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Assessment of Economic Efficiency of New Potato Varieties as Intellectual Property Objects

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► **Abstract.** In the context of market relations development and rapid changes in technological support and technologies, it is necessary for enterprises to use not only publicly available material and financial resources, but also to operate with non-material resources, namely intellectual property objects, to ensure competitive advantages. This is an effective approach to increase the profitability and competitiveness of the enterprise. Improving the methodology and organisation of evaluation of potato varieties for various economic purposes as intellectual property as part of intangible assets is relevant and allows determining the market value of the variety, eliminates errors in calculating the price, and contributes to profit. The purpose of the study is to develop methodological recommendations for assessing the value of potato varieties as an object of intellectual property. The study was based on theoretical elaborations of Ukrainian and foreign scientists. The materials of statistical reporting of agricultural enterprises engaged in the production of seed potatoes, developments of research institutions, data of the Ministry of Agrarian Policy and Food of Ukraine, the State Statistics Service of Ukraine were used for the research. The economic evaluation of breeding stages of creation of potato varieties for different economic purposes was carried out. Methodological approaches to assessing the value of potatoes as an object of intellectual property, and economic mechanisms for ensuring the acquisition of intellectual property rights and use of newly created potato varieties, have been developed. The stages of the breeding process of creating a variety from an economic point of view are studied. The most expenditure stages of breeding are determined. The importance of the direction of use of the variety and the impact on the cost of its creation are analysed. Methodological recommendations for estimating the cost of potato seeds have been elaborated, allowing to establish the payback period of the variety

► **Keywords:** potatoes, cost estimation, economic indicators, technical, table and diet varieties, costs

► Introduction

Potato growing is one of the priority branches of agricultural production in Ukraine. Ukraine is among the five leading countries in the world in terms of gross potato production. A further successful strategy for the development of potato growing is possible with the use of the latest scientific achievements, primarily breeding. Plant varieties are valuable objects of intellectual property in the agriculture of Ukraine and one of the most important factors of the enterprise activity, which guarantees successful business development. Although the identification of such objects as farm assets requires a qualified approach [1; 2].

Plant varieties are a popular and competitive product, and this is a reality. Today, more than 10 thousand plant varieties, including 194 potato varieties, are suitable for commercial distribution in Ukraine [3]. To become an object of property and generate income,

a variety must acquire legal protection, which is certified by a patent. The commercial carrier of the variety is seeds/planting material. And it is the patent holder who uses and disposes of the property rights to the variety and seed material of the variety [4].

All official methods of valuation of intellectual property, including varieties, are defined by National Standard No. 4 "Valuation of Intellectual Property Rights" [5]. Most often the assessment is carried out using the income approach, but also the cost approach or comparative (market) approach can be used. Thus, the income approach is that the value of rights to a variety is determined as a function of income. That is, what income can be generated by the use and/or disposal of this intellectual property in the future. According to O.V. Zakharchuk, "the cost approach is based on the assumption that the cost of an intellectual property object is equal to the cost

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of its creation, bringing it to working condition and depreciation" [4; 6]. Conventionally, if €1-2 million is spent on creating a variety in Europe, then the income from use should not be less than the costs [7].

The comparative (market) approach consists in comparing the object being evaluated with objects of similar purpose, qualities and usefulness that were sold during this time in a similar market. That is, the price is set by the market as fair and satisfies both the seller and the buyer [8; 9].

As a rule, the variety is effectively used in economic activity for at least 5-6 years or even during the entire period of validity of property rights – up to 30 years [1]. The main factors that affect the fair value of an object are as follows: rating, volume, term of use and, in accordance with the agreed interest, royalties [10].

In the process of assessing the value of the variety, it is necessary to ensure compliance with the provisions of legislative and regulatory legal acts of Ukraine. In practice, different approaches are used to determine the real value of intellectual property rights and the actual price of the license (permit), among which the most common are the so-called global, analytical and experimental methods [11; 12].

The methodological basis for research on the assessment of the cost of new varieties, including potatoes, and the efficiency of their production are theoretical developments of Ukrainian and foreign scientists. The economic efficiency of seed production and prospects for the development of seed production in Ukraine, along with the experience of commercial circulation and evaluation of the productivity of varieties are investigated in the works of V. Zakharov [13]; O. Zakharchuk [8; 14; 15]; M. Molotskyi; S. Vasylykivskyi; V. Kniaziuk; V. Vlasenko [16]; V. Mosakovskiy [17]; O. Tomchuk, J.C. Stark, M. Thornton [18].

