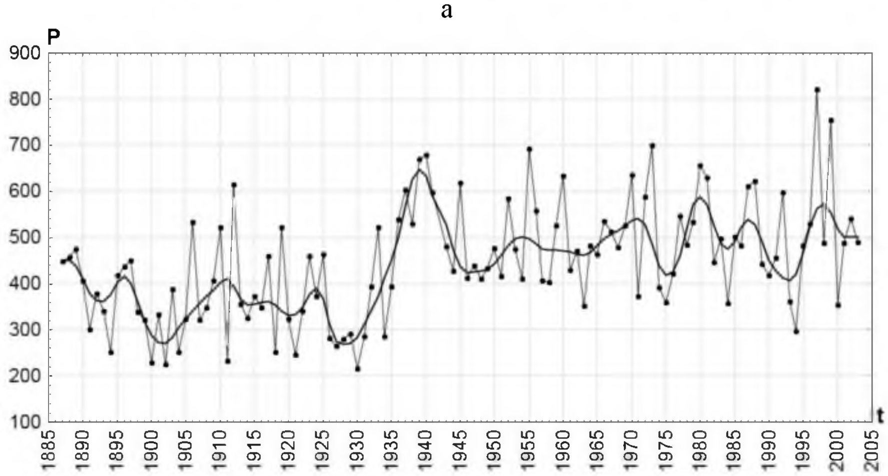

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Figure 2. (Continued).

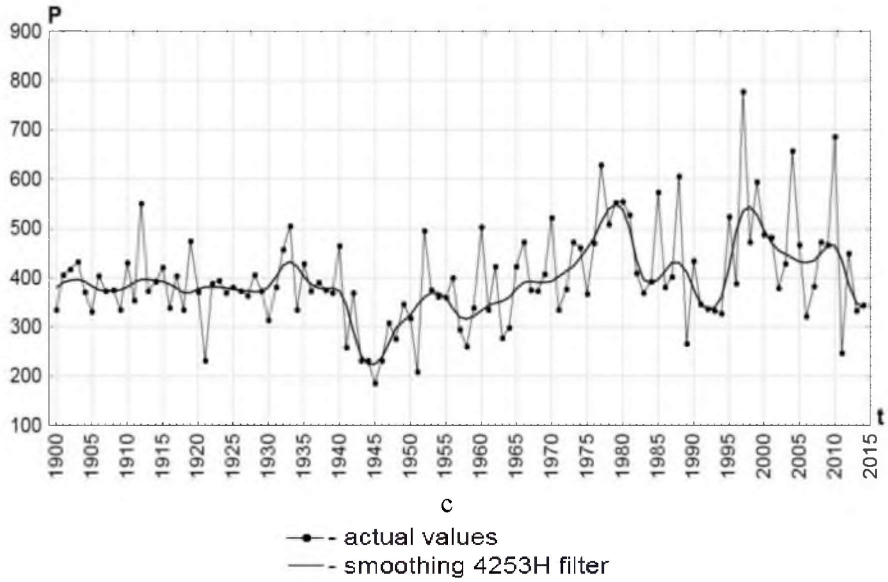

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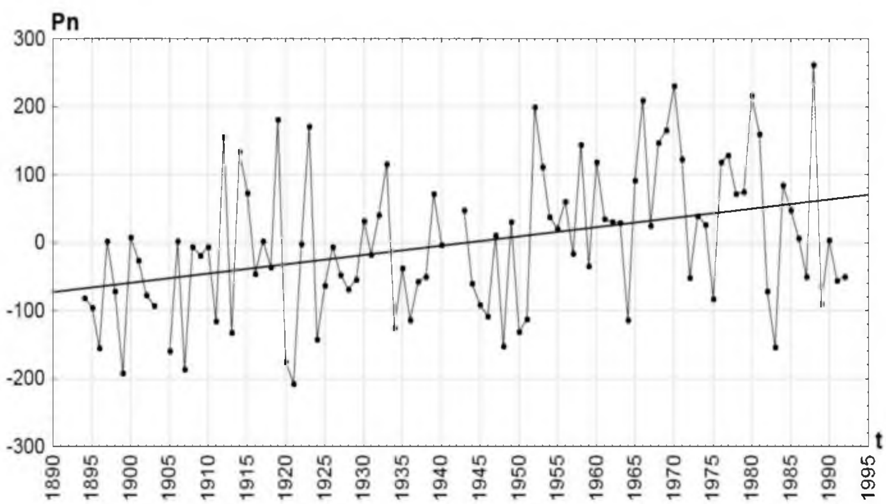
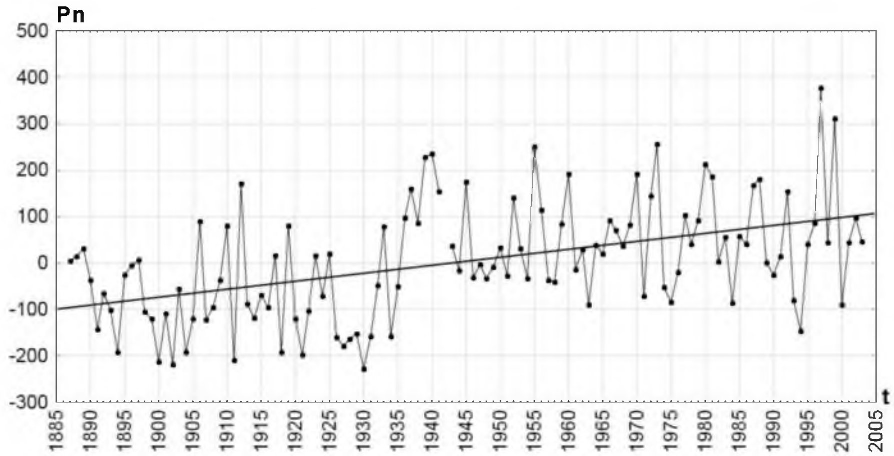
Figure 2. Dynamics of variation of precipitations (P, mm) in the south of Eastern European plain: *a) MS Odessa, b) MS Simferopol, c) MS Kherson.*



a

Figure 3. (Continued).



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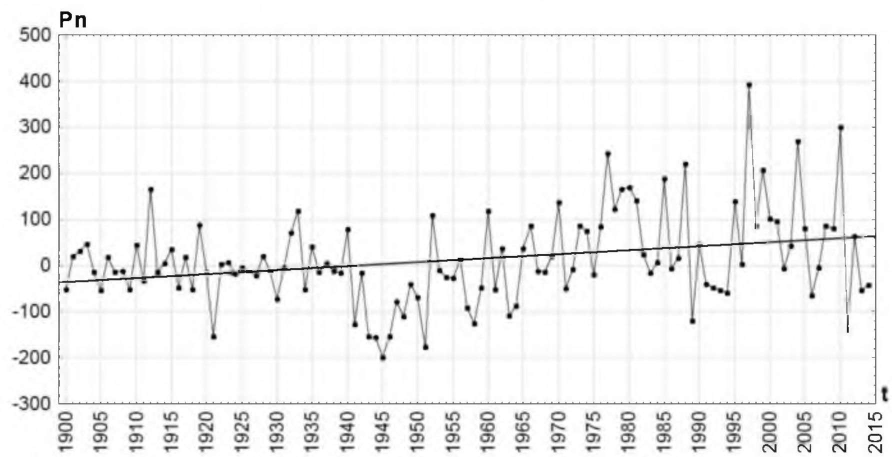


c

$$T_{\text{Odessa}} = 1{,}36 \cdot t - 68{,}6,\ r = 0{,}37;$$

$$T_{\text{Simferopol}} = 1{,}71 \cdot t - 96{,}9,\ r = 0{,}47;$$

$$T_{\text{Kherson}} = 0{,}88 \cdot t - 37{,}6,\ r = 0{,}29$$

Figure 3. Deviations of precipitations (P, mm) from norm within one century in 20th – atthe beginning of 21st century by data of meteorological stations of south of Eastern European plain: *a) MS Odessa, b) MS Simferopol, c) MS Kherson.*

Table 2. Statistical characteristics of moistening conditions in the south of Eastern European plain in 20th – at the beginning of 21st century

Indices	MS Odessa	MS Simferopol	MS Kherson
Average (norm)	399.8	446.9	399.7
Standard error	10.9	11.5	9.3
Median	395.0	444.6	380.0
Mode	402.0	Not found	334.0
Standard deviation	106.5	123.9	99.7
Dispersion of sample	11332.3	15359.0	9942.1
Excess kurtosis	-0.5	-0.1	1.7
Asymmetry	0.3	0.4	0.8
Minimum	192.0	215.8	186.0
Maximum	662.0	820.7	778.1
Reliability level (95.0%)	21.6	22.8	18.4
Variation	26.6	27.7	24.9

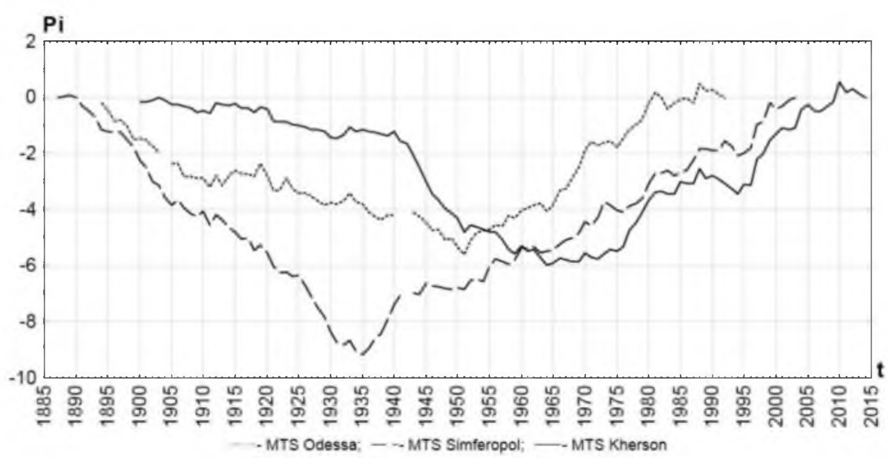


Figure 4. Coincident difference integral curves of precipitations (Pi) by data of meteorological stations in the south of Eastern European plain.

In the first period (end of 19th century – mid20th century) average value of annual precipitations amount registered at meteorological stations was 375 ± 12 mm; scale of the value is estimated as 208 ± 8 ÷ 646 ± 32 mm with variation coefficient 24.7 ± 2.8%.

Starting from1950 a steady tendency of moistening level rise was marked, average (using data from the same meteorological stations) value was 458 ± 23 mm of precipitations per year, scale of the value varied from 251 ± 26 up to

754 ± 47 mm with variation coefficient 23.7 ± 1.7%. In the second period (1950-2014) moistening increased in average by 1.22 times. In the second period the frequency of probability of display of years exceeding the century norm of precipitations increased twice – from 0.32 up to 0.66 (Figure 3).

4. Estimation of Influence of Climatic Dynamics on Bioproductivity

In virgin steppes with dominating steppe cereals (*Stipa, Festuca*) with variation coefficient of annual precipitations amount from 17 up to 27% the fluctuations of productivity of aerial phytomass in comparable periods were 19-23% (Table 3).

Table 3. Scale of values and variation coefficients of productivity of virgin steppe and yields of agricultural crops in 19th– 20th centuries

Location	Vegetation, agricultural crops	Years of registration	Phytomass/yields, c/ha			V, %	Data source
			average	max	min		
Priazovie	Goldilocks-sheep fescue-feather grass association	1967-1970	36.6	44.6	28.1	19.1	Bystritskaya, Osychnyuk, 1975
Nikolaev region, Nikolaev district	Sheep fescue-feather grass association	1981-1986	46.7	62.3	36.7	23.0	Lisetskii, 2007
Odessa county (modern Nikolaev district of Nikolaev region)	Spring wheat	1892-1900	5.0	11.2	0	72.2	Materials for the valuation …, 1902

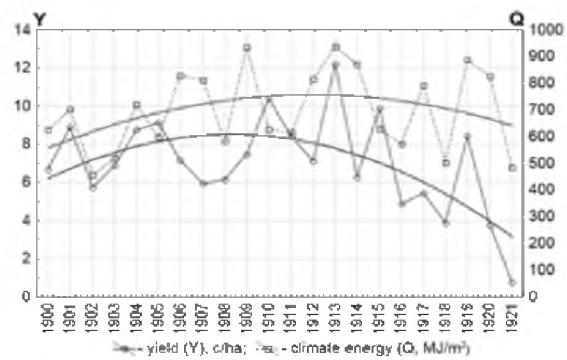
Table 3. (Continued)

Location	Vegetation, agricultural crops	Years of registration	Phytomass/yields, c/ha			V, %	Data source
			average	max	min		
Odessa county (modern Ochakov district of Nikolaev region)	The same	1892-1900	5.8	12.7	0	67.8	
Kherson province, Falz-Fein's estate (modern Velikoaleksandrovka district of Kherson region)	Winter rye	1880-1886	6.4	11.3	3.4	48.9	Materials for the valuation …, 1890
	Winter wheat	1881-1886	5.0	9.4	1.4	70.3	
	Spring wheat	1880-1886	4.0	7.6	0.1	64.8	
	Barley	1880-1886	7.1	13.3	0.3	67.5	
	Millet	1880-81, 1883-86	3.7	9.4	0.2	89.3	
	Oats	1881-1886	5.2	7.2	3.7	25.4	
Kherson province, Apostolovo country cottage (modern Apostolovo district of Dnepropetrovsk region)	Winter rye	1877-1886	4.1	5.6	2.9	22.7	Materials for the valuation…, 1890
	Spring wheat	1877-1886	3.0	5.2	1.5	29.1	
Kherson county	Millet	1877-1886	5.8	9.5	1.3	40.7	In the same source
Berdiansk county (modern Zaporozhye region), 8 farms of German colonists	Spring wheat	1860-1889	5.9	12.55	1.5	41.7	Postnikov, 1891

Location	Vegetation, agricultural crops	Years of registration	Phytomass/yields, c/ha			V, %	Data source
			average	max	min		
The Crimea	Winter wheat	1900-1921	7.0	12.2	0.8	35.8	Statistical and Economic Atlas of the Crimea, 1922
	The same	1900-1920	7.3	3.8	12.2	29.3	
	Barley	The same	5.7	10.0	0.3	42.1	
	Oats	The same	6.0	10.3	0.6	45.3	
Nikolaev region, Berezan district (kolkhoz (farms))	Winter wheat, in irrigated	1971-74, 1976-86	26.2	38.1	15.1	24.7	Main SRCR UAAS: http://iae.org.ua
Nikolaev region	Winter wheat, rarity plots	1975-1984	39.5	51.2	23.7	20.2	Heat resistance …, 1985
Odessa region	The same	The same	37.4	49.6	27.1	17.0	
Kherson region	The same	The same	33.8	47.9	19.5	27.8	
Nikolaev region	Winter wheat, in irrigated	The same	41.7	51.2	29.7	14.9	
Odessa region	The same	The same	35.8	46.4	24.5	18.6	
Kherson region	The same	The same	33.6	18.3	47.0	30.6	
Nikolaev region	Winter wheat, irrigation	1977-1984	45.3	51.3	40.1	10.8	
Odessa region	The same	1976-1984	47.8	55.1	40.8	9.8	
Kherson region	The same	The same	44.1	55.3	27.2	19.1	
Nikolaev region	Winter wheat, in irrigated	2009-2013	26.8	30.4	16.2	22.3	State Statistical Service of Ukraine: http://www.ukrstat.gov.ua
Kherson region	The same	1990-2000	27.4	37.2	17.0	21.9	
Kherson region	The same	2001-2014	25.7	34.8	15.8	21.6	
Kherson region	Winter wheat, irrigation	1990-2000	38.8	51.8	28.4	23.7	
Kherson region	The same	2001-2014	38.2	47.5	28.1	16.5	

Investigations of agroclimatologists (Zhuchenko, 1990) have shown that with rise of efficiency in agriculture and, consequently, yield dependence of the latter from climate and weather increases. Nevertheless, in this case this is not about reduction of absolute yield value (because possibility of provision of basic yield minimum due to scientific and technical progress), but about rise of dependence of yield relative variability from uncontrollable variations of external medium parameters and, first of all, weather fluctuations. At that the latter has the largest impact on high yield cultivars and hybrids of plants, which most of all depend on optimization of all factors of external medium.

