International Journal of Information Technology Project Management
Volume 14 • Issue 1

Modeling the Efficiency of Operating Costs in Introducting Innovations in the Agrarian Sphere:

Efficiency of Innovations in Crop Production

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ABSTRACT

The purpose of the work is to demonstrate the results of modeling the impact of innovation on the efficiency of operating costs for crop production by agricultural enterprises. Based on the dialectical method of cognition, abstract-logical, and graphic methods were used; nonlinear correlation-regression analysis and economic-mathematical modeling It is established that the innovations of technical and technological character contribute to the increase of the extremum of the yield function. At the same time, the impact of innovation on the profit function is twofold. In the case of free product innovation, an increase in output estimated at market prices generates an increase in the extremum of the profit function while increasing the profit optimum of costs. That is why the latter is approaching the technological optimum. In turn, the innovation payoff affects the profit curve, reducing the value of the cost optimum and the function extremum. However, a significant increase in the cost of an innovative product can lead to a decrease in profit below the achieved level.

KEYWORDS

Costs, Hybrid, Innovation, Law of diminishing returns, Modeling, Plant growing, Profit, Resource saving, Technology

INTRODUCTION

The effective functioning of an agricultural enterprise is possible only in case of purposeful implementation of the innovations. Not only is this process a means of increasing productivity, increasing resource efficiency and maximizing profits, it has in fact evolved into a philosophy of

DOI: 10.4018/IJITPM.323208

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developing the world's leading agricultural producers. At the same time, the limiting factors of innovative activity of domestic agro-formations are economic factors: fast-growing dynamics of prices for energy and mineral fertilizers, unregulated institutional environment, changes in monetary and fiscal spheres, ambiguity of the impact of innovations on the effectiveness and efficiency of the agro-formations functioning. At the same time, the innovative direction of the agricultural sector development necessitates the deepening of the methodological approaches to assessing the impact of the innovations on the productivity of agricultural production.

LITERATURE REVIEW INNOVATION IMPLEMENTATION MODELING

Agro-innovations refer to the introduction to use a new or significantly improved product (goods, service), new methods of sale or organization of business practices, the organization of jobs or external relations (Oslo Manual, 2005). The study of the methodological foundations of innovative activity showed that its theoretical basis was laid in the works of J. Schumpeter, J. Dunning, and R. Lucas. The focus of the research vector on the "productivity paradox" of innovations, including information technology, shows that their implementation undermines transformations in the activities of economic entities, such as new business processes, new skills, organizational and industry structures, ways of organizing production (Brinolfsson E. & Heath L.M., 2000). Today, the issue of the impact of the innovations on economic development has been given attention in the works by C. Edquist (1997; 2001), K. Dalman (1995), R. Nelson (1993; 1995), Shu Lin Gu (1999), K. Freeman (1987), B.O. Lundwall (1987), M. Gertler (2004), B. Asheim (2004; 2002), A. Isaxen (2002), F. Cook (1998; 2003), K.J. Morgan (1998), V. Babenko (2018), N. Davidenko (2019), S. Ramazanov (2019), A.B. Memon (2017) and others.

Practice shows that genetic modification, marker breeding, selection of agricultural crops resistant to various negative factors, agricultural crops for production of the second-generation biofuels, creation of biopesticides, biofertilizers, enzymes, as well as the development of ecologically oriented systems are the main directions of the scientific research in the agrarian sphere today (Edquist, C., 1997). Domestic agro-formations are widely introducing the innovations of technical and technological, organizational, and economic, social and managerial and informational character (Edquist, C., 2001). Soil protection systems, new varieties and hybrids, organic farming, No-till farming technologies, biopesticides and biofertilizers, new animal breeds, advanced fattening systems, new machinery and equipment, new marketing technologies, etc. are used much more often (Mazorenko, D.I., Maznyev, H.Ye., Tishchenko, L.M., Boblovs'kyy, O.Yu. & Havrylovych, N.Yu., 2007).

At the same time, the deepening of these processes creates new threats and risks due to the gradual monopolization of the market for agro-innovations by the foreign producers (Syngenta, Bayer, BASF, DuPont, etc.). The agrarian sector is significantly dependent on the import of mineral fertilizers. Thus, 10-12% of ammonium nitrate consumption, more than 35% of carbamide, more than 65% of ammonium sulfate are imported annually. Plant protection products are in fact entirely of the imported origin, with over 50% of the market is owned by Syngenta, Bayer, BASF (Nelson, R., 1993).