Despite the significant contribution of these researchers and the value of their findings, a number of unresolved issues remain. Assessment of the value of plant varieties as objects of intellectual property for scientific breeding institutions and institutions is one of the most urgent and pressing issues.

The research is based on the systematic and comprehensive study of economic phenomena and will be conducted using methodological approaches that are used in international practice [4]. The economic profitability of new varieties as objects of intellectual property that will improve the competitiveness of potatoes was also considered. To improve and change certain economic indicators for obtaining better quality seed material at low cost [16].

The materials of statistical reporting of agricultural enterprises engaged in the production of seed potatoes, developments of research institutions, data of the Ministry of Agrarian Policy and Food of Ukraine, and the State Statistics Service of Ukraine will be used in the study [3; 19; 20].

► Materials and Methods

The following methods were used to estimate the value of the variety: cost, analogues and income. The cost method is based on the principle of replacing the best and most efficient use of resources with a new variety, balancing the economic size and economic distribution of costs between the author of the variety and its consumer. The income method establishes the present value of future revenues expected to be received as a result of the use or alienation of intellectual property rights to a plant variety by assessing the annual expected effect of the implementation of property rights to this variety using discounting methods by year. The analogue method (comparative) determines the value of a variety based on actual cases of its sale in an active and transparent market of analogue varieties and if there is information about concluded transactions for the sale of property rights to analogue varieties, the results of a comparative analysis of the main indicators of similar plant varieties and adjustments to actual prices on the market of property rights to plant varieties [6; 14].

The methodological basis for research on the assessment of the cost of new potato varieties and the efficiency of their production are theoretical developments of Ukrainian and foreign scientists. Today, there are three classical approaches to the valuation of rights to potato varieties: cost, market and financial. The cost approach is based on the statement that the cost of a variety is equal to the cost of its creation, obtaining planting material and depreciation. The market approach is based on the method of sales comparison, that is, the newly created variety is compared with similar varieties that have been sold in a similar market. The financial approach involves setting the current value future income that is planned to be received through the use or alienation of property rights to the potato variety. At the same time, the annual estimated effect is calculated by applying discounting methods by years [1; 4; 21]. A number of methods have been applied in course of the research, the most significant of which are theoretical generalisation, comparison and analysis.

► Results and Discussion

In practice, various approaches are used to determine the real value of intellectual property rights and the actual price of a license. The study focused on potato varieties selected by the Institute of Potato Growing for table purposes: Fotynia, Mysteriya, Rodynna – medium ripening; Zhytnitsya – early ripening. In Tables 1-4, the cost of each of the varieties at each stage of the breeding process was calculated. Thus, according to the calculations, the cost of the Fotynia variety is UAH 1,000,000, while the cost of the Mysteriya variety is UAH 1,200,000, which is 20% more. This is primarily due to the cost of research to determine the complex of features: morphological, biochemical, and suitability for processing.

Table 1. Calculation of the cost estimate of the Fotynia variety

Years	Stages	Expenses, UAH
2007	Study of character collections and selection of samples for use by parental forms	120,000
2008	Conducting crosses in Polissya and Carpathians and obtaining hybrid seeds for breeding	70,000
2009	Study and selection in the first generation	70,000
2010	Study and selection of genotypes in the first tuberous generation by yield, shape, quantity and quality of tubers	80,000
2011	Study and selection by a complex of traits; yield, grade to the year of potatoes of the 1 st year, starchiness, phytophthora resistance	90,000
2012	The main test in the conditions of Polissya: yield, biochemical parameters, resistance to nematodes, phytophthora resistance, virus resistance, culinary qualities	90,000
2013	Competitive ecological trial of the first year in Polissya, Forest-steppe, Steppe: yield, starchiness, adaptability, quality, resistance to cancer, potato nematode, shelf life and suitability for processing	90,000
2014	Competitive environmental testing in different zones of Ukraine based on the same criteria. Propagation to the required volumes	90,000
2015	Distribution of planting material to different points of the State Service for the Protection of Plant Variety Rights. Propagation using seed measures	100,000
2016	State variety testing of the 2 nd year. Distribution of planting material to all points of the State Service for the Protection of Plant Variety Rights. Propagation using seed measures	100,000
2019	State variety testing. Listing in the register of plant varieties of Ukraine. Primary seed production	100,000
Total		1 000 000

