

Development of the Feed Additives Market in the Context of Food Security

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Abstract: The article describes peculiarities, current trends and regularities of the feed additives market development in Ukraine in the context of ensuring food security of the country. The researchers provide statistical analysis of the main indicators featuring development of the feed additives market in Ukraine. The work presents values of the coefficients of correlation, namely the Pearson correlation coefficient, Spearman's rank correlation coefficient and Fechner correlation coefficient, to identify correlation between the gross added value and agricultural output, volume of produced and sold agricultural products, added value by production costs and amount of capital investments in agriculture.

Effective development of the feed additives market in the context of ensuring food security of Ukraine requires a complex of strategic measures applied to improve the technical level of production; introduction of innovative technologies of production; reduction of capital intensity, heat and energy intensity of production; Internet technologies used for automation of the transportation process; development of the algorithms of servicing different categories of consumers and proposals on increase of the level of logistic servicing; determination of the priority directions of e-commerce as an effective tool to promote agricultural products at the foreign markets.

The paper presents a conceptual scheme of the measures necessary to ensure effective development of the feed additives market in Ukraine with consideration of the international practice. Implementation of the experience in the practice will contribute to the proper, scientifically substantiated and effective managerial decisions on the strategic directions of the feed additives market development to ensure food security of Ukraine.

Keywords: Feed additives market, agro-industrial complex, food security, development, sustainable functioning, features, trends, regularities, modelling, statistical methods, economic and mathematical tools, management, organizational and logistic basis.

INTRODUCTION

Food security of the country is primary provided by agriculture and particularly animal breeding. Sustainable operation and dynamic development of the sector mainly depends on the access to the high quality fodder and feed additives. Moreover, production of fodder and feed additives is one of the primary directions of the agro-industrial complex development. According to the data provided by specialists in agriculture, 60% of production costs is spend for fodder, and in animal breeding, it takes the majority. In particular, in milk production, the figure is 54%, in production of pork – 60%, poultry – 70%. The animal feed which is balanced by the main nutrients contribute to animal productivity and in-

creases it by 10-12%, and when it is enriched with vitamins, microelements and concentrates, efficiency of the feed base increases by 25-30%.

It is worth noting that in the recent years, recovery of the Ukrainian production of feed additives has become a heavily discussed issue. The process, however, requires significant investments and, considering the current political and economic situation, peculiarities of the branch operation, it involves certain risks. Thus, some experts assume that Ukraine should not aim to achieve self-sufficiency with feed additives. They name examples of foreign enterprises which depend of the feed additives import but still successfully operate. Other researchers are sure that these products should be produced in our country for the enterprises do not depend on the changeable political, financial and economic situation, as well as fluctuations in the conjuncture of the market of fodder and feed additives.

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Therefore, relevance of the present research is confirmed by the necessity to identify the trends and regularities of the feed additives market development in the context of ensuring food security of the country, as well as the need to model the processes of domestic enterprises' operation to mitigate the risks of their bankruptcy and illiquidity because of producing outdated products and investing in the outdated technologies.

LITERATURE REVIEW

Problems and prospects of development of the market of fodder and feed additives have been studied by numerous scientists, namely I. Petrychenko (2018); I. Voronetska, O. Kravchuk, H. Korniiichuk (2016); L. Stepasiuk, Z. Titenko (2016); M. Ibatullin (2017); V. Lavruk (2017); V. Petrychenko (2015, 2018); I. Yatsiv, S. Temnenko (2020) and others.

The managerial, innovative, personnel, financial, information aspects of business operation, including in the agrarian sector, are considered in the scientific works of foreign scientists (A. Kwilinski et al. (2017, 2020, 2022); R. Miśkiewicz (2019); A. Ahadiat and Z. Dacko-Pikiewicz (2020); J. Marszalek-Kawa et al. (2020); H. Dźwigoł et al. (2020); A. Ahadiat and Z. Dacko-Pikiewicz (2020); R. Vaníčková and K. Szczepańska-Woszczyzna (2020); K. Szczepańska-Woszczyzna and S. Gatnar (2022).

The issue of modelling and forecasting the social and economic processes and transformations in the market conjuncture by applying statistical, as well as economic and mathematical tools is discussed in the papers of such researchers as A. Yerina (2001); V. Heiets et al. (2005); R. Kulynych (2008); M. Medykovskyi, O. Shunevych (2011); A. Kuzmenko (2017) and others.