The consequence is a dictate from the representatives of foreign manufacturing companies, which "warms" the dynamics of prices for the means of production. The reason for this is the "one-stop shop" principle, which provides for the sale, along with seeds and fertilizers, of ancillary services that allow the genetic potential of new seed hybrids to be realized. This contributes to productivity growth and entails an increase in production intensity. At the same time, the volatility of the food market causes the deviation of the reached level of intensity from the margin optimum. As a consequence, much of the agricultural value added is concentrated in the production of tools and labor. Therefore, there is a need to investigate the impact of innovative processes in the agricultural sector on the economic efficiency of crop production.

THE PURPOSE AND METHODS

The purpose of the article is to clear up the results of modeling the impact of introduction of various innovations on the efficiency of operating costs for the production of certain types of crop products by the agricultural enterprises.

RESEARCH METHODOLOGY

Based on the dialectical method of cognition, abstract and logical method (systematization of publications on risk assessment and efficiency of implementation of agro-innovations); graphical (visualization of the impact of innovation on the behavior of production functions); nonlinear correlation and regression analysis (establishment of correlation between the intensity of production in crop production and the results of functioning of the industry); economic and mathematical modeling (estimation of influence of the innovations on formation of extreme values of production function and profit) were used.

RESULTS AND DISCUSSION

The interest in measuring the effectiveness of the innovations is dictated by their correlation with the performance of the enterprises, particular industries and agriculture in general. The empirical indicators of the innovation impact on enterprise efficiency are among the most important, but also the most complex characteristics of the innovation. In turn, the specificity of the technological process in agriculture, in particular in crop production, its subordination to the law of recoil returns, raises a number of methodological problems limiting the use of the traditional approaches to modeling the production processes. This leads to the application of the most appropriate for this parabolic function of production efficiency dependence of in this field on variable costs, which allows describing more precisely the relationship between the innovation and the result of its implementation.

The choice of economic and mathematical modeling, as the basic methodological approach in the study, allowed to confirm the assumption about the nonlinear form of dependence of the indicators of operating expenses efficiency of the agricultural enterprises on production of certain types of crop production (grain, technical, fruit, vegetable and fodder crops) from the results of innovation implementation. However, restrictions on the volume of magazine publication do not allow covering all the results obtained in one article. Considering the importance of the grain industry for the economic and food security of the state, let us dwell in more detail on modeling the impact of innovation implementation on the behavior of operating costs indicators of wheat production at the agricultural enterprises of Kharkiv region in 2015 – 2017. In particular, it was found that the dependence function of wheat yield on their variable production costs per 1 ha of its crops is as follows:

$$Y_{01} = -0,33X^2 + 7,98X \, , \tag{1}$$

where Y_{01} is the yield of wheat, ctw. / ha; X is variable production costs per 1 ha of the harvested area, thousand UAH.

Dependence (1) has a high level of statistical reliability (the coefficient of determination (R^2) is 0.9328, the calculated value of Fisher coefficient (F_p) equal to 61.4 is above its table value (F_{table}), equal to 8.5). After that, to determine the optimum cost that maximizes yield, differentiating (1) by variable X, we defined the equation of the first derivative:

$$\frac{dY_1^{'}}{dX} = -0,66X + 7,98\,. \qquad (2)$$

Further, equating the right side of the formula (2) to zero and solving the obtained equation with respect to X, we found out that function (1) reaches its maximum (48.4 ctw. / ha) at variable costs per unit of crops – 12.1 thousand UAH / ha. In the future, based on the assumption that a new hybrid of winter wheat was used, which, all else being equal, guarantees a 20% yield increase in the data set, which is the basis of function (1), the wheat yield in all study objects was increased by the specified interest. This made it possible to determine the equation of the dependence of the increased wheat yield on the actual variable costs per 1 ha at the agricultural enterprises under study of Kharkiv region. It looked like:

$$Y_{11} = -0,39X^2 + 9,58X\,, \qquad (3)$$

where Y_{11} is the yield of wheat, ctw. / ha; *X* is variable production costs per 1 ha of the harvested area, thousand UAH.