Analysis of dependence of productivity from climatic conditions (provision of heat and moisture – by (Volobuev, 1975)) with higher level of agriculture development is reduced (Figure 5).



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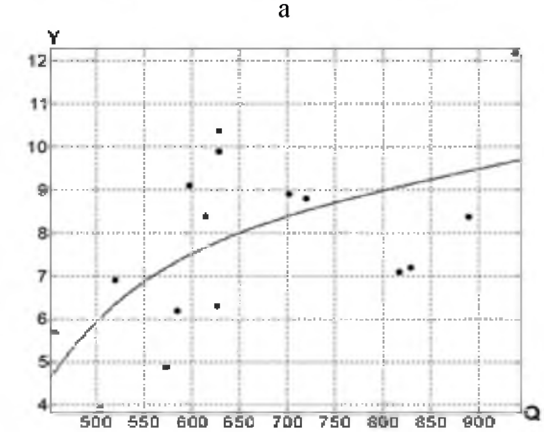
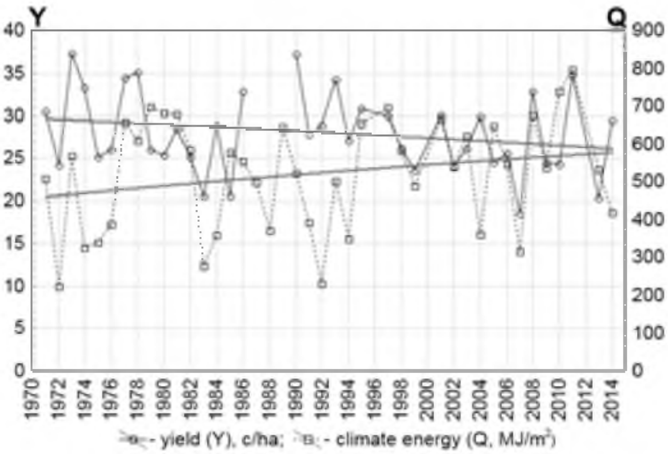


b

$$Y = 6.28 \cdot \exp(4.3 \cdot 10^{-4} Q) - 261.1 \cdot \exp(-9.4 \cdot 10^{-3} Q),\ r = 0.61$$

Figure 5. (Continued).



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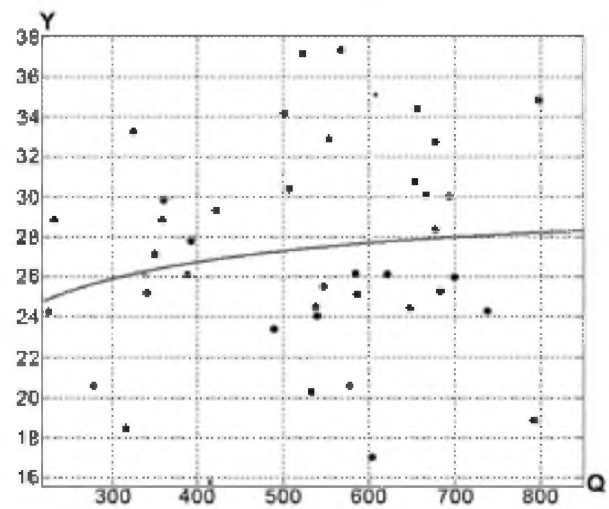


d

$$Y = 30.7 - 219 \cdot Q^{-0.67}, r = 0.15$$

Figure 5. Dynamics (a, b) and dependence (c, d) of spring wheat yield from energy of climatic expenditures (Q, MJ/m^2) in the territory of Eastern European plain in various periods of agricultural development: *a, b) 1900-1921; c, d) 1971-2014.*

In the second half of 19th century in usual farmsteads average variation of yields of six cereals was 56% and with higher efficiency in agriculture (of German colonists) it was 42%. Author's processing of yield row for the period 1886-1925 in Askania-Nova (Kovarsky, 1930) showed that using variation coefficients (indicated in brackets) the following ranked row of yields stability by crops: winter rye (50) < spring barley (54) < winter wheat = spring wheat (67). Influence of agrotechnical measures significantly changes productivity stability. Thus, according to the same data after introduction of clean tillage (1905-1925) compared to the previous period the variation coefficient by particular kinds of crops reduced by 12-39%. Consequently, at the beginning of 20th century agrotechnical achievements determined reduction of variation in yield of cereals (by for kinds) down to 38%. Role of rear experimental events is of large importance: such variation coefficient by winter wheat yield for the period 1900-1920 compared to the previous period, including dry lean 1921, was less by 6.5%. In 1921 minimum amounts of precipitations were marked on the large territory (for instance, that year there was only 230 mm of precipitations (58% of norm) in Odessa).

As it is shown in Figure 5, low level of use of agrotechnologies in 1900-1921 was reflected in rather high closeness of relationship (r=0.61) of yield variation (Y, c/ha) of the main most widespread crop (spring wheat) from energy climatic expenses (Q, MJ/m^2), which are determined by humidity (precipitations) and sun radiation (Volobuev, 1975). In modern conditions reduction of climatic influence by 4 times (r=0.15) on formation of yield of agricultural crops is conditioned by high technological vector of agricultural development that resulted into stability of productivity.

For comparison of stability index of agricultural productivity, which is expressed in yield of crops by two time sections the formula offered by I.B. Zagaitov and P.D. Polovinkin (1984) is used (by: Pykhtin, Veklenko, 1988):

$$V_c^t = 1 - \frac{\sum_{i=1}^{n} \left| P_i - \overline{P} \right|}{\sum_{i=1}^{n} P_i}, \qquad (2)$$

where V_c^t – is stability index changing from 0 to 1; P_i – is actual productivity; $\overline{P}$ – is average productivity for time t; $\sum_{i=1}^{n}$ – is amount of deviations by module.

Table 4. Comparative statistical characteristic of productivity of agriculture by two time sections

Indices	1860-1921	1971-2014
Average	6.04	27.22
Standard error	0.33	0.85
Median	5.84	26.20
Mode	Not found	24.50
Standard deviation	2.58	5.41
Dispersion of sample	6.66	29.31
Excess kurtosis	-0.14	-0.48
Asymmetry	0.20	-0.09
Minimum	0.74	15.80
Maximum	12.22	37.32
Reliability level (95.0%)	0.67	1.71
Variation, %	43	20

Value of temporary stability of agricultural productivity in 1860-1921 was 0.60, in 1971-2014 – 0.84. Space variability of stability in 1860-1921 was from 0.43 up to 0.83, in1971-2014 – 0.5-0.2. Introduction of innovative agrotechnologies ensured rise of space-time productivity of agriculture for the last 150 years by 1.3-1.8 times causing yield rise in average by 4.5 times (from 6.0 up to 27.7 c/ha) (Table 4) and stabilization of agroproduction process by approximately 2.2 times (variation reduction from 43 down to 20%).

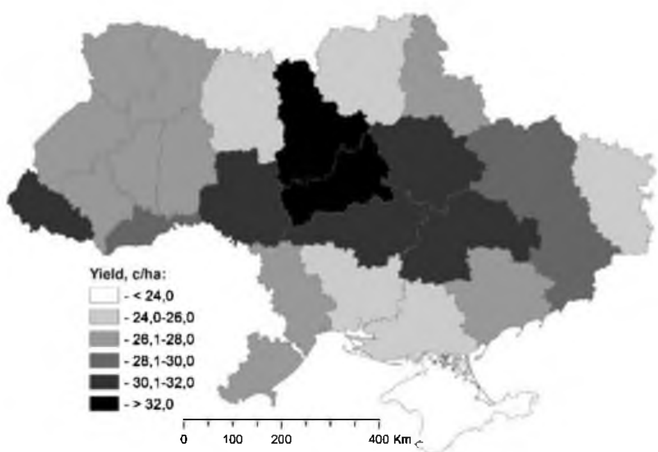
No uniform redistribution and deficit of annual climatic energy in the period of vegetation of agricultural crops in steppe and dry steppe zones of the south of Eastern European plain are significantly compensated by application of irrigation amelioration. Thus, in the second half of 20th century on in irrigated lands both in large land tenures and state crop testing sites yields of winter wheat were changing with the course of years with variation coefficient (V) 22% (i.e., variation still remains strong). In particular, 4 years (1975, 1976, 1979 and 1983) were characterized by severe droughts in the south of Ukraine (Heat resistance …, 1985). At the same time in agro-ecosystems of steppe zone with irrigation amelioration value V by winter wheat yield was the lowest – 16% (average variation).

From the beginning of irrigation functioning conditions of all components of natural environment changed, in particular, orientation and rates of soil processes changed (Lisetskii, Pichura, 2016a). Results of these changes may have either positive (improvement of water supply, productivity rise etc.) and negative effect (underflooding, salinization, alkalinity, bogging-up processes).

Orientation and intensity of negative phenomena on agricultural and adjacent lands depend, first of all, on climatic and hydrological conditions of the region, volumes of irrigation water supply. Constant under flooding of agricultural territories in the south of Eastern European plain caused by natural (precipitations) and anthropological factors (construction of cascade of water basins on the Dnieper and hydrotechnical irrigation systems) results into large economic losses of agricultural and industrial complex. Excessive moistening and under flooding of territories cause reduction of yield of agricultural crops down to 60%, in some cases, complete demolition. For scientific grounding of preventive measures of such situations it's expedient to apply modern complex approaches and non-linear methods of space-time simulation and forecasting on basis of GIS and neurotechnologies (Pichura et al., 2015; Lisetskii et al., 2015). The method of creation of forecasting estimation system of probability of net profit losses from shortage of yield caused by underflood of agricultural territories against Markov's discrete purpose (Zadorozhnyy, 2012).

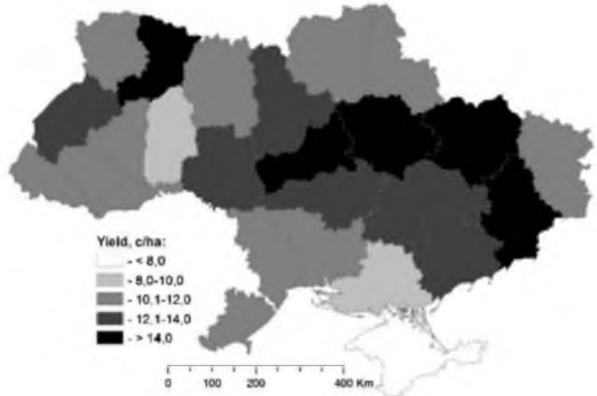
Development and support of irrigation in steppe and dry steppe zones of the south of Eastern European plain are a guarantee of preservation of tendency for getting stably high yields and provision of competitive positions of separate agricultural producers and countries as a whole. At present irrigation allowed getting yield of agricultural crops 1.45 times higher than yield of rain crops. i.e., profit on irrigated lands is increased in average by USD 1800/ha.

Territorial peculiarities of distribution agricultural industrial potential in Ukraine in 1990-2009 are shown in Figure 6.



a

Figure 6. (Continued).



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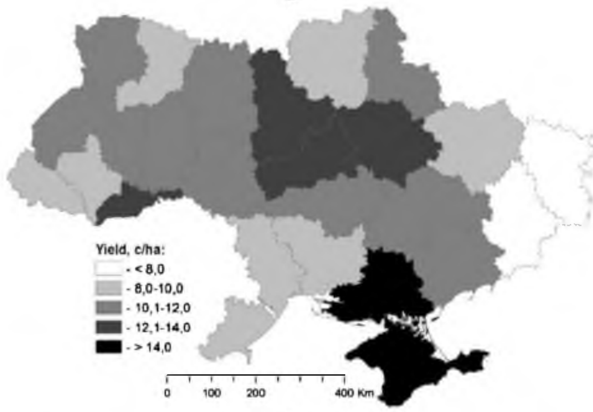

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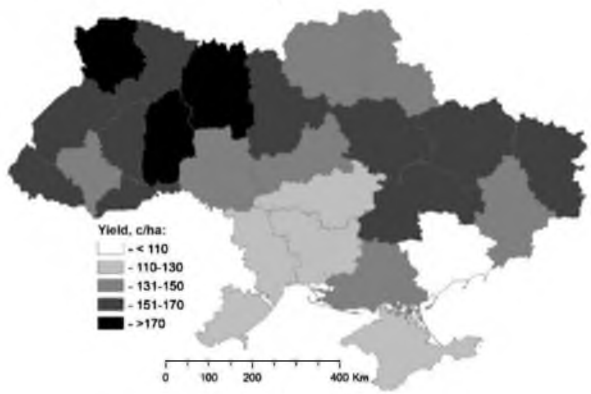


d

Figure 6. Average yield value of main export agricultural crops (c/ha) in Ukrainian regions (1990-2009): *a) wheat; b) sunflower; c) soy; d) vegetables.*

Agricultural industrial complex is the largest export industry in Ukraine. Foreign trade of AIC enterprises, which includes export of grain (plant growing products), food products and sunflower oil in 2014 brought to state budget 16.6 bln. USD, which placed this industry in the first place, having advanced metallurgy (15.2 bln. USD) for the first time in 25 years.

5. Historical View on Formation of Grain Market in 19TH – 20TH Centuries in the South of Ukraine

Retrospective view on formation of free market for southern edge of Russia in the second half of 10th – beginning of 20th century is remarkable in the part of market relations related to entry to the world market for grain export. Exactly this product attracted attention of foreign entrepreneurs in southern ports of the Black Sea. In this period in Odessa there were 8 consulates general and 12 consulates, in Nikolaev – 12 consulates, vice Consuls and consulate agents, which represented interests of Greek, Turkish, German, Netherlands, Belgian, Danish, Serbian, British, Portugal, Sweden-Norwegian, Brazilian, Italian, French and Austro-Hungarian capital. This system of public labor distribution southern regions became the largest suppliers of grain and other agricultural products. Construction of port and bread quay in Odessa was started at the beginning of 19th century, when in 1802 above 100 big ships with Russian bread arrived in Odessa. Nikolaev and Kherson as ports remained closed for foreign ships until 1862. But under effect of the world market their commercial ports were opened. In those times Russia did not have a commercial fleet and its foreign trade was realized by foreign ship and insurance companies, which allowed them to deliver from southern ports not only grain, but hundreds millions of golden rubles as profit. Great Britain was the main market outlet of grain. From Black Sea ports products were delivered to Germany, France, Holland, Belgium, Switzerland, Italy, Greece, Spain, Portugal, Austro-Hungary and Denmark.

Supremacy of foreign market over agricultural production of the south was obvious that was acknowledged in Russian official circles. Historical reliability of importance of southern Black Sea ports in grain export in the south of Ukraine is confirmed by statistical reports, statistical and economic reviews of Kherson province, reports of mayors of Odessa, Nikolaev, Kherson, statistics of grain export (Figure 7).