The present article aims to continue the scientific researching and is focused on substantiation of the conceptual fundamentals of improvement of the enterprises' operation in the agro-industrial complex. In the previous studies (Hnatyshyn, L., Prokopyshyn, O. and Trushkina, N, 2019-2022), the researchers developed scientific and methodological basis to improve the organizational and economic mechanism of managing development of the agricultural cooperative relationship; consolidated and systemized the existing scientific approaches to interpretation of the concept of "marketing management" with consideration of the specificity of agricultural enterprises' performance in conditions of digitalization; substantiated conceptual principles of the innovative agro-cluster establishment as an important constituent of the innovative ecosystem in conditions of ensuring sustainable development; defined the strategic measures to enhance efficiency of the logistic activity management at the enterprises of the agrarian sector of Ukraine in the current information environment.

In spite of such significant attention of scientists to the defined problem, it is still necessary to conduct scientific studies focused on identification of the trends and regularities of development of the Ukrainian feed additives market. All these aspects have shaped the subject of the present research and its goal.

METHODOLOGY

The defined problem has determined the goal of the present article which involves studying and identifying the features, current trends and regularities of the feed additives market development in Ukraine to provide its food security.

The research is based on the system, structural and functional, linguistic, synergetic, logical and semantic approaches.

The theoretical and methodological basis of the research is created by the principles of economic theory, theory of systems, information society, network economy, market infrastructure; concepts of strategic, logistic and marketing management; problems of the economy of agrarian enterprises; statistics, modelling and forecasting of the social and economic processes; information and analytical provision for management of business development; concepts of strategic, foreign economic, logistic and marketing management; problems of the economy of enterprises operating in the agro-industrial complex.

RESULTS AND DISCUSSION

Agro-industrial complex is determined as one of the strategic sectors of Ukrainian economy, which provided 12.4% of the gross added values (Table 1) and 9.3% of the total Ukrainian GDP in the pre-war period.

Table 1. Dynamics of the gross added value of agricultural production.

Year	All kinds of economic activities (at current prices), million UAH	Including agriculture, million UAH	Share in the total volume of gross added value, %
2010	992175	82948	8.4
2015	1689387	239806	14.2
2018	3017896	360998	12.0
2019	3421628	356563	10.4
2020	3626725	393077	10.8
2021	4691619	580519	12.4

Source: composed on the base of statistical and analytical data of the State Statistics Service of Ukraine.

According to the statistical analysis, in 2021 the share of agricultural production by non-financial corporations and the sector of national governance increased by 29.8 percentage points as compared to 2000, i.e. from 38.2 to 68% of the total agricultural output. The share of agricultural production by households reduced by 29.8 p.p. or from 61.8 to 32% of the total agricultural output (Table 2).

The share of production supplied by the business entities operating in the agrarian sector increased by 1.8 percentage points in 2020 as compared to 2013, i.e. from 7.2 to 9% of the total Ukrainian output by all kinds of economic activities. During that period, the share of production of complete animal feed stayed almost unchanged in the total volume of agricultural production and accounted for 3.2% in 2020 (in 2013, it was 3.1%) (Table 3).

Table 2. Dynamics of the agricultural output in Ukraine.

Year	Total Output (at Current prices), Million UAH	Including			
		Non-financial Corporations and the Sector of National Governance		Households	
		Million UAH	share, %	Million UAH	Share, %
2000	54259	20735	38.2	33524	61.8
2005	92540	36273	39.2	56267	60.8
2010	189405	94630	50.0	94775	50.0
2015	544206	327346	60.2	216860	39.8
2018	847587	532683	62.8	314904	37.2
2019	842767	531465	63.1	311302	36.9
2020	892852	566248	63.4	326604	36.6
2021	1366456	928917	68.0	437539	32.0

Source: composed on the base of statistical and analytical data of the State Statistics Service of Ukraine.

Table 3. Volume of production (goods, services) of the business entities operating in the agrarian sector.