By the analogy with function (1), the equation of the first derivative function (3) was determined by the variable X:

$$\frac{dY_{11}^{'}}{dX} = -0,78X + 9,58\,. \qquad (4)$$

Using (4) it is determined that function (3) reaches a maximum (58.0 ctw. / ha) with variable costs per 1 ha of crops equal to (1) 12.1 thousand UAH / ha. Thus, it is confirmed that the replacement of seeds with more yield, without additional costs for its acquisition and the invariability of other elements of technology, causes the increase in yields compared to the traditional technology. At the same time, given the parabolic shape of the production functions being investigated, the yield increase is the largest at the optimum yield cost.

In addition, the trend of reducing the unit cost of production is inversely proportional to the increase in productivity, which is a prerequisite for the formation of competitive advantages of the producer. Given that in market conditions, their availability causes an increase in demand for the resources and technologies that provide them, as well as prices for the latter, in the context of commercialization of scientific developments, the price of next-generation hybrids will be higher than the average level of seed prices.

Considering the fact that with the overhead costs, the average price per tonne of wheat seeds used for sowing by the agricultural enterprises of Kharkiv region in 2015 – 2017 amounted to UAH 4031.74, it was assumed that the price of the sowing unit of a new hybrid provided it increased, for example, by 25% will be 5039.70 UAH (4031.74 x 1.25). Due to this, the data set for forming function (3) was re-adjusted. Thus, variable production costs per 1 ha of its crops were increased by 201.59 UAH / ha. The increase was determined by multiplying the average seeding rate, which, according to typical technological maps, equals 0.2 t / ha (Mazorenko, D.I., Maznyev, H.Ye., Tishchenko, L.M., Boblovs'kyy, O.Yu. & Havrylovych, N.Yu., 2007), by raising the price of UAH 1007.96 / t (5039.70-4031.74). Given the recent adjustments, the dependence of increased wheat yield on increased variable costs per 1 ha of its crops is as follows:

$$Y_{21} = -0,37X^2 + 9,27X \,, \tag{5}$$

where Y_{11} is the yield of wheat, ctw. / ha; X is variable production costs per 1 ha of the harvested area, thousand UAH.

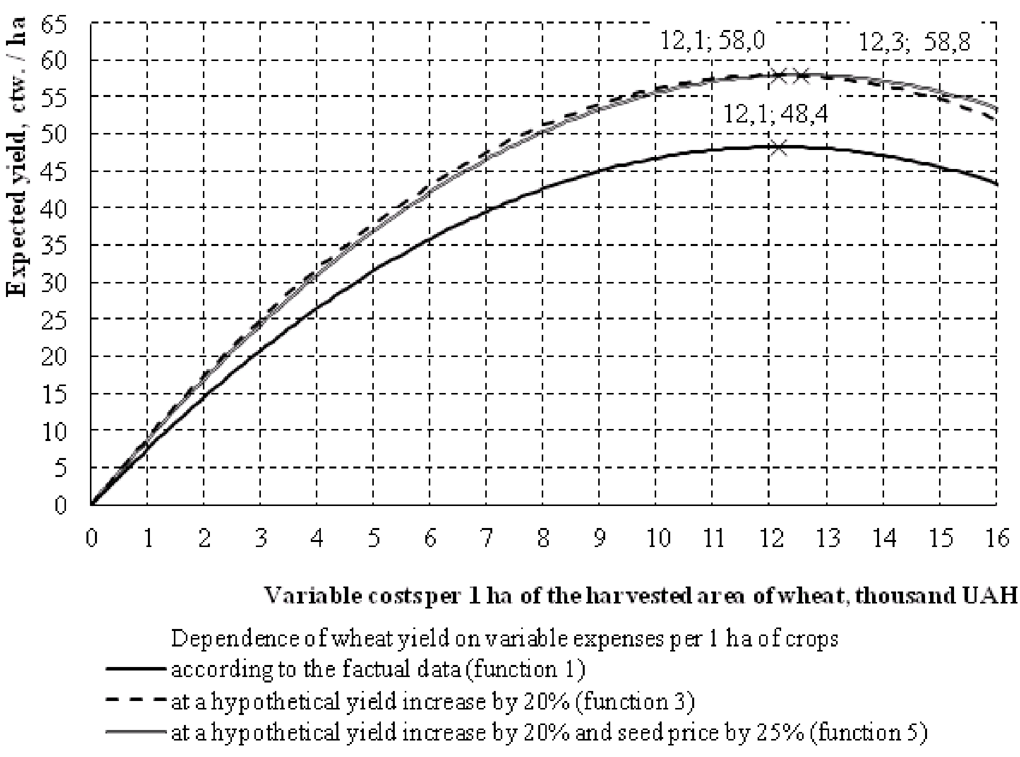
For function (5), as well as for (1) and (3), the equation of its first derivative function for variable X was determined:

