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FACTORS OF FEED PRODUCTION IN THE CONTEXT OF CLIMATE CHANGE

Alexander KOLESNIK, doctor of Agricultural Sciences, senior researcher
https://orcid.org/0000-0002-0602-3575
Stepan MIKHALCHENKO, doctor of agricultural sciences, professor
https://orcid.org/0000-0003-3679-073X
Vasily PRUDNIKOV, doctor of agricultural sciences, professor
https://orcid.org/0000-0001-9318-2015
Ruslan BATYR, candidate of Agricultural Sciences, doctoral student*
https://orcid.org/0000-0003-3183-8458
Livestock farming institute of NAAS, Kharkiv, Ukraine

The article examines the current state and dynamics of the development of the feed production industry in Ukraine and considers the impact of climate change factors and force majeure on its development.

It is determined that climate change has been observed not only all over the world, but also in the conditions of Ukraine. They are accompanied by an increase in Heat Supply and aridity of the growing season, uneven distribution of precipitation throughout the year.

It is established that over the past 20 years, the structure of sown areas of agricultural crops has changed significantly. In 2000, cereals accounted for 50.2%, technical 15.4%, and fodder 26.0 %. However, over the years, prices for cereals and technical crops (except sugar beet) have significantly increased, and the number of animals has significantly decreased. Therefore, in the total structure of sown areas, the area of industrial crops increased in 2021 to 32.3%, including the share of sunflower increased from 8.4% to 23.1%. The percentage of forage crops decreased from 26.0% in 2000 to 9.6% in 2010 and to 5.4% in 2021. it is proved that the use of nine different crops at the enterprise makes it possible to organize 7-full crop rotations with the best predecessors.

The analysis of the development of the feed production industry in PE "Agro-Novoselovka 2009" Novovodolazhsky district, Kharkiv region over the past 3 years is carried out. It is established that in 2021 the percentage of grain and leguminous crops was 69.6 %, technical – 26.2 %, fodder – 4.2 %. In 2022, their ratio did not change significantly and amounted to 72.2, 23.0 and 4.7%, respectively. the share of Feed area increased from 4.2% in 2021, to 4.7% in 2022 and to 7.5% in 2023, which is positive for feed production and animal feed supply.

It is determined that the company uses 7-field crop rotations and effective agrotechnical techniques in crop production, so that good predecessors are selected for agricultural crops. Corn for both silage and grain proved to be the most effective fodder crop in three years, under various conditions. However, the highest yield of crude protein per 1 ha was found in perennial grasses (alfalfa) for hay.

Keywords: feed production, climate, acreage, crop rotations, forage land, yield, feed units, productivity of 1 ha of area.

**Scientific consultant doctor of Agricultural Sciences, Professor S. A. Mikhalchenko*

ФАКТОРИ КОРМОВИРОБНИЦТВА В УМОВАХ ЗМІН КЛІМАТУ

Олександр КОЛІСНИК, доктор сільськогосподарських наук, старший дослідник, https://orcid.org/0000-0002-0602-3575
Степан МИХАЛЬЧЕНКО, доктор сільськогосподарських наук, професор https://orcid.org/0000-0003-3679-073X
Василь ПРУДНІКОВ, доктор сільськогосподарських наук, професор https://orcid.org/0000-0001-9318-2015
Руслан БАТИР, кандидат сільськогосподарських наук, докторант*
https://orcid.org/0000-0003-3183-8458
Інститут тваринництва НААН, Харків, Україна

В статті досліджено сучасний стан і динаміку розвитку галузі кормовиробництва в Україні та розглянуто питання щодо впливу факторів змін клімату та форс-мажорного характеру на її розвиток.

Визначено, що зміни клімату відмічено, не тільки у всьому світі, а й в умовах України. Вони супроводжуються зростанням теплозабезпеченості та посушливості вегетаційного періоду, нерівномірним розподілом атмосферних опадів протягом року.

Встановлено, що за останні 20 років структура посівних площ сільськогосподарських культур суттєво змінилася. У 2000 році зернові складали 50,2 %, технічні 15,4%, кормові 26,0 %. Проте за ці роки суттєво піднялися ціни на зернові та технічні (окрім цукрового буряка) а поголів'я тварин суттєво скоротилося. Тому в загальній структурі посівних площ, площа технічних культур збільшилась у 2021 році до 32,3 %, в тому числі питома вага соняшника збільшилась з 8,4 до 23,1 %. Відсоток кормових культур зменшився з 26,0 % у 2000 р. до 9,6 % у 2010 р. і до 5,4 % у 2021 р. доведено, що застосування на підприємстві дев'яти різних культур дає можливість організовувати 7-польні сівообороти з найкращими попередниками.