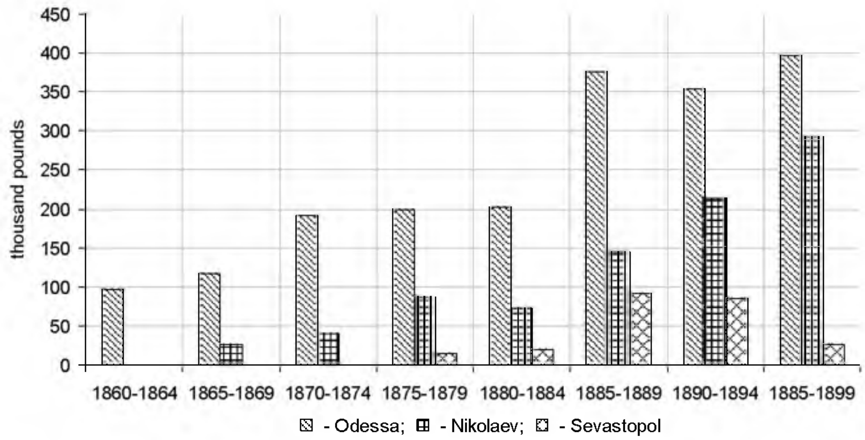
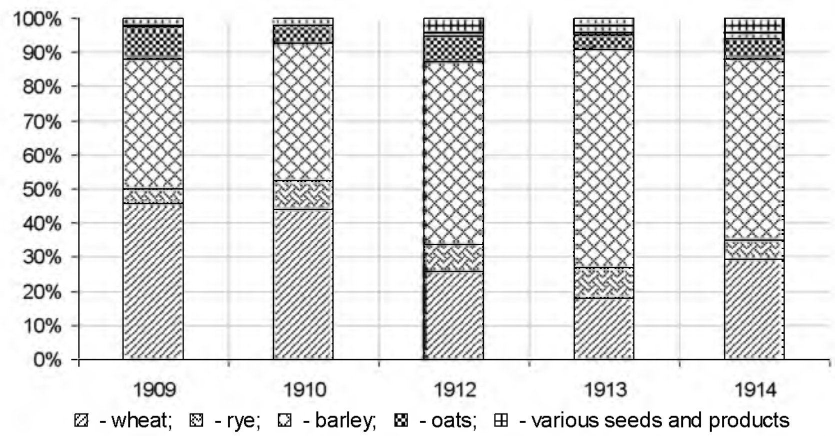


Figure 7. Dynamics of export of cereals (wheat, rye, barley and oats) from Black Sea ports.

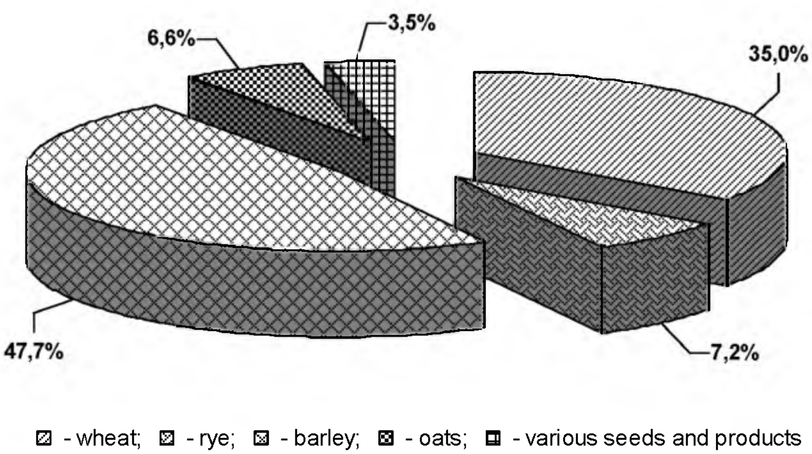
At the end of 19th century several railway lines were built, which allowed to deliver bread from remote regions. At the end of 19th century Odessa was on the first place by bread trade turnover in Russia: rarely less than 1600 mln. t of bread per year was delivered from Kherson, Podol, Volyn, Kiev, Ekaterinoslav and Tavria provinces. Bread export brought up to150 mln. rubles per year. As of 1898 bread supply ratio of three ports was as follows: in Odessa – 54%, in Nikolaev – 30%, in Sevastopol – 16%. This ratio was certainly changing with the course of time, but Odessa saved its leading position (Figure 7). Products were delivered not only from steppe provinces of Ukraine, but from Bessarabia, Don, Pre-Caucasian regions, although their share in export from south of Russia was insignificant.

Growth of demand for bread stimulated development of commercial crops framing in the south. But at that period Russian rivals, first of all, American exporters strengthened their positions on the world bread market. They were supplying bread to European countries and pushing Russian product out of it. The situation was worsened by the beginning of crisis of overproduction in agriculture in 1884. Therefore, when struggling for sales markets foreign merchants sold bread from Russian southern ports at exceptionally low prices, frequently promoting further reduction of prices on the world market. In spite of grain price reduction in the world and domestic markets commercial crops farming dominated in southern steppes of Ukraine. At the end of 19th century bread export widened and remained an important source of capital at the beginning of 20th century (Figure 8).

Foreign trade relations of southern steppe grain producers started narrowing under the influence of some factors. First of all, these were droughts, negative impact of one-crop farming, economic fall and defeat in competitive struggle with American exporters on the world market.



a)



b)

Figure 8. Variation (a) and average (b) share value of export of bread products in 1909-1914 from port in Nikolaev.

6. World Tendencies of Cereals Export

Foreign trade operations with grain in the ancient world were characterized by low activity and irregularity. The main buyers were the ancient Greece and Rome, and grains were exported by Sicily and North Africa. The early middle Ages were characterized by mostly natural farms almost to the early mercantilism in the 15th– 17th century. The most active phase of foreign trade relations was the period of late mercantilism, when the key stakeholders were represented by England, France, Spain and Italy. In the manufacturing period of capitalist development major exporter of grain were Russia, Poland, and importers were Britain, France, Spain, Portugal; the Netherlands (Amsterdam) conducted intermediary trade. Europe acted the main center of trade relations, including the "grain trade." At the end of the 18th century, the world's grain export was 0.75 million tons, i.e., 200 times less as compared to the current indicator.

The historical background of trade activation in the middle of the 19th century was the rapid development of industry, urban population growth and bread commercial production, creation and improvement of mechanized warehouses–grain elevators. The main importers of grain were the Western European countries, and the leader among them was the United Kingdom. This period was characterized by emergence of new expert regions of extensive bread production – the Danube countries, the United States, Canada, Argentina, Australia (Galushko et al, 2011).

The lack of food, especially grain products which even in the 19th century accounted for about a half of the daily diet (Brodel,' 1995), was one of the characteristic phenomena of the European history up till the middle of the 19th century. Lean years led to social upheavals in the country and society. As pointed out by known researcher F. Brodel,' for many centuries in Europe, hunger "returned with such persistence that became a part of the biological regime" (Brodel,' 1995, s.89). The so-called "Little Ice Age" that lasted for 14th-19th century played a significant role in the creation of unfavorable economic conditions. At this time, hungry years became typical for Europe – in the 16th – 19th century only in France hunger occurred 40 times across the whole country.

An important factor in the development of foreign trade and trade in grain, in particular, was that the traditional grain sources for Europe (Greece, Thrace, Egypt) till the 16th century fully ceded to the Ottoman Empire, and open lands in the New World were not yet developed. At this time food started being exported from the northern and eastern edge of Europe, and not least, the

Polish–Lithuanian Commonwealth, which, having low yields, shipped for export almost all locally grown wheat that was highly valued in European countries. During this period, the economic relations of the Polish state with Ukraine and its development by the Polish gentry, which, according to researchers, played a significant role in further spiritual and political influence of Poland on the Ukrainian territory, were being formed (Brodel,' 1995).

The first report on the fertile land then belonging to the Polish state was made by Polish historian and chronicler Maciejz Miechowa. In "Treatise on the Two Sarmatia" (1517) he pointed out, describing the territory of modern Ukraine, that there the land was "the most fertile in Europe and had the mildest climate" (Mehovskyy, 1936, s. 36). This phrase was almost literally repeated one hundred and eighty years later by French author Gaspard de Tandy, who served in the Polish court (Hauteville, 1697). Despite the lack of information and imperfect mechanisms of transmission, this statement started spreading and was becoming frequently mentioned in travel notes, official reports, etc. Thus, participant of the campaign of Charles XII at Poltava, priest Johann Bardo wrote about the great crops of wheat in Ukraine, so it would be more than enough to produce bread and alcoholic beverages (Bardili, 1730). Reports by French agents in 1771 and 1784 without specifying sources of information indicated "huge, as at home, piles of rotting wheat, which could feed the whole of Europe" and such cheapness of wheat so locals refused to grow it (Brodel,' 1995). By the end of the 18th century, the idea of the incredible productivity of Ukraine became an axiom and was reflected even in researches (Kirilov, 2014). The rapid growth in export volumes was observed in the late 50-ies of the 20th century, and in 1973-1975s it reached 160 million tons, or over 11% of the world production. Along with the growth of export, its composition changed as well–some countries with intensive development of livestock increased imports of feed grains (Denmark, the Netherlands, Japan), countries with high population growth significantly increased the demand for food grains (Sri-Lanka), exports were also increased by countries that suffered from crop failure (Galushko et al., 2011).

Now, the world grain market is the largest, being characterized by a number of price and non-price barriers to enter it. In the overall balance of international trade, grain is ranked third in terms of transportation volumes after coal and oil, but in terms of value it is ranked first. The level of marketability and grain production volumes for export are different–the largest share of exports belongs to wheat, and the lowest share belongs to rice, millet and sorghum. In recent years, there has been increasing competition in the grain market. In this regard, a government policy in many countries is to overcome dependence on imports and stimulate the growth of grain production by providing subsidies and preferences for commodity producers. The grain market is characterized by its dynamism and rapid growth of supply. So, the priority for sales today was Asian and African countries. The main feature of the modern world grain market is that production is growing slower than consumption. In recent years, grain shortage in the market had been offset by reserves. This situation has provoked increased prices for grains. Given the fact that grains are the basic food for the population and a major feed ingredient in livestock farming, we can say that the world is facing a food crisis that has become systemic. The continuous growth of the world population, in average by 1.2 percent a year and global changes in the consumption of animal products definitely require increased production of grains in the world.

Today, the main grain exporters in the world market are: The United States, Canada, Australia, Argentina, EU, Ukraine, Russia, which provides about 90% of its turnover (Table 5).

The United States produces more than a half of the world's grain exports. The leading exporters include 20-25 countries; the rest produces grain products mainly for their own use or import. Ukraine in 2014 took third place (16.7% of the world market) in exports of barley, fourth (6%) in exports of corn and sixth (5.4%) in terms exports of wheat. The major exporters in the wheat market are the United States (23%), Australia and EU (15% each), Canada (14%) and Argentina (9%). The Americas continue to hold the leadership in grain exports, its share in the world's exports is 51.2%. In the grain 2013-2014 seasons, according to the Global Grain Market Report of the USDA National Agricultural Statistics Service, the largest volumes of grain were exported by the United States, i.e., 72. 3 million tons, of which wheat accounts for 35 million tons, the second place is taken by the European Union (28 countries), i.e., 38.5 million tons of grains, of which wheat accounts for 30.5 million tons, Ukraine takes the third place – 32.3 and 23 million tons, the fourth place is taken by Canada–28 and 22 million tons respectively. The fifth and sixth places are shared by Australia and Russia with the wheat export volumes of 18.5 million tons. Asian countries have increased its export potential by 7.2 times; their share in the global grain market is 16%. Europe increased grain exports by 3.1 times; its niche in the global grain market is 26. 6%, it takes the 3 place in the world in terms of grain exports. The North American countries exported 122. 7 million tons, increasing its grain exports by 2.2 times, they take the second place, their share in world exports of corn is 37.5%.

Table 5. World grain exports, mil. t

Marketing years	Countries							
	US	Argentina	Australia	Ukraine	Canada	EU	Russia	Brazil
2013/2014	72.3	24.50	21.90	32.30	28.00	38.50	26.10	20.10
2014/2015	80.4	27.60	24.40	33.58	28.2	53.50	30.70	21.00
2015/2016	84.5	35.90	23.80	37.40	27.60	52.10	34.70	34.40
2015 in% to 2013	116.87	146.53	108.68	115.79	98.57	135.32	132.95	171.14

Source: formed according to data of the International Grains Council.

South American countries are actively involved in the competition for their niche in the global grain market, they have increased grain exports by 3.6 times and their share in the world exports of grain is 13% compared to only 5% in 1995. For 37 years, Oceania has increased grain exports by 8.7 million tons, or by 2 times. Although least developed countries have increased grain production over the years, but their exports have remained at the same level, they only meet domestic needs. Among the world's country, the United Stated is the largest grain exporter–99.9 million tons, having the 30.5% share in the world's exports of grain and almost the 60% share in the regional market. The United States are constantly increasing their export capacities; for 37 years they have increased grain exports by 2.5 times. Over these years, Argentina alone has overtaken the United States and increased its grain export potential by 2.7 times and has come second in the quantitative export of grain and ahead of France. In the 2016-2017 marketing year (MY), an increase in the world's grain production is anticipated. According to USDA forecasts, the world production of grains of all kinds will reach 2.6 billion tons, which is 4% higher than in the previous MY. Thus, wheat yield is expected to increase by 1.2%, feed grain yield is expected to grow by 6%, rice yield is estimated to gain another 2%.

According to forecasts of US experts, the total grain exports will amount to 383.6 million tons, i.e., 7.2 million tons less than in the previous season. However, the world grain stocks will grow. At the end of MY 2016-2017, they will reach 622 million, which is 4% higher than in the previous year.

The influence of the Black Sea region is growing in the world wheat trade. For two seasons in a row, Russia, Ukraine and Kazakhstan have sold in the foreign markets unprecedented volumes of wheat, which exceed the sales of the top exporting country like the United States and EU. According to results of the 2013/2014 grain season, wheat supply of these countries in world markets accounted for almost a third of the global sales volume of this type of grain. The world grain imports increased by 2.7 times and in 2014 they reached 306.4 million tons. The main importers of grain are Asian countries. In 2007, they bought 119.2 million tons of grain, this is by 28.7%, more than in 1990; their share in the world import of grains is 38.9%.

For 37 years, Africa increased its grain imports by 8.2 times. Imports of the least developed countries have increased over this period by 4.9 times. Due to natural disasters, Oceania countries increased grain imports by 4.9 times. Countries in Africa, Asia and South America tend to import food grains. Large grain imports into developing countries are caused by two main reasons: some countries are economically and organizationally weak to increase its grain production in the modern large natural population growth and the need to overcome low living standards and poor nutrition; the second group is characterized by a significant proportion of effort and money put into agriculture for the production of export crops, the sale of which in the foreign market provides means to import food (Sri-Lanka, Indonesia, Philippines, etc.). The rest of the continent and industrialized countries have mostly increased its import of feed grains.

The world's main grain importer is Japan. In the 1990-2000s, it was constantly buying 27 million tons of grain in the world market, and in 2007 it imported 25.5 million tons, showing decrease by 5.6%. Japan's share in the world import of grain is about 10%. The second place in the import of grain is taken by Mexico, taking over China's position. China is gradually reducing grain imports; over 50% of grain imports in China were accounted for food grains. South Korea and Spain in 2007 imported more than 12 million tons of grain. Spain, Malaysia increased grain imports by 6 times, Algeria experienced a 20-time increase. Feed grains account for more than a half of imports of the Netherlands.