Year	All kinds of economic activities (at current prices), billion UAH	Including agriculture, billion UAH	Production of complete animal feed, billion UAH
2013	2593.3	187.8	6.0
2014	2885.6	276.6	7.2
2015	3449.9	402.0	25.4
2016	4217.8	456.9	10.3
2017	5328.9	503.3	10.7
2018	6207.7	591.1	13.6
2019	6981.9	613.6	18.0
2020	7294.4	656.9	20.2

Source: composed on the base of statistical and analytical data of the State Statistics Service of Ukraine.

In 2010-2021, the share of sold agricultural products increased by 3.4 percentage points or from 2.6 to 6% of the total volume of sold products by all kinds of economic activities. The share of sold animal feed reduced by 6.7 percentage points or from 9.1 to 2.4% of the total volume of sold agricultural products (Table 4).

Table 4. Dynamics of the volume of sold agricultural products.

Year	All kinds of economic activities, billion UAH	Including agriculture, billion UAH	Production of complete animal feed, billion UAH
2010	3692.6	97.7	8.9
2011	4302.6	122.1	10.5
2012	4563.8	159.6	11.2

2013	4437.3	158.2	6.0
2014	4609.0	210.2	7.4
2015	5716.4	357.4	19.7
2016	6877.1	397.3	15.7
2017	8467.0	447.5	11.9
2018	10148.8	516.2	14.7
2019	10725.4	550.1	18.6
2020	11285.6	602.0	21.0
2021	15240.1	910.3	22.2

Source: composed on the base of statistical and analytical data of the State Statistics Service of Ukraine.

The estimates show that during the period of 2013-2020, the share of added value by the production costs of business entities operating in the agrarian sector increased by 1.8 percentage points, or from 6.5 to 8.3% of the total Ukrainian added value by all kinds of economic activities. In contrast, the share of added value by the costs of complete animal feed production reduced by 0.5 p.p., or from 1.9 to 1.4% of the added value in agriculture (Table 5).

Table 5. Added value by the production costs of business entities operating in the agrarian sector.

Year	All kinds of economic activities (at current prices), billion UAH	Including agriculture, billion UAH	Production of complete animal feed, billion UAH
2013	1038.4	67.3	1.3
2014	1293.6	123.5	1.8
2015	1396.3	179.1	8.8
2016	1805.6	181.7	2.9

2017	2257.3	189.9	1.9
2018	2510.7	195.3	2.9
2019	2973.6	200.5	3.9
2020	3140.9	260.2	3.7

Source: composed on the base of statistical and analytical data of the State Statistics Service of Ukraine.

It is determined that in the pre-war period, the number of agricultural enterprises gaining profit increased. Thus, the share of enterprises operating in the agrarian sector, which got profit in 2010-2020, increased by 13.2 percentage points, or from 69.9 to 83.1% of the total number of enterprises. The share of agricultural enterprises, which experienced losses, reduced in that period by 13.5 percentage points, or from 30.4 to 16.9% of the total number of enterprises by all kinds of economic activities. However, profitability of the enterprises operating in the agro-industrial complex reduced by 3.6 percentage points (from 17.5 to 13.9%) in 2010-2020. During the period of 2010-2021, profitability of the enterprises' operation in agriculture increased by 17.4%, whilst efficiency of those producing complete animal feed – by 4% (Table 6).

Table 6. Profitability of the operation activity, %.

Year	All kinds of Economic Activities	Including Agriculture	Production of Complete Animal Feed
2010	4.0	24.4	1.9
2011	5.9	24.7	1.1
2012	5.0	22.8	1.6
2013	3.9	11.7	2.6
2014	-4.1	21.4	-0.9
2015	1.0	43.0	0.9
2016	7.4	33.6	2.5
2017	8.8	23.2	5.5
2018	8.1	18.9	5.7
2019	10.2	19.8	7.7
2020	6.2	19.1	5.6
2021	12.6	41.8	5.9

Source: composed on the base of statistical and analytical data of the State Statistics Service of Ukraine.

According to the analysis of the statistical data, number of the business entities operating in the agrarian sector reduced by 10.6% in 2010-2021. The share of agricultural enterprises stayed almost unchanged and accounted for 3.3% of the total number of business entities by all kinds of economic activities in 2021. In the studied period, the number of enterprises engaged in production of complete animal feed increased by 5.8% (Table 7).

Table 7. Number of business entities operating in the agrarian sector.

