UDC 633.16:631.15:338.43
DOI https://doi.org/10.32782/2226-0099.2025.143.1.5

PROSPECTS FOR SORGHUM CULTIVATION AS A NICHE CROP IN MODERN AGRIBUSINESS

Boiko M.O. *– Candidate of Agricultural Sciences,*
Senior Lecturer at the Department of Ecology and Sustainable Development
named after Professor Yu.V. Pylypenka,
Kherson State Agrarian and Economic University
orcid.org/0009-0001-2291-3164

In modern conditions of agricultural production, accompanied by climate change, water scarcity, rising energy costs and the need to diversify crops, sorghum cultivation is becoming increasingly relevant. This niche crop demonstrates a high level of adaptability to arid conditions, low soil requirements and resistance to pests and diseases, which makes it an attractive alternative for regions with risky agriculture. Sorghum has a wide range of applications: it is used as a feed crop, for food needs, and in bioenergy. Of particular interest is the possibility of using sugar and grain sorghum for bioethanol production, which opens up additional economic benefits for agricultural producers. In addition, the high biomass yield allows this crop to be effectively used in the feed balance of farms.

The study carried out a comprehensive analysis of the world and domestic experience in growing sorghum as a promising niche crop. Particular attention was paid to the dynamics of the areas of grain and fodder sorghum crops in the countries of the European Union, where there is a steady growth of interest in this crop. The current state and the need for high-quality seed material, which is one of the key factors in increasing sorghum productivity and ensuring its stable cultivation in various soil and climatic zones, were considered. A special emphasis was placed on the prospects for expanding the sales markets for sorghum products, in particular in the food, feed, and bioenergy industries. Based on the study, potential ways of integrating sorghum into modern business models of agricultural enterprises as an important element of the strategy for sustainable development of the agricultural sector were identified. The introduction of sorghum into the crop structure can contribute to increasing the climate resilience of production, product diversification, and strengthening food security.

Key words: *sorghum, niche crop, bioethanol, agribusiness, cultivation efficiency.*

Бойко М.О. Перспективи вирощування сорго як нішевої культури в умовах сучасного агробізнесу

У сучасних умовах аграрного виробництва, що супроводжуються кліматичними змінами, дефіцитом водних ресурсів, зростанням вартості енергоносіїв та необхідністю диверсифікації посівів, вирощування сорго набуває дедалі більшої актуальності. Ця нішева культура демонструє високий рівень адаптивності до посушливих умов, низьку вимогливість до ґрунтів та стійкість до шкідників і хвороб, що робить її привабливою альтернативою для регіонів із ризикованим землеробством. Сорго має широкий спектр застосування: його використовують як кормову культуру, для харчових потреб, а також у біоенергетиці. Особливу увагу привертає можливість використання цукрового та зернового сорго для виробництва біоетанолу, що відкриває додаткові економічні переваги для агровиробників. Крім того, висока врожайність біомаси дозволяє ефективно використовувати цю культуру у кормовому балансі господарств.

У дослідженні здійснено комплексний аналіз світового та вітчизняного досвіду вирощування сорго як перспективної нішевої культури. Особливу увагу приділено динаміці площ посівів зернового та кормового сорго в країнах Європейського Союзу, де простежується стабільне зростання інтересу до цієї культури. Розглянуто сучасний стан і потребу в якісному насіннєвому матеріалі, який є одним із ключових чинників підвищення продуктивності сорго та забезпечення його стабільного вирощування в різних ґрунтово-кліматичних зонах. Окремий акцент зроблено на перспективах розширення ринків збуту продукції з сорго, зокрема у харчовій, кормовій та біоенергетичній галузях. На основі проведеного

дослідження визначено потенційні шляхи інтеграції сорго в сучасні бізнес-моделі агропідприємств як важливого елементу стратегії сталого розвитку аграрного сектору. Впровадження сорго у структуру посівів може сприяти підвищенню кліматичної стійкості виробництва, диверсифікації продукції та зміцненню продовольчої безпеки.