$$\frac{dY_{21}^{'}}{dX} = -0,74X + 9,27 \,. \tag{6}$$

This made it possible to establish that function (5) reaches its maximum (58.2 c / ha) at variable costs per unit of crops of 12.6 thousand UAH / ha (Fig. 1).

In this regard, the growth of the expense index with constant resultant causes the shift of the graph of function (5) to the right relative to the graph of function (3), which results in the increase of the yield optimum cost. At the same time, the parabolic form of the production function of the yield is the cause of the nonlinear dynamics of the marginal product. Thus, comparing the results of optimization

Figure 1. Variation of the dependence of wheat yield on variable costs per 1 ha of its crops at different genetic potential and the price of sowing material at the agricultural enterprises of Kharkiv region in 2015 – 2017 (authors' own calculations based on the forms of the statistical reporting f. 50 agriculture at the agricultural enterprises of Kharkiv region for 2015-2017) * The first figure in the footnote for the graph shows the optimal level of variable costs per unit of wheat crop, which maximizes the yield of thousands of UAH / ha; the second is the maximum profit achievable at the technological optimum, ctw. / ha



calculations for functions (1) and (5), showed that against the background of increasing the optimum cost by 0.5 thousand UAH / ha, the maximum possible level of yield is higher by 1.8 kg / ha.

The positive impact of the use of the next generation of seeds on the technological efficiency of the grain industry is one of the many options for agro-innovation processes. For the same purpose, new, balanced but at the same time more expensive mineral fertilizers or herbicides are being developed and put into practice, which at the same time fight against weeds and perennial weeds, although they are more expensive. An even more significant increase in yield and optimum level of intensity should be expected in the case of a combination of the approaches – the use of a new hybrid with complementary mineral fertilizers and remedies.

At the same time, it should be noted that increasing the yield is only a means of ensuring a stable profitability of the entity. Therefore, the measures aimed at increasing the yield correspond to the goals of the agricultural enterprise as much as they contribute to ensuring its profitability. In view of this, using the equation (1), a profit function was formed per 1 ha of wheat crops, which allowed us to determine the cost optima that maximize profit. For this purpose, equation (1) multiplied by the average price of wheat grain sold by the agricultural enterprises under study in 2015 – 2017 – 312 UAH / ctw. and from the obtained expression subtracted variable costs by 1 ha (*X*) and average fixed costs (0.76 thousand. UAH / ha). As a result, the profit function for 1 ha of wheat crops is as follows:

$$Y_{02} = \left(-0,33X^2 + 7,98X\right) \times 0,312 - X - 0,76 = -0,11X^2 + 1,49X - 0,76\,, \tag{7}$$

where Y_{02} is the expected profit, thousand UAH / ha.

It should be noted that the relevance of the profit estimation is based on the assumption that there is a 100% marketability of the gross grain harvest of wheat.

The next step was to differentiate function (7) by variable X, which allowed us to determine the equation of its first derivative:

$$\frac{dY_{02}}{dX} = -0,21X + 1,49\,. \tag{8}$$

This made it possible to determine that function (7) reaches a maximum profit - 4.7 thousand UAH / ha at specific cost of 7.3 thousand UAH / ha. At the same time, the value of the optimum variable cost per 1 ha of crops, which maximize profit, was comparatively lower than its counterpart for yield.