Year	All kinds of Economic Activities	Including Agriculture	Production of Complete Animal Feed
2010	2184105	72697	521
2011	1701797	56197	447
2012	1600304	62878	471
2013	1722251	65238	520
2014	1932325	67967	543
2015	1974439	70721	600
2016	1865631	66837	557
2017	1805144	69536	579
2018	1839672	69596	553
2019	1941701	68675	557
2020	1973652	67121	540
2021	1956320	64960	551

Source: composed on the base of statistical and analytical data of the State Statistics Service of Ukraine.

In 2010-2021, number of the staff employed in agriculture reduced by 29.3%, and those, engaged in production of complete animal feed – by 11.8%. The number of hired workers in the agrarian sector reduced by 29.9%, and those, engaged in production of complete animal feed – by 11.8% (Table 8).

Table 8. Number of employed and hired workers at the business entities producing animal feed.

Year	Number of Employed Workers		Number of Hired Workers	
	Agriculture	Production of Complete Animal Feed	Agriculture	Production of Complete Animal Feed
2010	723390	8050	656527	7716
2011	664502	8460	645012	8202
2012	666761	8600	636096	8288
2013	645224	6911	593341	6605
2014	654722	6204	598602	5865
2015	563859	7118	510330	6708
2016	577807	5974	523898	5616
2017	556527	6142	501033	5774
2018	549254	5848	493607	5504
2019	537188	6560	485917	6170

2020	509959	7213	462976	6906
2021	511098	7100	460015	6804

Source: composed on the base of statistical and analytical data of the State Statistics Service of Ukraine.

In Ukraine, the pre-war period was characterized by the trend of growing volume of the investments in agriculture development. In 2010-2021, the share of capital investments in development of the agrarian sector increased by 4.1 percentage points, or from 6 to 10.1% of the total volume of capital investments by all kinds of economic activities (Table 9).

Table 9. Dynamics of capital investments in the agrarian sector development in Ukraine.

Year	All kinds of Economic Activities (at Current Prices), Million UAH	Including Agriculture, Million UAH	Share in the Total Volume of Capital Investments, %
2010	180575.5	10817.7	6.0
2011	241286.0	16140.9	6.7
2012	273256.0	18564.2	6.8
2013	249873.4	18175.0	7.3

2014	219419.9	18388.1	8.4
2015	273116.4	29309.7	10.7
2016	359216.1	49660.0	13.8
2017	448461.5	63400.7	14.1
2018	578726.4	65059.4	11.2
2019	623978.9	58555.4	9.4
2020	508217.0	50189.4	9.9
2021	673899.3	67992.6	10.1

Source: composed on the base of statistical and analytical data of the State Statistics Service of Ukraine.

The key economic indicators characterizing operation of business entities in the agro-industrial complex include feed costs and growth rate. According to the data of the State Statistics Service of Ukraine, in 2021 consumption of mixed fodder reduced at the enterprises of all categories by 46.8% as compared to 1990, including at agricultural enterprises – by 45.2%, at the households of population – by 66.8%. However, the share of costs spent for the mixed fodder by the enterprises of all categories increased by 15.8 percentage points or from 14.6 to 30.4% of the total costs spent for all kinds of fodder (Table 10).

Table 10. Consumption of fodder for feeding agricultural animals, thousand tons of fodder units.

Year	Enterprises of all Categories		Including			
			Agricultural Enterprises		Households of Population	
	all Kinds of Fodder	Including Mixed Fodder	all Kinds of Fodder	Including Mixed Fodder	all Kinds of Fodder	Including Mixed Fodder
1990	103562	15156	78209	14040	25353	1116
2000	42513	2258	15951	996	26562	1262
2005	37481	3934	11790	2633	25691	1301
2010	33874	5707	11774	4837	22100	870
2011	33659	5755	11484	4928	22175	827
2012	34093	6206	11953	5356	22140	850
2013	34644	6413	12234	5663	22410	750
2014	32515	6245	11795	5655	20720	590
2015	30987	6440	11857	5920	19130	520
2016	30439	6822	11739	6326	18700	496
2017	29738	6881	11468	6411	18270	470
2018	29986	8819	12376	8359	17610	460
2019	29612	9115	12862	8735	16750	380
2020	27788	8730	12188	8360	15600	370
2021	26541	8060	11804	7690	14737	370

Source: composed on the base of statistical and analytical data of the State Statistics Service of Ukraine.

