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VALUATION OF TECHNOLOGICAL FEATURES OF TOBACCO SEED CULTIVATION IN UKRAINE AND ITS ECONOMIC EFFICIENCY

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Abstract

The article provides a valuation of the technological features of cultivating new perspective varieties of Ukrainian selection tobacco seeds, which have high resistance to biotic and abiotic factors, good raw material quality, and optimal levels of nicotine, carbohydrates, and proteins. The scientific principles of cultivation and realization of high productive, competitive tobacco varieties, such as Berley 38, Berley 46, Ternopil 14, and Ternopil Perspective, are substantiated. The economic efficiency of tobacco seed production for Ukrainian research institutions is determined. Only specialized research institutions with corresponding scientific potential and material-technical base should be engaged in tobacco seed cultivation and realization. The production of tobacco seed varieties with optimal chemical composition will increase the efficiency of tobacco production and competitiveness of national seed production.

Key words**:** *tobacco, variety, selection, seed production, economic efficiency*

INTRODUCTION

The world experience in cultivating agricultural crops confirms the significance of seed varieties in increasing plant production. To obtain a high yield of quality tobacco raw materials, it is crucial to have a scientifically grounded seed system and implement comprehensive measures that fully utilize the potential of the selected variety. The variety itself plays a leading role in increasing the yield and overall harvest of tobacco. The economic value of seed material is associated with the internal hereditary properties inherent in the seed of a particular variety and is determined by the number of formed characteristics inherent in it (yield, resistance to diseases, droughts, etc.). The implementation of the achievements of *Nicotiana tabacum* L. tobacco breeding is possible only with a well-organized seed system, the main tasks of which are to increase the seed productivity of varieties by breeding, accelerate seed multiplication, maintain genetically determined characteristics and properties of the varieties used in production. Given the requirements for modern tobacco varieties, seed productivity, improvement of seed production technology, and quality improvement (similarity of BN (superelite) seeds should be at least 90%, and BN (elite) - 80%) are of paramount importance. Such quality can be obtained provided there is genetically determined high seed productivity and strict adherence to a complex of agrotechnical measures that contribute to providing conditions for seed formation, progressive methods of its post-harvest processing, and preparation for sowing.

The development of new varieties that combine high seed productivity and stable yields of dry leaves with high product quality will help solve the pressing issue of the tobacco industry in Ukraine, which is to provide the tobacco industry with raw materials with optimal levels of nicotine, carbohydrates, and proteins.

Analysis of long-term literature data from foreign and domestic scientists shows that tobacco breeding and seed production are the foundation for the development of competitive production of tobacco raw

materials [1, 12, 16, 17, 18]. Scientific research on tobacco seed production has always been associated with the development of breeding work.

Over time, the Ukrainian Tobacco Research Station has developed numerous tobacco varieties that no longer meet the productivity and technological quality requirements for raw materials. These varieties have lost their competitiveness in the Ukrainian tobacco market. To address this, there has been a demand for the creation of new tobacco varieties and hybrids that possess valuable economic traits, ecological adaptability, disease resistance, and high-quality chemical composition. The focus is on developing varieties that can meet the evolving needs of the tobacco industry, ensuring sustainable and successful tobacco production in Ukraine. [2, 3]. In Ukraine, Gritsai L.L. and Sarichev Yu.F. studied the methods of breeding and seed production in primary and elite ranks [7, 17]. In 2012, the scientists from the scientific and technological department of Tobacco Growing at the Ternopil State Agricultural Experimental Station, which was established following the reorganization of the Ukrainian Tobacco Research Station, developed scientific and methodological recommendations. These recommendations aimed to enhance the sowing and yield qualities of the seed for new perspective tobacco varieties. By providing guidelines and techniques based on scientific research, the scientists aimed to improve the overall cultivation and productivity of these new tobacco varieties, contributing to the advancement of tobacco farming practices in Ukraine [4].

