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## CURRENT RANGE OF CORN HYBRIDS IN UKRAINE: ANALYSIS AND PROSPECTS

**Sydiakina O.V.** – Candidate of Agricultural Sciences, Associate Professor,  
Associate Professor at the Plant Science and Agroengineering Department,  
Kherson State Agrarian and Economic University

**Hamula Ye.A.** – Postgraduate Student,  
Kherson State Agrarian and Economic University

*The use of technology in growing new high-yielding varieties and hybrids resistant to diseases and pests, well-adapted to specific soil and climatic conditions, will increase corn production volumes – an important grain crop for universal use, including such a modern direction as the production of alternative fuels. In the pre-war period, the main requirement for the corn variety-hybrid assortment was high productivity of varieties and hybrids, as well as their high adaptability to soil-climatic and weather conditions. Today, there have been certain changes in the main requirements for corn hybrids, including low harvesting moisture content, high productivity, resistance to lodging and drought, disease resistance, low nutrient requirements, and low seed cost. As of April 24, 2024, the State Register includes 1682 corn varieties and hybrids, with 91.3% represented by common corn. 990 varieties and hybrids, or 59% of the total corn assortment, are modern varieties and hybrids registered since 2019. The majority of corn varieties and hybrids belong to the medium-early and medium-maturing groups by FAO – 45.7% and 39.2% of the total number. The recommended cultivation zones are mainly Steppe and Forest-Steppe – 19% and 14% of the total assortment. 33% of the corn variety-hybrid composition consists of highly plastic varieties and hybrids well adapted to the conditions of any agro-climatic zone of Ukraine. Growing hybrids with a lower FAO than recommended for a particular zone will result in incomplete use of solar radiation during vegetation and low yields. Growing hybrids with a higher FAO than recommended will result in incomplete grain ripening at harvest and unjustified costs for drying. 44.2% of the corn varieties and hybrids in the State Register are domestic, while 55.8% are foreign selections. The leaders in foreign corn breeding in Ukraine are France (16.9%), the USA (13.0%), and Germany (6.8%). Selecting the optimal hybrid composition of corn is an economically effective measure to increase crop productivity and grain production volumes.*

**Key words:** corn, grain, variety, hybrid, maturity group, cultivation zone, country of origin.

### **Сидякіна О.В., Гамула Є.А. Сучасний асортимент гібридів кукурудзи в Україні: аналіз та перспективи**

*Використання в технології вирощування нових високопродуктивних сортів і гібридів, стійких до хвороб і шкідників, добре адаптованих до конкретних ґрунтово-кліматичних умов, дозволить збільшити обсяги виробництва кукурудзи – важливої зернової культури універсального використання, зокрема й такого сучасного напрямку, як виробництво альтернативних видів палива. У довоєнний період основною вимогою до сорто-гібридного асортименту кукурудзи була висока продуктивність сортів та гібридів, а також їх висока адаптивність до ґрунтово-кліматичних умов. На сьогодні відбулися певні зміни щодо основних вимог, які висуваються до гібридів кукурудзи, серед яких слід відзначити такі: низька збиральна вологість, висока продуктивність, стійкість до перестояю та посухи, стійкість до хвороб, невибагливість до умов живлення, низька вартість насіння. Державний реєстр станом на 24 квітня 2024 р. налічує 1682 сортів і гібридів кукурудзи, на 91,3% представлених кукурудзою звичайною. 990 сортів і гібридів або 59% від загального асортименту кукурудзи – сучасні сорти і гібриди, занесені до Держреєстру з 2019 р. Переважна більшість сортів і гібридів кукурудзи відноситься до середньоранньої і середньостиглої груп за FAO – 45,7 і 39,2% від загальної кількості. Рекомендованими зонами вирощування в розрізі окремих зон, в основному, є Степова і Лісостепова – 19 і 14% від загального асортименту. 33% сорто-гібридного складу кукурудзи представлено*

високопластичними сортами і гібридами, добре адаптованими до умов будь-якої агро-грунтової зони України. Вирощування гібридів з меншим ФАО, ніж рекомендовано для даної зони, призведе до неповного використання посівами впродовж вегетації сонячної радіації та формування низького рівня врожайності. Вирощування гібридів з більшим ФАО, ніж рекомендовано, обумовлює неповне дозрівання зерна на момент збирання та не виправдані витрати на його досушування. 44,2% сортів і гібридів кукурудзи, представлених у Державному реєстрі, складають сорти і гібриди вітчизняної, 55,8% – іноземної селекції. Лідерами іноземної селекції кукурудзи в Україні є Франція (16,9%), США (13,0%) та Німеччина (6,8%). Добір оптимального гібридного складу кукурудзи – економічно ефективний захід підвищення продуктивності культури та збільшення обсягів зерновиробництва.