The studied period was characterized by the trend of reduced consumption of all kinds of fodder for production of a unit of animal products. Thus, at the enterprises of all categories, consumption of fodder per one centner of the cattle growth reduced by 29.3%, pig growth – by 34.6%, milk production – by 31.9%, and per one conditional cow – by 3.5% (Table 11).

Table 11. Consumption of all kinds of fodder for production of a unit of animal products and per one conditional cow, centner of fodder units (all categories of enterprises).

Year	Per One Centner			Per One Conditional Cow
	Growth of Cattle	Growth of Pigs	Milk Production	
1990	11.73	7.92	1.41	32.50
2000	8.88	9.05	1.33	29.63
2005	9.94	8.25	1.04	32.42
2010	10.98	7.26	1.02	31.01
2011	10.73	7.06	1.01	30.87
2012	11.17	6.82	0.98	31.35
2013	11.51	6.35	0.98	30.85
2014	11.93	6.28	0.97	30.53
2015	10.03	5.99	0.96	30.78
2016	9.89	5.79	0.96	31.23
2017	10.39	5.35	0.94	31.18
2018	9.26	5.64	0.91	31.97
2019	9.18	5.38	0.90	31.93
2020	8.52	5.23	0.87	31.29
2021	8.29	5.18	0.96	31.35

Source: composed on the base of statistical and analytical data of the State Statistics Service of Ukraine.

The similar situation was observed at agricultural enterprises. Consumption of fodder per one centner of cattle growth reduced by 2.7% in 1990-2021, growth of pigs – by 53.3%, milk production – by 41.5%, and per one conditional cow – by 11.7% (Table 12).

Table 12. Consumption of all kinds of fodder for production of a unit of animal products and per one conditional cow, centner of fodder units (agricultural enterprises).

Year	Per One Centner			Per one Conditional Cow
	Growth of Cattle	Growth of Pigs	Milk Production	
1990	13.53	9.85	1.47	32.50
2000	16.73	17.90	1.63	25.51
2005	15.89	8.97	1.31	30.15

2010	15.69	5.98	1.18	26.73
2011	14.98	5.37	1.16	25.99
2012	15.52	5.39	1.09	26.78
2013	14.97	4.62	1.06	25.60
2014	15.05	4.57	1.02	25.08
2015	14.80	4.46	1.00	26.46
2016	14.74	4.41	0.97	27.32
2017	14.34	4.31	0.94	27.26
2018	12.06	4.84	0.86	29.19
2019	13.95	4.84	0.89	29.59
2020	12.84	4.79	0.84	28.78
2021	13.17	4.60	0.86	28.70

Source: composed on the base of statistical and analytical data of the State Statistics Service of Ukraine.

To determine the dependence between the indicators of the enterprises' operation in the agrarian sector and the trends of development in condition of uncertainty of the conjuncture of the market of fodder and feed additives, the correlation analysis has been done. It confirms a high level of direct correlation between the gross added value and agricultural output because the value of accuracy of R approximation is equal to 0.9985, *i.e.* close to 1.

The similar correlation dependences are determined between the volume of produced and sold products, as well as between the added value by the production costs of business entities and capital investments in the agrarian sector development. The estimates prove a close direct correlation (the accuracy of R approximation is 0.7014 and 0.5365 respectively) between the volume of produced and sold agricultural products, added value by the production costs of business entities and capital investments in the agrarian sector development.

It is also confirmed by the results of computing of the Pearson correlation coefficient, Spearman's rank correlation coefficient and Fechner correlation coefficient, which are used to estimate the strength and direction of the correlation relationship between the above-mentioned indicators. The statistics of the Pearson correlation coefficient (r_{xy}) identifies dependence between the two variables X and Y , which get the value from -1 to +1 inclusively.

By using data of the Tables 1, 2 and the following formulas of the average values of the indicators \bar{x}, \bar{y}

$$\bar{x} = \frac{\sum x_i}{n}, \tag{1}$$

$$\bar{y} = \frac{\sum y_i}{n}, \tag{2}$$

$$\overline{xy} = \frac{\sum x_i \cdot y_i}{n}, \quad (3)$$

variance

$$S^2(y) = \frac{\sum (y_i - \bar{y})^2}{n}, \quad (5)$$

mean square deviation

$$S(x) = \sqrt{S^2(x)}, \quad (6)$$

$$S(y) = \sqrt{S^2(y)} \quad (7)$$

the Pearson correlation coefficient is calculated.

$$r_{xy} = \frac{\overline{xy} - \bar{x} \cdot \bar{y}}{S(x) \cdot S(y)}, \quad (8)$$

Thus, it proves a high level of linear correlation between the gross added value and agricultural output because the linear correlation coefficient is 0.9994.