Scientists from Zakarpatska Agricultural Experimental Station of the National Academy of Agrarian Sciences are involved in tobacco breeding. In recent years, Savina O.I. and Sheidyk K.A. have initiated research that has shown that the seed productivity of tobacco depends on the shape and density of the inflorescence, while the size of the flower, its color, and other features of the flower and capsule shape do not affect the productivity of tobacco. The conical shape of the inflorescence ensures high rates of seed productivity and viability [18, 20]. Savina O.I. has described the variability of the structure of tobacco flowers in apomixis. In order to establish the characteristic morphological features of the inflorescence and flower structure in different apomictic forms of tobacco, the author has developed a classifier [19]. According to Kovalyuk O.M., Sheidyk K.A. and Glyudzik-Shemota M.Yu., the problem of seed quality variability is important both theoretically and practically. As the authors rightly note, seed quality is formed under the influence of factors that determine the degree of modification variability of plants. Therefore, knowledge of the directions and nature of this variability is fundamental for managing it and developing effective technology for producing high-quality seed [5, 6, 9].

Further study of the generative characteristics of tobacco was carried out by Kovalyuk O.M. As a result of observations of the growth and development of generative characteristics, the need for selection of biotypes that are genetically capable of withstanding negative environmental factors with a high genetic potential for yield and quality without reducing seed productivity has been established [10].

Theoretical generalization and solving scientific problems in tobacco cultivation involve enhancing various elements of tobacco cultivation technology. This includes improving fertilizer application techniques and understanding the productivity patterns of different tobacco varieties in the specific conditions of the Western Forest-Steppe region. These aspects were described by Sikora Yu.V., who likely conducted research and studies in this field. By analyzing and synthesizing theoretical knowledge and addressing scientific challenges, researchers can develop more effective cultivation methods and optimize the use of resources to maximize the yield and quality of tobacco in the Western Forest-Steppe region [11, 21, 22].

The Tobacco Research Station of the National Scientific Center "Institute of Agriculture NAAS" conducts scientific research on tobacco in the Central Forest-Steppe zone of Ukraine but does not produce tobacco seeds

[13, 14]. Scientific research on Berley-type tobacco varieties is carried out in Macedonia and Bulgaria [15, 16]. There is very little or no scientific work on studying the tobacco seed market and the effectiveness of seed production in Ukraine, as well as in other countries. Therefore, research on evaluating the technological features of growing seed of new perspective Ukrainian breeding varieties of tobacco and determining the indicators of economic efficiency of seed production is becoming relevant.

MATERIALS AND METHODS

Scientific research was conducted in the Southern agro-climatic region of the Transnistrian zone of Ukraine, specifically on gray podzolic soils. The soil composition includes 1.6% humus, 1.68 mg of available phosphorus, and 10.2 mg of potassium per 100 g of soil, with a pH of 5.6. The research took place in field number 1 of the seven-year crop rotation at the scientific and technological department of tobacco growing in the Ternopil State Agricultural Experimental Station of the Institute of Feed Research and Agriculture of Podillia of the NAAS from 2017 to 2021.

The sum of active temperatures in Ternopil region is 2,550-2,600°C, and in the southern part of the region (where the scientific and technological department of tobacco growing is located) it is approximately 2,800°C. The period with an average daily temperature above +10 °C lasts for 160-165 days. During this period, amount of precipitation is 370-420 mm, and throughout the year it is 570-680 mm.

The weather conditions during 2017-2021 were generally favorable for the growth and development of tobacco plants. There was sufficient rainfall throughout the vegetation period, and the sum of active temperatures was mostly higher than normal, except for 2021 (Table 1).

Table 1. Hydrothermal conditions during the tobacco growing seasonat the Ternopil State Agricultural Experimental Station for the years 2017-2021

Indexes	Years				
	2017	2018	2019	2020	2021
∑ precipitation, mm	216.3	338.9	416.0	491.0	511.0
∑ temperature	4,002	3,118	3,183	3,003	2,773
HTC (hydrotechnical coefficient)	0.50	1.08	1.31	1.64	1.84
Characteristics of the vegetation period	dry	sufficiently moist	sufficiently moist	excessively moist	excessively moist
Duration of the vegetation period	180	170	164	175	161

Source: calculation based on the own annual scientific reports for the years 2017-2021.

