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Ukrainian Agricultural Contribution to the World Food Security: Economic Problems and Prospects

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ABSTRACT

Ukrainian agriculture belongs to the world Top-10 exporters of cereals and oilseeds. The option of increasing their contributions to the global food security by means of extensive expanding sown area in Ukraine has been already exhausted. To meet the contemporary challenges it is necessary to arrange intensive productions of wheat, barley, maize, sunflower, and soybeans with high yields. To monitor the regional dynamics over growing cereal and oilseed crops this research offers the aggregate rank assessments. They incorporate regional yields, shares of arable lands under wheat, barley, maize, sunflower, and soybeans, as well as shares of their productions by agricultural enterprises. To explore the existing disproportions between the used agricultural lands and obtained harvests this study recommends applying Lorenz curves and a set of inequality indicators such as Hoover and Theil indices, Gini coefficient, and also Ratio 20:20. Short-term and long-term prospects in enhancing Ukrainian contributions to the cereal and oilseed segments of the global food security were evaluated according to results of their leading exporters. To reach the levels of the chosen target countries, this research substantiates implementing optimal fertilizers application, rational land use, balanced pricing, developed transport infrastructure, as well as improved innovative, technological and market components in Ukrainian economy.

INTRODUCTION

Ukrainian agriculture holds the dominant world positions in growing cereal and oilseed crops. The national exporters belong to Top-10 Lists at wheat, barley, maize, sunflower, and soybeans markets with the total values of US$38.9 bln., US$6.9 bln., US$29.6 bln., US$7.2 bln., US$58.2 bln. (World's Top Exports, 2018). Demands for cereals and oilseeds continue to increase. It is an

expected trend since these crops have a triple use: firstly, for food purposes, secondly, for feeding in animal husbandry, and thirdly, as raw materials for manufacturing bio-fuel. The main world importers of

- wheat are Indonesia, Egypt, Algeria, Italy, Japan, and Nigeria;
- barley are China, Saudi Arabia, Iran, the Netherlands, Belgium, and Japan;
- maize are Japan, Mexico, South Korea, Egypt, Spain, and Vietnam;
- sunflower seeds and oil are India, Turkey, China, Spain, Indonesia, the Netherlands, and Germany;
- soybeans are China, Mexico, Japan, Spain, Indonesia, and Thailand.

Agriculture of each country is committed to providing food security. In view of the expected population's growth up to 9 bln. by 2050, this social and economic task becomes even more important in the global scale (Kavallari et al., 2015; Grafton et al., 2015; Candel and Biesbroek, 2018). Its solution requires involvements of all farmers around the world, especially the ones with the relevant experiences and results in this activity. Scientists in agricultural economics should not skip the issue in question. It entails conducting a topical analytical study over Ukrainian problems and prospects of agricultural participation in the cereal and oilseed segments of the global food security system.

Sustainable development of agrarian sector belongs to the prime themes of the contemporary scientific research. In particular, Mykhailova et al. (2018) shaped necessary institutional transformations in Ukrainian agriculture. Kolesnyk et al. (2018) focused on providing its ecological, productive, economical, social, intellectual-innovating, and globally integrative features. Katan et al. (2018), Khalatur et al. (2018), Babenko et al. (2017) grounded that being the most stable branch in Ukrainian economy, agrarian sector, to a large extent, defines macroeconomic growth, environmental health, financial security, and international integration for the whole country.

Agricultural development in the global scale is responsible for supporting the world food security. It demands a restricted resource use and sustainable technological intensification followed by the food growth (Norton et al., 2014; Godfray and Garnett, 2014; Meyers and Kalaitzandonakes, 2015; Serban et al, 2017). Ukrainian farmers are not ready to participate in providing food security with animal products since crisis issues in animal husbandry don't allow saturating even the domestic market (Vasylieva, 2015; Vasylieva and Velychko, 2017). At the same time, Ukrainian agriculture has well known achievements in cereal and oilseed segments analyzed by Schroeder and Meyers (2015), Kuzmenko et al. (2016). Ongoing world and domestic challenges induced by the market volatility, unstable production, strong competition, unequal export opportunities among the regions, high demands for crops (Rude and An, 2015; Hudym and Khalatur, 2016; Moroz et al., 2017; Malyarets et al., 2018) require a new investigation which should address options over increasing Ukrainian contributions to the cereal and oilseed components of the global food security.