Проведено аналіз розвитку галузі кормовиробництва у ПП «Агро-Новоселівка 2009» Нововодолазького району, Харківської області за останні 3 роки. Встановлено, що у 2021 році відсоток зернових і зернобобових культур складав 69,6 %, технічних – 26,2 %, кормових – 4,2 %. У 2022 році їх співвідношення суттєво не змінилося і склало відповідно 72,2; 23,0 та 4,7 %. частка площі кормових площ збільшувалась з 4,2 % у 2021 р., до 4,7 % у 2022 р. і до 7,5 % у 2023 р., що є позитивним для кормовиробництва і забезпечення тварин кормами.

Визначено, що на підприємстві застосовують 7-польні сівозміни та ефективні агротехнічні прийоми в рослинництві, завдяки чому для сільськогосподарських культур підібрані добрі попередники. Найбільш ефективною кормовою культурою за три роки, при різних умовах, виявила себе кукурудза як на силос так і на зерно. Проте найбільший вихід сирого протеїну з 1 га встановлено у багаторічних трав (люцерна) на сіно.

Ключові слова: кормовиробництво, клімат, посівні площі, сівозміни, кормові угіддя, урожайність, кормові одиниці, продуктивність 1 га площі.

**Науковий консультант - Михальченко С.А., доктор с.-г. наук, професор, Інститут тваринництва НААН*

Introduction. The basis for the development of the livestock industry is the feed production industry, which is formed from different types of feed depending on the livestock industry. In realizing the productive potential of farm animals, feed is crucial, since their share in the production of livestock products is about 60 %.

The development of feed production according to V. F. Petrichenko (2022) should be aimed, in particular, at increasing the specific share of high-yielding varieties of corn, perennial legumes and grasses, annual legumes adapted to various conditions, resistant to pathogens, environmental stresses, with increased symbiotic activity; increasing the yield of forage crops and rational use of hayfields and pastures.

An important prerequisite for the development of animal husbandry in agricultural formations of various forms of ownership is the creation of a strong feed base in each farm. The importance of the feed industry is due to the fact that it is the basis for the growth of livestock and increasing its productivity, and this in turn determines the growth rate and level of production of livestock products, since feed accounts for 68-73% in the cost of livestock production. However, in recent years, the deficit of feed protein is 25-30%, which requires a new approach and significant changes in the formation of the feed base (Ambrosov V. Ya., 2009).

Feed production is a multifaceted but imperfect industry in technical and technological terms, which requires both the use of innovative technologies, achievements of modern science and technology, and significant investments, attracting material and labor resources. The peculiarity of feed production is its belonging to all three spheres of the agro – industrial complex - (feed is the means of production (objects of labor) of livestock products); direct production (cultivation, harvesting and storage of feed); industries of processing agricultural products (production of mixed feed, feed from plant waste).

An important issue of agricultural production is the efficiency of feed production, because this industry is located at the "junction" of two branches of Agriculture: Animal Husbandry and crop production. Feed production is a multifaceted but imperfect industry in technical and technological terms, which requires both the use of innovative technologies, achievements of modern science and technology, and significant investments, attracting material and labor resources (Ambrosov V. Ya., 2009).

Important scientific developments on forage crop cultivation technologies were carried out by well-known scientists of Ukraine A. A. Babich, V. F. Petrichenko, M. I. Bakhmat, G. I. Demidas, V. G. Kurgak, A.V. Korneychuk, I. I. Senik., Yu. a. Veklenko and others. However, many issues of this issue are still insufficiently studied.

Climate change has been observed not only all over the world, but also in the conditions of Ukraine. As V. A. Balabukh Notes (2022), they are accompanied by an increase in Heat Supply and aridity of the growing season, uneven distribution of precipitation throughout the year, a shift in the long-term timing of meteorological calendar phenomena, and so on.

At the same time, according to Ambrosov V. Ya. (2009), the production of feed both in quantity and quality does not meet the needs of animal husbandry, which is a consequence of low efficiency of feed use, their overspending, high feed capacity of a unit of production. In this regard, the problem of innovative development of feed production and improving the efficiency of animal husbandry on this basis requires a detailed study, taking into account theoretical, methodological and practical aspects. Also, in the context of global warming and a decrease in the level of summer precipitation, there is an increasing need to study the intensification of forage crops and provide livestock with high-quality feed.

The purpose of this article was to establish the influence of agroclimatic features and technological factors on the intensity of forage crop cultivation in the conditions of eastern Ukraine.

Materials and methods. The object of the study is the process of functioning of the feed production industry, both in Ukraine as a whole and in a separate enterprise, in the context of global climate change.

The theoretical and methodological basis of the research is a set of methods, approaches, principles of scientific knowledge, fundamental provisions of agrobiology of forage crops, scientific developments on the formation of effective feed production and justification of directions for improving the efficiency of forage crops in the context of climate change.

The article uses the method of analysis and synthesis, abstract-logical (formation of theoretical generalizations and conclusions), economic-mathematical, statistical, comparison and generalization. The theoretical and informational base of the research consists of the works of domestic scientists, analytical reviews of experts, as well as statistical information on the dynamics of the formation of the feed production industry.