Ключові слова: *сорго, нішева культура, біоетанол, агробізнес, ефективність вирощування.*

Problem statement. In the current context of agribusiness, there is a growing need for implementing new approaches to agricultural production that ensure economic efficiency, adaptability to climate change, and resilience to market fluctuations. One of the promising niche crops that meets these requirements is sorghum – a cereal crop that combines high drought tolerance, versatile applications, and profitability of cultivation.

Sorghum is a valuable alternative to traditional grain crops such as wheat, corn, and barley, particularly in regions with unfavorable climatic conditions. Its high drought resistance and low soil fertility requirements make it an attractive option for farmers seeking to reduce production risks and increase profitability. In addition, sorghum has a wide range of applications – from the feed and food industries to bioenergy – which expands its commercial potential.

The relevance of this research is driven by the need to diversify agricultural production, improve the efficiency of land use, and identify alternative crops capable of ensuring stable yields under changing climate conditions. Analyzing the prospects for cultivating sorghum as a niche crop in modern agribusiness will provide insights into its economic feasibility, potential markets, and technological aspects of cultivation.

Analysis of recent research and publications. In global scientific literature, sorghum is regarded as a crop with significant potential in the context of global warming and the growing need for alternative sources of food and bioenergy. International research has primarily focused on the impact of agronomic practices, soil and climatic conditions, and genetic factors on sorghum productivity [1–5].

In domestic scientific studies, sorghum is primarily considered a promising crop for the southern and central regions of Ukraine. Particular attention is given to improving cultivation technologies, selecting adapted varieties, and increasing the economic efficiency of sorghum production. Researchers Baklanova T.V., Hamayunova V.V., and Sydiakina O.V. analyze the dynamics of sorghum grain production from 2000 to 2021, focusing on sown area and crop yields in Ukraine and leading producing countries. They emphasize that Ukraine has significant potential to increase sorghum production, as its yield has been steadily rising and currently exceeds 4 tons per hectare [6]. Boiko M.O. explores the impact of various agronomic practices on sorghum productivity. In particular, the researcher examines optimal sowing dates, seed depth, seeding rates, and the use of mineral fertilizers to enhance yield and grain quality. The author also evaluates the potential of sorghum for producing flour, groats, and bakery products [7–11].

However, despite the considerable volume of scientific research, certain aspects of sorghum cultivation and utilization require further investigation. In particular, key issues remain regarding the genetic improvement of the crop, its resistance to pests and diseases, the impact of various agronomic practices on the quality characteristics of the yield, as well as the prospects for expanding the use of sorghum in alternative energy production and the food industry.

Research objective. This article aims to identify promising directions for growing sorghum in the agricultural sector and determine the key factors influencing the efficiency of its cultivation under modern conditions.

Presentation of the main research findings. In the context of global climate change, growing demand for alternative grain crops, and the need to increase the profitability of agricultural production, the search for new niche crops is becoming particularly relevant. One such promising crop is sorghum (Sorghum bicolor). In Ukraine, sorghum cultivation has not become widespread yet; however, global experience demonstrates the significant potential of this crop as an alternative to traditional cereals. In particular, in the United States, China, India, and several African countries, sorghum is an essential component of agricultural production. Its competitive advantages include efficient water usage, high yields even under adverse conditions, and resistance to pests and diseases.

It was projected that in 2024, the global production of sorghum would reach approximately 61.3 million tons, representing a 4.3% increase compared to 2023 when production totaled 58.8 million tons. Africa remains the leading region for sorghum cultivation, with the forecasted harvest reaching 28.3 million tons. Among the top-producing countries on the continent are Nigeria (7 million tons), Sudan (5.3 million tons), and Ethiopia (4.1 million tons).

Although the United States remains the world's second largest sorghum producer, heat and rainfall deficits could reduce its harvest from 8.1 to 7.1 million tons. India is also showing a decline in production, with production expected to fall from 4.4 to 4.2 million tons in 2024. While China and Australia are holding steady yields, Mexico, Brazil, and Argentina are increasing production. Mexico is expected to increase production from 4.3 to 4.5 million tons, Brazil – from 5 to 5.2 million tons, and Argentina – from 2.6 to 3 million tons [12].