The bread balance is an important economic factor for many countries. The passive balance characterizes the country dependence on imports and points to the need to establish additional feed grain supplies or increase the volume of its own grain production. The reasons for this situation are an imperfect structure of the country's commodity production, intensification of livestock production, grain supply and demand imbalance. In some countries, passive balance of grain is offset by export of animal products. Although the value of exports offset grain passive balance, these countries cannot be equated to the previous group because:

a. The export of agricultural products and export operations in most of these countries is in the hands of the foreign capital returning not the entire cost of exported products to the country;
b. Countries from the previous group export not raw materials, but finished products–butter, cheese and the like, and the developing countries mainly export raw materials or semi-finished products, since prices are much lower.

In some agricultural countries the main cause of grain passive balance is a general inhibition of agriculture development due to imperfection of agricultural relationships, low introduction of product innovation and investment in the agricultural sector and other social and economic conditions.

The factors that influenced the grain market, include the following: reduction in world production and carry-over stocks of grain; reduction in wheat production in the United States, in India; need for large-scale imports; drought in Australia, a massive use of grains in bioethanol production; significant increase in corn consumption in China and exit of this country from the export market; reduction in corn production in Argentina and natural export offer reduction; tense world balance of barley; insufficient supply of malting barley in the EU countries; increase in freight rates; EUR strengthening; fluctuations of quotes in the energy market; large speculative transactions of investment funds on commodity exchanges; attempts to reform the export systems of Australia and Canada; regulatory policies of the European Commission in the grain market. During 2007/2008 MY the factors determining the grain market were as follows: adverse weather conditions in Europe; decline in grain production in Canada; unprecedented reduction in the world stocks of wheat; Ukraine's withdrawal from the export wheat and barley market; new drought in Australia; adverse weather conditions in Argentina; introduction of duties on grain exports from Russia; adverse weather conditions in the winter wheat growing regions in the United States; huge need for grain imports to South–East Asia, Middle East, North America, India. As a result, the markets experienced an incredible increase in prices and quotations for wheat, barley, corn.

7. World Trade in Wheat

Today almost 20% of the world's wheat harvest is in the international market. Major exporters that determine the state of the world wheat market is

Argentina, Australia, Canada, EU, Kazakhstan, Russia, Ukraine and the United States. According to the U.S. Department of Agriculture total wheat export offers from major exporters in MY 2015/2016 accounted for 88.7% of the total world trade, while in the last season the figure was 87.4% (Table 6, Figure 9).

According to the results of 2013/2014 MY, the world grain production has reached its historic high. In particular, compared to previous years, world production of wheat has risen to 715.1 million tons, or 8.4%, feed grains have reached 1306.7 million tons, or increased by 13.0%, and rice has constituted 496. 9 million tons, or increased by 1.2%.

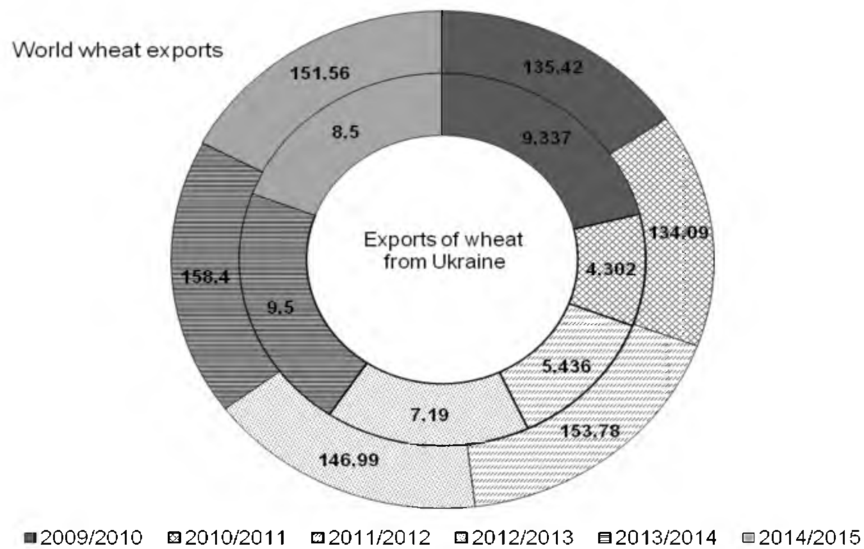
According to the Food and Agriculture Organization of the United Nations, there are countries in which the state of food insecurity is at a very low level, including Syria, Yemen and South Sudan. Overall, 33 countries, including 26 African countries, need external food aid.

World imports of wheat for the period have increased by 2.4 times (Table 7).

Table 6. World Wheat Exports, mil. t

Countries	Marketing years						Share in world exports 2014/2015, %
	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	
Argentina	5.255	7.742	11.951	7.450	1.800	6.500	4.3
Australia	13.764	18.455	23.031	21.269	18.00	19.00	12.5
Canada	18.992	16.768	17.603	18.581	21.50	21.00	13.9
European Union	22.279	23.086	16.691	22.621	30.00	27.50	18.1
India	0.060	0.073	1.0723	8.651	5.00	2.50	1.6
Kazakhstan	7.871	5.519	11.069	6.801	8.00	7.00	4.6
Russia	18.556	3.983	21.627	11.289	18.20	19.00	12.5
Turkey	4.363	2.944	3.678	3.583	4.00	3.20	2.1
Ukraine	9.337	4.302	5.436	7.190	9.50	8.50	5.6
Uruguay	1.039	1.612	1.78	0.811	1.20	1.50	1.0
USA	24.143	36.046	28.142	27.695	31.50	26.00	17.2
Other	9.764	13.560	11.046	11.054	9.704	9.860	6.5
Total	135.42	134.09	153.78	146.99	158.40	151.56	100

Source: US Department of Agriculture USA, calculations of the National Bank.



Source: US Department of Agriculture USA, calculations of the National Bank.

Figure 9. Global wheat exports for 2009/2010 – 2014/2015.

Table 7. Main Wheat Importing Countries, mil. T

Years	Countries										
	EU	US	Nigeria	Iran	Turkey	Japan	Brazil	Algeria	Indonesia	Egypt	Other
2013	5.3	3.3	4.1	6.6	3.6	6.6	7.4	6.5	7.1	8.3	85.4
2014	4.0	4.6	4.6	4.8	4.0	6.1	7.1	7.5	7.4	10.2	96.4
2015	5.0	4.6	4.8	5.5	5.8	6.0	7.0	7.4	7.7	9.5	90.2
2015 in% to 2013	94.34	139.39	117.07	83.33	161.11	90.91	94.59	113.85	108.45	114.46	105.62

Source: US Department of Agriculture USA, calculations of the National Bank.

The main importers are countries of MENA (Middle East and North Africa); their share in world imports is 33%. It should be noted that Asia has reduced purchases of grains in the last 7 years by 11.7%, which mainly the role of China can be traced, which for 37 years has reduced wheat imports by 75% and for 7 years by 30%. The share of Europe in global wheat imports is

25%, Africa accounts for 23.5%. Purchase of wheat by countries of North and South America has been increased by 5.3 and 3.3 times, respectively.

The main importer of wheat is now Brazil, its share in world wheat imports is 5.5%. Brazil prefers growing feed grains and more export-oriented crops, so wheat grain imports have increased by 3.5 times over this years (Table 3). The second place is taken by Italy. Since 1970, its procurement of wheat had been constantly growing and in 2007 it imported 5.6 times more grain than in 1970. But it is typical for Italy, since its agriculture is focused more on southern crops and less on grain. Over these years Japan has purchased on average 5.3 million tons of wheat and, despite the increase in productivity, this production there does not manage to meet the needs for food. For 37 years Indonesia has increased the purchase of wheat by 16.3 times; the reasons are the growing population, low yields and natural conditions.

Most wheat is exported in the form of seeds and only 10.7 million tons are exported as wheat flour. Grains are easier to store and transport and flour is usually subject to customs duty. Countries with intensive livestock farming are interested in bran for fattening animals. Some countries (Germany), even specially import wheat in the amount exceeding their needs; bags of flour are taken out and bran remains.

The largest wheat flour exporters are Asia (4.8 million tons) and Europe (3.6 million tons). America exports 1.6 million tons of wheat flour. Although global wheat flour import is 10.5 million tons. Asian countries have imported 4.8 million tons (33% of the world's figure); Europe has imported 2.2 million tons (25% of the world's figure); Africa has imported 1.8 million tons; the figure of the Americas is 1.6 million tons.

In 2006/2007 MY season, the wheat market started experiencing the shortage of wheat in India and reduction in wheat production estimates in the United States, Australia, Ukraine, Russia and EU. In January 2007, according to USDA, the total reduction in world wheat production as compared to the 2005/2006season constituted almost 30 million tons, and reduction in carry – over stocks was 25.2 million tons. Such situation led to gradual increasing prices. The first serious impetus for the significant increase in world market prices was major procurement of wheat (up to 5 million tons) by India. Australia, according to the tender results, became a major supplier of wheat to India, but a severe drought in the country forced the Australian monopoly AWB to terminate a number of export contracts and their obligations under the Indian tender were partially covered by the supply of wheat from other regions in the world, including the Black sea region.

The second impulse was reduction in the production of the main export type of wheat in the countries of EU, especially in the Eastern Europe Countries. The third factor in increased wheat prices was the decision of the Ukrainian government to impose restrictions on export of grain by quotas.

The intense global wheat balance and limited supply in the current season because of repeated droughts in Australia, rated higher and dramatically increased exports of Russian wheat. As a result, Russia imposed export duties (10% on wheat and 30% on barley). Adverse weather conditions in Argentina (frosts) led to a decrease in yield of wheat in the country by about 2 million tons in a few weeks. As a result, the government increased export duty on wheat by 8% up to 28%, and suspended the issuing of export licenses. High world prices make the largest wheat importers to shorten procurement volumes (Galushko et al, 2011).

8. Ukraine: Its Role and Place in the World Grain Market

Grain trade in Ukraine can be traced back to ancient times. Nearly half of all grain grow n went abroad through ports of the Azov and Black Seas and the share of Ukraine's exports of wheat in the Russian Empire was 90% (Mel'nik, 2010). The legend of Ukraine as a European breadbasket is also associated with grain production volumes in the Ukrainian villages in the second half of the nineteenth century–the first decade of the twentieth century, when nearly a half of export of grain was provided by landowners and farms. Ukraine being a part of the Russian Empire gained the status of "breadbasket" when its share in wheat exports reached 90%. On Ukrainian lands, 43% of the global barley harvest, 20% of wheat and 10% of corn was harvested. Export of Ukrainian wheat in the late 19th century and till the First World War played an important role in the economy of the empire. In 1910-1911 the Ukrainian province produced 19.6 million tons of grain per year, of which 4.9 million tons (nearly a quarter of yield) were exported, primarily to Germany (Zolotarev, 1925).

The revolutionary agrarian reforms of Bolsheviks actually destroyed the social and economic structure of grain production, that's why "the breadbasket of Europe," especially in arid 1921, became dependent on grain imports, with no grain for nutrition, seeding and livestock. The dynamics of foreign trade of Ukraine for 1921-1924 was characterized by growth, but in late 1924 a trend towards recession was already traced because exports of grain decreased.

Grain market experts considered Ukraine the traditional grain exporter. Former glory of "the European breadbasket" allowed all-Union procurement offices to see Ukraine as a major exporter of grain, given its geographical position, network of ports and railways. "What does Soviet Ukraine trade in"–wrote A.A. Zolotarev in 1925–of course, bread." Of the total exported goods for the amount of 93. 6 million rubles, bread was sold in the amount of 85.1 million. rubles, i.e., 91%; in addition, almost 60% of the grain was rye, wheat was about 22%, barley constituted 12% and corn accounted for 5%. Our export in 1923-1924 was "rye" (Zolotarev, 1925).

Al'terman was an authoritative grain farming scholar of this period. According to his calculations, Ukraine during the second half of 1920ies, except for 1928-1929, exported 227-250 million tons of grain to the European market, which were 165-180 million pounds less than in 1910-1913, and the reason for this recession, to his opinion, was the consequences of revolutionary changes in the countryside and the destruction of landlordism, limiting of wealthy peasants (Al'terman, 1928).

In 1928 A. Al'terman published data in his book revealing the structure of grain exports, including the proportion of grain exported to the Soviet republics. If the pre-revolution grain turnover was mainly wheat–barley (75% of the commodity weight), the NEP turnover was wheat–rye (86%). The statistics of the Ukrainian grain market, which was developed by A. Al'terman, showed a decrease of exports, but with due account for the volumes exported to the Soviet republics, which showed the emergence of the "breadbasket" of union importance. Thus, in 1923-1924 Ukraine exported 248.5 million pounds of grain, of which in domestic market 80 million pounds were exported to Belarus and 83.4 million pounds were exported to Russia, and the export volume was 85.1 million pounds. But the next year, exports decreased to 42.5 million, and increased in 1926-1927 to 56.2 million tons; 89.6 and 82.6 million tons of grain were taken to the neighboring Soviet republics, respectively (Al'terman, 1928).

In 1925 Ukraine as the Soviet breadbasket was the subject of union and export grain procurement. Corn exports took half the value of agricultural exports, i.e., relatively high yield equalized imbalance of exports. The main consumers of Ukrainian grain were European countries. Thus, in 1925-1926 wheat exported mainly to England, Italy, Belgium and France; rye was exported to Sweden, Germany, Holland, England; barley was purchased by England, Germany, Belgium and corn was supplied to England, Sweden and France (Al'terman, 1928).

It was believed that the export of grain to the state cooperative farms was profitable, given the scarce procurement prices for farmers and export, but the dynamics of foreign exchange earnings showed its instability. Ukraine's export opportunities were limited. It failed during the NEP years to achieve even half of the pre-war volumes of grain export, thus ceased to be "the breadbasket of Europe."

Scarcity of grain crops in Ukraine in 1928 due to freezing of crops had a negative impact on grain procurement and export.

Article of V. M. Soloveichik (1928) noted that crops were 31-38% of gross agricultural production, and marketability did not reach even a third of the wholesale fee (Soloveichik, 1928). He emphasized the instability of grain export resources, which tended to decrease.

So, finding out Ukrainian grain export volumes during the New Economic Policy period and comparing it with the pre-war period, it is necessary to state an undeniable fact of a catastrophic decline. Only in 1923 and 1926, Ukraine reached a quarter of pre-war exports, and in subsequent years the figure was relatively low. The main reason for the decline of exports, according to the analysis of the 1920s literature by the authors which were known analysts, were agrarian reforms of Bolsheviks, i.e., the destruction of landlordism and economic constraints on farms, the share of which accounted for the bulk of grain export. Bet on state and collective farms made in 1919 was false because they gave only 4% of the grain commodity weight in Ukraine.

The grain volume of USSR and the Ukrainian Soviet Socialist Republic in 1920s for export could not compete with the offer of the world's main producers – the United States, Canada, Argentina and Australia. Traditionally, as before 1913, Ukrainian consumers of bread were European countries– Britain, Germany, Italy, France, Sweden, Holland, but it was small batches of grain. Ukraine, starting from the First World War and especially during the revolution and debilitating civil war, lost the glory of the "European breadbasket."

After the Second World War, the idea of Ukraine as the breadbasket of Europe was lost. Interest in the Ukrainian agricultural production revived after the formation of the European Union, primarily on the part of Germany and Austria. The German business press occasionally publishes articles under the title: "Breadbasket of Eastern Europe offers huge opportunities," "Return of the European Granary" (Soloveichik, 1928).

Since the early 1990s, Ukraine is a significant economic and independent player on the world grain market, mainly as an exporter. In other words, the grain sector in Ukraine is" ... a strategic and export-oriented, which in its potential volumes is capable of impacting the global food security. Fluctuations in world grain production proportions causes tension not only in the agricultural sector, but also in the social sector, which requires constant monitoring of dynamics in changes of its volume and analysis of grain market development trends in certain producing countries" (Soloveichik, 1928).