Source: developed by the authors on the basis of accounting and breeding research data

Table 2. Calculation of the cost estimate of the Rodynna variety

Years	Stages	Expenses, UAH
2008	Study of character collections and selection of samples for use by parental forms	132,000
2009	Conducting crosses in Polissya and Carpathians and obtaining hybrid seeds for breeding	84,000
2010	Study and selection in the first generation	84,000
2011	Study and selection of genotypes in the first tuberous generation by yield, shape, quantity and quality of tubers	96,000
2012	Study and selection by a complex of traits; yield, grade to the year of potatoes of the 1 st year, starchiness, phytophthora resistance	108,000
2013	The main test in the conditions of Polissya: yield, biochemical parameters, resistance to nematodes, phytophthora resistance, virus resistance, culinary qualities	108,000
2014	Competitive ecological trial of the first year in Polissya, Forest-steppe, Steppe: yield, starchiness, adaptability, quality, resistance to cancer, potato nematode, shelf life and suitability for processing	108,000
2015	Competitive environmental testing in different zones of Ukraine based on the same criteria. Propagation to the required volumes	108,000
2016	Competitive ecological trial of the 1 st year in Polissya, Forest-steppe and Steppe: adaptability, yield, starchiness, keeping quality, shelf life, processing and culinary qualities. Assessment of resistance to major diseases and pests	120,000
2017	Competitive ecological trial of the 2 nd year in Polissya, Forest-steppe and Steppe: adaptability, yield, starchiness, keeping quality, shelf life, processing and culinary qualities. Assessment of resistance to major diseases and pests	108,000
2018	State variety testing of the 2 nd year. Distribution of planting material to different points of the State Service for the Protection of Plant Variety Rights. Propagation using seed measures	72,000
2019	State variety testing of the 2 nd year. Distribution of planting material to different points of the State Service for the Protection of Plant Variety Rights. Propagation using seed measures	72,000
2020	Listing in the Register of plant varieties suitable for distribution in Ukraine	
Total		1,200,000

Source: developed by the authors on the basis of accounting and breeding research data

The most expensive varieties are *Mysteriya* and *Zhytnytsya*, their price reaches UAH 1,300,000, which is related to the specifics of these varieties.

Thus, one variety has purple tubers and yellow flesh; the other variety has pink tubers and creamy flesh.

Table 3. Calculation of the cost estimate of the *Mysteriya* variety

Years	Stages	Costs, UAH
2008	Study of character collections and selection of samples for use by parental forms	143,000
2009	Conducting crosses in Polissya and Carpathians and obtaining hybrid seeds for breeding	91,000
2010	Study and selection in the first generation	91,000
2011	Study and selection of genotypes in the first tuberous generation by yield, shape, quantity and quality of tubers	104,000
2012	Study and selection by a complex of traits; yield, grade to the year of potatoes of the 1 st year, starchiness, phytophthora resistance	117,000
2013	The main test in the conditions of Polissya: yield, biochemical parameters, resistance to nematodes, phytophthora resistance, virus resistance, culinary qualities	117,000
2014	Competitive ecological trial of the first year in Polissya, Forest-steppe, Steppe: yield, starchiness, adaptability, quality, resistance to cancer, potato nematode, shelf life and suitability for processing	117,000
2015	Competitive environmental testing in different zones of Ukraine based on the same criteria. Propagation to the required volumes	117,000
2016	Competitive ecological trial of the 1 st year in Polissya, Forest-steppe and Steppe: adaptability, yield, starchiness, shelf life, processing and culinary qualities. Assessment of resistance to major diseases and pests	130,000
2017	Competitive ecological trial of the 2 nd year in Polissya, Forest-steppe and Steppe: adaptability, yield, starchiness, shelf life, processing and culinary qualities. Assessment of resistance to major diseases and pests	117,000
2018	State variety testing of the 2 nd year. Distribution of planting material to different points of the State Service for the Protection of Plant Variety Rights. Propagation using seed measures	78,000
2019	State variety testing of the 2 nd year. Distribution of planting material to different points of the State Service for the Protection of Plant Variety Rights. Propagation using seed measures	78,000
2020	Listing in the Register of plant varieties suitable for distribution in Ukraine	-
Total		1,300,000

