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N. Vorona, PhD. of Technical Science, Associate Professor, *E-mail: tarnin@te.net.ua*
ORCID: https://orcid.org/0000-0001-6903-9016, Researcher ID: F-8020-2016, Scopus ID: 57188205800
B. Iegorov, Doctor of Technical Science, Professor, *E-mail: bogdanegoroff58@gmail.com*
ORCID 0000-0001-7526-0315, ResearcherID Q-1365-2015, Scopus ID 56578802600
A. Makarynska, Doctor of Technical Science, Associate Professor, *E-mail: allavm2015@gmail.com*
ORCID: https://orcid.org/0000-0003-1879-8455, Researcher ID: C-5217-2016, Scopus ID: 57192819060
Department of Grain and Compound Feed Technologies, Tel. no. (048)712-40-13
Odesa National University of Technology, 112 Kanatna Str., Odesa, Ukraine, 65039

LUPINE IS A PROMISING LEGUME CROP FOR COMPOUND FEED PRODUCTION

Abstract

It has been established that food security is an essential component of the overall national security of every country, as it is recognized as a necessary condition and prerequisite for the social and economic stability of the state. Food plays a vital role in human life. Feed production acts as an intermediate link in the production chain, encompassing raw material suppliers (agricultural enterprises, farms), processors (feed mills), and consumers (poultry and livestock complexes). Thus, the feed industry is a key link in providing the population with meat products. Under conditions of war and other market changes, the dynamics of the feed market in Ukraine are undergoing significant transformations. The dynamics of changes in feed production volumes by animal species in Ukraine since 2013 have been presented. It has been established that the leader in feed production is Myronivsky Hliboproduct (MHP), which produces one-third of the total volume. The main global challenges faced by the feed production sector during the full-scale war in Ukraine have been highlighted, including disruptions in logistics for raw material supply, resources, and product distribution; shortages and high costs of energy resources; labor shortages due to mass emigration and employee mobilization; reduction in workforce; and an unstable market. The top 10 agro-industrial companies in Ukraine that earned nearly 90 billion UAH in 2023 (according to the Opentadatabot Index) have been listed. Changes in the production volumes of feed crops in Ukraine from 2019 to 2023 have been presented. According to Forbes, grain production in Ukraine in 2023 decreased by 7.9% compared to 2022. It has been substantiated that the search for new types of protein grain raw materials contributes to the diversification of protein sources and can support the stability of feed production amid full-scale war, changing market conditions, yields, and other factors. Lupin can be an important component in agricultural production systems, as its high protein content can expand protein sources for feed and other products. Regarding the use of lupin in animal feed, its protein contains all essential amino acids, making it appealing for animal nutrition. Most types of lupin are rich in fiber and other beneficial components such as oils, antioxidants, and vitamins. Lupin oil is a valuable product as it contains significant amounts of fat-soluble vitamins and provitamins, such as tocopherols (vitamin E), sterols, and carotenoids. This oil's distinctive feature is its high content of essential linoleic and linolenic acids. Statistics on global and Ukrainian lupin production reflect data only for seed production, with the average global seed yield in 2019 being 11.4 centners per hectare, while in Ukraine, a higher yield of 14.0 centners per hectare was noted. Ukraine does not import lupin seeds but actively exports them. In 2020, lupin exports amounted to 4.2 thousand tons worth $1.4 million, approximately half of Ukraine's production. The main importing countries were the Netherlands and Poland. Ukraine ranks 9th in the world in terms of lupin production.

Key words: lupine, volumes of compound feed production, agro-industrial companies, food security of the country, protein deficiency.

Introduction

The compound feed industry is an essential component of Ukraine's agro-industrial complex, playing a key role in the development of animal husbandry, poultry farming, fisheries, and the food industry.

The technology for producing compound feed encompasses a variety of operations aimed at maximizing the potential nutritional value of feed components. This process involves modifying ingredient components to maximize their natural value and achieve the best possible return from their use [1].

Food security is a critical element of every country's overall national security, as it is recognized as a mandatory condition and prerequisite for a state's social and economic stability. Food products play an essential role in human life.