**Ключові слова:** кукурудза, зерно, сорт, гібрид, група стиглості, зона вирощування, країна-оригінаитор.

**Problem statement.** Corn is one of the most important cereal crops, widely used in food, feed, and industrial sectors. It is utilized in the production of various products such as grits, flour, oil, starch, and many others. Additionally, corn is extensively used in animal husbandry and as a raw material for industrial processes. This broad range of applications makes corn a strategically important factor in ensuring the stability of modern agricultural production [1, 2].

In recent years, due to its high starch content (60–85%) and established production processes, corn has gained increasing importance as a raw material for biofuel production, offering significant prospects for energy independence for producing countries. In the United States, almost half of the harvested corn is processed into biodiesel, providing a serious alternative to traditional diesel fuel. Ukraine has enormous potential in this direction: from every 10 million tons of corn, approximately 4 million tons of biofuel can be produced [3].

The use of alternative fuels will reduce dependence on imported oil products, expand domestic market opportunities, and help reduce carbon dioxide emissions, which will be particularly important in the post-war recovery period of Ukraine considering the current environmental situation related to active military actions.

Increasing corn grain production is a relevant task in the modern stage of agricultural sector development in Ukraine. One of the highly effective ways to address this task is to utilize new varieties and hybrids with improved yield and quality characteristics, resistance to diseases and pests, meeting the current market demands for cereal crops.

**Analysis of recent research and publications.** The productivity of corn is directly or indirectly influenced by biotic and abiotic factors, as well as components of the plant structure itself. Changes in climatic conditions, the development of new varieties and hybrids necessitate continuous scientific research into enhancing the productivity of this crop under various soil and climatic conditions. For example, the productivity of corn hybrids from «Pioneer Seeds Ukraine» and the French company «Laboulet» was studied at the educational-scientific-production complex of Uman National University of Horticulture. The results of two years of research showed that the yield and grain quality of the studied corn hybrids depended significantly on the potential of the hybrid itself and the weather conditions during the growing years. The studied hybrids produced grain with very high starch content and very low or low protein and fat content, with varying grain weight indicators. Based on the research results, the highest-yielding corn hybrids were recommended for implementation in production in the Right-Bank Forest-Steppe conditions [4].

The biological characteristics of corn hybrids and the agroecological conditions of the growing years significantly affected the duration of interphase periods and individual

productivity indicators of early-maturing hybrid P8521, medium-early PR39B76, and medium-maturing PR38N86 [5].

A comparative analysis of the productivity of 22 corn hybrids of different maturity groups from Syngenta's selection was conducted in the conditions of the Forest-Steppe zone of Ukraine. The hybrids NK Falcon (FAO 220), Simba (FAO 270), Lucius (FAO 340), Dollar (FAO 390), and Galaktik (FAO 470) showed the highest grain yield. In the irrigation conditions of the Southern Steppe of Ukraine, high productivity was noted for Syngenta's selection hybrids Impulse (FAO 280), Rotango (FAO 200), and Enermax (FAO 330) [6, 7].

According to the results of research on the productivity of corn hybrids of different maturity groups from the selection of the Institute of Irrigated Agriculture of the National Academy of Agrarian Sciences in the conditions of the Southern Steppe of Ukraine, it was found that the hybrids Podilsky 274 SV (FAO 270), Azov (FAO 330), VTS 380 MV (FAO 380), and Sokolov 407 MV (FAO 400) provide the highest grain yield [8].