1. THEORETICAL FRAMEWORK

Cereals and oilseeds count for above 25% and 20% of the total agricultural production in Ukraine. They bring the highest incomes with the average profitability of 26.7% and 49.3% for the last 5 years (State statistics service of Ukraine, 2017). Sown area under wheat, barley, and maize was 48.7%, the one under sunflower and soybeans was 29.2% of the total arable land in Ukraine in 2017. At present, Ukrainian share of the total territory conveyed to arable lands is 44.2%. Evidently, the national agriculture almost exhausted all possibilities of the extensive increase in cereal and oilseed harvests by means of expanding sown areas. However, the yields of these crops are barely 30-50% of the varieties' potentials.

Moreover, fluctuations of wheat, barley, maize, sunflower, and soybeans yields amounted to 24.2%, 41.5%, 19.8%, 15.5%, and 25% in 2013-2017. Thus, the depicted agricultural background substantiates the research starting hypothesis about exploring options of rising Ukrainian agricultural contribution to the global food security by means of stable high yields of cereals and oilseeds. Hence, the goal of this research was to carry out a quantitative analysis over problems and prospects of enhancing exports of wheat, barley, maize, sunflower, and soybeans from Ukrainian producers. The set objective meant accomplishing 3 tasks such as:

- to specify regional rank in cereal and oilseed segments;
- to evaluate inequality in growing wheat, barley, maize, sunflower, and soybeans at the state level;
- to offer target profiles of developing cereal and oilseed productions in Ukraine in comparison with the indicators of the prominent world exporters.
- The obtained results to the first task were connected with the aggregate rank assessments including
- regional yields which characterize effectiveness of land use;
- shares of sown areas under wheat, barley, maize, sunflower, and soybeans among the regions that depict levels of concentration at these crops;
- shares of agricultural enterprises in growing cereals and oilseeds that confirm innovative activity and better maintenance with production resources (Phillips et al., 2012; Shorikov and Babenko, 2014; Velychko and Velychko, 2017).

Mathematical tools for obtaining results to the second task was a set of inequality indicators, containing Lorenz curve, Hoover and Theil indices, Gini coefficient and Ratio 20:20 (Vasylieva, 2017). In particular, Lorenz curve facilitates a visual monitoring over unbalances between sown areas and collected harvests of wheat, barley, maize, sunflower, and soybeans. Hoover index evaluates the highest level of these disproportions. Theil index determines the corresponding average distributions. Gini coefficient calculates a total measure of inequality. Its top and bottom quintiles are compared with Ratio 20:20.

The obtained results to the third task were dedicated to creating target profiles on increasing yields of cereals and oilseeds for the remote and near future dealing with indicators of Top-10 exporters. Implementations of the chosen agricultural practices, concerning land use, fertilizers' application, development of infrastructure, and price competitiveness would benefit Ukrainian agricultural contribution to providing the global food security.

2. RESULTS OF CALCULATIONS

Assessments of wheat, barley, maize, sunflower, and soybeans productions in 24 Ukrainian regions were calculated on the samples of data from State statistics service of Ukraine (2017). Table 1 and Table 2 comprise regional ranks over the analyzed indicators and display the aggregate assessments grouped in the order of the decreasing effectiveness of cereal and oilseed productions. It should be noted that the similar mathematical approach is successful at both micro- and macroeconomic levels (Dovgal et al., 2017).