The Food and Agriculture Organization of the United Nations (FAO) has released its first forecast for the 2024/25 marketing year (July/June), projecting global cereal production at 2,846 million tons, which is nearly equal to the record output of 2023/24. Global cereal stocks are expected to increase by 1.5% from their opening levels, reaching a new record of 897 million tons. Stocks of maize, barley, sorghum, and rice are projected to rise, while wheat inventories may decline. The global stock-to-use ratio is likely to remain stable at 30.9% [13].

In Europe, approximately 250,000 hectares of arable land have been allocated for grain sorghum cultivation. Over the past year, the sowing area for this crop has expanded by 34%, indicating a growing interest in sorghum among farmers. Among the 27 European countries, France remains the leader in sorghum cultivation, with 103,000 hectares sown – an increase of nearly 89% compared to the previous year. Hungary (44,940 ha), Italy (40,580 ha), and Romania (16,000 ha) also report substantial sorghum acreage. In Romania, frequent droughts hinder the cultivation of spring crops, making sorghum a promising alternative in crop rotations for farmers (Fig. 1).

Forage sorghum production in Europe has increased by 11%. The cultivation area for this crop across the 27 EU countries now covers 98,000 hectares, indicating steady growth. Farmers in France made a significant contribution to this increase, with the area under forage sorghum expanding by 17%, reaching 35,000 hectares. In Italy, the area grew by 20% to 30,000 hectares, while in Poland, it increased by 5% to 5,000 hectares (Fig. 2).

The growing interest in sorghum cultivation in Europe is contributing not only to expanding sown areas but also to developing the crop's seed production sector. Due to increasing demand for sorghum – especially under changing climate conditions – sorghum seed production is also showing a positive growth trend. In 2024, Europe is expected to allocate 2,600 hectares for sorghum seed production, marking a record high for seed-growing farms on the continent. This increase highlights the growing

importance of sorghum in crop rotation systems. Expanding production areas will help farmers replenish seed stocks, which have decreased as a result of the sharp rise in sorghum cultivation in 2024.

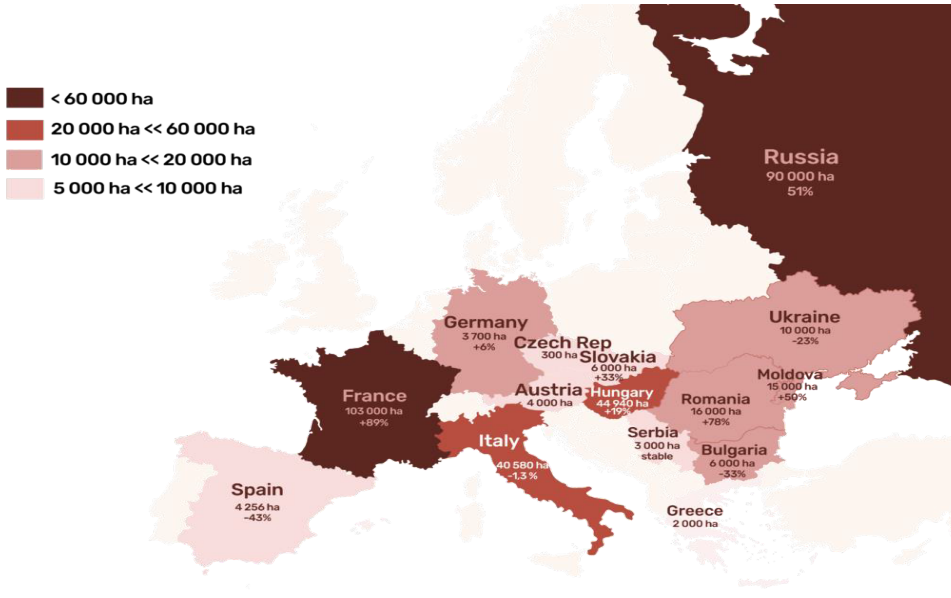

Fig. 1. Arable land area allocated for grain sorghum cultivation in Europe, ha
Source: Sorghum ID, 2024 [14]