Additional surveys were carried out in the state of emergency "Agro-Novoselovka 2009" in 2021, 2022 and 2023 on the sown areas of fodder, grain and industrial crops. The effectiveness of fodder and grain crops under various agroclimatic conditions was studied.

Research results. According to the World Meteorological Organization (WMO, 2019), since the 80s of the last century, every decade has been warmer than the previous one and this trend will continue in the future. The annual global temperature in 2019 was 1.1°C higher than the average for 1850-1900).

Today's warming trend is of particular importance, as much of it is the result of human activity since the mid-twentieth century and has been occurring at a rate unprecedented for decades to millennia.

Global climate change over time has coincided with population growth over the past century, leading to a significant increase in food demand. The United Nations predicts that the world's population will reach 9.7 billion by 2050, 10.8 billion by 2080, and 11.2 billion by 2100. While these projections do suggest a slowdown in global population growth, Africa and South Asia are expected to grow significantly and steadily: by 2100, these two regions may well be home to a population of 9 billion out of the projected 11 billion people on the planet. Driven by these important demographic forces, demand for products is expected to increase significantly, especially in Africa and South Asia (FAO, 2018). As noted by William Chutney (2019), climate change can cause food shortages and, as a result, hunger in the world. According to UN FAO (2018) estimates in 2017, more than 820 million people, about one in nine of the population, are still malnourished.

Climate changes on a global scale have also affected the territory of Ukraine. Since the beginning of the 80s and still in Ukraine, there has been a rather rapid trend towards an increase in the average annual air temperature. So, according to the Ukrainian hydrometeorological center, if the change in annual temperature in the northern hemisphere of the Earth for 50 years has not yet reached 1 °C, then in Ukraine it has increased by 1.4 °C. Over the past 20 years, the average monthly temperature in winter has increased by 2–3 °C, which has led to a reduction in winter by almost a month. This warming extends from south to North (Adamenko T. I., 2023).

The average air temperature increased in the north-eastern and south-eastern sub–regions of Ukraine by 2.7-2.8 °C, in the north – western–by 1.1-1.7°C. In accordance with the increase in air temperature, the number of frosty days decreased by about 5-10%.

Humidity increased by 10-25%. Smaller changes are observed in relation to precipitation: for them, the trend values are outside the 90% significance level. In Crimea, the trends of temperature and humidity changes were the same as for the mainland regions, but their absolute value was less, which is probably due to the influence of the Black Sea. Every 10 years in the regions of Ukraine, on average, there is an increase in temperature by 0.3–0.4 °C, that is, over 30 years – by 1 °C. According to scientists of the Institute of Botany of the National Academy of Sciences of Ukraine, this can lead to a shift of natural zones by 160 km (Lyakhu D. S., 2024).

According to the Ukrainian hydrometeorological center (2019), warming will continue until 2030. the temperature will rise by an average of 0.2–0.3 °C. At this rate of warming in Ukraine in 2030, it will be possible to grow crops in the southern regions only if the irrigation system is restored, since droughts will constantly recur. By 2050, a 2 °C increase in temperature could lead to desertification in the southern regions. These changes significantly affect the development of feed production and the provision of feed to farm animals.

Due to a significant reduction in the acreage under forage crops in recent years, the dynamics of forage crop production in Ukraine is generally negative (Table 1).

Table 1

Area of agricultural crops in Ukraine, mln. Ga

Indicators	2000	2005	2010	2015	2021
Agricultural crops, total	27,1	26,0	26,9	26,9	28,6
Grain crops and legumes	13,6	15,0	15,1	14,7	16,0
including wheat	5,31	6,18	6,13	6,69	6,91
corn	1,36	1,71	2,71	4,12	5,52
Technical crops	4,18	5,26	7,29	8,35	9,24
including sugar beet, thousand hectares	856	652	501	237	227
sunflower	2,94	3,74	4,57	5,11	6,62
Fodder crops	7,06	3,73	2,60	1,99	1,53
including feed corn	1,92	0,77	0,47	0,31	0,21

Thus, in Ukraine there is a trend inherent in countries with highly developed agriculture, where the increase in crop production is achieved through more intensive use of land resources, which ensures an increase in crop yields.

Over the past 20 years, the structure of sown areas of agricultural crops has changed significantly. Their total area increased by 1.5 million square meters. ha or by 5.5 %. The area under grain crops increased by 2.4 million hectares. ha or 17.6 %, wheat by 1.6 million. ha (30.1 %), corn – from 1.36 to 5.52 million hectares. ha or 4.0 times. Over the years, the area of industrial crops has increased 2.2 times. However, the area sown with sugar beet decreased from 856 to 227 thousand hectares, or 3.7 times, and sunflower – increased by 3.7 million. ha or 2.3 times. Over the years, the number of farm animals has almost halved. Accordingly, the area of forage crops sown decreased from 7.0 to 1.53 million hectares. ha or 4.8 times, including the area of fodder corn decreased from 1.9 million hectares. ha up to 0.21 or 9 times.