The natural-climatic conditions of the research site and the duration of the growing season are favorable for the ripening of tobacco seeds and contribute to achieving planting conditions for elite and super-elite planting materials. The research materials consisted of promising tobacco varieties of Ukrainian selection, including Krupnolisty (Ternopil 14, Ternopil perspective) and Berley (Berley 38, Berley 46) varieties. These varieties were developed by the scientific and technological department of the Ternopil State Agricultural Experimental Station and are listed in the State Register of plant varieties approved for distribution in Ukraine. They are known for their high resistance to biotic and abiotic factors, as well as their high yield and good quality of raw materials.

The research used a measurement-weighting method for measuring biometric indicators of tobacco plants, laboratory methods for determining the similarity of basic and base tobacco seeds and the quality composition of tobacco raw materials, and statistical methods for identifying the degree of dominance and selection schemes using genetic recombination of genes with diallel crossing and subsequent selection. The $NIR_{0,05}$ (minimum significant difference at the 5% level of significance) and economic indicators of the implementation of elite seeds of different tobacco varieties were determined

using calculation and mathematical-statistical methods.

RESULTS AND DISCUSSIONS

The task of seed production is to produce high-quality seed in the required quantity to fully meet the needs of the corresponding tobacco cultivation zone, while preserving the biological and economic properties of the variety, and also ensuring control over the varietal qualities of the seed.

Primary seed production is the initial stage preceding the cultivation of elite seed, which includes the selection of the source material, evaluation of its offspring, and obtaining super-elite seed. Primary seed production of tobacco in our department is carried out by the method of individual family selection with offspring verification for two years according to the scheme shown in Figure 1.

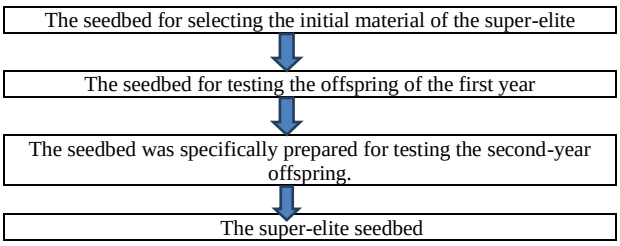

Fig. 1. Scheme of primary tobacco seed production
Source: [4].

Every year a two-year supply of elite seed of perspective varieties is produced. The creation of such a reserve fund is dictated by the long period of post-harvest maturation of the collected seed, which, for the most part, improves its sowing qualities only in the next year of storage.

Tobacco is a seedling crop, and it is necessary to grow the required amount of seedlings for planting in open ground. The seeding rate of tobacco seeds per 1 hectare is 35-40 grams, and from one hectare, it is possible to harvest 80-120 kg of seed. Such a result is achieved by observing the basic agrotechnical techniques of growing tobacco seeds, which include:

-planting tobacco seedlings in the field at optimal times from April 25 to May 10;

-a combined method of collecting leaves (the first two tiers are harvested when technically ripe, while the rest of the leaves are harvested when slightly overripe to ensure a prolonged process of photosynthesis for seed ripening;

-formation of inflorescences (removal of flowers and buds that appear later than central ones, which promotes the production of full-fledged seeds and accelerates their ripening;

-maintaining spatial isolation (not less than 300 meters between varieties) to ensure the purity of the variety.

In order to store seeds in a warehouse for a long period of time, it is necessary to create appropriate conditions throughout the year: the air temperature should not be lower than 12-15°C and the relative humidity of the air should not be higher than 70%. The typicality of the variety, its productivity, and the quality of the raw material are maintained at the achieved breeding level and improved through periodic selection of super elite, mostly every 4-5 years.