In non-irrigated conditions of the Southern Steppe of Ukraine, with an increase in the FAO group, the productivity of corn hybrids showed a clear tendency to decrease. The highest yield was formed by early-maturing hybrids DN Palanok (FAO 180) and DB Lada (FAO 190). In irrigated conditions, the maximum level of productivity was established for growing hybrids of domestic selection Askania (FAO 320), DN Bulat (FAO 350), DN Rava (FAO 430), and Primorsky (FAO 430) [9].

An innovative direction today is the cultivation of dwarf corn hybrids with significantly lower above-ground biomass than before, even 5 years ago when farmers' activities were aimed at maximizing plant height and forming a powerful vegetative mass. Companies such as «Bayer» (Monsanto, DEKALB hybrids) and «Corteva» (Pioneer hybrids) are currently striving to minimize the vegetative mass of corn plants so that most nutrients go to the cob, and the cob releases moisture as quickly as possible – processes that cannot be accelerated in the case of forming large plant stature [10].

The reasoned selection of corn hybrids of different FAO groups for specific soil-climatic conditions reveals significant prospects for increasing productivity, improving grain quality, ensuring sustainable development of the grain industry, and strengthening Ukraine's position in the international agricultural market [11, 12], determining the relevance of the conducted research.

**Problem statement.** The scientific research involved analyzing the State Register of plant varieties suitable for distribution in Ukraine, identifying modern requirements for corn varieties and hybrids grown in the soil-climatic conditions of Ukraine, as well as prospects for the development of the Ukrainian corn industry. The following methods were used for scientific research: comparative-analytical method to identify patterns of the studied characteristics based on statistical data; graphical method to visualize research results and illustrate identified patterns; abstract-logical method to make theoretical generalizations, formulate conclusions, and recommendations. The information base of the scientific research included statistical data from the State Register of plant varieties suitable for distribution in Ukraine as of April 24, 2024, information from scientific literature sources, and results of analytical research and calculations.

**Presentation of the main material of the research.** The main requirement of modern farmers for the hybrid composition of corn is undoubtedly the ability of hybrids to achieve a high level of productivity, which, in turn, contributes to reducing costs and increasing the economic efficiency of grain production. In the pre-war period, when choosing a particular hybrid, the primary consideration was its adaptability to

soil-climatic and weather conditions. Today, the format of requirements has somewhat changed, and the top issues being addressed relate to seed quality, prices, and logistical decisions. In 2023, there was a high demand for flexible hybrids that can withstand prolonged delays, while for the 2024 sowing season, the primary requirement is grain moisture content, specifically – the grain must be dry (Fig. 1). This is due to the high cost of gas, where grain drying becomes a significant expense in the technology. Therefore, hybrids with low moisture content (around 13–14%) or hybrids with rapid moisture release while maintaining high productivity potential are in demand [13].

The State Register of plant varieties suitable for distribution in Ukraine, as of April 24, 2024, includes 1682 varieties and hybrids of corn, mainly common corn hybrids (1535 or 91.3% of the total corn assortment) (Fig. 2). There are 131 hybrids of sweet corn (7.8%), 10 waxy corn hybrids (0.59%), and 6 popcorn hybrids (0.36%).

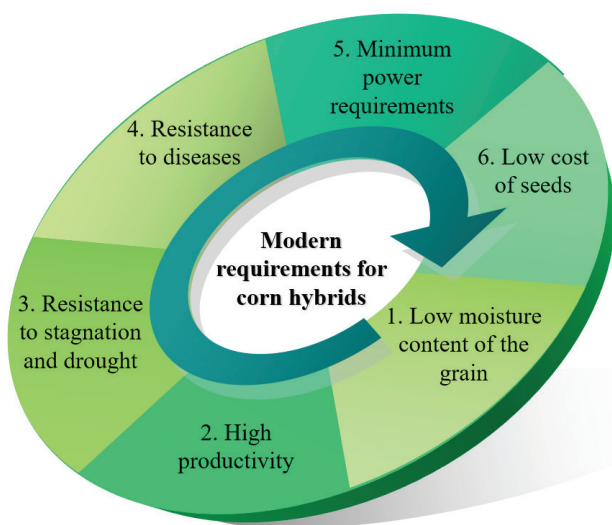


Fig. 1. Modern requirements of agrarians for the hybrid composition of corn [13]