By calculating the Spearman's rank correlation coefficient, the strength and direction of the correlation between the volume of produced and sold agricultural products is estimated. The Spearman's rank correlation coefficient is a nonparametric measure of statistical dependence of ranking between two variables. It assesses how well the relationship between two variables can be described using a monotonic function.

The coefficient is computed by using the formula

$$r = 1 - \frac{6 \sum d^2}{n \cdot (n^2 - 1)}, \quad (9)$$

where d^2 – is total of the squares of the rank difference;

n – is the number of observations.

By using data of the Table 3, 4 and the formula (9), the value $r=0.905$ is obtained. Thus, there is a close relationship (value of the Spearman's rank correlation coefficient is close to 1)

between the volumes of produced and sold agricultural products. The sign “+” means a direct correlation relationship between the indicators, i.e. a higher value of the volume of production correlates with the higher value of the volume of sold agricultural products.

By computing the Fechner correlation coefficient, it is possible to identify presence and direction of the correlation relationship between the added value by the production costs and the amount of capital investments in agriculture.

By using the data of the Tables 5, 9 and the formula

$$k = \frac{\sum a - \sum b}{\sum a + \sum b} \quad (10)$$

the value $k=0.75$ is obtained. It proves a significant direct correlation between these indicators.

To develop scenarios of development of the feed additives market (in case of no full-scale russian invasion of Ukraine), tools of the economic and mathematical modelling are applied. Forecast of the main indicators of development of the feed additives market for 2023-2027 has been done by applying the autoregressive model (Table 13). The model is primarily used because the performed calculations are simple and operational; the obtained results have a low level of deviation; results are not characterized by subjectivism (as compared to the method of expert estimates), etc.

The autoregressive model looks like:

$$Y_t = \alpha_1 y_{t-1} + \alpha_2 y_{t-2} + \dots + \alpha_n y_{t-n}, \quad (11)$$

where y_t – is the predicted value of the indicator:

$y_{t-1}, y_{t-2}, \dots, y_{t-n}$ – are the preliminary values of the predicted indicator;

$\alpha_1, \alpha_2, \dots, \alpha_n$ – are the autoregression coefficients

t – is the ordinal number of the preliminary values of the indicator.

Table 13. Predicted values of the main indicators of the feed additives market development in Ukraine.

Indicator	Years				
	2023	2024	2025	2026	2027
Gross added value of agricultural production, <i>billion UAH</i>	931.9	1180.7	1496.0	1895.4	2401.5
Agricultural output, <i>billion UAH</i>	2218.2	2826.2	3600.9	4587.9	5845.4
<i>Including non-financial corporations and the sector of national governance</i>	1601.4	2102.7	2760.8	3624.9	4759.5
households	616.8	723.5	840.1	963	1085.9
Output of business entities in the agrarian sector, <i>billion UAH</i>	928.6	1042.2	1169.6	1312.7	1473.2
Output of complete animal feed, <i>billion UAH</i>	16.0	14.7	13.6	12.6	11.6
Volume of sold agricultural products, <i>billion UAH</i>	1360.9	1663.9	2034.5	2487.5	3041.5
Volume of sold complete animal feed, <i>billion UAH</i>	24.0	24.9	25.9	26.9	27.9
Added value by the production costs of business entities operating in the agrarian sector, <i>billion UAH</i>	379.0	429.7	487.1	552.2	625.9

Added value by the costs of the complete animal feed production, <i>billion UAH</i>	1.2	0.8	0.5	0.4	0.3
Number of acting business entities engaged in fodder production	554	555	557	558	560
Number of employed workers engaged in production of complete animal feed	6830	6699	6570	6444	6320
Number of hired workers engaged in production of complete animal feed	6536	6406	6278	6153	6031
Capital investments in the agrarian sector development, <i>million UAH</i>	80441.5	87496.2	95169.6	103516.0	112594.3
Total consumption of all kinds of fodders at agrarian economies, <i>thousand tons of fodder units</i>	13893	10052	7272	5262	3807
<i>including at agricultural enterprises</i>	1794	699	273	106	41
Consumption of mixed fodder at all categories of enterprises, <i>thousand tons of fodder units</i>	5006	3945	3109	2450	1931
<i>including at agricultural enterprises</i>	4482	3421	2612	1994	1522

Source: composed by the authors based on personal estimates.