In previous years, the main task of tobacco breeding was to increase the volume of produced variety seeds. At the current stage of tobacco farming, in our opinion, the priority is the cultivation of new competitive tobacco varieties (BN, elite) with good commercial range and optimal levels of nicotine, proteins, and carbohydrates in tobacco raw materials.

The Ternopil State Agricultural Research Station stands out as the sole entity within the Ukrainian National Academy of Agrarian Sciences system, engaged in the production and commercialization of exclusive seeds derived from its own assortment of tobacco varieties. These seeds are made available to legal entities involved in tobacco production, as well as meeting the requirements of individual small-scale farming operations.

The breeding and genetic potential of our institution includes 157 tobacco varieties: 52.9% (83 variety samples) of the Eastern subtype, which includes the variety types Large-leaf – 21.0% (33), Americana – 12.1% (19), Basma – 6.4% (10), Herzegovina – 2.5% (4), Trabzon – 4.5% (7), Samsun – 4.5% (7), Dubek – 1.9% (3); 25.5% (40 variety samples) of the American subtype, including Burley – 11.5% (18) and Virginia - 14% (22); 3.2% (5 variety samples) of the Southern subtype (Kerty variety type) and 18.4% or 29

variety samples of other tobacco variety types (Figure 2).

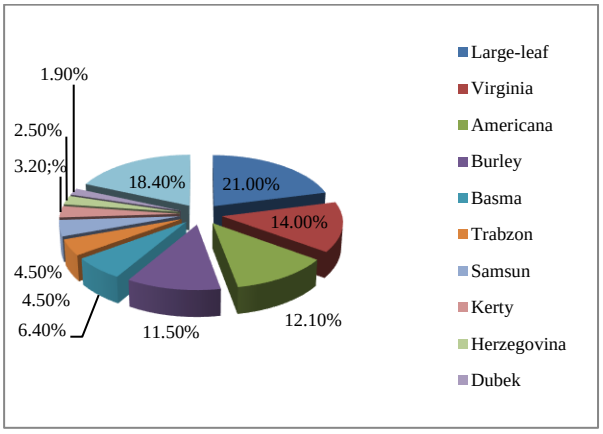

Fig. 2. Genetic potential of tobacco breeding
Source: author's calculation.

For comparison, the selection potential of *Nicotiana tabacum* L. in Bulgaria includes 158 varieties, of which 130 are of the Southern (Orientalis) subspecies, 28 are of the American (Americana) subspecies, including 17 of the Virginia type and 10 of the Burley type [12]. The tobacco collection in Poland comprises a total of 803 samples, sourced from various regions. Approximately one-third of these samples are derived from Polish breeding centers, primarily the Institute of Soil Science and Plant Cultivation (IUNG)_ located in Pulawy. A notable portion of the collection, more than seventy samples, originates from the United States, while an equal number is obtained from the former USSR, with a focus on its European region, particularly the Krasnodar Territory. Additionally, there are varieties obtained from countries such as Canada and Australia, as well as France, Germany, Romania, Italy, Hungary, and other European nations. The collection also includes samples obtained from South America, Asia, and Africa, representing a diverse range of tobacco varieties sourced from a total of 30 countries [1].

The tobacco varieties created by the breeders from the scientific and technological department of tobacco cultivation at the Ternopil State Agricultural Experimental Station have experienced significant popularity in recent years. These varieties have undergone rigorous evaluation and have been officially recognized by being included in the State Register of plant varieties authorized for distribution in Ukraine. As a result, they have garnered substantial demand within the country. These particular varieties exhibit exceptional resistance to both biotic and abiotic factors, showcasing their ability to withstand various pests, diseases, and environmental challenges. Moreover, they are known for their high productivity, consistently yielding abundant crops. Additionally, the quality of the tobacco raw materials produced by these varieties is widely regarded as excellent, meeting or exceeding the desired standards. Phenological observations of plant growth and development show that these are varieties: Burley 38, Burley 46, Ternopil 14, and Ternopil perspective. The results are shown in Table 2.