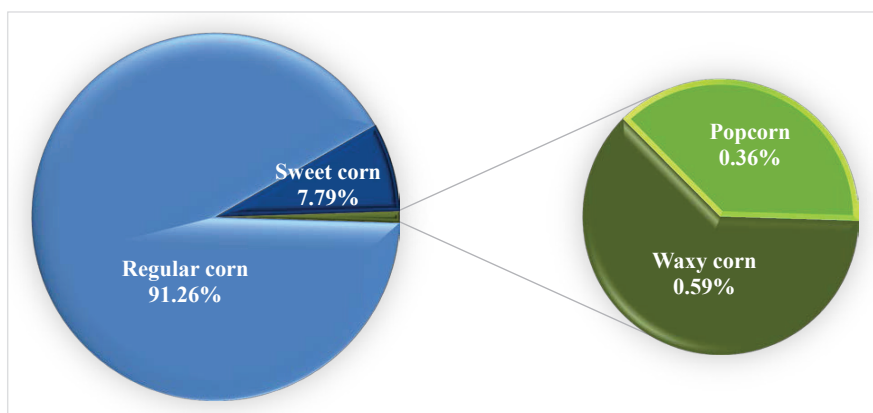


Fig. 2. The share of corn subspecies in the State Register of plant varieties suitable for distribution in Ukraine, as of April 24, 2024

The main assortment consists of modern varieties and hybrids. For example, in 2019, the State Register was updated with 176 varieties and hybrids (10% of the total), in 2020 – 188 (11%), in 2021 – 196 (12%), in 2022 – 136 (8%), in 2023 – 251 (15%), and in 2024 – 43 (3% as of April 24, 2024) (Fig. 3). This means that from 2019, 990 varieties and hybrids have been added to the State Register, accounting for 59% of the total corn assortment.

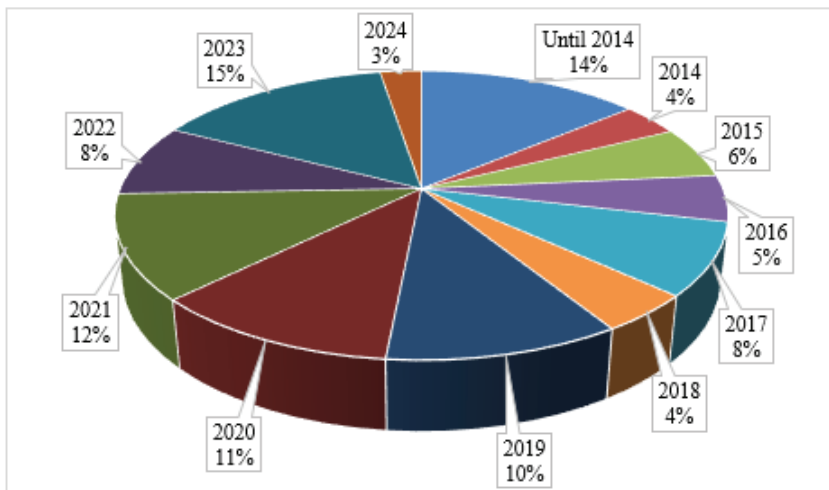


Fig. 3. The share of varieties and hybrids of corn by years of entry into the State Register of plant varieties suitable for distribution in Ukraine, as of April 24, 2024

Depending on the parental forms, hybrids are classified as intraspecific, intraline, or interline hybrids. In production conditions, hybrids obtained by crossing self-pollinated lines are mainly used. Due to heterosis, hybrids are 25–30% more productive than varieties. The maximum yield increase is achieved by first-generation hybrids. Continued cultivation may lead to a decrease in heterosis effect [14].

The Food and Agriculture Organization (FAO) of the United Nations has proposed a unified classification system for comparing the maturity of hybrids from different countries worldwide to assess the maturity groups of corn hybrids effectively (Table 1).

The predominant majority of corn hybrids in the State Register of plant varieties suitable for distribution in Ukraine belong to the mid-early and mid-late FAO maturity groups – 45.7% and 39.2% of the total, respectively (Fig. 4). The share of mid-late hybrids is 7.7%, early hybrids – 6.9%, and late hybrids – 0.5%.