Table 2

Structure of acreage in Ukraine, %

Indicators	2000	2005	2010	2015	2021
Rural culture-household	100,0	100,0	100,0	100,0	100,0
Grain crops and legumes	50,2	57,6	56,0	54,8	56,0
Including wheat	39,0	41,2	40,7	45,4	43,2
corn	10,0	11,4	18,0	28,0	34,5
Technical crops	15,4	20,2	27,1	31,0	32,3
Including sugar beet, thousand hectares	20,4	12,4	6,9	2,8	2,5
sunflower	70,3	71,2	62,7	61,1	71,6
Fodder crops	26,0	14,4	9,6	7,4	5,4
Feed corn	27,2	20,7	18,2	15,5	13,9

Under the influence of market conditions, external and internal food situations, the ratio of acreage in Ukraine has changed significantly in recent years. That is, there have been significant changes in the structure of acreage not in favor of crop rotations and the feed production industry. Most Ukrainian scientists believe that in the structure of sown areas, fodder should be 50-60 % (Sprynchuk N. A., Voronetskaya I. S., 2022, Shapoval I. S.; Veklenko Yu.a., Kravchenko V. P., 2024).

In 2000, cereals accounted for 50.2%, technical 15.4%, and fodder 26.0% of arable land. However, over the years, prices for cereals and technical crops (except sugar beet) have significantly increased, and the number of animals has significantly decreased. Therefore, in the total structure of sown areas, the area of industrial crops increased in 2021 to 32.3%, including the share of sunflower increased from 8.4% to 23.1%. The percentage of forage crops decreased from 26.0% in 2000 to 9.6% in 2010 and to 5.4% in 2021.

As noted by leading scientists of the Institute of feed and Agriculture of Podillia of the National Academy of Agrarian Sciences of Ukraine Sprynchuk N. A. (2022), Korniychuk O. V., Petrichenko I. V. (2022), over the past decades in the field of animal husbandry of the leading countries of the world have undergone extremely high rates of transformation, called "revolution in animal husbandry". This was accompanied by significant technological innovations and structural changes in this sector. At the same time, millions of rural residents continue to keep animals within traditional production systems, which helps to ensure the livelihood and food security of the state, to a large extent inherent in the modern Ukrainian Village.

Does this trend of rapid reduction of forage land correspond to the modern needs of animal husbandry, especially cattle breeding? This question can only be answered by analyzing the structure and productivity of the feed wedge in a particular enterprise.

An example of a modern medium-sized agricultural enterprise is the private enterprise "Agro-Novoselovka 2009" of Novovodolazhsky district, Kharkiv region. It is located south-east of the Regional Center on the border of forest-steppe and steppe natural zones and has a meat and grain specialization. The total land area of the enterprise over the past three years has been unchanged at about 3 thousand hectares, and the area of crops increased from 2553 hectares in 2021 to 2753 hectares in 2022, in 2023 the area of agricultural land was 2888.4 hectares, hayfields 29.9, pastures 105.5 hectares. The number of cattle increased in three years from 564 to 713 heads, or 26.4%, while the

number of pigs had a steady tendency to increase from 2,875 to 6,634 heads, or 2.3 times.

The company uses scientifically verified and tested 7-field crop rotations and effective agrotechnical techniques in crop production, thanks to which the genetic potential of varieties and hybrids of agricultural crops is realized.

Crop rotation is quite a powerful tool that allows you to solve many problems, both agronomic and economic. In modern agriculture, with the deepening of the processes of specialization and concentration of production, the role of crop rotations increases (Senik I. I., 2020). Neither fertilizers and irrigation, nor pesticides used in the cultivation of agricultural crops, do not allow you to completely get rid of weeds, pests and diseases. Moreover, the better the land is fertilized and irrigated, the more favorable conditions are created for the development of weeds and diseases.

Of course, not all cultures are demanding of their rapid return to the same field. For example, corn, millet, buckwheat can be grown even for several years in a row without significantly reducing the yield. But repeated sowing of peas, sugar beet, wheat, barley, oats can have a very negative impact on the harvest. But they respond well to proper placement in crop rotation and the choice of a predecessor.

The use of nine different crops at the enterprise makes it possible to select the best and best predecessors (Table 3).