Table 2. Average biometric indicators and yield of perspective tobacco varieties at the Ternopil State Agricultural Experimental Station for 2017-2021

№ s/n	Variety	Plant height, cm	Number of technical leaves, pcs	Leaf size, cm		Yield, t/ha	
				length	width	actual	+, - to standard
1.	Berley 38 (standard)	145	24	40	25	2.47	–
2.	Berley 46	175	25	55	32	3.29	+0.82
3.	Ternopil 7 (standard)	205	25	47	26	2.69	–
4.	Ternopil 14	210	25	52	25	2.82	+0.13
5.	Ternopil perspective	170	25	45	26	2.86	+0.17

NIR_{05} – 2.5 c/ha.
Source: own calculation based on annual scientific reports for 2017-2021.

Tobacco variety Berley 38 was entered into the State Register of Plant Varieties Suitable for Distribution in Ukraine in 2001 and is a standard variety for Berley-type tobaccos. It is

a skeleton-type raw material with an elliptical plant habit and a height of 125-150 cm. It has 23-24 technical leaves, with a leaf plate size of 45x24 cm. The average yield is 3.0 t/ha, with a yield of higher-grade varieties up to 82-82%. The nicotine content is 1.9%, with 6.7% protein and 1.56% carbohydrates. The dried raw material is brown. It is a medium-late maturing variety with a vegetation period of 119 days, and it is complex-resistant to diseases. Care for seedlings and cultivation techniques are generally accepted for Berley-type tobaccos. The optimal planting dates are the first and second decades of May, with a planting density of 70x40 cm. It has valuable economic characteristics, being high-yielding despite relatively low growth due to the high materiality of the leaf plate.

After years of dedicated breeding efforts, a groundbreaking tobacco variety named Berley 46 has been successfully developed. This new variety possesses notable advantages in terms of both biological and economic characteristics compared to the standard variety, Berley 38. Berley 46 showcases improved traits that offer enhanced performance and potential benefits in various aspects of tobacco cultivation and production. The plant habit of Berley 46 is conical, with skeleton-type raw material. It is characterized by the uniform ripening of leaves in tiers. Berley 46 features wide-elliptical-shaped leaves with a moderately pointed top. Notably, this variety exhibits resistance to adverse soil and climatic conditions, making it well-suited for challenging environments. It also possesses a complex resistance profile against various diseases, including Peronospora tabacina, Tomato spotted wilt virus, Potato virus G, and Pseudomonas syringae. This robust resistance helps protect the plant from these harmful pathogens, ensuring the overall health and productivity of the tobacco crop. It is suitable for pesticide-free cultivation technology. The Berley 46 tobacco variety was obtained through individual selection in populations of intervarietal hybrids Berley Polsky x Banat. Berley Polsky tobacco variety is known for its high nicotine content and yellow leaf color, while the Banat tobacco variety excels in plant height and disease/pest resistance.The height of the plants is 175 cm. The certificate of state registration of the Berley 46 plant variety (No.161042 of November 30, 2016) confirms its registration. The new variety offers a significant advantage with its remarkable yield of tobacco raw materials, reaching 3.29 tons per hectare. This yield surpasses the standard variety by 0.82 tons per hectare. Additionally, the new variety demonstrates a higher production of premium-grade tobacco, with an estimated range of 90-95%. Moreover, the chemical composition of the raw material from this variety is noteworthy, with a nicotine content of 2.08%, protein content of 5.42%, and carbohydrate content of 1.11%. These favorable attributes make the new variety highly desirable for its impressive yield, quality, and chemical composition of the tobacco raw materials it produces. The dried raw material is light brown.