The promising grain industry plays a significant role in the development of the agricultural sector of Ukraine. Corn is a strategic product and a barometer of the state of agriculture, an important export product that should provide significant amounts of currency. In all parts of the country, grain demand remains steady. This suggests liquidity of agricultural products. Corn has good portability and storage level so it creates an opportunity for Ukraine to form government strategic reserves. Besides, grain is the most exported product, through which the state can achieve stability of the currency.

In recent years Ukraine has become one of the leading exporters of grain on the world food market. Export crops perform a vital function for preserving a positive trade balance.

The grain market is a system-integrated market of AIC of Ukraine, having a significant production and export capacity. According to the State Statistics Committee, the planted area in 2015 for crops make up 58% of the national acreage, the grain share in the total value of crop production is 40%.

Changes in foreign policies of Ukraine toward closer economic integration with the countries of EU, accession to the WTO, the existing economic and agriculture potential allow domestic enterprises not only satisfy the domestic market, but also actively participate in international trade. Export of grain takes an important place in the export of agricultural products.

For 2015, the overall export of Ukraine to the EU countries totaled 13,015.2 million US dollars and decreased as compared to 2014 by 23.5% (by 3987.7 million US dollars), imports were 15,330.2 million US dollars and declined by 27.2% (by 5,739 million US dollars). The negative balance was 2,315 US dollars. The largest volumes of exports to the EU countries accounted for agricultural and food products–31.2% of total exports, ferrous metals equaled 20.2%, electrical and mechanical machinery amounted to13.8% mineral products were 11.4%.

Cooperation of Ukraine with the EU in 2015. Among the goods of AIC and food industries, the largest share of exports accounted for crops, i.e., 40.2% of the total volume of AIC goods (including corn–31.5%, wheat–7.3%), fats and oils of animal or vegetable origin equaled 16.8% (sunflower oil–14.1%), seeds and oleaginous fruits amounted to 15.9%. The largest export of grain grown in Ukraine falls on the European Union (Table 8, Figure10). In 2012 the EU market purchased 7.7 million tons of grain in the amount of 1.9 billion US dollars.

Table 8. Ukraine's foreign trade in grains with the world's countries, including the European Union in 2007-2015

Years	Export, million US dollars	Imports, million US dollars	Exports to EU countries, million US dollars	% exports to EU in total exports
2007	763.7	86.6	624.08	81.72
2008	3703.8	146.5	962.30	25.98
2009	3556.2	98.5	454.27	12.77
2010	2467.1	145.6	158.12	6.41
2011	3617.1	219.9	1031.62	28.52
2012	6999.9	249.1	1982.99	28.32
2013	6351.7	306.5	1722.59	27.12
2014	6544.1	366.6	1805.40	27.59
2015	6057.5	154.7	1625.80	26.84

Year 2012 turned out to be successful for Ukraine in terms of consolidation in foreign markets. This is evidenced by the fact that domestic grain has been actively purchased by European countries that 5 years ago doubted its quality. The European Union remains one of the major trading partners of Ukraine. In recent years, the share of grain export in the EU ranges between 25-28% of the total exports. Key figures of foreign trade of Ukraine in grains are listed in the Table 9.

Table 9. Key figures of foreign trade of Ukraine in grains

Indexes	Years							
	2000	2005	2010	2011	2012	2013	2014	2015
Export of grains	122.8	1500.0	2467.1	3617.1	6999.9	6351.7	6544.1	6057.5
Imports of grains	118.4	150.5	145.6	219.9	249.1	306.5	366.6	154.7
Balance of foreign trade in grains	4.4	1349.5	2321.5	3397.2	6750.8	6045.2	6177.5	5902.8
Foreign trade turnover in grains	241.2	1650.5	2612.7	3837.0	7249.0	6658.2	6910.7	6212.2
Export to import coverage ratio	1.1	9.9	16.9	16.5	28.1	20.7	17.9	39.2

Source: based on the data of the State Statistics Service of Ukraine.

When determining Ukraine's place in the global trade in grains. It is worth noting that a considerable part of grain is exported. The share of export of grains in Ukraine's foreign trade is significantly higher than that of imports.

For Ukraine 2014 was remarkable in terms of grain harvest (63.9 million tons of grains), according to the Ministry of Agriculture. In 2015 the grain harvest was 6% less than in the previous year, but despite this fact, the unprecedented wheat export was recorded in that year and 37.4 million tons of grains in the amount of 6,057.5 million US dollars were shipped abroad.

According to "AIC-Inform" that published the "grain" exporters rating, the largest exporter, as in the previous season, was Ukrainian agricultural company "Nibulon." In MY 2014-2015, the company supplied 4.2 million tons of grains and oilseeds to foreign markets. In MY 2015-2016, Nibulon opened up several new export destinations: China, Thailand and Mexico. The latter deserves special attention given the country's geographical remoteness and proximity to the leading agricultural producers – the United States and Argentina. These countries traditionally take a strong market position in the western hemisphere.

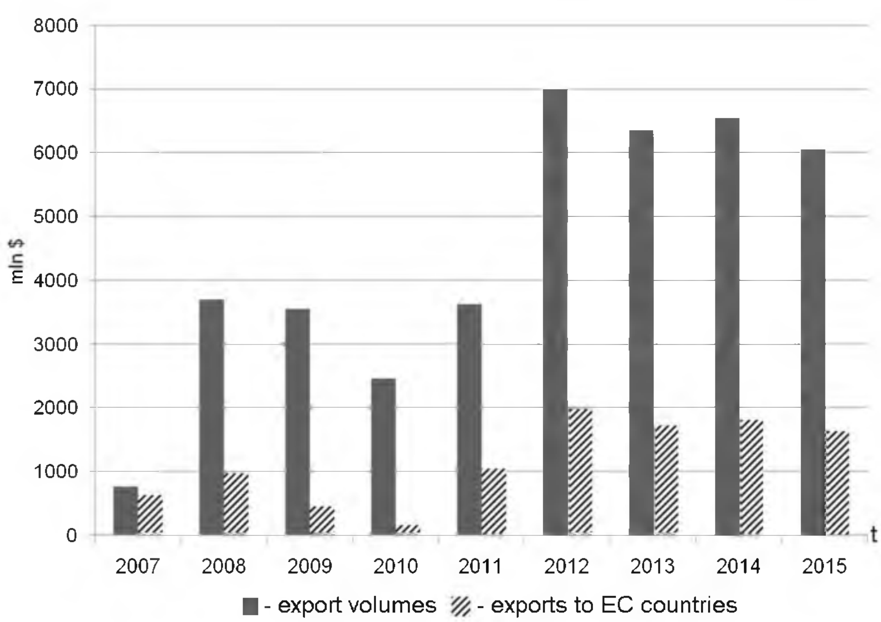


Figure 10. Foreign trade of Ukraine in grains with the EU countries.

The dynamics of trade balance, which can be traced in a greater time period, confirms the lack of stable trends in Ukraine's foreign trade (Table 10).

Table 10. State of Ukraine's Foreign Trade (million US dollars)

Indexes	Years							
	2000	2005	2010	2011	2012	2013	2014	2015
The foreign trade turnover	33376	88100	129355	171030	173803	161035	124857	89780.2
Exports of goods and services	18059	44400	63164.6	82186.4	82408.9	76450.2	64106.8	46804.2
Agricultural export products	734.2	4307	9936.1	12804.1	17880.6	17024	16671	14564
Export of grain	122.8	1500.0	2467.1	3617.1	6999.9	6351.7	6544.10	6057.5
Imports of goods and services	15317	43700	66189.9	88843.4	91394.2	84584.7	60750.6	42976
Imports of agricultural products	407.3	2684.1	5763.6	6346.7	7875.4	8600.0	6100.0	3800.0
Imports of grain	118.4	150.5	145.6	219.9	249.1	306.5	366.6	154.7
Balance of trade	2742.5	700	-3025.3	-6657	-8985.3	-8134.5	3356.2	3828.2

Source: based on the data of the State Statistics Service of Ukraine.

During 2000-2012, the turnover increased by 5.2 times. Further, under the influence of the financial and economic situation in the country, there go three years of decline in trade turnover with subsequent rapid almost double decline, which is still taking place now. The foreign trade balance, after having been kept at the positive level since 2010, changed to negative. In 2014, under the conditions of a significant drop in turnover, the surplus was resumed, but this was due to the more rapid reduction in imports than in exports (exports in 2015 decreased by 27%, imports declined by 29.2%).

In turn, the state of foreign trade of agricultural products in Ukraine can be analyzed based on data from Table 11.

Table 11. The main value of external trade of agricultural products Ukraine, mil. US dollars

Indexes	Years							
	2000	2005	2010	2011	2012	2013	2014	2015
Foreign trade turnover in– agricultural products	1141.5	6991.1	15699.7	19150.8	25756	25624	22771	18364
Exports of agricultural products	734.2	4307	9936.1	12804.1	17880.6	17024	16671	14564
Agricultural products export share in general national exports,%	4.07	9.70	15.73	15.58	21.70	22.27	26.01	31.12
Imports of agricultural products	407.3	2684.1	5763.6	6346.7	7875.4	8600.0	6100.0	3800.00
Agricultural products import share in general national imports,%	5.93	6.14	8.71	7.14	8.62	10.17	10.04	8.84
Agricultural products foreign trade balance	326.9	1622.9	4172.5	6457.4	10005.2	8424	10571	10764
The coverage ratio of export import	1.80	1.60	1.72	2.02	2.27	1.98	2.73	3.83

Source: based on the data of the State Statistics Service of Ukraine.

It should be noted Ukraine has a potential as a major exporter of agricultural products. Over the analyzed period, there has been a tendency to increase in the share of exports of agricultural products in the general state export from 4.1% in 2000 to 31.1% in 2015, while in recent years a decline in the share of agricultural imports has been observed, which indicates an increase of security in the country's own agricultural products. The import-export ratio is of primary importance in terms of foreign trade security. The data given shows that export revenues fully cover the cost of importing. It plays a positive role in the country development.

Liberalization and patronage not only personify objective and subjective contradictions that constantly arise in the global market, but have to overcome them through appropriate effective economic mechanisms. Content wise, the mechanism of liberalization and protectionism, according to V.I. Hubenko, is a dynamic system of international relation, connected with purposeful movement of capital between countries and a relevant regulatory function of public administration aimed at protecting national interests (Prisyazhnyuk et al., 2011).

Studies show that an increase in agricultural production in Ukraine has led to an increase in agricultural exports. According to the State Statistics Service, the share of exports of agricultural products in the structure of Ukraine's total exports in 2015 was 31.12%. At the same time, the volume of AIC products export grew by 3.4 times up to 14.6 billion US dollars (Table 12). An export of these products by 58% covers imports. In Ukraine, the foreign trade balance by four groups of agro-food products is generally positive, and food export is almost 2.4 times more than its import.

Table 12. Dynamics of AIC products export of Ukraine in 2005-2015, million US dollars

Indexes	Years								2015-2005, times
	2005	2009	2010	2011	2012	2013	2014	2015	
Crop production	1695.8	5034.9	3976.3	5532.1	9213.9	1083.1	1014.5	823.4	0.16
Animal products	732.2	596.0	771.4	936.6	961.3	8849.1	8736.1	7971.5	13.38
Production of oil-fat industry	587.2	1796.0	2617.3	3396.4	4211.5	3497.4	3822.0	3299.8	1.84
Food products	1291.7	2088.0	2571.1	2939.0	3493.9	3500.5	3096.3	2468.4	1.18
Exports of AIC– all	4307.0	9514.9	9936.1	12804.1	17880.6	17024	16671	14564	3.38

Source: based on the data of the State Statistics Service of Ukraine.

In the global market, Ukraine makes export and import transactions in agri-food products with 117 countries at various segments of the global market: Asia, Europe, Africa and other countries. More than half the volume of exports of domestic AIC products is provided for by plant origin (51.5%), mainly due to the sale of grains: wheat, corn, barley. This has led to a significant expansion of trade relations in the world grain market. Thus, in 2005 the export geography included 75 countries, in 2012 this figure reached 101, i.e., 26 countries more. The main importers of Ukrainian wheat in 2005-2012 were Spain, Egypt, Israel and Tunisia, which over the years have imported 7.6, 6.0, 4.2 and 3.0 million tons, respectively (Sabluk, 2009). The main partners of Ukraine in corn imports are Belarus, Spain, Iran, Tunisia and Egypt respectively having purchased 1.1; 5.5; 3.9; 1.8 and 8.2 mil. tons respectively (Sabluk, 2008). The main importers of barley were the Middle East: Saudi Arabia, Iran and Jordan, which had exported over 18.3 million tons from Ukraine for 2005-2012.

Exports of agricultural products from Ukraine in 2015 amounted to 14.6 billion USD. It exceeded imports by 11.1 billion US dollars – an unprecedented record for the country since its independence. Exports of agricultural products in Ukraine for the year exceeded imports by unprecedented 11 billion US dollars.

The basis of the commodity structure of Ukrainian agricultural exports was grains – 16% of total exports, fats and oils – 9%, and oilseeds – 4%. Despite the unfavorable price situation in the world markets for 12 months in 2015 we've got a positive balance of foreign trade in AIC – 11.1 billion US dollars. This is a record figure in the history of Ukraine's independence. The positive balance of foreign trade in agricultural products in 2015 increased by 0.4 billion US dollars, compared to 2014 and by 1.9 billion US dollars compared to 2013. The total volume of export of Ukrainian agricultural products for the last year was 14.6 billion US dollars. At the same time the share of exports of agricultural commodities in the commodity structure of Ukraine's exports in 2015 was also an unprecedented figure – 38.2%. The basis of the commodity structure of Ukrainian agricultural exports were grains – 16% of total exports, fats and oils – 9% and oilseeds – 4%. The surplus of foreign trade in Ukraine increased by 2.6 times. In 2014 Ukraine exported agricultural products in the amount of 16.7 billion US dollars, i.e., 1.8% less than in the previous year. An agricultural import to Ukraine in 2014 was reduced by 25.8% up to 6.1 billion US dollars. The most exported Ukrainian agricultural products in 2014 were sunflower oil (21.3% of total AIC exports), corn (20.1%), wheat (13.7%), mill cake, except for soybean and peanut –5.6% and rape (5.2%). Thus, the supply of grain abroad accounted for 39% of total exports of agricultural products from Ukraine and fats and oils corresponded to 23%.

9. Port Terminals for Grain Export from Ukraine

Export of grain is for more than 90% provided by transportation on ships of Ukraine. The main flow (over 60%) through grain terminals in the ports is from June till December, and the peak is in November-December, when the capacities are loaded at 90%. According to the Transport Strategy Center, the capacity for transshipment of grain in Ukrainian ports is about 44.1 million tons per year with the ability to simultaneously store nearly 2.4 million tons (Table 13). Usually the busiest three ports of Odesa (Odesa SP, Pivdennyi, Illichivsk, Mykolaivsky SP and terminals of Nibulon and Avlita.

Table 13. Characteristics of Sea Ports for Transshipment of Grain in 2013

Port/Terminal	Volume of simultaneous storage, thous. tons	Annual capacity, mil. t	In%, total	
			Volume of simultaneous storage, thous. tons	Annual capacity, mil. t
Odesa SP	340	6000	14.2	13.6
TIS (Pivdennyi)	290	4800	12.1	10.9
Ilichivsk SP	200	4000	8.4	9.1
Bunge (Mykolaiv)	140	4000	5.9	9.1
Avlita (Sevastopol)	170	3500	7.1	7.9
Ilichivsk SRH	120	3500	5.0	7.9
Nibulon (Mykolaiv)	130	3000	5.4	6.8
Brooklyn-Kyiv	240	3000	10.1	6.8
Borivazh- (Pivdennyi)	130	2000	5.4	4.5
Mykolaivsky SP	170	2000	7.1	4.5
Nika-Tera (Mykolaiv)	140	2000	5.9	4.5
Khersonsky SP	120	1200	5.0	2.7
Other	198	5140	8.3	11.6
Together	2388	44140	100.0	100.0

Source: based on the data of the State Statistics Service of Ukraine.