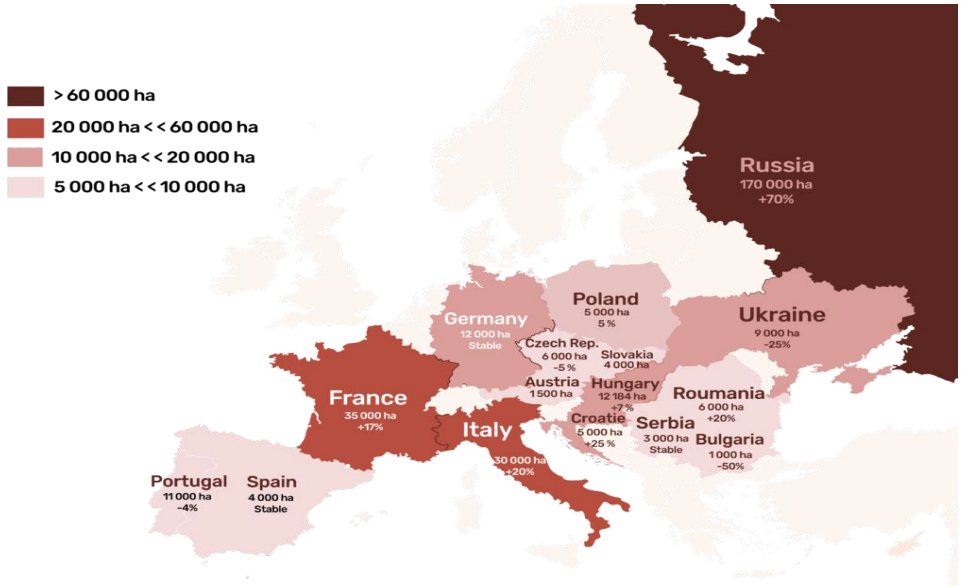

Fig. 2. Arable land area allocated for forage sorghum cultivation in Europe, ha
Source: Sorghum ID, 2024 [14]

For comparison, during the 2018/19 period, only 675 hectares were devoted to sorghum seed production, while in 2023, the area reached 1,950 hectares, reflecting a 34% year-on-year increase. Among the key seed-producing countries are Hungary (1,050 ha), France (1,006 ha), and Spain (400 ha) [15].

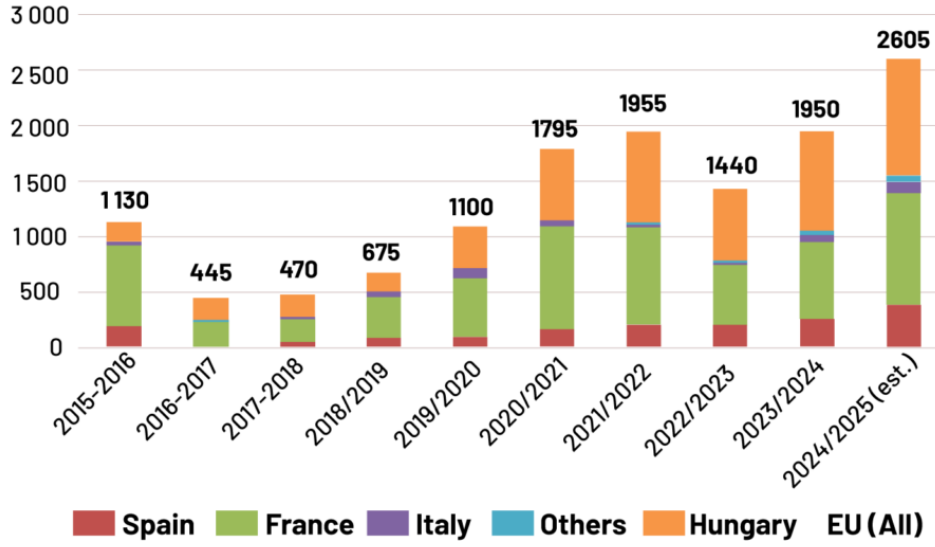

Fig. 3. Area under sorghum seed production in the EU, ha

Source: Sorghum ID, 2024 [14]

At the same time, Ukraine is also showing interest in sorghum cultivation. However, in recent years, sorghum seed sales have declined approximately 5 to 7 times. During the peak of the crop's development in Ukraine, the total area under sorghum cultivation reached 150,000–170,000 hectares. Currently, this figure has dropped to no more than 10,000 hectares. The main reasons for this decline are the COVID-19 pandemic, followed by the occupation of southern territories.