The Ternopil 7 tobacco variety was included in the State Register of plant varieties suitable for distribution in Ukraine in 1995, and it is a standard variety for Large-leaf type tobaccos. It is characterized by high resistance to adverse soil and climatic conditions, complex disease resistance, resistance to drying out of lower leaves, and medium ripening. The planting scheme is 70x25 cm. The plant has an oval-cylindrical habit, is tall, with an average plant height of 205 cm, the leaf base is sessile, with 25 leaflets of medium layer size, 47x26 cm. The average yield is 2.69 t/ha. The average material density is 0.481 g/cm^2. The nicotine content is 1.3%, protein content is 4.35%, and carbohydrate content is 1.65%. The output of higher-grade products is 80%.

The Ternopil 14 variety is listed in the State Register of plant varieties suitable for distribution in Ukraine since 1999. It was developed through individual selection from the super-elite lines of the Ternopil 7 variety. Planting density is 70x25 cm. The plant has an oval-cylindrical habit, grows tall up to 210 cm, with the leaf base sitting on the stem, and 25 leaves sized 52x25 cm. The average material yield is 0.450 g/cm^2. The nicotine content is 1.2%, protein content is 6.4%, and carbohydrate content is 2.1%. The output of

higher-grade varieties is 80%. The variety is complex-resistant to diseases. The average yield is 2.82 t/ha, which is 0.13 t/ha higher than the standard variety. The output of higher-grade varieties is 82%. The color of the dry leaves is yellow-brown. The new variety is recommended for cultivation in small-scale and individual farms, and it has successfully undergone ecological testing in the steppe zone of Ukraine, including the Kherson region and AR Crimea. The testing results have shown positive outcomes, confirming the variety's suitability and adaptability to the specific environmental conditions of these regions.

The tobacco variety Ternopil perspective, belonging to the large-leaved type, has been included in the State Register of plant varieties approved for cultivation in Ukraine since 2008. This variety was developed through individual selection within populations of intervarietal hybrids, specifically Virginia 22 x Ternopil 14. Its inclusion in the State Register signifies its recognition and approval by the relevant authorities for cultivation in Ukraine. It belongs to the skeleton type of raw material. The variety is complex-resistant to diseases. The planting density is 70x30 cm. The plant habit is doubly conical. The average plant height is 160-170 cm. The Ternopil perspective tobacco variety features 25 technically mature leaves that are egg-shaped with moderately pointed tips. The leaf blade size measures 45x26 cm. It has a nicotine content of 1.61%, carbohydrates content of 3.6%, and proteins content of 4.58%. The average weight per unit area is 0.566 g/cm2.The color of the ripe leaf in the field is light green, and the dried raw material is light brown. The average yield is 2.86 t/ha, which is 0.18 t/ha more than the standard variety Ternopil 7. The yield of higher quality grades is 85%.

The quality of tobacco raw material is influenced by its chemical composition, which encompasses more than 70 different substances.

However, the main indicators used for evaluation are nicotine, carbohydrates, and protein substances [8, 23, 24].

There are significant differences between the production of tobacco seeds and other agricultural crops.

The harvested crop of grains (winter and spring wheat, barley, buckwheat) and technical crops (rapeseed, sunflower) is sold in the current or next year.

Tobacco seeds can maintain their sowing qualities (similarity, color, smell) for 5-7 years, so it can be sold during this period.

The revenue from the sale of tobacco seeds is one of the main sources of funding for the scientific and technological department of tobacco cultivation, where scientific work in the field of tobacco seed production is organized at the highest level in Ukraine. Table 3 shows the amount of tobacco seed sold in 2017-2021 and the revenue from its sale.

The sale of seeds is preceded by their certification by the State Enterprise "State Center for Certification and Expertise of Agricultural Products". Seed testing is carried out in accordance with the requirements of DSTU 4138-2002 Seeds of Agricultural Crops. Method for determining quality and DSTU 2340-93 Seeds of Agricultural Crops. Sowing and varietal qualities.

As can be seen from Table 3, the Berley 38 variety had a higher share in the structure of seed sales for two years: 99.4% in 2017 and 62.1% in 2018.