International agreements define food security as "a state of the economy in which everyone is guaranteed access to food, drinking water, and other products of sufficient quality, variety, and quantity necessary for the physical and social development of individuals, the health and reproduction of the population of the country." Under the current socio-economic development conditions of Ukraine's agro-industrial complex, the compound feed industry plays a key role.

Compound feed production is an intermediary link in the production chain, which includes raw material suppliers (agricultural enterprises, farms), processors (compound feed enterprises), and consumers (poultry and livestock complexes). Thus, the compound feed industry is a vital link in ensuring the population's access to meat products.

Over the past decade, the agro-industrial complex has faced crises, especially in animal husbandry and related sectors such as feed production. Poor-quality compound feeds, where grain components on average accounted for over 70%, significantly exceeding the standards recommended by the European Union, have played a particularly negative role in this situation. This places the compound feed industry in a 70% dependency on agriculture.

The Ukrainian agricultural sector has faced its

Fig. 1 - Lupine and lupine seeds

greatest challenges due to the full-scale aggressive war by Russia against our country. The impact of the military conflict on agriculture has been extremely significant, leading to serious consequences for both Ukraine and the global agricultural market.

A large portion of cultivated land is currently either mined or rendered unusable due to extensive bombings. Access to some agricultural lands is restricted, as hostile actions are aimed at deliberately destroying storage facilities and agricultural equipment. All these factors indirectly affect the development prospects of agriculture in the near future.

In current conditions, Ukrainian agribusiness operates with significant challenges, demonstrating flexibility and efficiency. Due to difficulties in grain logistics, agriculture is shifting focus, placing greater emphasis on growing oilseeds and legumes. Farmers are actively seeking alternative ways to sell their products. Modern challenges have highlighted the issue of Ukraine's raw material exports and have accelerated the development of the agricultural sector towards producing higher-value-added products, such as compound feed production [2, 3].

Moreover, addressing the issue of global food security encourages the search for new raw materials for compound feed production and the development of technologies to utilize less common or non-edible components for humans. One such protein component is feed lupine.

The Ukrainian agro-industrial sector is a key component of the country's economy and plays a significant role in generating export revenue. Compound feed production is a vital part of this sector, ensuring the availability of quality and sufficient feed for the development of animal husbandry. Under conditions of war and changing market conditions, the dynamics of the compound feed market in Ukraine are undergoing significant transformations.

Until 2020, there was growth and active development in the natural compound feed market. This trend can be explained by changing approaches to feed production and consumption in animal husbandry. In particular, there has been an increase in demand for organic and environmentally friendly products. The market situation is influenced by various factors, such as war and changes in consumer behavior, requiring the industry to adapt to new conditions [4].

Purpose and objectives of the analysis

The purpose of the study is to justify the feasibility of using lupine as part of compound feed for farm animals and poultry to solve the protein problem and ensure the country's food security.

Results and its discussion

At the beginning of 2023, Ukraine's compound feed industry faced a series of important transformations and challenges. Achieving sustainable efficiency amidst complex economic and political conditions on the national and global stage required transformation.

Analyzing the development of the compound feed market is essential for understanding the prospects of the country's food security. The Ukrainian compound feed industry continues to play a key role in ensuring high-quality and effective feed for the development of animal husbandry, as the realization of genetic potential, health status, and the quality of end products are 50-60% dependent on feeding efficiency. However, feed production requires constant attention.

In Ukraine, the annual volume of compound feed production exceeded 6 million tons until 2021, according to the State Statistics Service (Fig. 2), a figure that has remained stable since 2013. As of 2022, statistical data has not been released due to the full-scale war.

Analysis of the data shows that starting from 2019, there has been a decline in the volume of compound feed production in Ukraine. The reason for this was the spread of COVID-19. The most significant decrease was experienced by producers of compound feed for poultry, while the production of compound feed for pigs and cattle saw slight growth.