Previously, the largest areas for sorghum cultivation were located in Zaporizhzhia, Kherson, Mykolaiv, and Odesa regions, but production in these areas has nearly come to a halt. An additional challenge is the underdeveloped marketing infrastructure, as sales markets for sorghum products are still not fully formed. Moreover, the sharp reduction in commercial crop areas has led to a decline in demand for sorghum seed.

At the same time, although the cultivation areas for certain niche crops have expanded, the years 2022–2024 saw a rise in seed imports for crops such as rye, oats, sorghum, flax, hemp, mustard, as well as sugar beet and vegetable seeds [16, 17].

Researchers at the Institute of Agrarian Economics forecast a 3.4% increase in the gross output of crop production in Ukraine in 2025 compared to 2024. The main contributing factors are the expected growth in the production of grain and leguminous crops, particularly sorghum, which is projected to increase by 20.0% [18].

In Ukraine, sorghum is represented by four cultivated types:

– Grain sorghum – grown for feed, industrial, and food purposes.
– Dzhuhara, Haolian, and Sudan grass – primarily cultivated as forage crops.

Based on its production purpose, sorghum can be classified into grain, sweet, and forage types. Among grain hybrids, U.S.-developed varieties such as Sprint and Prime have demonstrated excellent performance in Ukraine [19]. These hybrids are notable for their ability to deliver stable yields even under unstable weather conditions. Their successful cultivation underscores the potential of sorghum as a valuable crop for Ukraine's agricultural sector.

However, the efficiency of sorghum cultivation depends not only on the selection of a suitable hybrid or variety. A complex set of factors – both agronomic and organizational-economic – influences yield levels and the overall economic feasibility of growing sorghum.

Below is a systematized table of key factors that determine the efficiency of sorghum cultivation under modern agribusiness conditions (Table 1).

Table 1

Key Factors Influencing the Efficiency of Sorghum Cultivation

№	Factor	Impact description
1	Climatic conditions	Sorghum is drought-resistant, suitable for the southern and central regions of Ukraine.
2	Soil conditions	Grows well on light, fertile soils with a neutral reaction, resistant to saline and marginal lands.
3	Seed variety and quality	The selection of adapted hybrids ensures resistance to stress factors and high yields.
4	Cultivation technology	Compliance with crop rotation, sowing depth, and weed control are critically important for young plants.
5	Fertilizers and plant protection	Balanced nutrition (especially nitrogen) and protection against pests and diseases guarantee stable yields.
6	Technical support	Machinery is needed for sowing, tending, and harvesting, especially for sweet sorghum (wet stalk).
7	Market infrastructure	Availability of demand for products (grain, silage, bioethanol), access to the sales market, and logistics.
8	State support	Participation in subsidy, compensation, and grant programs increases the investment attractiveness of culture.
9	Environmental sustainability	Sorghum is an environmentally friendly crop with low resource consumption and the possibility of use in bioenergy.

Source: author's development

Recently, sorghum has been increasingly regarded as a bioenergy crop, as its grain can be used to produce bioethanol, while its stalks can serve as a source of solid biofuel. From one hectare of cultivation, it is possible to harvest up to 7–12 tons per hectare of grain, with a starch content of up to 70–80%, which allows for a bioethanol yield of approximately 4–5 tons per hectare [20].

Sorghum is characterized by a high photosynthetic efficiency and the ability to rapidly accumulate substantial biomass with high energy potential. Importantly, most

of the energy-rich substances in its composition are easily processed into ethanol. In particular, sweet sorghum contains a significant amount of simple sugars, while grain sorghum is rich in starch. Moreover, sorghum demonstrates a higher starch yield (up to 74%) compared to the traditional bioethanol crop – corn (approximately 67%). Sweet sorghum also ensures a higher alcohol yield, further enhancing its attractiveness for the biofuel industry.

By combining the use of both grain and stalks for bioethanol production, sorghum has the potential to yield approximately 7,000 liters per hectare. As a result, scientists are actively engaged in breeding new sorghum varieties aimed at renewable fuel production. Researchers are working on the genetic improvement of sorghum to increase the sugar content in the stalks, which is a key factor for efficient bioethanol production. In addition, efforts are being made to develop varieties that can deliver higher yields with lower water consumption – an especially important property in the context of climate change.