Table 3

Indicators of crop production development of PE "Agro-Novoselovka 2009"

Field crops	2021			2022			2023		
	ha	c	%	ha	c	%	ha	c	%
Cereals and legumes, total	1778	83427,7	69,6	1936	77567	72,2	1867	82199	67,6
including winter wheat	849	34228,3	33,3	1029	42970,6	38,4	567	24927,6	20,6
spring wheat	-	-	-	214	7146,6	8,0	468	13886,8	17,0
winter barley	-	-	-	10	522,6	0,4	106	2549,4	3,9
spring barley	277	8092,8	10,8	223	6221,8	8,3	132	4485,2	4,8
corn for grain	460	37812,6	18,0	351	17533,6	13,1	411	30475,8	14,9
peas	192	3294,0	7,5	109	3171,8	4,1	183	5874,8	6,6
Technical crops, total	669	9981,7	26,2	617	12543,9	23,0	679	12120,1	24,6
including sunflower	669	9981,7	26,2	617	12543,9	23,0	647	11886,7	23,5
mustard							32	233,4	1,2
Feed-total	106	31165,9	4,2	127	29567,7	4,7	207	49223,8	7,5
including corn for silage and green feed	83	30521,9	3,3	127	29567,7	4,7	207	49223,8	7,5
annual herbs	-			-	-		-	-	-
perennial grasses for hay	23	644	0,9	36	1872	0,7	56	3808	0,9
Total crops	2553		100	2706	-	100	2819	-	100

The total area of Zeon and leguminous crops sown over the past three years has not changed significantly, in 2022 it increased by 8.9 %, in 2023 only by 5.0% compared to 2021. however, it should be noted that the area of winter wheat sown in 2022 increased by 180 hectares or 25% compared to 2021. And this is quite logical, because in the spring of 2022, due to Russian military aggression, it was extremely difficult or even impossible to conduct a spring sowing campaign (this includes direct military operations near the farm, and a lack of fuel, fertilizers, herbicides, etc.). In this regard, in 2023, the area of winter wheat sown decreased by almost 2 times compared to 2022, while the area of spring wheat, on the contrary, increased by 2 times and reached 416 hectares. The area sown with spring barley decreased in 2022 by 54 hectares, in 2023 – by 145 hectares or 2 times. The sown area of industrial crops, namely sunflower, in 2022 decreased by 52 hectares (8.4 %), in 2023– increased by 30 hectares. As for the area of forage crops, it had a positive trend for animal husbandry, that is, it increased in 2022 by 19 hectares, in 2023 by 101 hectares or 2 times compared to 2021. The area of corn increased 1.5 times in 2022, and 2.5 times in 2023, and the area of perennial grasses per hay (alfalfa) increased 1.5 and 2.4 times, respectively. This made it possible to increase the harvesting of silage in 2023 by 1.6 times and hay in 2022 by 3 times , in 2023 by 6 times.

Analyzing the structure of the area of crops, it should be noted that in 2021 the percentage of grain and leguminous crops was 69.6%, technical – 26.2%, fodder – 4.2 %. In 2022, their ratio did not change significantly and amounted to 72.2, 23.0 and 4.7%, respectively. In 2023, the same trend was observed, with the exception of a significant increase in the share of forage land by 90%, and the ratio was 67.8, 24.7 and 7.5 %. The share of winter wheat has changed significantly. So, in 2021 it was 33.3%, in 2022 it was 33.3%. it increased to 38.4%, and in 2023, due to the impact of force majeure factors of the war and the inability to hold the autumn sowing of 2022, it decreased by 2 times to 20.6%. The percentage of spring wheat, on the contrary, doubled from 8.0% to 17.0%. In the structure of crops, spring barley halved, from 10.8% in 2021 to 4.8% in 2023. it should be noted a positive trend of a steady decrease in the share of industrial crops, namely sunflower, from 26.2% in 2021 to 23.0% in 2022, and to 24.7% in 2023. on the contrary, the share of fodder areas increased from 4.2% in 2021, to 4.7% in 2023. 2022 and up to 7.5% in 2023, which is positive for feed production and providing animals with feed.

So, thanks to this ratio of areas of individual crops and 7-field crop rotation, all crops were provided with excellent predecessors. So, winter wheat was sown after legumes (peas), perennial legumes and corn for silage. However, their area for the entire area of wheat sowing was not enough, so for the second part, the predecessor was corn for grain with manure application at the rate of 10 t/ha. It should be noted that the state of emergency "Agro-Novoselovka 2009" contains about 700 heads of cattle, which annually produces about 4500-5000 tons of manure for crop production. However, it is not possible to make the 10t/ha of manure indicated in the technological maps for all crops, since the company has only 2,800 hectares of crops. Therefore, manure is applied under undesirable precursors in order to enrich the soil with nitrogen.

Corn does not belong to crops that are very demanding of their predecessors, it grows best after winter crops, legumes, perennial grasses, buckwheat. The best precursors for alfalfa are winter and early spring crops, such as wheat, barley, and oats. They leave the soil in a clean phytosanitary state, which contributes to better rooting of alfalfa (Kamenshchuk B. D., 2020).

It should be noted that a negative factor is the presence of 23-26% of sunflower seeds in the structure of the company's acreage. That is, it indicates that the Sunflower returns to its field every four years. There is one very important rule: sunflower seeds, in crop rotation, must be returned to their previous place no earlier than six to eight years

(Butko V. Ya., 2014).