In 2013/ 20 14 MY through seaports Ukraine exported a record amount of grain, as well as throughput of ports and terminals was increased (Table 14, Figure11). In addition, Ukraine in 2013/14 MY exported a record amount of grain in containers. The modernization of some grain trans-shipping enterprises and commissioning of new facilities made it possible to produce about half of the grain export from Ukraine with large tonnage fleet.

Table 14. Dynamics of Grain Transshipment by Ukrainian Seaports, thous. Tons

Ports	Years			2015 in% to 2013
	2013	2014	2015	
TIS (Pivdennyi)	6165.3	9139.8	9760.0	158.3
Mykolaiv	6938.7	6932.9	8760.0	126.2
Odesa	5338.6	6675.9	8610.0	161.3
Il'ichevsk	3835.5	4593.0	5090.0	132.7
SMT "Oktyabrsk"	1643.1	2241.8	2450.0	149.1
Berdyansk	681.6	1286.9	1000.0	146.7
Kherson	1354.7	1220.6	943.6	69.7
Mariupol	725.9	748.1	407.5	56.1
Reni	449.1	624.8	245.0	54.6
Ismail	14.4	65.7	159.7	1109.0

Source: according to UkrAgroConsult.

According to port sources, in 2013/2014 MY export shipment of grain through the ports of Ukraine reached the record figure of 31.5 million tons. The previous record export shipments through the ports were in 2008/2009 MY at 23.5 million tons.

In the first half of 2013/2014 MY, seaports of Ukraine reached a new record high monthly throughput capacity for grain handling–5 million tons were shipped in December 2013 due to favorable weather conditions and corn high-yield.

Grains in 2013/2014 MY were characterized by record volumes of grain shipments in containers. According to UkrAgroConsult, in 2013/2014 MY containerized grain exports from Ukraine totaled a record 190 thousand tons' vs 66 thousand tons in 2012/ 013 MY and exceeded the previous record of 2008/2009 MY.

In 2013/2014 MY, the proportion of large fleet in grain exports from Ukraine increased to a record 49% compared to less than 10% in 2007/2008 MY. The share of small tonnage fleet in export shipments is declining, despite the development of river transport. In addition, in 2012/2013 MY Ukraine shipped the biggest batch of grain in the volume of 93 thousand tons.

In the Ukrainian ports for 2015, the volume of transshipment was 37.46 million tons of grain cargoes (including 36.84 million tons of grain), i.e., 10.5% (12.4%) more than in 2014. Transshipment by seaports of Ukraine for 2015: Pivdennyi – 9.76 million tons of grain cargoes, which is 6.8% more than in 2014; Mykolaiv seaport – 8.76 million tons (+26.4%); Odesa–8.61 million tons (+29%), Ilichivsk – 5.09 million tons (+10.9%); Berdiansk – 1.00 million tons (-22.2%), Kherson SP – 943.6 thousand tons (-22.7%); Mariupol port – 407.45 thousand tons (-45.5%), Ismail – 159.65 thousand tons (+143%).

Today, oldest port elevators – Odesa and Mykolaiv owned by the State Food and Grain Corporation of Ukraine, are being modernized. As a result, the Mykolaiv grain elevator transshipment capacity will increase by 35%. A series of modernization measures at the Odesa port elevator is also planned with the purpose to increase transshipment terminal capacities up to 3 million tons per year.

According to the Administration of Seaports of Ukraine, under the plan of modernization of ports, the Illichivsk port plans to increase its capacity for handling grain and leguminous cargoes by nearly 12 million tons, Pivdennyi – by 21 million tons, Odesa – by 5 million tons. The construction of the "Brooklyn" grain terminal at Androvsky Mol with the capacity of 4 million tons should be noted. It should be recalled that the first phase of the grain terminal was opened in 2013 – 11 tanks designed to store 72.4 thousand tons of grain.

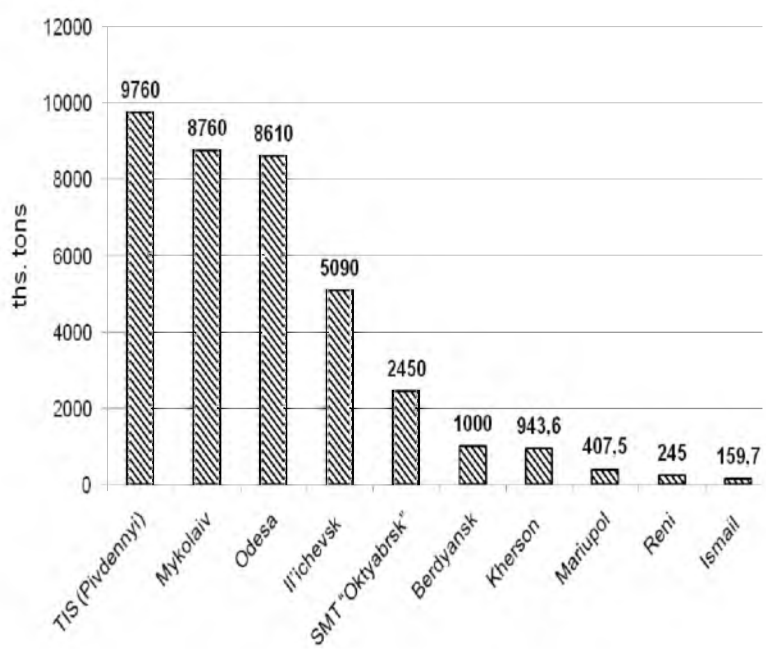


Figure 11. The volume of grain transshipment by Ukrainian sea ports in 2015.

The capacity for storage of grain was increased at the "Nika-Tera" terminal, from 40 up to 210 thousand tons, which allowed the company in 2013/2014 MY to double the volumes of grain.

In the spring of 2014, a new grain terminal in the port of Ochakiv was commissioned with the capacity of 250 thousand tons. According to available data, in 2013/2014 MY, this terminal shipped 11.8 thousand tons of grain for export.

According to calculations of UkrAgroConsult, for the period of July 2015–March 2016 export shipments of grain cargoes through maritime ports of Ukraine have totaled 30.4 million tons, which is 12% more than in the same period of the last season (27.1 million etc.). In 2014/2015 MY exports of grain through the ports reached an unprecedented figure of 34.6 million tons.

Taking into consideration the record pace of exports and forecast of record grain exports from Ukraine, UkrAgroConsult expects that in this 2015/2016 MY shipment of grain through the ports can update the record of the previous season.

CONCLUSION

Among former members of Soviet Union – Kazakhstan, Russia and Ukraine have the highest potential for increase of food supplies and strengthening of food security in the world, which recently is becoming more important in establishment of the world agricultural market. Crops export from Black Sea ports was large-scale even at the end of 19th century. The situation has started repeating in recent times: in last years Ukraine has become one of the leading grain exporters on the world food market.

Global and regional consequences in change of climate results into rise of uncertainties in yield for main consumer agricultural crops. With a favorable combination of meteorological factors discontinuities in soil fertility, caused by both natural regularities and influence of agricultural production of various duration and intensity, are seriously leveled off. It was shown that as far as lands were being used for agricultural purpose and soil-degradation processes were being developed both leveling of differences in lands quality and fertility reduction at different rate depending on differences of primary fertility level took place. With an unfavorable combination of agroclimatic conditions the pattern of productivity space distribution is especially informative for non-correlated years, when soil fertility is shown most clearly. Complex comparable estimation of lands quality should become one of the most important improvement mechanisms in new economic conditions. It permits to assess added profit in agriculture arising in labor productivity with equivalent expenses on lands with highest fertility and to create an objective basis for establishment of the fair land tax.

Rational use of land resources and introduction of adaptive argotechnologies in terms of changing climate is a guarantee of high stable yields and provision of competitive positions of agricultural producers. Introduction of innovative agrotechnologies ensured yield rise in average by 4.5 times and stabilization of agricultural production of the process by 2.2 times for last 150 years.

Grain market of the country is important indicator of the quality of economic reforms, implementation of agri-food policy. Grain market is characterized by its dynamism and rapid growth of supply. Grain market can serve as a kind of model of development other agricultural markets, raw materials and food. It includes almost all the elements of a market economy. The development of the grain market affects not only a wide range of issues relating to the functioning of the grain farming directly, but the whole agri-food complex.

REFERENCES

Agrarnii tizhden' (2011). *Vseukraïns'ka dilova gazeta,* 19(188): 5-6. [Agricultural week. *Ukrainian business newspaper,* 19(188): 5-6].

Agricultural support policies in transition economies. (2000). *World Bank Technical Paper*, 470: 11-114.

Al'terman, A. (1928). Problema tovarnosti zernovogo khozyaistva Ukrainy s sotsial'no-ekonomicheskoi tochki zreniya. *Khozyaistvo Ukrainy,* 6: 101-110. [The problem of marketability of the grain economy of Ukraine with the socio-economy point of view. *Economy of Ukraine,* 6: 101-110].

Al'terman, A. (1928). Rozvitok khlibnogo gospodarstva ta khlibnoï torgivli Ukraini. *Kharkiv:* 526. [Development of grain and grain trade economy of Ukraine. *Kharkiv:* 526].

Anderson, K., Jensen, H. G., Nelgen, S. and Strutt, A. (2016). What is the Appropriate Counterfactual When Estimating Effects of Multilateral Trade Policy Reform? *Journal of Agricultural Economics*, 67 (3): 764-778. DOI: 10.1111/1477-9552.12181.

Bardili, J. (1730). Reisen und Campagnen durch Teutschland in Polen, Lithauen, roth und weiß Reußland, Volhynien, Severien und Ukrainie. *Stuttgart*: 422.

Bezuglii, M. D. (2012). Stan, osnovni tendentsiï rozvitku sil's'kogo gospodarstva Ukraïni protyagom 2011 roku ta napryami rozvitku v 2012 rotsi. *Ekonomika APK,* 4: 3-14. [Stan, the main trends of agriculture of Ukraine for 2011 and areas of development in 2012. *Economy AIC,* 4: 3-14].

Bijanzadeh, E. and Mokarram, M. (2016). The self-organizing map for determination of main features related to biological yield and yield of wheat. *Australian Journal of Crop Science*, 10 (4): 539-545. DOI: 10.21475/ajcs.2016.10.04.p7336x.

Bose, P., Kasabov, N. K., Bruzzone, L. and Hartono, R. N. (2016). Spiking Neural Networks for Crop Yield Estimation Based on Spatiotemporal Analysis of Image Time Series. *IEEE Transactions on Geoscience and Remote Sensing*. Article in Press. DOI: 10.1109/TGRS.2016.2586602.

Bren D'Amour, C., Wenz, L., Kalkuhl, M., Christoph Steckel, J. and Creutzig, F. (2016). Teleconnected food supply shocks. *Environmental Research Letters*, 11 (3), art. no. 035007. DOI: 10.1088/1748-9326/11/3/035007.

Brodel,' F. (1995). Material'na tsivilizatsiya, ekonomika i kapitalizm, XV - XVIII st. *Strukturi povsyakdennosti: mozhlive i nemozhlive:* 544. [Material civilization, economy and capitalism, XV - XVIII century. *The structures of everyday life, possible and impossible:* 544].

Brosig, S., Glauben, T., Levkovych, I., Prehn, S. and Teuber, R. (2016). Are We Moving Towards Functioning Agricultural Markets and Trade Relations? *Journal of Agricultural Economics*, 67 (3): 677-684. DOI: 10.1111/1477-9552.12183.

Bystritskaya, T. P. and Osychnyuk, V. V. (1975). Pochvy i pervichnaya biologicheskaya produktivnost' stepei Priazov'ya. Moscow: Nauka [Soils and primary biological productivity of the Azov Sea steppes. Moscow: Nauka].

Cai, H. and Song, Y. (2016). The state's position in international agricultural commodity trade A complex network. *China Agricultural Economic Review*, 8 (3): 430-442. DOI: 10.1108/CAER-02-2016-0032.

Challinor, A. (2009). Towards the development of adaptation options using climate and crop yield forecasting at seasonal to multi-decadal timescales. *Environmental Science and Policy*, 12 (4): 453-465. DOI: 10.1016/j.envsci.2008.09.008.

Danilenko, O. V. (2010). Zhitnitsya Єvropi: Rozvitok ukraïns'kogo khlibnogo eksportu v roki nepu. *Istorichni i politologichni doslidzhennya,* 3-4 (45-46):

171; 11. [Breadbasket of Europe: The development of Ukrainian grain exports during the NEP. *Historical and political research,* 3-4 (45-46): 171; 11].

Davenport, F., Steigerwald, D. and Sweeney, S. (2016). Open trade, price supports, and regional price behavior in Mexican maize markets. *Economic Geography*, 92 (2): 201-225. DOI: 10.1080/00130095.2015.1112731.

DePaepe, J. L. and Álvarez, R. (2016). Wheat yield gap in the pampas: Modeling the impact of environmental factors. *Agronomy Journal*, 108 (4): 1367-1378. DOI: 10.2134/agronj2015.0482.

Derzhavna sluzhba statistiki Ukraini. http://www.ukrstat.gov.ua/. [State Statistics Service of Ukraine. http://www.ukrstat.gov.ua].

Dronin, N. and Kirilenko, A. (2011). Climate change, food stress, and security in Russia. *Regional Environmental Change*, 11 (1): 167-178. DOI: 10.1007/s10113-010-0165-x.

ES i Egipet kupuyut' naibil'she ukraïns'kogo zerna. http://economics.unian.net/ukr/news/155893-es-i-egipet-kupuyut-naybilshe-ukrajinskogo-zerna.html. [EU and Egypt buy most of Ukrainian grain. http://economics.unian.net/ukr/news/155893-es-i-egipet-kupuyut-naybilshe-ukrajinskogo-zerna.html.].

Fellmann, T., Hélaine, S. and Nekhay, O. (2014). Harvest failures, temporary export restrictions and global food security: the example of limited grain exports from Russia, Ukraine and Kazakhstan. *Food Security*. Article in Press. DOI: 10.1007/s12571-014-0372-2.

Galushko, V. P. and Beregovogo, V. K. (2011). Ekonomika svitovogo sil's'kogo gospodarstva. *Kiïv, ZAT "Nichlava," TOV TSTI "Energetika ta elektrifikatsiya":* 1000. [Economics of world agriculture. Kyiv. JSC "Nichlava" TSTI Ltd. "Energy and Electrification": 1000].

Ge, H., Gray, R. and Nolan, J. (2015). Agricultural supply chain optimization and complexity: A comparison of analytic vs simulated solutions and policies. *International Journal of Production Economics*, 159: 208-220. DOI: 10.1016/j.ijpe.2014.09.023.

Gershgorin, B. and Majda, A. J. (2012). Quantifying uncertainty for climate change and long-range forecasting scenarios with model errors. *Part I: Gaussian models. Journal of Climate*, 25 (13): 4523-4548. DOI: 10.1175/JCLI-D-11-00454.1.

Götz, L., Djuric, I. and Nivievskyi, O. (2016). Regional price effects of extreme weather events and wheat export controls in Russia and Ukraine. *Journal of Agricultural Economics*, 67 (3): 741-763. DOI: 10.1111/1477-9552.12167.