Table 1. Rank assessments of regional contributions to cereal production

Region	*Yield*			*Share in regional sown area*			*Share of agricultural enterprises' production*	*Aggregate rank assessment*
	Wheat	*Barley*	*Maize*	*Wheat*	*Barley*	*Maize*		
Ternopil	23	25	23	15	20	11	14	131
Khmelnytskiy	24	24	24	12	14	13	20	131
Vinnytsya	19	21	18	13	11	17	18	117
Sumy	21	17	20	9	3	21	23	114
Chernihiv	17	20	21	7	1	23	24	113
Lviv	18	23	17	14	15	4	8	99
Odesa	9	13	6	22	24	7	13	94
Rivne	15	19	16	11	17	9	7	94
Kyiv	6	16	13	10	7	18	22	92
Kharkiv	16	13	7	18	16	12	10	92
Ivano-Frankivsk	22	22	14	5	13	10	5	91
Cherkasy	8	12	12	8	5	22	21	88
Zhytomyr	13	13	19	3	4	15	19	86
Volyn	14	11	22	19	8	3	3	80
Poltava	11	9	9	2	6	24	17	78
Donetsk	11	8	2	21	18	5	11	76
Chernivtsi	19	18	10	1	10	16	1	75
Kherson	5	3	15	23	22	2	4	74
Dnipropetrovsk	7	4	5	16	21	14	6	73
Kirovohrad	3	6	8	6	12	19	15	69
Mykolayiv	4	5	3	17	23	6	9	67
Zaporizhya	2	2	4	24	19	1	12	64
Luhansk	9	1	1	20	9	8	16	64
Zakarpattya	1	7	11	4	2	20	2	47

Source: author's calculations based on the data of State statistics service of Ukraine (2017).

Table 2. Rank assessments of regional contributions to oilseed production

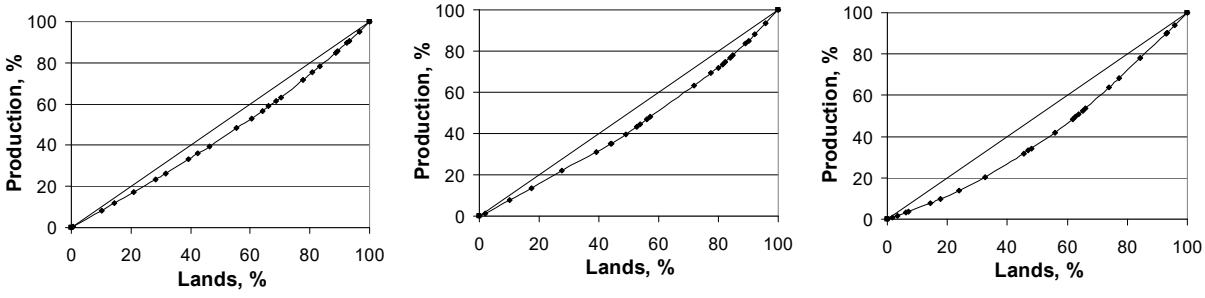
Region	*Yield*		*Share in regional sown area*		*Share of agricultural enterprises' production*	*Aggregate rank assessment*
	Sunflower	*Soybeans*	*Sunflower*	*Soybeans*		
Khmelnytskiy	24	18	9	22	21	94
Ternopil	22	22	7	16	19	86
Rivne	21	19	3	18	23	84
Sumy	20	11	14	20	16	81
Vinnytsya	23	12	11	13	15	74
Zhytomyr	12	17	8	23	13	73
Chernihiv	15	13	12	14	19	73
Kyiv	14	9	10	21	17	71
Ivano-Frankivsk	16	20	6	10	18	70
Cherkasy	18	8	13	17	14	70

Chernivtsi	19	10	5	24	10	68
Volyn	17	15	2	9	22	65
Lviv	9	16	4	12	23	64
Poltava	13	7	15	19	7	61
Zaporizhya	2	21	23	5	4	55
Kherson	1	23	17	11	1	53
Kirovohrad	7	5	20	15	3	50
Odesa	8	14	16	4	8	50
Zakarpattya	10	24	1	8	6	49
Kharkiv	11	3	18	7	9	48
Dnipropetrovsk	6	6	19	3	12	46
Luhansk	3	2	24	1	11	41
Mykolayiv	4	4	22	6	2	38
Donetsk	5	1	21	2	5	34

Source: author's calculations based on the data of State statistics service of Ukraine (2017).