A separate area of research is currently devoted to the development of varieties and hybrids with improved fermentation ability, which will allow for increasing the yield of fuel and reduce the cost of its production. In addition, scientists are experimenting with improving the agrotechnology of growing sorghum to increase its energy efficiency and make biofuels more accessible and economically profitable. Thanks to such developments, sorghum is becoming not only an important food crop, but also one of the key elements of the future of renewable energy.

Conclusions and suggestions. As a result of the study, it was found that sorghum is one of the most promising niche crops for agricultural production in the conditions of modern agribusiness. Its high drought resistance, adaptability to adverse climatic conditions and ability to form significant biomass make the crop particularly attractive for cultivation in the southern and central regions of Ukraine, where drought periods are increasingly observed. At the same time, the growing demand for sorghum products from the feed, food, and energy industries contributes to expanding the sales market and creates the prerequisites for diversifying agricultural production. Grain and sugar sorghum have high potential in producing bioethanol due to the significant content of starch and sugars, respectively, which corresponds to modern trends in the development of alternative energy.

Despite significant agronomic and economic advantages, the development of sorghum cultivation in Ukraine is constrained by a number of factors, in particular the lack of a developed marketing infrastructure, insufficient quality seeds, a weak processing base and farmers' limited awareness about the technologies for growing this crop. In this regard, it is advisable to develop state support programs for niche crops, focus efforts on supporting national selection, improving local logistics and cooperation, and intensifying educational work among agricultural producers. It is also important to expand scientific and applied research aimed at substantiating the economic efficiency of sorghum cultivation in conditions of climate change and its integration into the strategy for sustainable development of the agricultural sector of Ukraine.

REFERENCES:

1. Adepoju A.B., Oladele M.O., and Odedina M.O. Influence of spacing and planting density on growth, yield, and quality of grain sorghum. *Journal of Agricultural Science and Technology.* 2017. Vol. 17(3), 643–652.

2. Abd El-Hakim, H. F., El-Monem, A. A., & Mahmoud, Y. A. G. Response of grain sorghum yield and yield components to different row spacing and seeding rates under

sandy soil conditions. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*. 2019. Vol. 10(3), 63–72.

3. Biswarup M., Lakshmi S. Ch., Dakshyani D., & Maniratnam K. Effect of micronutrients on growth and yield of sorghum (Sorghum bicolor L.) under rainfed condition. *International Journal of Environment and Climate Change*. 2023. Vol.13(7). 259–263 DOI:10.9734/ijecc/2023/v13i71875 URL: https://www.researchgate.net/ publication/370502080_Effect_of_Micronutrients_on_Growth_and_Yield_of_Sorghum_Sorghum_bicolor_L

4. Herrera, D. M., Peixoto, W. M., Abreu, J. G. d., Reis, R. H. P. d., Cabral, C. E. A., Barros, L. V. d., Klein, V. A. C., & Passos, E. F. d. Sorghum Densification with Changes in Plant Spacing Arrangement: Productivity and Qualitative Characteristics of Silage Material. *Agronomy*. 2024. Vol. 14*(*2), 358. https://doi.org/10.3390/agronomy14020358

5. Santin, T.P.; Frigeri, K.D.M.; Agostini, A.; Silva, H.R.; Frigeri, K.D.M.; Kalles, N.Z.; Coelho, E.M.; Dias, A.M. Fermentative characteristics and chemical composition of sorgo silage (Sorghum bicolor) with use of absorbents additives. *Braz. J. Dev.* 2020. Vol. 6, 54931–54943. URL: https://ojs.brazilianjournals.com.br/ojs/index.php/BRJD/article/view/14477/12026

6. Бакланова Т.В., Гамаюнова В.В., Сидякіна О.В. Сучасні тенденції вирощування сорго в Україні та світі. *Таврійський науковий вісник. Серія: сільськогосподарські науки.* 2023. Вип. 134, С. 9–17. DOI https://doi.org/10.32782/2226-0099.2023.134.2