Haghverdi, A., Leib, B. G., Washington-Allen, R. A., Buschermohle, M. J. and Ayers, P. D. (2016). Studying uniform and variable rate center pivot irrigation strategies with the aid of site-specific water production functions. *Computers and Electronics in Agriculture*, 123: 327-340. DOI: 10.1016/j.compag.2016.03.010.

Hauteville, de (1697). Polnischer Staat oder eigentliche Beschreibung des Königreichs Polen und des Grossherzogthums Litauen. *Cölln*: 44.

Ivaniuk, U. V. (2014). Determinants of Ukraine's agricultural trade: The time-varying estimates. *World Applied Sciences Journal,* 30 (11): 1593-1598. DOI: 10.5829/idosi.wasj.2014.30.11.14219.

Janson, J. E. (1881). Opyt statisticheskogo issledovaniya o krest'yanskikh nadelakh i platezhakh. SPb. [The experience of statistical research on peasant allotments and payments. SPb].

Jia, R. L., Wang, D. H., Tu, J. Q. and Li, S. P. (2016). Correlation between agricultural markets in dynamic perspective – Evidence from China and the US futures markets. *Physica A: Statistical Mechanics and its Applications*, 464: 83-92. DOI: 10.1016/j.physa.2016.07.048.

Kirilov, Yu. E. (2014). Brend "Zhitnitsya Evropi": mif chi real'nist.' *Ekonomika APC,* 3: 101-107. [Brand of the "breadbasket of Europe": Myth or Reality. *Economy AIC,* 3: 101-107].

Kokic, P., Crimp, S. and Howden, M. (2011). Forecasting climate variables using a mixed-effect state-space model. *Environmetrics*, 22 (3): 409-419. DOI: 10.1002/env.1074.

Kotljakov, V. M., Glazovskij, N. F. and Nikolaeva, G. M. (1992). Institut geografii Rossiiskoi akademii nauk na rubezhe 90-kh godov. Izvestiya – Akademiya Nauk, Seriya Geograficheskaya, 3: 72-75 [Institute of Geography of the Russian Academy of Sciences at the turn of the 90 s. Izvestiya – Akademiya Nauk, Seriya Geograficheskaya, 3: 72-75].

Kovarsky, A. E. (1930). Polevodstvo Askaniya-Nova v istoricheskom obozrenii za 100 let (1828-1929 goda). *Byul. Fitotekhn. st.,* 1: 79-128. [Historical Review of Askania-Nova Field Husbandry, 1828-1929. *Bulletin of Phototechnical Station,* 1: 79-128].

Kuz'michov, V. P. (1970). Boniteti ґruntiv Ukraïni. *Agrokhimiya i ґruntoznavstvo*, 13: 125-148. [Bonitets Ukrainian soil. *Agricultural Chemistry and Soil Science*, 13: 125-148].

Levers, C., Butsic, V., Verburg, P.H., Müller, D. and Kuemmerle, T. (2016). Drivers of changes in agricultural intensity in Europe. *Land Use Policy*, 58: 380-393. DOI: 10.1016/j.landusepol.2016.08.013.

Li, W., Feng, C., Dai, C., Li, Y., Li, C. and Liu, M. (2016). An inexact risk management model for agricultural land-use planning under water shortage. *Frontiers of Earth Science*, 10 (3): 419-431. DOI: 10.1007/s11707-015-0544-1.

Liang, X. Z., Xu, M., Yuan, X., Ling, T., Choi, H. I., Zhang, F., Chen, L., Liu, S., Su, S., Qiao, F., He, Y., Wang, J. X. L., Kunkel, K. E., Gao, W., Joseph, E., Morris, V., Yu, T. W., Dudhia, J. and Michalakes, J. (2012). Regional climate-weather research and forecasting model. *Bulletin of the American Meteorological Society*, 93 (9): 1363-1387. DOI: 10.1175/ BAMS-D-11-00180.1.

Liefert, W. M., Serova, E. and Liefert, O. (2010). The growing importance of the former USSR countries in world agricultural markets. *Agricultural Economics,* 41 (1): 65-71. DOI: 10.1111/j.1574-0862.2010.00489.x.

Likhochvor, V. V., Petrinenko, V. F. and Ivashchuk, P. V. (2008). Zernovirobnitstvo. *L'viv, NVF "Ukraïns'ki tekhnologiï":* 624. [Grain production. *Lviv, Firm "Ukrainian technologies":* 624].

Lisetskii, F. and Pichura V. (2016). Steppe ecosystem functioning of East European Plain under age-long climatic change influence. *Indian Journal of Science and Technology*, 9(18): 1-9. http://dx.doi.org/10.17485/ ijst/2016/v9i18/93780.

Lisetskii, F. N. (2007). Interannual variation in productivity of steppe pastures as related to climatic changes. *Russian Journal of Ecology*, 38 (5): 311-316.

Lisetskii, F. N. and Pichura, V. I. (2016). Assessment and forecast of soil formation under irrigation in the steppe zone of Ukraine. *Russian Agricultural Sciences,* 2: 154-158. http://dx.doi.org/10.3103/S 1068367416020075.

Lisetskii, F. N., Buryak, J. A., Zemlyakova, A. V. and Pichura, V. I. (2014). Basin organizations of nature use, Belgorod region. *Biogeosystem Technique*, 2 (2): 163-173. DOI: 10.13187/bgt.2014.2.163.

Lisetskii, F. N., Chernyavskikh, V. I.and Degtyar, O. V. (2010). Pastures in the zone of temperate climate: trends for development, dynamics, ecological fundamentals of rational use. *Pastures: Dynamics, Economics and Management*: 51-84. https://www.novapublishers.com/catalog/ product_info.php?products_id=12508.

Lisetskii, F. N., Pavlyuk, Ya. V., Kirilenko, Zh. A. and Pichura, V. I. (2014). Basin organization of nature management for solving hydroecological problems. *Russian Meteorology and Hydrology*, 39 (8): 550-557. http://dx.doi.org/10.3103/s106837391408007X.

Lisetskii, F.N., Pichura, V.I., Pavlyuk, Y.V. and Marinina O.A. (2015). Comparative assessment of methods for forecasting river runoff with different conditions of organization. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*, 6 (4): 56-60.

Lisetskii, F. N., Stolba, V. F. and Goleusov, P. V. (2016). Modeling of the evolution of steppe Chernozems and development of the method of pedogenetic chronology. *Eurasian Soil Science*, 49 (8): 846-858. http://dx.doi.org/10.1134/S1064229316080056.

Lisetskii, F. N., Tokhtar, V. K., Ostapko, V. M., Prykhodko, S. A. and Petrunova, T. V. (2016). Regularities and features of differentiation and anthropogenic transformation of steppe vegetation. *Terrestrial Biomes: Geographic Distribution, Biodiversity and Environmental Threats*: 103-126.

Marj, A. F. and Meijerink, A. M. J. (2011). Agricultural drought forecasting using satellite images, climate indices and artificial neural network. *International Journal of Remote Sensing*, 32 (24): 9707-9719. DOI: 10.1080/01431161.2011.575896.

Materialy dlya otsenki zemel' Khersonskoi gubernii po zakonu 8 iyunya 1893 goda. (1902). V. II, III. Kherson: 81 p., 326 p. [Materials for the valuation of land Kherson province by law June 8, 1893. (1902). Vol. II, III. Kherson: 81 and 326].

Materialy dlya otsenki zemel' Khersonskoi gubernii. (1890). V. VI. Khersonskii uezd. Kherson. [Materials for the valuation of land Kherson province. (1890). V. 6. Kherson district. Kherson: 400].

Mekhovskii, M. (1936). Traktat o dvukh Sarmatiyakh. *Moskva:* 79. [Treatise of two Sarmatyyah. *Moscow:* 79].

Mel'nik, L.L. (2010). Eksport zerna Ukraïnoyu: stan, problemi ta perspektivi. *Agrosvit,* 23: 7-10. [Export of grain Ukraine: state, problems and prospects. *Agrosvit,* 23: 7-10].

Melnyk, T. and Golovachova, O. (2015). Foreign trade and regulatory policy in agriculture: National and international experience. *Economic Annals-XXI*, 3-4 (2): 12-16.

Meyfroidt, P., Schierhorn, F., Prishchepov, A. V., Müller, D. and Kuemmerle, T. (2016). Drivers, constraints and trade-offs associated with recultivating abandoned cropland in Russia, Ukraine and Kazakhstan. *Global Environmental Change,* 37: 1-15. DOI: 10.1016/j.gloenvcha.2016.01.003.

Mokarram, M. and Bijanzadeh, E. (2016). Prediction of biological and grain yield of barley using multiple regression and artificial neural network models. *Australian Journal of Crop Science*, 10 (6): 895-903. DOI: 10.21475/ajcs.2016.10.06.p7634.

Monsalve, F., Zafrilla, J. E. and Cadarso, M. T. (2016). Where have all the funds gone? Multiregional input-output analysis of the European Agricultural Fund for Rural Development. *Ecological Economics*, 129: 62-71. DOI: 10.1016/j.ecolecon.2016.06.006.

Mizhnarodna rada po zernu. http://www.igc.int/downloads/gmrsummary/gmrsummr.pdf. [The International Council Grains. http://www.igc.int/downloads/ gmrsummary/ gmrsummr.pdf].

Nabokih, A. I. (1911). Sostav i proiskhozhdenie razlichnykh gorizontov nekotorykh yuzhno-russkikh pochv i gruntov. St. Petersburg. [The composition and origin of the various horizons of some of the South Russian soil and ground. St. Petersburg].

Pall, Z., Perekhozhuk, O., Teuber, R. and Glauben, T. (2013). Are Russian Wheat Exporters Able to Price Discriminate? Empirical Evidence from the Last Decade. *Journal of Agricultural Economics*, 64 (1): 177-196. DOI: 10.1111/1477-9552.12006.

Pantazi, X. E., Moshou, D., Alexandridis, T., Whetton, R. L. and Mouazen, A. M. (2016). Wheat yield prediction using machine learning and advanced sensing techniques. *Computers and Electronics in Agriculture*, 121: 57-65. DOI: 10.1016/j.compag.2015.11.018.

Pichura, V. I. (2015). Basin approach to spatial-temporal modeling and neyroprediction of potassium content in dry steppe soils. *Biogeosystem Technique*, 2 (4): 172-184.DOI: 10.13187/bgt.2015.4.172.

Pichura, V. I., Pilipenko, Yu. V., Lisetskiy, F. N. and Dovbysh, O. E. (2015). Forecasting of Hydrochemichal Regime of the Lower Dnieper Section using Neurotechnologies. *Hydrobiological Journal*, 51 (3): 100-110. DOI:10.1615/HydrobJ.v51.i3.80.

Postnikov, V. E. (1891). Yuzhno-russkoe krest'yanskoe khozyaistvo. Moscow [South-Russian peasant economy. Moscow].

Prisyazhnyuk, V. M., Zubets,' M. V. and Sabluk, P. T. (2011). Agrarnii sektor ekonomiki Ukraini (stan i perspektivi rozvitku). *NNTSIAE:* 1008. [The agricultural sector of Ukraine (state and prospects). *NNTSIAE:* 1008].

Pykhtin, I. G., Veklenko, V. I. (1988). Usloviya ustoichivoi produktivnosti sevooborotov. *Zemledelie*, 3: 41-43. [Terms rotations sustainable yield. *Zemledelie*, 3: 41-43].

Sabluk, P. T., Kaliev, G. A. and Vlasov, V. I. (2008). Svitove i regional'ne virobnitstvo agrarnoï produktsiï: monografiya. *Kiiv:* 210. [Global and regional agricultural production: monograph. *Kyiv:* 210].

Sabluk, R. P. (2009). Suchasni tendentsiï svitovoï torgivli zernom. *Ekonomika APC,* 9: 84-88. [Modern trends in world grain trade. *Economy AIC,* 9: 84-88].

Saharov, S. I. and Hamzin, M. N. (1965). Opyt primeneniya vychislitel'nykh mashin dlya kachestvennoi otsenki zemel' *Izvestiya – Akademiya Nauk, Seriya Geograficheskaya*, 5: 105-108. [Experience in the use of computers for the qualitative assessment of land. *Izvestiya – Akademiya Nauk, Seriya Geograficheskaya*, 5: 105-108].

Sbornik Khersonskogo zemstva. (1904), 3: 33. [The collection of the Kherson Zemstvo (1904), 3: 33].

Schindler, J., Graef, F., König, H., Mchau, D., Saidia, P. and Sieber, S. (2016). Sustainability impact assessment to improve food security of smallholders in Tanzania. *Environmental Impact Assessment Review*, 60: 52-63. DOI: 10.1016/j.eiar.2016.04.006.

Schmitz, A. and Meyers, W. H. (2015). Transition to agricultural market economies: The future of Kazakhstan, Russia and Ukraine. *Transition to Agricultural Market Economies: The Future of Kazakhstan, Russia and Ukraine:* 258.

Shif, L. I. (1925). Materialy po sel'skokhozyaistvennomu raionirovaniyu Odesskoi gubernii. Odessa: Izd. Odes. gub. stat. byuro: 315. [Materials on agricultural zoning of Odessa province. Odessa: Odes. Stat. Office: 315].

Shpara, D. (2008). Zernovye kul'tury. *Moskva*: 656. [Cereal culture. *Moscow*: 656].

Soloveichik, V. M. (1928). Osnovnye voprosy 5-letnego plana rekonstruktsii sel'skogo khozyaistva USSR. *Khozyaistvo Ukrainy,* 10: 25-43. [Basic questions 5-year-old plan of reconstruction of the agricultural sector of USSR. *Economy of Ukraine,* 10: 25-43].

Statistichnii zbirnik Ukraini za 2012: Spivrobitnitstvo Ukraini ta EU (2012). http://www.ukrstat.gov.ua. [Statistical Yearbook of Ukraine for 2012: Cooperation between Ukraine and the EU. http://www.ukrstat.gov.ua].

Statistichnii zbirnik Ukraini za 2013: Spivrobitnitstvo Ukraini ta EU (2013). http://www.ukrstat.gov.ua. [Statistical Yearbook of Ukraine for 2013: Cooperation between Ukraine and the EU. http://www.ukrstat.gov.ua].

Statistichnii zbirnik Ukraini za 2015: Spivrobitnitstvo Ukraini ta EU (2015). http://www.ukrstat.gov.ua. [Statistical Yearbook of Ukraine for 2015: Cooperation between Ukraine and the EU. http://www.ukrstat.gov.ua].

Statistiko-ekonomicheskii atlas Kryma. Simferopol.' (1922). 1: 49 [Statistical and Economic Atlas of the Crimea. Simferopol, 1: 49].

Statistiko-ekonomicheskii obzor Khersonskoi gubernii za 1896 g. (1897). Kherson, 1897. [Statistical and economic review Kherson province for 1896 (1897). Kherson].

Tjutjunnik, D. A., Korotkova, A. Ja. and Nadol'naja,G. N. (1988). Otsenka produktivnosti i prostranstvennoi neodnorodnosti agrolandshaftov Ukrainskoi SSR po dannym urozhainosti ozimoi pshenitsy. *Fizicheskaya geografiya i geomorfologiya,* 35: 22-28. [Evaluation of productivity and space-inhomogeneity agrolandscapes Ukrainian SSR according to the yield of winter wheat]. *Physical geography and geomorphology*, 35: 22-28].

Troccoli, A. (2010). Seasonal climate forecasting. *Meteorological Applications*, 17 (3): 251-268. DOI: 10.1002/met.184.