Source: developed by the authors on the basis of accounting and breeding research data

Table 4. Calculation of the cost estimate of the *Zhytnytsya* variety

Years	Stages	Expenses, UAH
2008	Study of character collections and selection of samples for use by parental forms	143,000
2009	Conducting crosses in Polissya and Carpathians and obtaining hybrid seeds for breeding	91,000
2010	Study and selection in the first generation	91,000
2011	Study and selection of genotypes in the first tuberous generation by yield, shape, quantity and quality of tubers	104,000
2012	Study and selection by a complex of traits; yield, grade to the year of potatoes of the 1 st year, starchiness, phytophthora resistance	117,000
2013	The main test in the conditions of Polissya: yield, biochemical parameters, resistance to nematodes, phytophthora resistance, virus resistance, culinary qualities	117,000
2014	Competitive ecological trial of the first year in Polissya, Forest-steppe, Steppe: yield, starchiness, adaptability, quality, resistance to cancer, potato nematode, shelf life and suitability for processing	117,000
2015	Competitive environmental testing in different zones of Ukraine based on the same criteria. Propagation to the required volumes	117,000
2016	Competitive ecological trial of the 1 st year in Polissya, Forest-steppe and Steppe: adaptability, yield, starchiness, keeping quality, shelf life, processing and culinary qualities. Assessment of resistance to major diseases and pests.	130,000
2017	Competitive ecological trial of the 2 nd year in Polissya, Forest-steppe and Steppe: adaptability, yield, starchiness, keeping quality, shelf life, processing and culinary qualities. Assessment of resistance to major diseases and pests.	117,000
2018	State variety testing of the 2 nd year. Distribution of planting material to different points of the State Service for the Protection of Plant Variety Rights. Propagation using seed measures	78,000

Table 4, Continued

Years	Stages	Expenses, UAH
2019	State variety testing of the 2 nd year. Distribution of planting material to different points of the State Service for the Protection of Plant Variety Rights. Propagation using seed measures	78,000
2020	Listing in the Register of plant varieties suitable for distribution in Ukraine	–
Total		1,300,000

Source: developed by the authors on the basis of accounting and breeding research data

Important indicators during the research is the structure of production costs for each of the varieties. Thus, in 2020, the production costs of Fotynia variety amounted to UAH 192,300 per 1 ha, Rodynna

variety – UAH 174,800 per 1 ha, Zhytnytsya variety – UAH 150,300 per 1 ha, and Mysteriya variety – UAH 199,300 per 1 ha (Table 5).

Table 5. Structure of potato production expenses in 2020

Expense items	Fotynia variety, UAH/ha	Mysteria variety, UAH/ha	Rodynna variety, UAH/ha	Zhytnytsya variety, UAH/ha
Seed material	140,000	147,000	122,500	98,000
Fertilisers	8,300	8,300	8,300	8,300
Protective equipment	20,300	20,300	20,300	20,300
Fuel and lubricants	3,800	3,800	3,800	3,800
Labour remuneration	600	600	600	600
Storage expenses	11,900	11,900	11,900	11,900
Depreciation	6,800	6,800	6,800	6,800
Other direct and general production costs	600	600	600	600
Total	192,300	199,300	174,800	150,300

Source: developed by the authors based on accounting and reporting data of the Institute of Potato Growing

Naturally, production expenses vary from year to year, as they depend on inflation and market prices. Potatoes are a very capital-intensive crop. Although, when fully realised, its profitability is expected to be very high. This is related to the price on the market and also depends on the sales channels. Usually, food potatoes do not have a sufficiently high price on the market, for example, compared to seed potatoes. Potatoes intended for processing into starch will be lower in price than food potatoes. This determines the level of profitability.

According to the research of the Department of Scientific and Economic Research of the Institute of

Potato Growing, the planned indicator of profitability of potato production by varieties is (Table 6): Fotyniya variety as a food potato, which will be sold at an average market price of UAH 42 per kg – 243.2%; Rodynna variety with an average selling price of UAH 35 per kg – 286.2%; Zhytnytsya variety at a price of UAH 28 per kg – 399.0%; Mysteriya variety, provided that such potatoes are sold at a price of UAH 42 per kg – 351.6%. The most expensive is the Mysteriya variety. However, it did not provide high yields and is quite laborious and demanding to grow. Thus, the Zhytnytsya variety has the highest percentage of profitability in the presence of a fairly low production cost.