Starting from 2019, the revenue from the sale of Berley 46 seeds has been occupying a significant share in the structure of tobacco seed sales: 49.8% in 2019, 31.8% in 2020, and 58.9% in 2021. Both Berley 38 and Berley 46 belong to the Berley variety type, while varieties of the Large-Leaved type, such as Ternopil 7, Ternopil 14, and Ternopil perspective, surpass Berley types only in 2020 – 54.5%, while in other years they occupy a small share: 0.6% in 2017, 37.9% in 2018, 24.4% in 2019, and 32.0% in 2021.

According to the technological process, 10 hectares of tobacco plantations provide year-round work for 18-22 rural workers, and during the seasonal work period, 48-50 people are employed in tobacco farming.

Table 3. Implementation of elite tobacco seed by Ternopil State Agricultural Experimental Station for 2017-2021 (sorted by varieties)

Variety name	Quantity sold, kg	Revenue, thousand UAH*	% of Total Sales
2017			
Burley 38	2.562	47.24	99.4
Ternopil perspective	0.015	0.30	0.6
Total per Year	**2.577**	**47.54**	**100**
2018			
Burley 38	2.060	57.90	62.1
Burley 46	0.120	3.48	3.6
Ternopil perspective	0.020	0.58	0.6
Ternopil 14	1.120	31.10	33.7
Total per Year	**3.320**	**93.06**	**100**
2019			
Burley 38	0.595	17.85	25.8
Burley 46	1.146	32.70	49.8
Ternopil perspective	0.518	14.81	22.5
Ternopil 14	0.043	1.30	1.9
Total per Year	**2.302**	**66.66**	**100**
2020			
Burley 38	0.810	24.30	13.7
Burley 46	1.875	53.60	31.8
Ternopil perspective	1.907	52.70	32.4
Ternopil 14	1.305	29.00	22.1
Total per Year	**5.897**	**191.52**	**100**
2021			
Burley 38	0.806	37.70	9.1
Burley 46	5.190	249.70	58.9
Ternopil perspective	0.122	6.10	1.4
Ternopil 14	2.702	122.00	30.6
Total per Year	**8.820**	**415.50**	**100**

Source: calculation based on annual scientific reports from 2017-2021
*UAH (hryvnia) -the national currency of Ukraine.

Over the past two years of research, the seed has provided a planting area of 168 hectares in 2020 and 252 hectares in 2021. In 2020, 740 jobs were created in tobacco farming, and in 2021, 1,100 rural workers provided their families with decent incomes. The economic feasibility and historical background have been decisive in the fact that tobacco occupies a significant share of the private land use structure in the Transnistrian region of Ukraine. Growing tobacco as a cash crop under modern conditions of rural self-employment provides a source of stable income for families, and traditions ensure the transfer of skills and knowledge from generation to generation.

Analysis of the realized seed allows us to conclude that agricultural producers prefer the Berley-type tobacco varieties, the raw material of which is characterized by better yield and higher nicotine content.

High efficiency of selection for obtaining quality varieties of the Berley type and relatively frequent variety replacements create favorable opportunities for the annual optimal formation of the varietal structure of production depending on the requirements and demand of the respective raw material segment of the market and rapidly changing market conditions.

Tobacco (*Nicotiana tabacum* L.) is one of the main industrial crops grown in Ukraine for the sake of the leaves, which are used to make cigarettes, cigars, pipe tobacco, and snuff. Green tobacco leaves are a raw material for obtaining food protein. Essential oil is obtained from tobacco inflorescences, which is used in the perfumery and chemical industries.

Table 4 shows indicators of the economic efficiency of tobacco seed production.

The cost of one kg of tobacco seed, including expenses for harvesting, post-harvest ripening, cleaning, and storage, ranged from 274 to 367 dollars per kilogram from 2019 to 2021.

At an average selling price of 1,119 to 1,726 dollars, a net profit of 861 to 1,359 dollars was obtained from the sale of one kilogram of elite tobacco seed.