Ukraina – zernova zhitnitsya Evropi (2013). http://odnarodyna.com.ua/ content/ukraina-zernovaya-zhitnica-evropy. [Ukraine – grain granary of Europe. http://odnarodyna.com.ua/ content/ukraina-zernovaya-zhitnica-evropy].

Valdes, R., Von Cramon-Taubadel, S. and Engler, A. (2016). What drives stock market integration? An analysis using agribusiness stocks. *Agricultural Economics (United Kingdom)*, 47 (5): 571-580. DOI: 10.1111/agec.12256.

Valujeva, K., O'Sullivan, L., Gutzler, C., Fealy, R. and Schulte, R. P. O. (2016). The challenge of managing soil functions at multiple scales: An optimization study of the synergistic and antagonistic trade-offs between soil functions in Ireland. *Land Use Policy*, 58: 335-347. DOI: 10.1016/j.landusepol.2016.07.028.

Volobuev, V. R. (1975). Introduction to energetic of soil formation. Franklin Book Programs: [Cairo].

Yermolaev, O. P., Lisetskii, F. N., Marinina, O. A. and Buryak, Z. A. (2015). Basin and eco-regional approach to optimize the use of water and land resources. *Biosciences Biotechnology Research Asia*, 12: 145-158.

Zadorozhnyy, A. I. (2012). Metodika prognozirovaniya dinamiki gruntovykh vod na osnove apparata tsepey Markova i otsenki ubytkov v rezul'tate nedopolucheniya urozhaya ot podtopleniya sel'skokhozyaystvennykh territoriy. *Sovremennye problemy nauki i obrazovaniya,* 6: 627. [Methods of predicting the dynamics of groundwater based on Markov chain device and measuring any resulting shortfall in the harvest from the flooding of agricultural lands. *Modern problems of science and education,* 6: 627].

Zharostoikost' i produktivnost' ozimoi pshenitsy (1985). Kiev: Vishcha shkola [Heat resistance and productivity of winter wheat (1985). Kiev: VishchaSchool].

Zhu, Y. (2016). International trade and food security: Conceptual discussion, WTO and the case of China. *China Agricultural Economic Review*, 8 (3): 399-411. DOI: 10.1108/CAER-09-2015-0127.

Zhuchenko, A. A. (1990). Adaptivnoe rastenievodstvo (ekologo-geneticheskie osnovy). Kishinev: Shtiintsa: 432 [Adaptive plant-growing (genetic and ecological bases). Kishinev: Stiintsa Publishers: 432].

Zolotarev, A. O. (1925). Kratkie itogi i perspektivy torgovli USSR. *Khozyaistvo Ukrainy,* 3:119-120. [Brief results and prospects of trade USSR. *Economy of Ukraine,* 3:119-120].

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Institution. Belgorod State University **Position**, The chief of the department of sciences and research, vice-rector in science	1999-2002
Institution. Belgorod State University **Position**, vice-director of the institute of natural-sciences problems (Belgorod	1997-1999
Institution. Odessa State University **Position**, vice-director of the South centre of agroecology	1994-1995
Institution. Odessa State University **Position**, researcher	1983-1984

Research Interests: ecology, soil science, soil geography, geomorphology, geoarchaeology, pedoarchaeology, the study of ancient systems of land use new scientific methods (GIS, remote sensing).

Professional Appointments: Author, co-author of over 450 publications, including 15 books, 50 papers in peer-reviewed journals, and 22 of the objects of intellectual property (databases, computer programs).

Honors: Russian Academy of Sciences expert (certificate 2016-01-2224-6301)	2016
Commemorative Dokuchaev medal, Soil Science Society	2016
Expert of the Russian Humanitarian Science Foundation	2015-present
Expert of the Russian ministry of Education	2011-present
Diploma of the Russian ministry of Education	2013
Manager of the year in the nomination “Science”	2008
Laureate of National ecological prize	2007
Diploma holder of the National Ecological prize “EcoSpace”	2005
Expert of the Institute for Sustainable Communities	2002

Honorary worker of higher professional education of the Russian Federation	2002
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Laureate of the South center of scientific and technical activity contest, the investigations and social initiatives on the best scientific work in the sphere of ecology	1990

Publications Last 3 Years:

Book Chapters

Lisetskii F.N., Tokhtar V.K., Ostapko V.M., Prykhodko S.A. Petrunova T.V. Regularities and features of differentiation and anthropogenic transformation of steppe vegetation. In: Marlon Nguyen, editor. *Terrestrial Biomes: Geographic Distribution, Biodiversity and Environmental Threats*. Nova Science Publishers, Inc., 2016. Chapter 4. P. 103-126.

Journal Publications

Lisetskii F., Chepelev O. Quantitative substantiation of pedogenesis model key components. *Advances in Environmental Biology*. 2014. Vol. 8. No 4. P. 996-1000.

Lisetskii F.N., Goleusov P.V., Moysiyenko I.I., Sudnik-Wojcikowska B., Microzonal distribution of soils and plants along the catenas of mound structures. *Contemporary Problems of Ecology*. 2014. Vol. 7. No 3. P. 282-293.

Lisetskii F.N., Marinina O.A., Jakuschenko D.G. A new approach to dating the fallow lands in old-cultivated areas of the steppe zone. *Research Journal of pharmaceutical, biological and chemical sciences*. 2014. Vol. 5. No 6. P. 1325-1330.

Lisetskii F.N., Pavlyuk Ya.V., Kirilenko Zh.A., Pichura V.I. Basin organization of nature management for solving hydroecological problems. *Russian Meteorology and Hydrology*. 2014. Vol. 39. No 8. P. 550-557.

Lisetskii F.N., Zemlyakova A.V., Terekhin E.A., Naroznyaya A.G., Pavlyuk Y.V., Ukrainskii P.A., Kirilenko Z.A., Marinina O.A., Samofalova O.M. New opportunities of geoplanning in the rural area with the implementing of geoinformational technologies and remote sensing. *Advances in Environmental Biology*. 2014. Vol. 8. No 10. P. 536-539.

Goleusov P.V., Lisetsky F.N. Restoration of soil and vegetation cover in post-mining geo-systems and their renaturation prospects in the area of the Kursk Magnetic Anomaly. *Gornyi Zhurnal*. 2014. No 8. P. 69-74.

Lisetskii F.N. Utilizzo come naturale antichi modelli di studio carriole pedo-geomorfologico rapporto. *Italian Science Review*. 2014; 6 (15). P. 29-33. Available at URL: http://www.ias-journal.org/archive/2014/june/Lisetskii.pdf.

Lisetskii F., Marinina O., Gadzhiev R. Trasformazione biomeccanica del profilo di suoli forestali. *Italian Science Review*. 2014; 12(21). P. 134-137. Available at URL: http://www.ias-journal.org/archive/2014/december/Lisetskii.pdf.

Lisetskii, F., Stolba, V.F., Marinina, O. Indicators of agricultural soil genesis under varying conditions of land use, Steppe Crimea. *Geoderma*. 2015. Vol. 239-240. P. 304-316. http://dx.doi.org/10.1016/j.geoderma.2014.11.006.

Lisetskii F.N., Pichura V.I., Pavlyuk Y.V., Marinina O.A. Comparative assessment of methods for forecasting river runoff with different conditions of organization. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*. 2015. Vol. 6. No 4. P. 56-60.

Yermolaev O.P., Lisetskii F.N., Marinina O.A., Buryak Zh.A. Basin and eco-regional approach to optimize the use of water and land resources. *Biosciences, Biotechnology Research Asia*. 2015. Vol. 12 (Spl. Edn. 2). P. 145-158.

Pichura V.I., Pilipenko Yu.V., Lisetskiy F.N., Dovbysh O.E. Forecasting of hydrochemichal regime of the Lower Dniepersection using neurotechnologies. *Hydrobiological Journal*. 2015. Vol. 51. No 3. P. 100-110. http://dx.doi.org/10.1615/HydrobJ.v51.i3.80.

Lisetskii F.N., Rodionova M.E. Transformation of dry-steppe soils under long-term agrogenic impacts in the area of ancient Olbia. *Eurasian Soil Science*. 2015. Vol. 48. No 4. P. 347-358. http://dx.doi.org/10.1134/S1064229315040055.

Lisetskii F., Terekhin E., Marinina O., Zemlyakova A. Integration strategies of academic research and environmental education. *Procedia – Social and Behavioral Sciences*. 2015. Vol. 214. P. 183-191. http://dx.doi.org/10.1016/j.sbspro.2015.11.616.

Goleusov P.V., Lisetskii F.N., Chepelev O.A. Prisniy A.V. The rate of soil formation in regenerative ecosystems with various combinations of substratum and vegetation conditions. *International Journal of Applied Engineering Research*. 2015. Vol. 10. No 24. P. 45413-45416.

Pozachenyuk E.A., Lisetskii F.N., Vlasova A.N., Buryak Zh.A., Marinina O.A., Kalinchuk I.V. Model of position-dynamic structure of river basins. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*. 2015. Vol. 6. No 6. P. 1776-1780.

Lisetskii F., Pichura V. Steppe ecosystem functioning of East-European Plain under age-long climatic change influence. *Indian Journal of Science and Technology*. 2016. Vol. 9(18). P. 1-9. http://dx.doi.org/10.17485/ijst/2016/v9i18/93780.

Lisetskii F.N., Sudnik-Wojcikowska B., Moysiyenko I.I. Flora differentiation among local ecotopes in the transzonal study of forest-steppe and steppe mounds. Biology Bulletin. 2016. Vol. 43. No 2. P. 169-176. http://dx.doi.org/10.1134/S1062359016010106.

Lisetskii F.N., Stolba V.F., Goleusov P.V. Modeling of the evolution of steppe chernozems and development of the method of pedogenetic chronology. *Eurasian Soil Science*. 2016. Vol. 49. No 8. P. 846-858. http://dx.doi.org/10.1134/S1064229316080056.

Gusev A.V., Lisetskii F.N., Ermakova E.I. Principles and experience of justification of ecological representativeness of Emerald network potential sites. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*. 2016. Vol. 7. No 2. P. 1178-1189.

Lisetskii F.N., Marinina O.A., Gadzhiev R.S., Vorobyeva E.Ya. Rationale for indicators of arable farming duration (based on research findings in the county of the antique polis of Kerkinitis). *The Social Sciences*. 2016. Vol. 11. Is. 13. P. 3361-3365.

Lisetskii F.N., Matsibora A.V., Pichura V.I. Geodatabase of buried soils for reconstruction of palaeoecologic conditions in the steppe zone of East European Plain. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*. 2016. Vol. 7. No 5. P. 1637-1643.

Lisetskii F.N., Pichura V.I. Assessment and forecast of soil formation under irrigation in the steppe zone of Ukraine. *Russian Agricultural Sciences*. 2016. Vol. 42. Nohttp://elibrary.ru/contents.asp?issueid=1556155&selid=25501421 2. P. 155-159. http://dx.doi.org/10.3103/S1068367416020075.

Lisetskii F.N., Smekalova T.N., Marinina O.A. Biogeochemical features of fallow lands in the steppe zone. *Contemporary Problems of Ecology*. 2016. Vol. 9. No 3. P. 366-375. http://dx.doi.org/10.1134/S1995425516030094.

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Lisetskii F.N., Pavlyuk Ya.V., Kirilenko Zh.A., Pichura V.I. Basin organization of nature management for solving hydroecological problems // Russian meteorology and hydrology. 2014. Vol. 39. No. 8. pp. 550-557. DOI: 10.3103/S106837391408007X.

Pichura V.I., Lisetskii F.N., Pavlyuk Ya.V. Secular variation of the stability of agricultural landscapes in the area of irrigation reclamation Dry Steppe zone (for example, south of the Kherson region) // Scientific bulletin of Belgorod State University. Series: Natural sciences. 2014. Vol. 28. No.17 (188). pp. 140-147.

Lisetskiy F.N., PichuraV.I., MarininaO.A., SemenyukA.P. I cambiamenti ambientali nella steppa Crimea per tutto il periodo romano di storia antica e di là // ItalianScienceReview. 2015. Is. 10(31). pp. 83-88.

Pichura V.I., Pilipenko Yu.V., Lisetskiy F.N., Dovbysh O.E. Forecasting of hydrochemichal regime of the lower Dnieper section using neurotechnologies // Hydrobiological Journal. 2015. Vol. 51. No 3. pp. 100-110. DOI: 10.1615/HydrobJ.v51.i3.80.

Lisetskii F.N., Buryak J.A., Zemlyakova A.V., Pichura V.I. Basin organizations of nature use, Belgorod region // Biogeosystem Technique. 2014. Vol. (2). No 2. pp. 163-173. DOI: 10.13187/bgt.2014.2.163.

Pichura V.I., Breus D.S. The basin Approach in the study of spatial distribution anthropogenic pressure with irrigation land reclamation of the Dry Steppe zone / Biogeosystem Technique, 2015, Vol. 3, Is. 1, pp. 89-100. DOI: 10.13187/bgt.2015.3.89.

PichuraV.I.Basin approach to spatial-temporal modeling and neuroprediction of potassium content in Dry Steppe soils / Biogeosystem Technique. 2015. No 2 (4). pp. 172-184. DOI: 10.13187/bgt.2015.4.172.

Lisetskii F.N., Pichura V.I., Pavlyuk Y.V., Marinina O.A. Comparative assessment of methods for forecasting river runoff with different conditions of organization // Research Journal of Pharmaceutical, Biological and Chemical Sciences. 2015. Vol. 6. No 4. pp. 56-60.

Lisetskii F.N., Pichura V.I. Assessment and forecast of soil formation under irrigation in the steppe zone of Ukraine // Russian Agricultural Sciences. 2016. No 2. pp. 154-158. DOI: 10.3103/S 1068367416020075.

Lisetskii F., Pichura V. Steppe ecosystem functioning of East European Plain under age-long climatic change influence // Indian Journal of Science and Technology. 2016. Vol. 9(18). pp. 1-9. DOI: 10.17485/ijst/2016/v9i18/93780.

Lisetskii F.N., Pichura V.I. Paleoecological conditions Antiquity in the Northern Black Sea region (according to the sedimentation in lake Saki, Crimea) // European Geographical Studies, 2016, Vol. 11, Is. 3. pp. 83-107. DOI: 10.13187/egs.2016.11.83.

Lisetskii F.N., Matsibora A.V., and Pichura V.I.Geodatabase of buried soils for reconstruction of palaeoecologic conditions in the Steppe Zone of East European Plain // Research Journal of Pharmaceutical, Biological and Chemical Sciences. 2016. Vol. 7. Is. 5. pp. 1637-1643.

Pichura V.I. Damage to environmental sustainability of the Dnieper river basin caused by agriculture // Scientific reports NUBiP Ukraine. 2016. № 5 (6). http://journals.nubip.edu.ua/index.php/Dopovidi/article/view/7231/7010.

Lisetskii F.N., Matsibora A.V., Pichura V.I. Reconstruction of paleoclimatic conditions of the second half of the Holocene on the results of the study of buried and floodplain soils in the south of the East European Plain // International Journal of Environmental Problems. 2016. Vol. 4. Is. 2.pp. 131-148. DOI: 10.13187/ijep.2016.4.131.

Pichura V.I. Spatial prediction of soil erosion risk in the Dnieper river basin using revised universal soil loss equation and GIS-technology // Bulletin of Zhytomyr National Agroecological University. 2016. Vol. 1. №2 (56). pp. 3-11.

Pichura V.I. Structure of the hydrogeomorphological system for creating the geo-foundation for the ecological framework of the Dnieper river basin // Bulletin of Dnepropetrovsk State Agricultural and Economic University. 2016. № 2 (40). pp. 19-25.

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