When choosing a particular corn hybrid, it is necessary to take into account its biological potential and the soil-climatic conditions of the cultivation zone. Recommended cultivation zones for corn hybrids according to the State Register, analyzed by specific zones, are mainly Steppe and Forest-Steppe – 19% and 14% of the total assortment, respectively (Fig. 5). Only 2% is allocated to the Polissya zone. Highly versatile hybrids well adapted to cultivation in any agro-soil zone of Ukraine account for 33% in the State Register.

The consequences of cultivating hybrids with a lower or higher FAO rating than recommended for a specific zone are demonstrated in Figure 6.

Table 1

**Classification of corn hybrids by maturity groups (FAO) [15]**

Maturity group	Number of leaves	Vegetative period, days	Total active temperature, °C	Maturity group according to FAO
Very early-maturing	up to 11	85	2100	100–149
Early-maturing	12–14	90–100	2200	150–199
Middle-early	15–16	105–115	2400	200–299
Middle-maturing	17–18	115–120	2600	300–399
Middle-late	19–20	120–130	2800	400–499
Late-maturing	21–23	135–140	3000	500–599
Very late-maturing	more than 23	145–150	more than 3000	more than 600

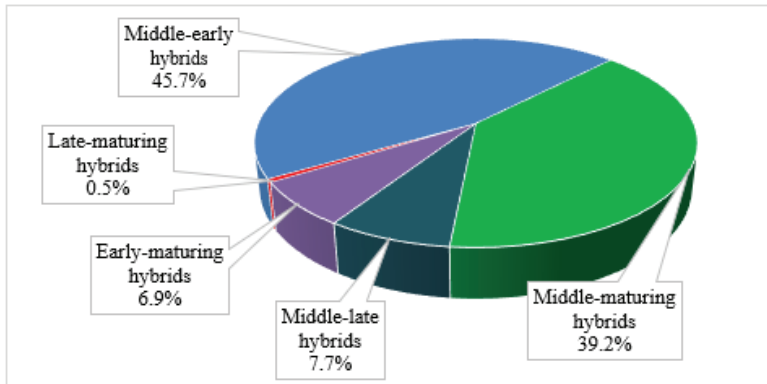


Fig. 4. The share of hybrids of different maturity groups in the State Register of plant varieties suitable for distribution in Ukraine, as of April 24, 2024

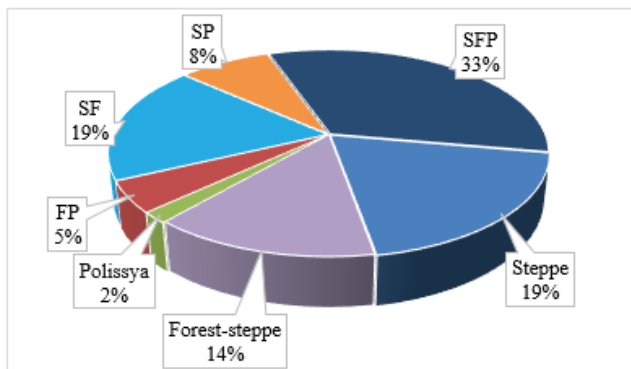


Fig. 5. Recommended zones for growing corn varieties and hybrids in the State Register of Plant Varieties Suitable for Distribution in Ukraine, as of April 24, 2024



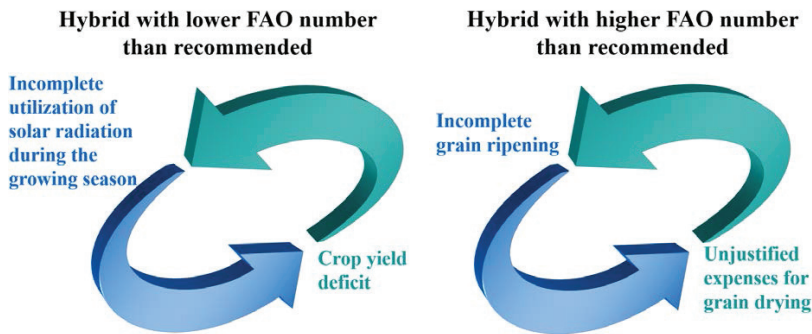


Fig. 6. Consequences of growing hybrids with less or more FAO than recommended

Nearly half (44.2%) of the corn varieties and hybrids represented in the State Register are domestic selections, indicating a high level of breeding activity in Ukraine with this crop (Fig. 7). However, there is a common stereotype among farmers that Ukrainian-bred hybrids are of lower quality than foreign ones, so they are often planted in less fertile soils with minimal fertilizer input. As a result, the yield is indeed low. At the same time, scientists from the All-Ukrainian Institute of Selection (the domestic leader among corn seed producers) argue that domestic varieties and hybrids have quality characteristics similar to foreign ones, including important indicators for farmers such as moisture release. In terms of grain moisture content at harvest time, domestic corn varieties and hybrids are not inferior to foreign ones [16].