Table 6. Estimated economic indicators of potato production for different uses

Economic indicators	Fotyniya Variety	Mysteriya Variety	Rodynna Variety	Zhytnytsya Variety
Expenses, UAH per ha	192,300	199,300	174,800	150,300
Yield, t/ha	55	60	45	50
Cost price, UAH per 1 ton	3 496,4	3 321,7	3 884,4	3 006,0
Sales revenue, UAH	660,000	900,000	675,000	750,000
Net income, UAH	467,700	700,700	500,200	599,700
Profitability, %	243,2	351,6	286,2	399,0

Source: developed by the authors based on accounting and reporting data of the Institute of Potato Growing

In 2019, the income from the main activities of the Institute of Potato Growing, that is, from the sale of varieties as objects of intellectual property, amounted to UAH 1,506,588. In 2020, these figures increased and amounted to UAH 1,765,639. As of 2021, the income amounted to UAH 3,867,380 which is 61% more than in 2019. This trend indicates the economic efficiency of new varieties as objects of intellectual property, increasing the level of their profitability, and the total income of the institution.

► Conclusions

Increasing the volume of potato production, reducing costs and increasing profitability is the main task of producers. The variety in modern economic conditions is of exceptional importance, and the use of new-generation varieties is the most affordable and cost-effective step to obtain additional gross yields. In our research, the varieties showed a yield of 45-60 t/ha, the cost of 1 ton of products is UAH 3.0-3.88 thousand, the level of profitability is 243-399%. The share of newly bred high-yielding potato varieties in

the increase in yield is 35-40%. Potato growing in the issues of ensuring food security of the state is a strategic branch of agricultural production, further development of which is impossible without improving the efficiency of the current system of breeding and seed production. The guarantor of increasing potato production, as evidenced by world experience and numerous publications, is timely variety replacement and variety renewal. Therefore, producers of various forms of ownership need to constantly update the line of potato varieties in farms, use high-quality seeds of high generations, which in turn will be the key to improving the efficiency of potato production and significantly affect the level of demand for newly created varieties.

The formation of economic relations on the basis of calculations based on the market price of the license object, the licensee's operating income, the licensee's expenses for the creation of new varieties will allow to develop and improve the market of intellectual property, including in potato growing.

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Оцінка економічної ефективності нових сортів картоплі як об'єктів інтелектуальної власності

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► **Анотація.** В умовах розвитку ринкових відносин і швидкої зміни технологічного забезпечення та технологій підприємствам для забезпечення конкурентних переваг необхідно використовувати не лише загальнодоступні матеріальні та фінансові ресурси, а й оперувати ресурсами не матеріального характеру, а саме об'єктами інтелектуальної власності. Це слугує дієвим способом підвищення прибутковості і конкурентоспроможності підприємства. Удосконалення методики й організації оцінки сортів картоплі різного господарського призначення як інтелектуальної власності у складі нематеріальних активів є актуальним і дозволяє визначити ринкову вартість сорту, унеможливило помилки у розрахунку ціни, сприяє отриманню прибутку. Метою статті є розробка методичних рекомендацій з оцінки вартості сортів картоплі як об'єкта інтелектуальної власності. У процесі дослідження використано теоретичні розробки українських і зарубіжних вчених. Для досліджень використані матеріали статистичної звітності сільськогосподарських підприємств, що займаються виробництвом насінневої картоплі, розробки науково-дослідних установ, дані Міністерства аграрної політики і продовольства України, Державної служби статистики України. Здійснено економічну оцінку селекційних етапів створення сортів картоплі різного господарського призначення. Розроблено методичні підходи до оцінки вартості картоплі як об'єкту інтелектуальної власності, а також економічні механізми забезпечення набуття прав та використання інтелектуальної власності на новостворені сорти картоплі. Досліджено етапи селекційного процесу створення сорту з економічної точки зору. Визначено найбільш затратні етапи селекції. Проаналізовано важливість наряду використання сорту та вплив на вартість його створення. Розроблено методичні рекомендації щодо оцінки вартості насіння картоплі, що дає змогу встановити термін окупності сорту

► **Ключові слова:** картопля, оцінка вартості, економічні показники, технічний, столовий та дієтичний сорти, витрати