The leader in compound feed production is Myronivsky Hliboproduct (MHP), which accounts for one-third of the total volume. Another third of the market is occupied by vertically integrated agro-holdings that own various types of livestock and their own lands for com-

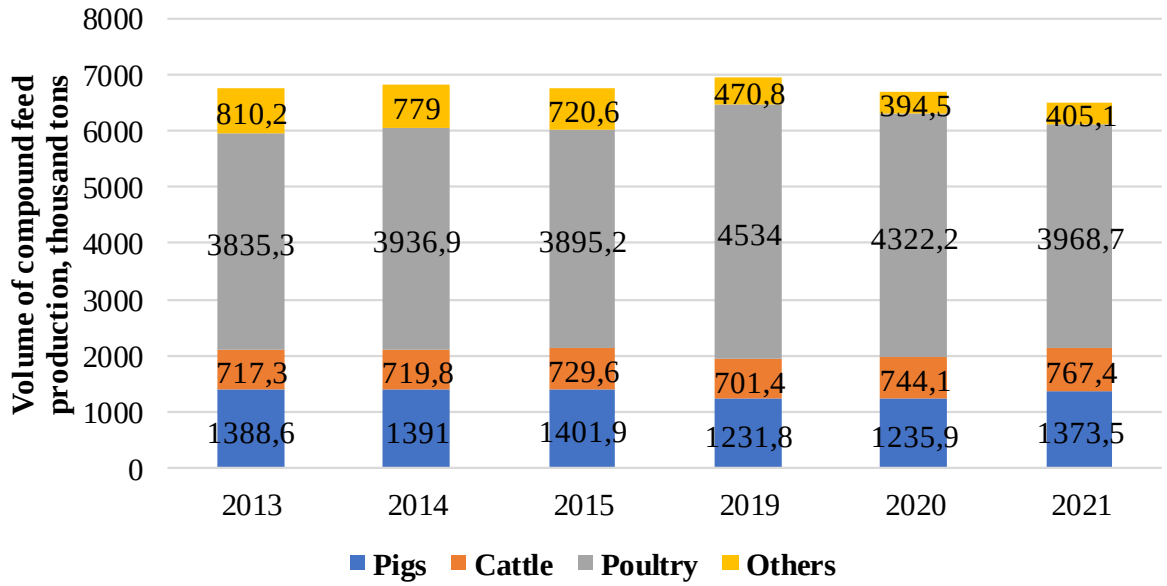

Fig. 2 - Dynamics of changes in the volume of compound feed production by animal type in Ukraine [5]

Table 1 – Ranking of the largest Agro-Industrial Companies in Ukraine [6]

Place	Name	2023, billion UAH	2022, billion UAH	Place in 2022
1	Myronivka Poultry Farm	21,43	13,99	2
2	Lebedynsky seed plant	15,68	13,44	3
3	Friendship-New	7,5	5,18	7
4	Enselko Agro	7,21	6,41	5
5	Starunska Poultry Farm	7,13	3,3	16
6	Podillia	6,04	4,78	9
7	Oril- Leader	5,76	5,1	8
8	Dniprovsky bird complex	5,37	4,08	12
9	Bird complex Zorya Podillia	5,3	3,41	15
10	Western Bug	5,15	4,19	11

Table 2 - Production of feed raw materials in Ukraine, thousand tons [7]

Cultures	Marketing year (MY)				Change, %
	2019/2020	2020/2021	2021/2022	2022/2023	
Crops	75716	65005	86521	51260	-32,3
Corn for grain	35887	30297	42126	25000	-30,3
Wheat	29171	25420	33007	19500	-33,2
Barley	9528	7947	9923	5700	-40,2
Sunflower	16500	14100	17500	9500	-42,4
Soy	4499	3000	3800	2800	-37,8
Turnip	3465	2750	3015	3200	-7,6

pound feed production. The remaining third belongs to occupied by vertically integrated agro-holdings that own various types of livestock and their own lands for compound feed production. The remaining third belongs to small compound feed plants and workshops, which purchase raw materials, produce feed, and sell it, representing commercial production in the market niche.

The main global challenges faced by the compound feed production industry during the full-scale war in Ukraine include:

- disruption of logistics for raw material supply, resources, and sales of finished products;
- shortage and high cost of energy resources;
- labor shortages due to mass emigration and mobilization of employees;
- reduction in the number of employees;
- an unstable market.