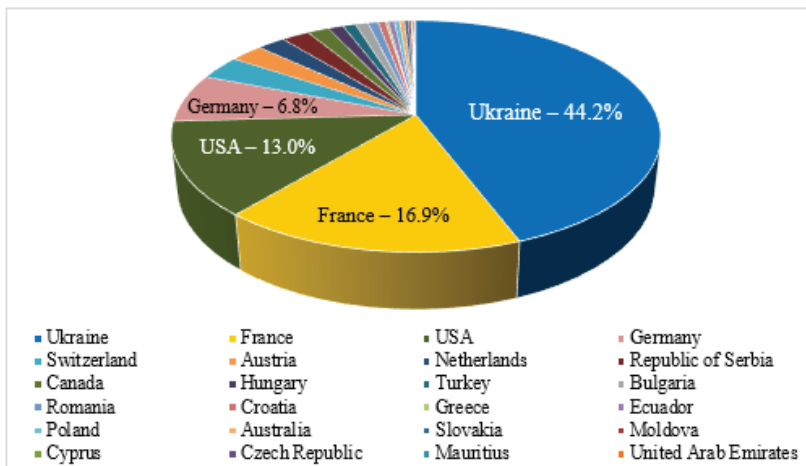


Fig. 7. The share of originator countries of corn varieties and hybrids in the State Register of plant varieties suitable for distribution in Ukraine as of April 24, 2024

Foreign corn varieties and hybrids make up 55.8% of the State Register. France is the leader in foreign corn breeding in Ukraine, accounting for 16.9% of French-bred varieties and hybrids in the State Register. Leading world companies representing French breeding in Ukraine include Syngenta Seeds S.A.S., Limagrain Europe, Clause, Euralis

Semences, Maisadour Semences, Cussade Semences S A, SAS Florimond Desprez Veuve et Fils, Sakata vegetables Europe S.A.S., Vilmorin S.A., R2n, and others.

The second place in Ukraine among foreign corn varieties and hybrids is occupied by the USA, accounting for 13.0% of the total number of varieties and hybrids in the State Register. Leading companies include Monsanto Technology LLC, Lark Seeds International, Harris Moran Seed Company, Ekland Marketing Co. of California, Inc., Hollar Seeds, Florida Foundation Seed Producers Inc., Board of Trustees Operating Michigan State University, and others.

The share of German-bred corn varieties and hybrids in the State Register of plant varieties suitable for distribution in Ukraine is 6.8%. This assortment is represented by companies such as Bayer CropScience AG, KWS SAAT AG, Rijk Zwaan Welver GmbH, Saaten-Union GmbH, Norddeutsche Pflanzenzucht Hans-Georg Lembke KG, Europlant Pflanzenzucht GmbH, Deutsche Saatveredelung AG, and others.

Therefore, selecting an optimal hybrid composition for corn is an economically effective and justified way to increase productivity and grain production volumes. The modern assortment of corn varieties and hybrids impresses with its diversity – from FAO group, plant height, drought resistance, disease and pest resistance to response to various agronomic practices. However, new corn biotypes are poorly studied and require in-depth scientific research to ensure their maximum effectiveness in production conditions.

**Conclusions and recommendations.** Research on new corn varieties and hybrids is an important step towards increasing the productivity of this strategically important crop, ensuring sustainable grain production, and achieving high economic benefits. Modern varieties and hybrids have improved genetic characteristics, including high productivity, low grain moisture content, high disease and pest resistance, adaptability to different soil-climatic conditions, etc. Their widespread adoption in production processes will significantly increase grain production volumes and ensure the sustainable development of Ukraine's agricultural sector.

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