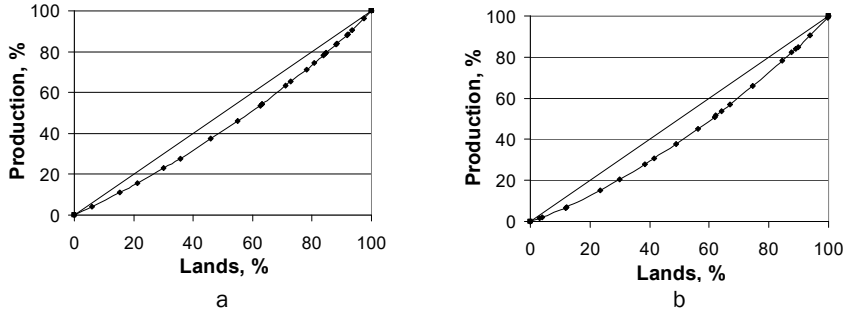
The assessments of disproportions between the harvests of the considered crops and their sown areas were performed on the samples of data from State statistics service of Ukraine (2017). Lorenz curves in Figure 1 and Figure 2 reveal inequality in growing cereals and oilseeds.

Figure 1. Lorenz curves to inequality in production of: a – wheat, b – barley, c – maize.



Source: composed by the author based on the data of State statistics service of Ukraine (2017).

Figure 2. Lorenz curves to inequality in production of: a – sunflower, b – soybeans.



Source: composed by the author based on the data of State statistics service of Ukraine (2017).

The calculated quantitative indicators of inequality in production of the considered crops are collected in Table 3.

Table 3. Inequality indicators to production of cereals and oilseeds

Crop	Hoover index	Theil index	Gini coefficient	Ratio 20:20
Wheat	0.074	0.014	0.095	1.55
Barley	0.094	0.025	0.123	1.78
Maize	0.138	0.054	0.179	2.46
Sunflower	0.089	0.023	0.121	1.78
Soybeans	0.113	0.038	0.153	2.17

Source: author's calculations based on the data of State statistics service of Ukraine (2017).

3. DISCUSSION

As distinct from studies of Rude and An (2015), Schroeder and Meyers (2015), Kuzmenko et al. (2016), the accomplished research proposes a uniform approach dealing with a qualitative analysis of problems and prospects in cereal and oilseed segments of Ukrainian agriculture. Let us start the discussion from the results regarding an intensive development of the respective regional productions. Data in Table 1 convince that Top-5 cereal producers with the aggregate rank assessments over 100 had high ranks by all considered crops. The reason for such result was their preferential growing by competitive agricultural enterprises. In contrast, 5 off-track regions with the aggregate rank assessments below 70 had poor ranks of yields of all considered crops and uneven distribution of their sown areas. Data in Table 2 clarifies that Top-3 oilseed producers with the aggregate rank assessments over 83 demonstrated high yields of both considered crops. Their growing was concentrated in strong agricultural enterprises. They preferred soybeans which less exhaust soil fertility. On the contrary, 2 off-track regions with the aggregate rank assessments below 40 had poor ranks of yields of both considered crops. Their dominant producers were small-scale households. They focused on growing sunflower which essentially ruins soil fertility.