Modern compound feed production depends on

grain harvests, the level of grain exports, the state of logistics chains, and the condition of the livestock and poultry industries. In Ukraine, up to 70% of grain raw materials are used in compound feeds, making producers heavily dependent on it.

One of the key problems is uncontrolled fluctuations in grain prices. Price stability is critical for planning operations and maintaining optimal livestock numbers. The influence of geopolitical and economic challenges on the external market also raises concerns about the supply and availability of raw materials for compound feed production.

According to the Opentadatabot Index, the combined revenue of the top 10 agricultural companies in 2023 increased by 35%. The leaders in the agricultural market earned nearly 90 billion UAH (Table 1).

As shown in the table, the leaders in the revenue ranking have experienced a significant drop in profits. Notable growth has been observed in the segment of vertically integrated agro-holdings, which control production from crop cultivation to compound feed production.

An analysis of actual data (2019-2023) regarding the production volumes of major feed crops indicates a substantial decrease in the production of corn (by 30.3%), barley (40.2%), sunflower (42.4%), wheat (33.2%), and other agricultural crops (Table 2).

According to Forbes, grain production in Ukraine in 2023 decreased by 7.9% compared to 2022. However, the enemy was unable to destroy or halt the operations of Ukraine's agro-industrial complex. Under current conditions, the country's agricultural sector continues to fight for both its own and global food independence.

As reported by the Kyiv School of Economics in June 2023, the total direct damage inflicted on Ukraine's agro-industrial complex amounted to $8.7 billion USD. Losses related to the destruction and damage of agricultural machinery exceed $4.7 billion USD, while losses due to the destruction and theft of produced goods are estimated at $1.9 billion USD. Indirect losses to the agro-industrial complex are estimated at $40.3 billion USD [8].

The reduction in production volumes is due to several factors, such as the temporary occupation of parts of Ukrainian territories, ongoing military actions, the demining of liberated lands, decreased yields compared to 2022, and the complicated and significantly prolonged harvesting process caused by rainy autumn weather and other negative influences. As of early 2024, the livestock sector has generally remained stable: most types of products remain profitable, except for beef production. In April 2024, profitability declined for all types of products except poultry. Contributing factors included rising barley and corn prices on the domestic market, a seasonal drop in milk prices, and falling pork prices due to increased domestic supply. At the same time, chicken, as the most affordable type of meat for end consumers, continues to show positive profitability trends.

The need to find new types of protein grain raw materials has become urgent in light of the challenges facing the compound feed industry. Identifying new protein sources for compound feed production may prove essential for ensuring efficient animal feeding and addressing the protein deficit, which, according to FAO, poses a potential threat in the near future.

One promising alternative could involve the use of new grain crop varieties or technological innovations in cultivating traditional types to increase the protein content of grains. Additionally, exploring alternative protein sources, such as local legumes, dehulled soybeans, processed rapeseed, lupine, and others, is crucial.

The search for new types of protein grain raw materials promotes the diversification of protein sources and could contribute to the stability of compound feed production in the context of full-scale war, shifting market conditions, crop yields, and other factors.

Lupine is a leguminous plant known for its high content of high-quality and easily digestible protein and other beneficial nutrients. Lupine is a valuable and promising plant species used both for animal feed and for improving soil conditions.

Lupine can be an important component in agricultural production systems, as its high protein content can expand protein sources for feed and other products. Regarding the use of lupine in compound feeds, its protein contains all essential amino acids, making it valuable for animal nutrition. Most types of lupine have high fiber content and other beneficial components such as oils, antioxidants, and vitamins.

The green mass of lupine is used as animal feed in the form of green forage, silage, hay, and grass meal. Lupine plays an exceptionally important role as one of the best green manure crops, especially for improving the fertility of sod-podzolic, sandy, and sandy-loam soils in the Polissia region due to worsening environmental conditions. Lupine is a unique plant with a high nitrogen-fixing and phosphate-mobilizing potential through symbiosis with Rhizobium bacteria, which can improve soil fertility. It naturally enriches the soil with nitrogen, leaving more than 100 kg of mineral nitrogen per hectare that is easily absorbed by plants, thus enhancing soil fertility.