It should be noted that in most cases the optimum values are purely indicative, as evidenced by the analysis of statistics of the agricultural enterprises in Kharkiv region. In particular, in the period under review, almost two-thirds of the agricultural enterprises in Kharkiv region exceeded the optimal cost levels, which ensure that the maximum level of profit is reached, which causes it to be lower than its expected value. In this case, their actual cost levels in most cases did not exceed the optimum value, which ensured the maximum level of yield (Oliynyk, O.V., Makohon, V.V. & Brik, S.V., 2019).

Returning to the results of the study, we note that in the future using the algorithm used for function (1) of equations (3) and (5) was transformed into a function of profit per 1 ha of wheat crops, which allowed us to determine the cost optima that maximize profit taking into account the assumptions made changes in costs and output due to the use of a new winter wheat hybrid. So, two profit functions are obtained, the first of which reflects its dependence on variable costs per unit of crop, provided that only yields are increased:

$$Y_{12} = \left(-0,39X^2 + 9,58X\right) \times 0,312 - X - 0,76 = -0,12X^2 + 1,99X - 0,76\,, \tag{9}$$

where Y_{12} is the expected profit, thousand UAH / ha.

Instead, the second, which characterizes its dependence on variable costs per unit of wheat crop, while increasing its yield and price of seeds is characterized by the equation:

$$Y_{22} = \left(-0,37X^2 + 9,27X\right) \times 0,312 - X - 0,76 = -0,12X^2 + 1,89X - 0,76, \qquad (10)$$

where Y_{22} is the expected profit, thousand UAH / ha.

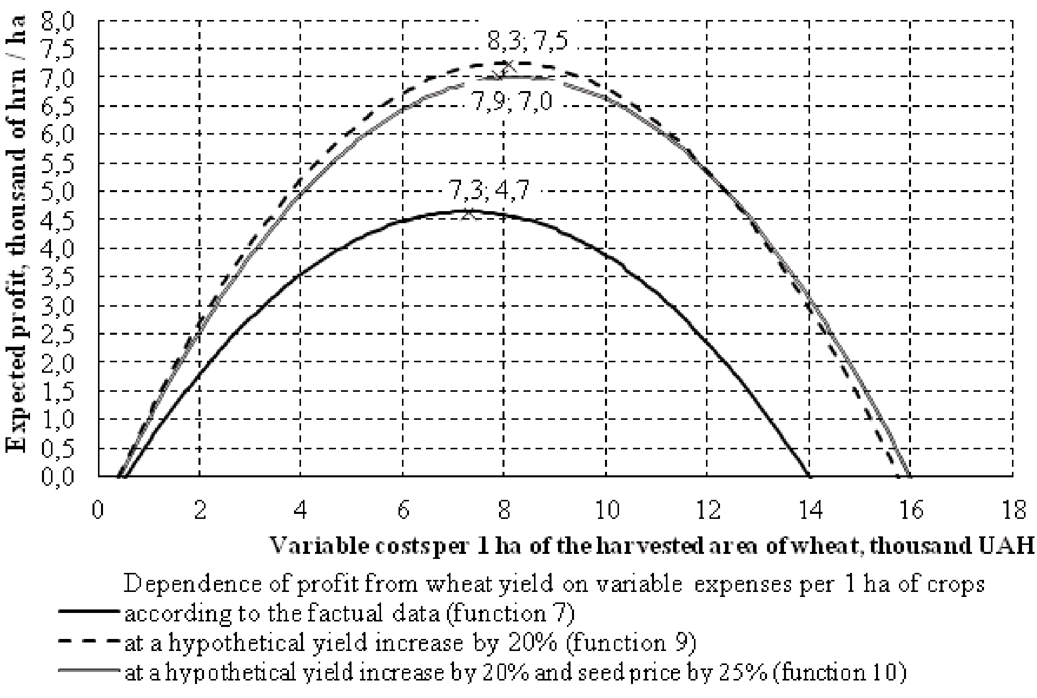
After that, functions (9) and (10) were differentiated by variable X, which allowed us to determine the equations of their first derivatives:

$$\frac{dY_{12}}{dX} = -0,24X + 1,9, \qquad (11)$$

$$\frac{dY_{22}}{dX} = -0,24X + 1,89. \qquad (12)$$

This made it possible to determine that function (9) reaches its maximum at a specific cost of 8.1 thousand UAH / ha, and the maximum possible yield of profit per 1 hectare of the harvested area will be equal to 7.3 thousand UAH / ha. Instead, function (10) reaches its maximum at a specific cost of 8.2 thousand UAH / ha, and maximum possible yield per 1 ha of the harvested area will be equal to 7.0 thousand UAH / ha (Fig. 2).