Figure 3 shows the dynamics of the increase in cost, prices, and net profit from the sale of one kilogram of tobacco seed.

Table 4. Economic indicators of elite tobacco seed sales at the Ternopil State Agricultural Experimental Station for 2017-2021

Economic indicators	Years				
	2017	2018	2019	2020	2021
Seed sold, kg	2,577	3,320	2,302	5,897	8,820
Total seed cost, USD	472	790	594	1,616	3,237
Revenue from seed sales, total, USD	1,786	3,423	2,576	7,106	15,223
Net profit, total, USD	1,314	2,633	1,982	5,490	11,985
Cost of production per unit, USD/kg	183	238	258	274	367
Average selling price, USD/kg	693	1,031	1,119	1,205	1,726
Net profit per unit of production, USD/kg	510	793	861	931	1,359

Note. The average exchange rate of the US dollar: 2017 – 26.60 UAH, 2018 – 27.20 UAH, 2019 – 25.85 UAH, 2020 – 26.96 UAH, 2021 – 27.29 UAH.

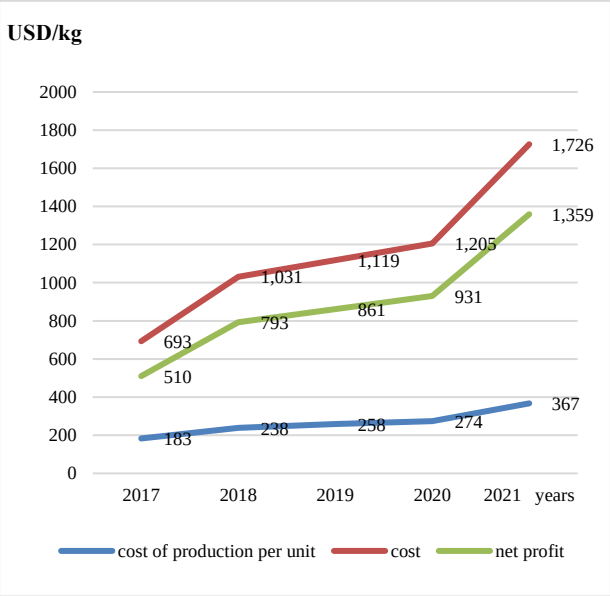

Fig.3. Dynamics of economic indicators of tobacco seed sales at the Ternopil State Agricultural Experimental Station for the years 2017-2021.
Source: author's calculation.

For many decades, our institution has been providing high-quality tobacco seed to the countries of the Caucasus (Georgia, Azerbaijan, Armenia) and Central Asia (Kazakhstan and Uzbekistan). The revenue from the sale of tobacco seed constituted a significant part of the income from the sale of agricultural products. After the collapse of the Soviet Union, the sale of tobacco seed is carried out only within Ukraine. At present, we provide tobacco growers in the Lviv, Ternopil, Chernivtsi, Cherkasy, Dnipropetrovsk, Kyiv, Khmelnytskyi and Zakarpatska regions of Ukraine with seed.
Therefore, the production of elite seed of high-yielding competitive varieties of tobacco is a good source of revenue for the special fund of the budget for scientific institutions that have the right and ability to engage in the seed production of this technical crop.

CONCLUSIONS

New perspective varieties of Ukrainian tobacco, which are highly resistant to biotic and abiotic factors, have good quality raw materials, and optimal levels of nicotine, carbohydrates, and proteins: Berley 38, Berley 46, Ternopil 14, and Ternopil perspective, have wide distribution and are in demand on the Ukrainian market.
Growing competitive varieties of tobacco seeds provides significant revenues to research institutions for the special fund of the budget. From the sale of one kilogram of elite tobacco seed, net profits range from $861 to $1,359.
The study of technological features of growing new promising varieties of Ukrainian tobacco seeds and their implementation in production will contribute to increasing the efficiency of tobacco production and the competitiveness of seed production in Ukraine.

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