Therefore, it is necessary to place sunflower seeds in crop rotation after crops that usually leave a little nitrogen in the soil. Such precursors can be winter cereals. Excess nitrogen can cause overgrowth and delayed maturation of sunflower seeds, which is highly undesirable. As a rule, it is optimal for sunflower in the crop rotation to allocate one field in such a way that it is returned to this field no earlier than in 4-5 years, and if there is winter rapeseed and sugar beet in the crop rotation – in 7-8 years. Thanks to this, it is possible to almost completely avoid the defeat of crops by diseases and pests.

But if you grow sunflower seeds every 2-3 years, a variety of parasites (broomrape, white and gray rot, powdery mildew, etc.) spread significantly. This leads to a decrease in yield and deterioration of seed quality. Corn (both for silage and grain), winter wheat, spring ears, and legumes do not use the moisture of deep soil horizons, so these crops are the best as precursors for sunflower (Petrenko S. D., 2021).

The advantage of sunflower as a precursor for other crops is determined by the climatic conditions during its cultivation. In regions where there is a large amount of moisture, it is considered a fairly good precursor for winter wheat, as well as for other winter cereals. This plant permeates the soil with its powerful roots, which creates favorable conditions for the next crop to assimilate a large volume of soil. In the field, sunflower leaves approximately 7 t / ha of dry organic mass of plant residues, they must be crushed and embedded in the soil so that the next crop can use nutrients. Sunflower plant residues contain a significant amount of magnesium and potassium, which is why subsequent crops, in most cases, do without potash fertilizers, but instead, after sunflower, almost completely exhausted reserves of nutrients (especially nitrogen) and moisture reserves (Petrenko S. D., 2021).

The most important criterion for evaluating fodder and grain crops is their feed value based on 1 ha (table. 4). The most effective crop in terms of nutrient yield in all years was corn for grain. The company uses a high-yielding early-maturing hybrid of corn Kharkiv 195 MV. For its sowing, the required rate of manure of 10 tons and mineral fertilizers $N_{60}P_{60}K_{90}$ was applied per hectare. Thus, in 2021, with a yield of 82.2 c/ha, the yield of feed units from 1 ha was 106.0 C, and crude protein 731.6 C. In second place in terms of the yield of feed units was corn for silage (99.3 C) with a yield of 367.7 c/ha of green mass.

Table 4

Nutritional indicators of grain and fodder crops crop production PE "Agro-Novoselovka 2009", C

Crops	2021			2022			2023		
	c/ha	f.u/ha	cr.pr/ha	c/ha	f.u/ha	cr.pr/ha	c/ha	f.u/ha	cr.pr/ha
winter wheat	40,3	47,6	487,9	41,8	49,3	428,9	44,0	51,9	451,4
spring wheat	-	-	-	33,4	39,4	342,7	29,7	35,0	304,7
winter barley	-	-	-	52,3	62,8	538,7	24,1	28,9	248,2
spring barley	29,2	33,6	280,3	27,9	32,1	267,8	34,0	39,1	326,4
corn for grain	82,2	106,0	731,6	50,0	64,5	445,0	74,2	95,7	660,4
peas	17,2	20,5	326,8	29,1	34,6	552,9	32,1	38,2	609,9
corn for silage and feed	367,7	99,3	786,9	232,8	62,9	498,2	237,8	64,2	508,9
perennial grasses for hay	58,0	29,6	696,0	52,0	26,5	624,0	68,0	34,7	816,0

The third place was taken by winter wheat (47.6 centners per unit/ha) and spring barley – 33.6 centners per unit/ha. The last place was occupied by legumes, perennial grasses for hay (alfalfa) – 29.6 C and peas – 20.5 C. In terms of crude protein yield (SP), corn for silage – 786.9 and for grain-731.6 C K/Ha was in the first place. In second place were perennial grasses for hay 696.0 C with a yield of 58.0 c/ha. The third place was taken by winter wheat (487.9 C). And on the last one – peas (326.8 C) and spring barley (280.3 C).

In 2022, crop productivity was affected by many force majeure factors of martial law and objective factors affecting climate change. However, due to the noted factors of influence, no manure was applied for spring crops, and mineral fertilizers were applied only in the form of top dressing at the level of N30P30K30. The yield of winter wheat and barley sown in autumn 2021 turned out to be quite high due to favorable weather factors in winter, and amounted to 41.8 and 52.3 C/ha, respectively. However, critically difficult spring and summer cultivation and top dressing of plants led to a decrease in the yield of spring and fodder crops. Thus, the yield of spring wheat decreased to 33.4 C/ha, corn for grain to 50.0 c/ha (by 64.0%), corn for silage to 232.8 c/ha (by 58.2%), perennial grasses for hay to 52.0 c/ha (by 11.5 %). Accordingly, the yield of nutrients from 1 ha of crops also decreased, which led to changes in the ratio between individual crops in terms of their efficiency. Thus, the first places in terms of the yield of feed units per hectare of area were traditionally occupied by corn for grain (64.5 C) and silage (62.9 C) and spring barley (62.8 C). The second place was taken by winter wheat – 49.3 C, the third – spring wheat (39.4 C) and peas (34.6 C), and the last place was taken by perennial grasses for hay 26.5 C K/ha. The highest yield of crude protein per hectare, on the contrary, was observed in perennial grasses for hay 624.0 C, in second place due to their high yield were peas (552.9 C) and spring barley (538.7 C). The third place was taken by corn for silage (498.2 C) and grain (445.0 C). And in last place were spring wheat (342.7 C) and barley (267.8 C).