Figure 2. Dependence of the profit output on the sale of wheat grain from variable costs per 1 ha of its crops at different genetic potential and the price of seed at the agricultural enterprises of Kharkiv region in 2015 – 2017 (authors' own calculations based on the forms of the statistical reporting f. 50 agriculture at the agricultural enterprises of Kharkiv region for 2015 – 2017) * The first figure in the footnote for the graph shows the optimal level of variable costs per unit of wheat crop, which maximizes the yield of thousands of UAH / ha; the second is the maximum profit achievable at the technological optimum, cwt. / ha



It is clear that the obtained estimates of the economic optimum and maximum profit in practice will be somewhat lower, as one can expect an increase in unit costs, especially on the farms with high levels of agricultural technology, due to the increase in the costs of fuel and lubricants for harvesting at higher yields, increase in labor costs as well as transportation, drying and storage of grain. But since the modeling of yields on different farms is different, which causes the variation of fixed costs in them, using the average in its profit equals largely offset the impact of this increase in specific costs, without complicating the analytical form of the profit equation for the further analysis.

Thus, modeling the behavior of the production function of the profit from the sale of wheat in case of use of a new hybrid, without additional costs for its purchase, showed the scaling of the profit graph relative to the old technology. At the same time, the largest increase in profit (by 2.6 thousand UAH / ha) will be at the economic optimum cost. At the same time, with an increase in the price of wheat seeds, the optimum cost, which maximizes profit, is shifted to the right by 0.8 thousand UAH / ha.

At the same time, productivity growth, as well as the increase in the price of products, leads to a right-wing shift in the cost optimum, this guarantees maximizing profit and bringing it closer to the technological optimum. Thus, a comparison of their values for functions (1) and (9), which characterize the dependence of yield and profit on variable costs per unit of crops according to the actual data, shows that the difference between them was 4.9 thousand UAH / ha. Instead, the discrepancy between the values of technological and economic cost optimums for functions (3) and (9), which characterize the dependence on yield and profit according to the yield-adjusted data, but without an increase in the specific costs, was 4.1 thousand UAH / ha. In this regard, the latter occurred against the background of the economic optimum approaching the technological one, without changing the absolute value of the latter.

At the same time, modeling the behavior of the production function of profit (10), based on the assumption of replacement of the previously used hybrid with more yield and increase in unit costs, in proportion to the increase in seed prices, showed a shift of its graph to the right relative to the graph for function (9). At the same time, if the value of the economic optimum of expenses increased by 0.1 thousand UAH / ha, then the maximum possible value of profit on the contrary decreased by 0.3 thousand UAH / ha.

Based on this, it can be argued that in case of a rise in the price of wheat seeds is acceptable not by 25%, but 1.5-2 times it is quite possible against the background of further increase in technological efficiency, reducing the maximum expected level of profit below the level determined by the actual data. Thus, provided that if the price for the introduced hybrid seed is higher than the base level twice the technological and economic cost optimisers will increase in accordance with 14.0 and 8.7 thousand UAH / ha. In this case, the maximum possible level of yield will increase by only 0.8 ctw. / ha, and the maximum profit will decrease to the level of 6.3 thousand UAH / ha, i.e. by 0.7 thousand UAH / ha. Therefore, against the backdrop of a clear increase in technological efficiency of production under the influence of innovation, the profitability vector does not have a clear direction. Thus, if the profit of the enterprise reaches its maximum value as soon as it is included in the technology of the innovative product (solution) obtained on a free basis, then its value begins to gradually decrease in proportion to the growth of specific costs caused by the influence of the market situation, which causes the price increase to the resources that are the basis of innovation.