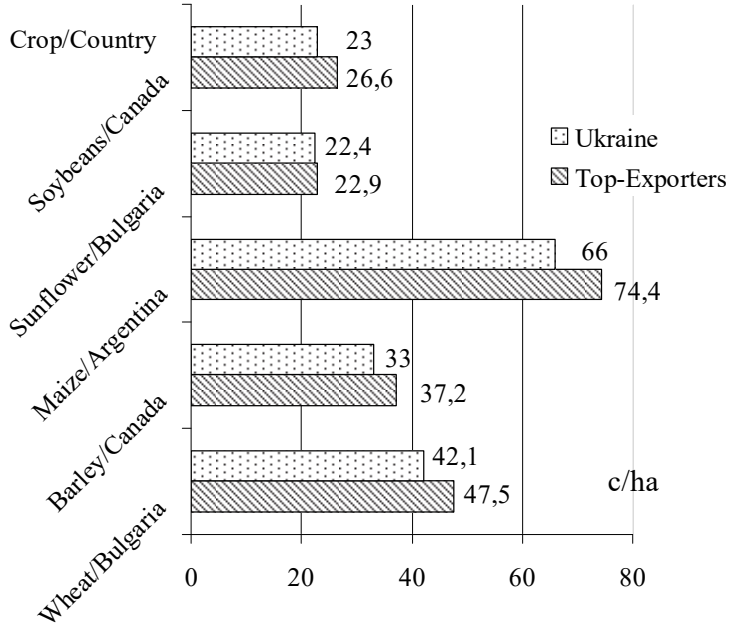
Let us proceed to discussing results concerning an extensive development of the respective regional productions at the expense of sown areas under cereals and oilseeds. An average normative monetary value of arable land in Ukraine amounts to US$2583 per ha. In particular, it varies between US$1719 per ha in Zhytomyr region and US$3324 per ha in Cherkasy one. Figure 1 revealed that maize production happened to be the most unbalanced among cereals. In contrast, wheat growing appeared to be in the most balanced state. Inequality indicators in Table 3 mean that the total disproportions in wheat, barley, and maize productions are 9.5%, 12.3%, and 17.9%. Their average levels of the inequality entropy achieve 1.4%, 2.5%, and 5.4%. The gaps between top and bottom quintiles of wheat, barley, and maize growers reach 1.55, 1.78, and 2.46 times. An alignment over Ukrainian cereal production supposes the corresponding rearrangements by 7.4%, 9.4%, and 13.8%. Figure 2 convinced that soybeans production was more balanced than sunflower growing. Inequality indicators in Table 3 mean that the total disproportions in sunflower and soybeans productions are 12.1% and 15.3%. Their average levels of the inequality entropy achieve 2.3% and 3.8%. The gaps between top and bottom quintiles of sunflower and soybeans growers reach 1.78 and 2.17 times. An alignment over Ukrainian oilseed production supposes the corresponding rearrangements by 8.9% and 11.3%.

At last, Ukrainian prospects for increasing wheat, barley, maize, sunflower, and soybeans contributions to the global food security might be determined via achievements of their Top-exporters. Among them Ukraine was ranked at the 6th, 4th, 4th, 1st, 7th positions with 7.1%, 10.2%, 10.1%, 47.5%, 1.8% at the corresponding markets in 2017.

According to the research hypothesis, the closest higher yields collected by Top-10 exporters of the considered crops should be Ukrainian aim of development in the short-run. The corresponding target profile was displayed in the form of linear diagram in Figure 3. The highest yields collected by Top-10 exporters of wheat, barley, maize, sunflower, and soybeans could be the strategic benchmarks in the long-run. The corresponding target profile was depicted in the form of linear diagram in Figure 4.

The achieved results in target countries suppose applications of contemporary technological and economic practices. They provided the 1st and 2nd positions to the USA in maize and soybeans exports (market shares of 32.3% and 37.2%), 3rd position to Argentina in maize export (market share of 13.1%), and also 5th position to Canada in soybeans export (market share of 3.3%). All target countries apply optimal quantity of fertilizers. In particular, Bulgaria, Canada, Germany, Hungary, and the USA use on average 107.9, 105.2, 198.8, 113.4, and 133.7 kg of fertilizers per ha of cropland (FAO, 2018). Target countries prevent irrational land use restricting arable shares in the cultivated areas. In particular, these indicators in Argentina, Bulgaria, Canada, Germany, and the USA reach 26.4%, 70%, 69.6%, 70.8%, and 37.5%. On the contrary, the similar values in Ukraine are 42.3 kg of fertilizers per ha and 78.8% of arable lands. Such irrational approach is explained by the prolonged ban over market turnover of agricultural land in Ukraine (Koroteyev et al., 2017).