In 2023, 10 tons of manure and mineral fertilizers $N_{60}P_{60}K_{90}$ were applied for grain crops. However, crop production in eastern Ukraine was significantly affected by the weather conditions of the summer period, such as insufficient precipitation and elevated temperatures. It should be noted that most crops have increased their yields, including winter wheat (by 2.2 centners/ha), spring barley (by 6.1 centners/ha), and perennial grasses (by 16 centners/ha), peas – by 3 centners/ha and corn for silage (by 5 centners/ha). On the contrary, spring wheat decreased its yield by 3.7 c/ha, winter barley by 2.2 times to 24.1 C/ha. Despite different weather conditions and the level of fertilizer application, as in all years, the highest yield of feed units per hectare was 95.7 C. in second place was corn for silage – 64.5 C, followed by winter wheat – 51.9 C, then spring barley, wheat and peas. The lowest yield of feed units was obtained from perennial grasses for hay 34.7 C, and crude protein per hectare of area – on the contrary, the largest 816 C. in second place were corn for grain (660 C) and peas (609 C), corn for silage 509 C. the lowest amount of crude protein per hectare was determined for spring wheat and barley grains.

As a result, we note that the most effective forage crop for three years, under various conditions, even under adverse weather conditions, was the hybrid corn Kharkiv 195 MV, both for silage and grain.

Discussion. The analysis showed that over the past 20 years, the structure of sown areas of agricultural crops has changed significantly. Thus, the area of grain and leguminous crops increased slightly by 17.6%, and the area of sunflower by 2.3 times, and in the structure of crops from 11.0% in 2020 to 23.2% in 2021. in contrast, the area of fodder crops decreased during this period from 26.0% to 5.4%, which is a negative factor for the development of animal husbandry. Scientists, based on monitoring the state

of development of feed production in Ukraine, claim that in the field of crop production in the future there is a negative trend towards reducing the area under forage crops (Ambrosov V. Ya., 2009). However, according to N. A. Sprynchuk (2020), there is a tendency to increase crop production in Ukraine due to more intensive use of land resources and an increase in crop yields.

In recent years, Ukraine has seen an increase in the average annual temperature and a sharp increase in uneven precipitation throughout the year. As a result, the frequency of repeated droughts and floods has more than doubled (Petrichenko V. F., 2022). These changes significantly affect the development of feed production and the provision of feed to farm animals.

Analysis of the average size (2816 ha) of the agricultural enterprise PE "Agro-Novoselovka 2009" of Novovodolazhsky district, Kharkiv region confirmed the general state trend of changes in the structure of sown areas. So, over the past three years, the share of grain and leguminous crops was 67-72%, sunflower – 23.6-26.2%, fodder increased from 4.2% to 7.5 %. This made it possible to increase silage harvesting in 2023 by 61.3% and hay harvesting by 6 times compared to 2021.

The company uses 7-full crop rotations and effective agrotechnical techniques in crop production, so that good predecessors are selected for agricultural crops. Unfortunately, the company has disadvantages due to the discrepancy between the areas of the best predecessors and the rotation of crops, because the best predecessors are chosen for more economically profitable crops, such as winter wheat, corn for grain and sunflower. Another significant disadvantage is that the company does not have pure or black vapors, which are the best precursors for winter wheat..

The most effective forage crop for three years under various conditions, corn for both silage and grain, perennial grasses for hay (alfalfa) provided the lowest yield of feed units per hectare, and crude protein, on the contrary, the largest amount. And in the structure of acreage, they occupied less than one percent. However, according to Petrichenko V. F. (2022) and Petrichenko I. V. (2013), perennial legumes in the structure of sown areas of forage crops should occupy 50-55% and their characteristic feature is that they can grow on various types of soils, including low-fertile and eroded.

When selecting perennial grasses for sowing, it is necessary to pay attention to their yield and feed value. In studies by Kulik M. et al. (2024), millet (56.0 t/ha) and perennial sorghum (53.6 t/ha) had the highest biomass yield in forest-steppe conditions. However, it should be noted that grass mixtures of three or four components have an advantage over single-component ones. According to the NSC "Institute of Agriculture of the National Academy of Sciences", the highest yield was provided by alfalfa-runoff mixture, namely (on average for four years): single-species alfalfa sowing – 7.84 t / ha; alfalfa + eastern fescue-9.32 t / ha; alfalfa + gryastitsa combined-8.82 t/ha; alfalfa + stoeless runoff – 10.3 t / ha of dry matter (Kukharchuk P. I., Slyusar S. M., 2017).