A common innovative solution is to streamline the consumption of production resources, which leads to cost savings for individual items. Within this variant the gradation is possible from full independence of the yield from the magnitude of the savings to a small or even very tangible for the agricultural enterprise. In particular, it is acceptable that as a result of the introduction of the energy-saving regime an agricultural enterprise managed to reduce the variable production costs by 20% from the previous level. Modeling of this situation involves reducing the corresponding cost indices in the data set by 20%. Consequently, using the modified data set described above, it was determined that the equation of the dependence of wheat yield on variable costs per 1 ha of its crops in the studied agricultural enterprises of Kharkiv region has the form:

$$Y_{41} = -0,51X^2 + 9,97X \text{ ,} \tag{13}$$

where Y_{41} is wheat yield, cwt. / ha; X is variable production costs per 1 ha of the harvested area, thousand UAH.

By analogy with function (1), it was determined that the equation of the first derivative function (13) for variable X is as follows:

$$\frac{dY_{41}^{'}}{dX} = -1,02X + 9,97 \text{ .} \tag{14}$$

Considering the result obtained by differentiation of function (13), the result is that it reaches its maximum (48.4 ctw. / ha) at variable costs per 1 ha of crops 9.7 thousand UAH. So, against the backdrop of a constant maximum yield, the maximum cost that guarantees it is lower by UAH 2.4 thousand or 25%.

In the future, the equation (13) was transformed into a profit function per 1 ha of wheat crops, which allowed us to determine the cost optimizer that maximizes profit while reducing the variable costs per unit of crop:

$$Y_{42} = \left(-0,51X^2 + 9,97X\right) \times 0,312 - X - 0,76 = -0,16X^2 + 2,11X - 0,76 \text{ ,} \tag{15}$$

where Y_{42} is the expected profit, thousand UAH / ha.

Having defined for function (15) its first derivative of variable X, which has the form:

$$\frac{dY_{42}}{dX} = -0,32X + 2,11, \tag{16}$$

we have found that it reaches its maximum at a specific cost of 6.6 thousand UAH / ha, and the maximum possible yield per 1 ha of the harvested area will be equal to 6.2 thousand UAH / ha. Thus, the introduced energy saving measures allowed increasing the maximum profit level by UAH 1.5 thousand or by 33.3%. At the same time, the value of the cost optimal that provides it was lower, compared with the level calculated on the actual data, by 0.7 thousand UAH or by 9.3%. Therefore, it should be noted that the left-hand shift of both the yield schedule and profit is influenced by the introduction of organizational and economic innovations. At the same time, against the background of the constant maximum yield level, the maximum profit increases by a percentage which is higher than the relative cost savings.

The analysis of the practice shows that in many cases not only technical and technological innovations, but also their combinations with innovations of organizational and economic nature have a significant impact on the profitability of the agricultural enterprise. In turn, the most important are the transformation of marketing policies, in particular the entry of the manufacturer into the foreign market, or the contracting of products through the conclusion of forward agreements with the State Food and Grain Corporation of Ukraine (SFGCU). This allows to rise, or at least in advance, even before the start of the technological cycle to have a price below which a farm will not sell its products.

The analysis of the method of forming the functions of yield and profit shows that the change in price affects only the second of them. That is, if the improvement of marketing policy provides an increase in the selling price for 50 UAH / ctw. wheat grain by a farm compared to the basic one, then forming the profit function of equation (1) should be multiplied not by the average selling price, but by its increased value:

$$Y_{52} = \left(-0,33X^2 + 7,98X\right) \times 0,362 - X - 0,76 = -0,12X^2 + 1,89X - 0,76\,, \qquad (17)$$

where Y_{02} is the expected profit, thousand UAH / ha;