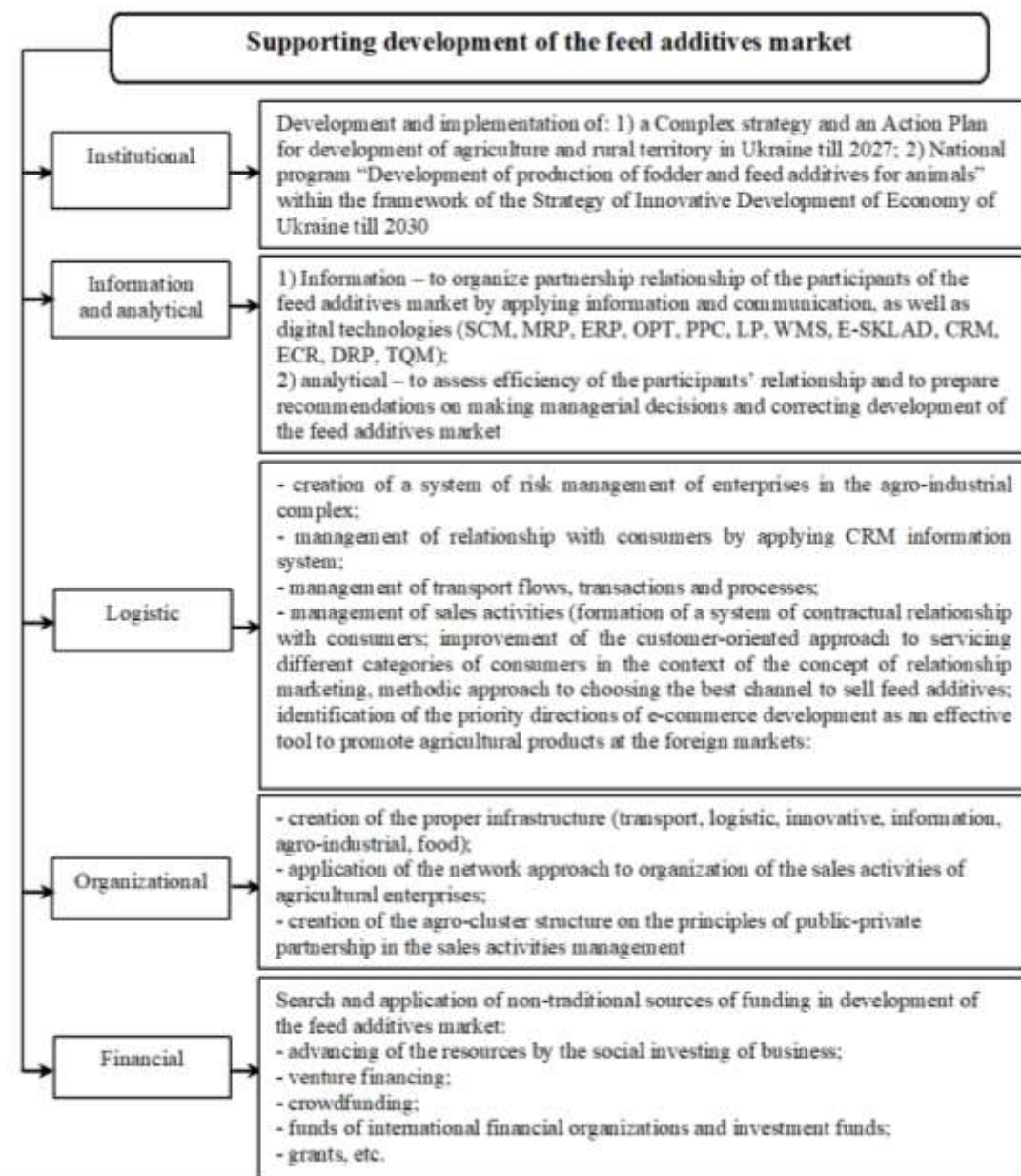


Fig. (1). Conceptual scheme of the necessary measures to ensure effective development of the feed additives market in Ukraine with consideration of the international practice.