The most common grass mixtures, as in the western and northern parts of Ukraine as a whole, were and are mixtures of oats with legumes, most often with spring vetch (Hetman N. Ya., 2023, Lekhman A.V. et al., 2023). This is confirmed by V. F. Petrichenko (2022), who notes that it is advisable to grow two-and three-component legume-cereal-cabbage mixtures using oats with cabbage or legumes, which in the structure of crops of annual fodder crops should occupy at least 65-70 %.

In turn, N. Ya.Getman and L. M. Burko (2023) add that in the conditions of the central forest-steppe of Ukraine, alfalfa sown for three years of life and 2 years of use is able to fix 735 kg/ha of nitrogen from the air, enriching the soil by 598 kg/ha with nitrogen. During spring coverless sowing in two slopes, alfalfa captures 173 kg/ha of nitrogen from the air, leaving it in the soil 148 kg/ha. Also, the results of the study of the

nitrogen-fixing ability of alfalfa and increasing soil nitrogen saturation are confirmed by Olifirovich V. F., Veklenko Yu.a. (2022). Didur I. M., Shevchuk V. V. (2020) prove that legume-rhizobial systems capture 40 to 300 kg of nitrogen per 1 ha of crop each year from the atmosphere.

Studies of Rudavskaya N. M. and Oyster Mushroom V. V. (2018) found that on average for two years of using the grass stand, the highest yield (9.0 t/ha of dry weight) was provided by legume-cereal grass mixture, fertilized normally N60P60K90 with seed treatment with rhizobophyte and polymyxobacterin biologics.

Summing up the above, we can make suggestions for improving crop rotations in general, and feed production in particular. The company needs to introduce mandatory pure or black pairs in the amount of 10-15% of the sown area into the structure of sown areas, in conditions of climate change, increase the feed wedge to the desired minimum 10-15%, especially in conditions of climate change, it is desirable to increase the area of sowing perennial grasses inside the feed areas, as well as use two-or three-component (legume-cereal) feed mixtures with the proportion of legume grasses at the level of 50-60 %.

Conclusions: Based on the conducted studies to establish the influence of agroclimatic features on the intensity of forage crop cultivation, the following conclusions can be drawn:

1. Research has established that over the past 20 years in Ukraine, the structure of sown areas of agricultural crops has changed significantly. Their total area increased by 1.5 million square meters. ha or by 5.5 %. The area under grain crops increased by 2.4 million hectares. ha or 17.6 %, wheat by 1.6 million.ha (30.1 %), corn – from 1.36 to 5.52 million hectares. ha or 4.0 times. Over the years, the area of industrial crops has increased 2.2 times. However, the area under sugar beet cultivation decreased from 856 to 227 thousand hectares, or 3.7 times, and the area under sunflower increased by 3.7 million hectares. ha or 2.3 times.

2. It is proved that in the structure of acreage in Ukraine in 2000, cereals accounted for 50.2 %, technical 15.4%, fodder 26.0%. However, over the years, prices for cereals and technical crops (except sugar beet) have significantly increased, and the number of animals has significantly decreased. Therefore, in the total structure of sown areas, the area of industrial crops increased in 2021 to 32.3%, including the share of sunflower increased from 8.4% to 23.1%. The percentage of forage crops decreased from 26.0% in 2000 to 9.6% in 2010 and to 5.4% in 2021.

3. The analysis of the state of feed production in PE "Agro-Novoselovka 2009" Novovodolazhsky district, Kharkiv region over the past three years is carried out. It is established that the company uses scientifically verified and tested 7-field crop rotations and effective agrotechnical techniques in crop production, thanks to which the genetic potential of varieties and hybrids of agricultural crops is realized.

4. Analyzing the structure of acreage in the enterprise, it was found that the area of grain and industrial crops has practically not changed over the past 3 years, and the area of fodder crops has increased from 4.2% to 7.5%. However, sunflower seeds have a critical amount (23-26% of the total area sown) for the formation of optimal crop rotations.

5. Analysis of crop productivity showed that corn for both silage and grain proved to be the most effective forage crop in three years, under various conditions, even under adverse weather conditions. And in terms of raw protein yield, perennial grasses for hay were the most effective.

6. To effectively overcome the negative factors of changes in climatic conditions and the structure of acreage, the company is proposed to introduce mandatory pure or

black pairs in the amount of 10-15% of the acreage into the structure of acreage, in the conditions of climate change, increase the feed wedge to the desired 10-15%, and inside the fodder areas it is desirable to increase the area of sowing perennial grasses, as well as use two-or three-component (legume-cereal) feed mixtures with the proportion of legume grasses at the level of 50-60%.

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