Lupine is also used as raw material for the processing industry. Protein concentrates obtained from its seeds are used to produce artificial fibers, adhesives, plastics, and more. Lupine oil is a valuable product as it contains significant amounts of fat-soluble vitamins and provitamins such as tocopherols (vitamin E), sterols, and carotenoids. A distinguishing feature of this oil is its high content of essential linoleic and linolenic acids.

These fatty acids, particularly linoleic and linolenic, are important for health as they are essential for the normal functioning of the body and can have a therapeutic effect in preventing cholesterol metabolism disorders and cardiovascular diseases. These acids play a critical role in reducing the risk of developing cardiovascular diseases. Therefore, lupine oil can be considered a promising product for maintaining and improving cardiovascular health due to its content of beneficial fatty acids and vitamins [9, 10, 11, 12].

Overall, the use of lupine in agriculture can have a positive impact on animal productivity and the environmental sustainability of production systems.

In Ukraine, lupine is mainly cultivated in the Polissia region. Yellow fodder and blue narrow-leaved lupine varieties are common in Chernihiv, Zhytomyr, Kyiv, Rivne, and Volyn regions. White lupine is grown

in the Forest-Steppe and Transcarpathia. The area of fodder lupine crops grown for grain covers 55-65 thousand hectares. The average grain yield of fodder lupines is relatively low: 8-10 centners per hectare for yellow lupine and 16-18 centners per hectare for white lupine. With advanced agrotechnology and intensive cultivation techniques, grain yields can reach 25-28 centners per hectare, while green mass yields can amount to 450-500 centners per hectare.

In Ukraine, three types of annual lupine are grown: blue or narrow-leaved, yellow, and white, along with one perennial lupine species. The main varieties used are yellow and white fodder lupine [10].

Analysts from the Ukrainian Agribusiness Club Association point to a global trend of reducing lupine crop areas. Over the past 20 years, the average annual decline in lupine cultivation has been 2.54%. As of 2019, the global total area under this crop was 887.1 thousand hectares. This decrease is attributed to lupine's lower yield compared to other grain and leguminous crops.

Currently, Australia has a significant share of lupine seed production, amounting to 474.6 thousand tons, or 47% of global production.

Statistics on global and Ukrainian lupine production primarily focus on seed production. In 2019, the average global seed yield of lupine was 11.4 centners per hectare, while in Ukraine, it was higher at 14.0 centners per hectare. It has been established that with intensive cultivation technologies, lupine yields can reach 25-28 centners per hectare.

In the early 1970s, lupine crops in the USSR covered 2 million hectares, including 500 thousand hectares for grain. In the 1980s-90s, Ukraine's lupine cultivation for seed exceeded 100 thousand hectares, while areas used for fodder reached 300 thousand hectares. According to the State Statistics Service, in 2020, the area sown with lupine seed in Ukraine was only 5 thousand hectares, a 35% decrease compared to the previous year.

During Soviet times, lupine was grown not only for seed but also as green mass for livestock feed and as green manure to improve soil fertility. The decline in lupine production in Ukraine is associated with structural changes in production, including a decrease in cattle numbers and the choice of more profitable crops in plant production.

Ukraine does not import lupine seed but actively exports it. In 2020, lupine exports amounted to 4.2 thousand tons worth $1.4 million, which is approximately half of Ukraine's production. The main importing countries were the Netherlands and Poland. Ukraine ranks ninth among the world's largest lupine producers [9].

Conclusions

The compound feed industry is indispensably key in ensuring the country's food security. The satisfaction of the population's needs for products of animal origin and the state of people's health depend on its effectiveness. The compound feed industry suffered from the full-scale war in Ukraine no less than other industries. The main problems are staff shortages, disruptions in logistics chains, price fluctuations on the raw materials market. In this regard, the search for new types of protein grain raw materials contributes to the diversification of protein sources and can contribute to the stability of compound feed production during wartime.

Lupine is a high-protein legume that contains all essential amino acids, oil, antioxidants and vitamins. Thus, due to the need for rational diversification and improved quality characteristics of feed for agricultural animals and poultry, the use of lupine in compound feed production is proposed. This is expected to provide an economic benefit of approximately 40 million UAH in profit and a 3-5% increase in compound feed production output.