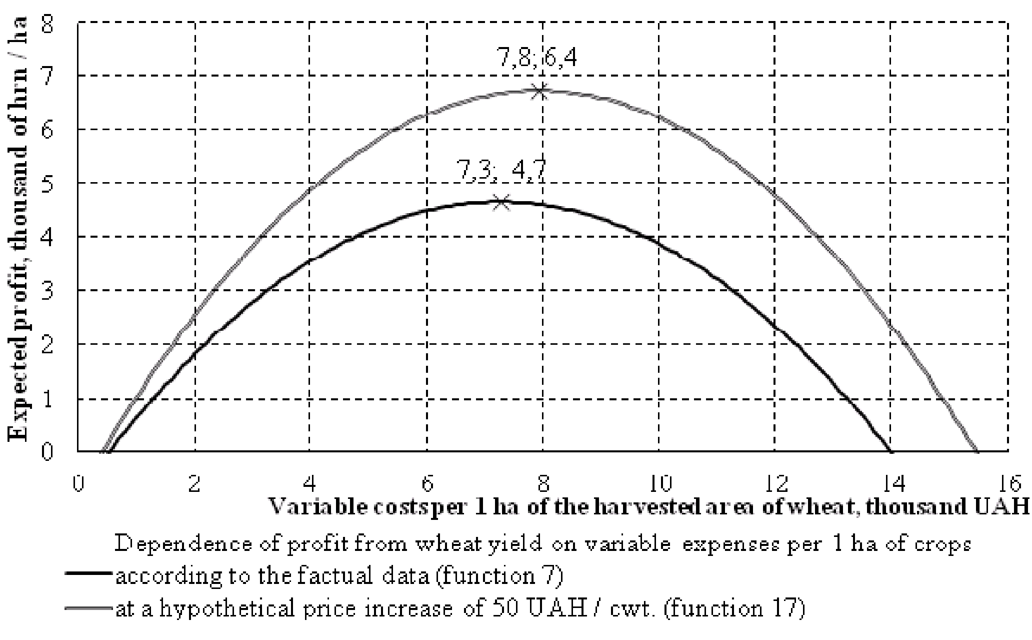
Having defined the equation of the first derivative of function (17) by the variable X, which has the form:

$$\frac{dY_{52}^{'}}{dX} = -0,24X + 1,89\,, \qquad (18)$$

it was established: this function reaches its maximum (6.2 thousand UAH / ha) at variable costs per 1 ha of crops – 6.7 thousand UAH (Fig. 3).

Thus, the introduction of marketing innovations that help increase the cost of sales significantly increases both the maximum expected profit and the optimal cost that guarantees it. However, if the deviation of the cost optimum, which maximizes profit from its analogue for yield, was 40.1% when calculated from actual data, then this gap was reduced to 34.6% taking into account the results obtained in the simulation using function (17). This, in turn, enhances the ability of the agricultural enterprise to innovate, which will enhance both yield and grain quality.

Figure 3. Dependence of the profit output from the sale of wheat grain from variable costs per 1 ha of its crops at different selling prices by the agricultural enterprises in Kharkiv region in 2015 – 2017 (authors' own calculations based on the forms of statistical reporting f. 50 agriculture at the agricultural enterprises of Kharkiv region for 2015-2017) * The first figure in the footnote to the graph shows the optimal level of variable costs per unit of wheat crop, which maximizes the yield of thousand UAH / ha; the second is the maximum profit achievable at the economic optimum, thousand UAH / ha



CONCLUSION

The deepening of the innovative processes in the agricultural sector leads to the search for objective approaches to assess their impact on the performance indicators of production of certain types of agricultural products. In particular, it was found that the introduction of technical and technological innovations should contribute to the achievement of a positive technological effect, in particular their effect causes an increase in both the yield (technological) cost optimal and the extremum of the yield function. At the same time, the impact of these innovations on the profit function is twofold. In particular, in case of free receipt of an innovative product, all the output gain obtained, estimated at market prices, generates an increase in the extremum of the profit function while increasing the cost optimum at which it is achievable. That is why the latter is approaching the technological optimum. In turn, paying for innovation has a significant impact on the profit curve, reducing both the value of the cost optimum and the extremum of the function. However, a significant increase in the value of an innovative product can lead to a decrease in profit below the previously reached level, which makes the introduction of an innovative product inappropriate. In turn, the innovations of organizational and economic nature increase the efficiency of technical and technological ones. Marketing innovations help to bring economic and technological cost optics closer together, which extends the opportunity to attract more valuable technological innovations without the risk of a negative financial result. A promising direction for further research is to substantiate approaches to modeling the impact of innovation on agricultural production efficiency, taking into account the sources and forms of financing operating costs.

ACKNOWLEDGEMENTS

The authors of this publication declare there is no conflict of interest.

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors. Funding for this research was covered by the authors of the article.

The study was conducted at the Faculty of Accounting and Finance of Kharkiv National University named after Vasily Dokuchaev. The authors are grateful to the Rectorate and the management of the Faculty of Accounting and Finance for their support.

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