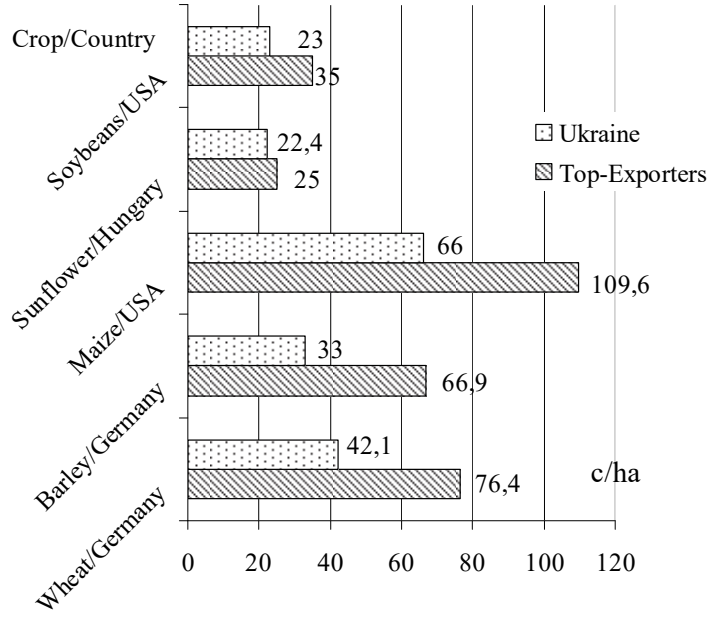
Figure 3. Short-run target profile to production of cereals and oilseeds.



Source: composed by the author based on the data of FAO (2018).

Agriculture like the whole Ukrainian economy lacks Innovations, Technological readiness, and Goods market efficiency (ranks 61, 81, and 101) as distinct from Canada (ranks 23, 23, and 18), Germany (ranks 5, 8, and 11), and the USA (ranks 2, 6, and 7). Export development also demands advanced transport infrastructure (Lugovskyy and Skiba, 2016; Atkociuniene and Kiausiene, 2017). Canada, Germany, Hungary, and the USA were ranked 16, 10, 56, and 9 by the World Economic Forum in 2017. Unfortunately, Ukraine lags behind in estimates of automobile roads and port facilities (ranks 130 and 93) (The Global Competitiveness Report, 2017).

Figure 4. Long-run target profile to production of cereals and oilseeds



Source: composed by the author based on the data of FAO (2018).

At the same time, average producers' prices in Ukraine were US$128.7, 117.7, 138.2, 333.3, and 348.1 per tonne of wheat, barley, maize, sunflower, and soybeans. They appeared to be lower than the prices of US$155.5 and 154.9 for wheat in Bulgaria and Germany, US$165.4 and 139.4 for barley in Canada and Germany, US$134 for maize in the USA, US$394.2 and 375.9 for sunflower in Bulgaria and Hungary, US$349 for soybeans in the USA (FAO, 2018). It could be a promising signal about the existing options for updating technological and economic practices in Ukraine to increase its cereal and oilseed contributions to the global food security.

CONCLUSION

It was clarified that the rising yields and harvests from agricultural enterprises should be the key priorities of increasing the regional productions and exports of cereals and oilseeds. According to the calculated aggregate rank assessments it was recommended to transfer technological and economic practices in wheat, barley, maize sunflower, and soybeans growing from Ternopil and Khmelnytskiy to Zakarpattya, Mykolayiv, and Donetsk regions.

The burning issue of increasing Ukrainian contributions to the cereal and oilseed segments of the global food security is irrational use of agricultural land. The highest imbalances of 13.8% and 11.3% between sown areas and harvests were found to be in growing maize and soybeans.

Compliance with the practices of the target countries among Top-10 exporters of wheat, barley, maize, sunflower, and soybeans would result in rising the corresponding harvests by 12.8%, 12.7%, 12.7%, 2.2%, and 15.7% in the short-run as well as by 81.5%, 102.7%, 66.1%, 11.6%, and 52.2% in the long-run. Ukrainian agriculture would reach these increments due to the optimal fertilizers' application, rational land use, developed transport infrastructure, balanced pricing, and also improved innovative, technological and market environment.

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