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Н.В. Ворона, канд. техн. наук, доцент, *E-mail: tarnin@te.net.ua*
Б.В. Єгоров, д-р техн. наук, професор, *E-mail: bogdanegoroff58@gmail.com,*
А.В. Макаринська, д-р техн. наук, доцент, *E-mail:allavm2015@gmail.com*
Кафедра технології зерна і комбікормів, Tel. +38048 7124013
Одеський національний технологічний університет, вул. Канатна, 112, м. Одеса, 65039, Україна

ЛЮПИН – ПЕРСПЕКТИВНА БОБОВА КУЛЬТУРА У СКЛАДІ КОМБІКОРМІВ

Анотація

Встановлено, що питання продовольчої безпеки є важливою складовою загальної національної безпеки кожної країни, оскільки визнається обов'язковою умовою та передумовою соціальної та економічної стабільності держави. Продукти харчування відіграють важливу роль у життєдіяльності людини. Виробництво комбікормів є проміжною ланкою виробничого ланцюга, що включає постачальників сировини (сільськогосподарські підприємства, фермерські господарства), переробників (комбікормові підприємства) та споживачів (птахівничі і тваринницькі комплекси). Таким чином, комбікормова промисловість є важливою ланкою у забезпеченні населення м'ясною продукцією. В умовах війни та інших змін ринкових умов динаміка ринку комбікормів в Україні зазнає істотних перетворень. Представлено динаміку змін об'ємів виробництва комбікормів за видами тварин в Україні з 2013 року. Встановлено, що лідером з виробництва комбікормової продукції є Миронівський хлібопродукт (МХП), який виробляє третину загального обсягу. Наведено основні глобальні проблеми, з якими зіткнулась галузь виробництва комбікормів під час повномасштабної війни в Україні: порушення логістичних зв'язків з постачання сировини, ресурсів та збуту готової продукції; дефіцит та висока вартість енергетичних ресурсів; кадровий голод через масовий виїзд за кордон та мобілізацію співробітників; зменшення кількості співробітників; нестабільний ринок. Представлено, топ-10 агропромислових компаній України, які заробили майже 90 млрд грн за 2023 рік (за даними Opentadatabot Index). Наведено зміни об'ємів виробництва кормових культур в Україні у період з 2019 по 2023 роки. Згідно даних Forbes у 2023 році виробництво зерна в Україні скоротилося на 7,9% у порівнянні з 2022 роком. Обґрунтовано, що пошук нових видів білкової зернової сировини сприяє диверсифікації джерел білка та може сприяти стабільності виробництва комбікормів в умовах повномасштабної війни, зміни ринкових умов, врожайності та інших факторів. Люпин може бути важливим компонентом в системах сільськогосподарського виробництва, оскільки його високий вміст білка може призвести до розширення джерела білка для кормів та інших продуктів. Що стосується використання люпину в комбікормах, його білок містить усі необхідні амінокислоти, що робить його цікавим для годівлі тварин. Більшість видів люпину мають високий вміст волокон та інших корисних компонентів, таких як олія, антиоксиданти та вітаміни. Олія люпину є цінним продуктом, оскільки містить значні кількості жиророзчинних вітамінів і провітамінів, таких як токофероли (вітамін Е), стероли та каротиноїди. Особливістю цієї олії є високий вміст незамінних лінолевої та ліноленової кислот. Статистика світового та українського виробництва люпину фіксує дані лише щодо насіннєвого напряму, і в 2019 році середньосвітова урожайність люпину на насіння становила 11,4 центнерів на гектар, тоді як в Україні відзначалася вищою урожайністю на рівні 14,0 центнерів на гектар. Україна не ввозить насіння люпину, але активно експортує його. У 2020 році експорт люпину становив 4,2 тис. тонн на суму $1,4 млн, що приблизно складає половину українського виробництва. Основними країнами-імпортерами були Нідерланди та Польща. Україна посідає 9-те місце в світовому рейтингу найбільших виробників люпину.

Ключові слова: люпин, об'єми виробництва комбікормів, агропромислові компанії, продовольча безпека країни, білковий дефіцит.

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