7. Бойко М.О. ПІДВИЩЕННЯ ВРОЖАЙНОСТІ ТА ЯКОСТІ ЗЕРНА ГІБРИДІВ СОРГО ЗЕРНОВОГО У ЗОНІ ПІВДЕННОГО СТЕПУ УКРАЇНИ. *Вісник аграрної науки.* 2024. Том 102 (8). С. 73–80. DOI: https://doi.org/10.31073/agrovisnyk202408-08

8. Бойко М.О. Сорго як харчовий продукт: перспективи та нові можливості. *Таврійський науковий вісник. Серія: Сільськогосподарські науки.* 2024. Вип.138. С. 15–21. DOI https://doi.org/10.32782/2226-0099.2024.138.2

9. Бойко М. О. Вплив густоти посіву та строків сівби на продуктивність гібридів сорго зернового в умовах Півдня України. *Вісник аграрної науки Причорномор'я.* 2016. Вип. 3 (91). С. 96–104.

10. Бойко М.О. Обґрунтування агротехнічних прийомів вирощування сорго зернового в умовах Півдня України. *Науковий вісник Національного університету біоресурсів і природокористування України. Сер.: Агрономія.* 2016. № 235. С. 33–39.

11. Бойко М. О. ПОСУХОСТІЙКІ КУЛЬТУРИ ДЛЯ ЗЕРНОВОГО КЛИНУ ПІВДНЯ УКРАЇНИ. Proceedings of the XIV International Scientific and Practical Conference. Copenhagen, Denmark. 2023. Pp. 23–25. URL: https://isg-konf.com/world-trends-realities-and-accompanying-problems-of-development/

12. Тріумфальна хода сорго по всьому світу триває. URL: https://www.sorghum-id.com/uk/тріумфальна-хода-сорго-по-всьому-світ/ (дата звернення: 12.04.2025).

13. ФАО дала перший глобальний прогноз щодо зернових на 2024/25 МР. URL: https://agroportal.ua/news/mir/fao-ozvuchila-pershiy-globalniy-prognoz-shchodo-zernovih-na-2024-25-mr (дата звернення: 12.04.2025).

14. Sorghum ID, 2024 р. URL: https://agroportal.ua/ru/tags/sorghum-id (дата звернення: 05.04.2025).

15. Зростання площ під зерновим сорго в Європі: статистика та перспективи. URL: https://www.agronom.com.ua/zrostannya-ploshh-pid-zernovym-sorgo-v-yevropi-statystyka-ta-perspektyvy/ (дата звернення: 06.04.2025).

16. Bioko, V., & Bioko, L. Prodovolcha bezpeka ta ryzyky dlia ahrarnoho vyrobnytstva pid chas viiny v Ukraini [Food security and risks for agricultural production during the war in Ukraine]. *Ekonomika ta suspilstvo -Economy and Society.* 2022. (41). DOI https://doi.org/10.32782/2524-0072/2022-41-27

17. Boiko, L. Niche crops for revitalization of agribusiness in the period of uncertainty. *Taurida Scientific Herald. Series: Economics.* 2023. (17), 44–49. DOI https://doi.org/10.32782/2708-0366/2023.17.6

18. Науковці спрогнозували виробництво рослинницької продукції в Україні у 2025 році. URL: https://www.agronom.com.ua/naukovtsi-sprognozuvaly-vyrobnytstvo-roslynnytskoyi-produktsiyi-v-ukrayini-u-2025-rotsi/ (дата звернення: 17.04.2025).

19. Бойко М. О. Формування асиміляційного апарату гібридів сорго зернового в залежності від строків сівби та густоти посівів. *Таврійський науковий вісник.* 2017. Вип. 97. С. 18–22. URL: https://www.ksau.kherson.ua/files/visnik/TNV_97_Агро%20науки.pdf

20. Перспективність використання сорго звичайного для біоенергетики. Вивчення технології вирощування сорго звичайного на біопаливо. URL: https://bio.gov.ua/uk/bioenergy/news/perspektyvnist-vykorystannya-sorgo-zvychaynogo-dlya-bioenergetyky-vyvchennya-tehnologiyi-vyroshchuvannya-sorgo-zvychaynogo-na-biopalyvo (дата звернення: 17.04.2025).