Source: developed by the authors.

The statistical analysis of the main indicators of business operation in the agro-industrial complex and results of the research (Hnatyshyn, L., Prokopyszyn, O. and Trushkina, N, 2023) prove that effective development of the feed additives market is hampered by a complex of barriers which are related with the full-scale Russian invasion of Ukraine; instable political and economic situation; threats to the food security; deterioration of the foreign economic conditions and investment climate; blocked sea ports; limited financial resources; destruction and damage to the infrastructure objects (logistic, transport, agro-industrial), etc.

To ensure food security of the country, it is necessary to eliminate the mentioned barriers and create proper institutional, normative-regulatory, marketing, logistic, information and analytical, organizational, infrastructural and financial provision for the feed additives market development (Fig. 1).

The effective basis for the feed additives market development will create a transparent and clear system of managerial decisions on improvement of the operational management at the enterprises acting at the feed additives market in the instable and turbulent environment. To solve the outlined problem of ensuring food security, a particular attention should be paid to stimulation of the network interaction and partnership relationship on the base of agro-cluster structures; management of the marketing and logistic activities of agricultural enterprises by applying information and communication, digital, innovative technologies, relevant economic and mathematical tools.

CONCLUSIONS

The research proves the necessity to develop a Complex strategy and an Action Plan for development of agriculture and rural territory in Ukraine till 2027, National program “Development of production of fodder and feed additives for animals” within the framework of the Strategy of Innovative Development of Economy of Ukraine till 2030. Implementation of these will create a strong feed base due to the rational use of fodder resources, application of advanced technologies of raw material processing and production of essential aminoacids, vitamins, ferments and mineral supplements.

Moreover, it is reasonable to search for new sources of funding the agrarian sector including national and foreign investments, as well as advancing of the resources by social investing of business; venture financing, crowdfunding, funds of international financial organizations, grants, etc. It will provide sustainable development of the domestic agro-industrial complex in total.

The effective development of the feed additives market in the context of ensuring food security of Ukraine requires fulfilling a complex of strategic measures on:

improvement of the technical level of production;

introduction of innovative technologies at production;

reduction of the capital intensity, heat and energy intensity of production;

management of the process of transportation (introduction of information systems of cargo management; application of an

automatic processing of documents of cargo transportation; development of proposals on optimization of the transport loading; using Internet-technologies for automation of the transportation processes);

management of the processes of consumer servicing (analysis and forecast of the volume of agricultural products cargo with consideration of the seasonal factor; development of the algorithms of servicing different categories of consumers and proposals on enhancing the level of logistic services);

management of sales activities (substantiation of the network approach to organization of the sales activities of agricultural enterprises; formation of a system of contractual relationship with consumers; improvement of the customer-oriented approach to servicing different categories of consumers in the context of the concept of relationship marketing, mechanism of implementation of the public-private partnership in managing the sales activities of enterprises by establishing agro-clusters, methodic approach to the choice of the best channel to sell feed additives; determination of the priority directions for e-commerce development as an effective tool to promote agricultural products at the foreign markets).

Results of the research prove numerous risks which should be considered when organizing activities of enterprises in the agro-industrial complex. Thus, it is reasonable to conduct permanent monitoring and system analysis of the risks for agricultural enterprises' activities, and manage them by using a complex of methods and information systems, which enable predicting the risk occurrence and adequate responding to minimize them.

The authors have composed a conceptual scheme of the measures required to ensure effective development of the feed additives market in Ukraine with consideration of the international practice. Implementation of these measures will contribute to making proper, scientifically substantiated and effective decisions on the strategic directions of the feed additives market development for ensuring food security of Ukraine.

The further research will be devoted to development of a scenario of the feed additives markets development in Ukraine by applying the methods of forecasting, substantiation of the marketing strategy of managing the enterprises engaged in producing feed additives in conditions of the post-war reconstruction of the domestic agrarian sector, as well as justification of the paradigm of marketing management of the enterprises producing feed additives in the context of implementation of the strategy of the post-war reconstruction of the agrarian sector of Ukraine.

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