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PROFIT SENSITIVITY ANALYSIS IN AGRICULTURE BASED ON EFFECTS MEASUREMENT

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Abstract

The article addresses methodological issues aimed at estimating the sensitivity of profit under the influence of changes in yield per hectare and reduction of unit costs. As a result of the calculations, three areas of profit elasticity were delimited: moderate, increased, high. The area of moderate elasticity located in the range of yield of 30-31q/ha is characterized by the increase of yield by one quintal which ensures the highest increase of profit 6.44 lei per unit of product. In the areas of increased elasticity (40-41 q/ha) and high elasticity (50-51 q/ha) the increase of the corn yield contributes to the increase of the respective unit profit by 3.65 and 2.35 lei. The research allowed us to determine the minimum amount of profit. It was found out that in agricultural enterprises the actual amount of profit for wheat and corn is less than the minimum amount, which does not allow the achievement of simple reproduction.

***Key words*:** *agricultural production, effect, profit, profitability threshold*

INTRODUCTION

The pursuit of a profitable business involves the achievement of sufficient profit to cover expenses, debt repayment and technological reinvestment for business development. Like any economic phenomenon, profit can be studied from a dynamic, structural and factorial point of view, so as to ensure the coherent certainty of these aspects of analysis.
The analysis of profit sensitivity to the variation of the costs and of the activity level foresees the application of the profitability threshold method which is also known as "critical point", "dead point". This method makes it possible to establish the conditions necessary to achieve microeconomic balance, as it highlights the level of activity at which the company must be located in order not to work at a loss [7].
In this context, the purpose of the paper is the determination of profit elasticity in accordance with agricultural crops yield.

MATERIALS AND METHODS

The profitability threshold and the conditions of microeconomic equilibrium depend on the branch specifics of the analyzed enterprises [5]. In this context, the analysis methodology based on the indicators specific to the branch aspect of the agricultural enterprises allows the estimation of the profit sensitivity under the influence of the yield per hectare and the reduction of the unit cost. The research has shown that fluctuations in profit from the sale of agricultural products depend on changes in the volume of sold products (Q), the average selling price per unit of product (P), unit cost (C), based on the following formula of factorial dependence [2]:

$$B = Q \times (P - C) \qquad (1)$$

According to the formula, we can mention that the company cannot influence the prices of the agricultural products it sells, nor the prices of the materials does it buy (fertilizers, seeds, pesticides, petroleum products, etc.). Therefore, the only variable on which the agricultural enterprise can act is the average production (yield) per hectare, the increase of which can allow increasing the sales volume and reducing the unit cost [1]. In our opinion, the average production per hectare corresponding to the profitability threshold

(q_{min}) must be determined according to the formula [10]:

$$q_{min} = \frac{CFh}{P - CVp} \quad (2)$$

where:
CF_h – constant costs calculated per hectare, lei;
P - average selling price per unit of product;
CV_p - variable costs per unit of product (Lei).
Thus, from formula 2 we can observe that the formative element of the profitability threshold is the division of production costs into variable and constant [6].
Depending on this aspect, we propose the calculation of the cost per unit of agricultural product according to the formula [9]:

$$C = CV_p + \frac{CF_h}{q} \quad (3)$$

where:
q – yield (average productivity) per hectare, quintals.
The information base of the investigation constituted the following selected sources from agricultural enterprises in the Central Region of the Republic of Moldova:
- Annual statistical survey 21-Sale "Sale of agricultural production";
- Register of cost records by types of agricultural products.
It is known that the profit per unit of product expresses the difference between the average selling price (P) and the unit cost (C). Substituting C according to formula 3 we obtain the calculation ratio of the profit to 1q of product (Bp).

$$B_p = P - C = P - (CV_p + \frac{CF_h}{q}) \quad (4)$$

Thus, the profit per hectare of productive area (Bh) will be calculated according to the formula:

$$B_h = q \times (P - CV_p) - CF_h \quad (5)$$

Change in profit per hectare under the influence of yield increase (ΔB_h^q) and the reduction of the unit cost (ΔB_h^c) are traditionally determined by the relationships:

$$\Delta B_h^q = (q_1 - q_0) \times (P_0 - C_0) \quad (6)$$

$$\Delta B_h^c = -(C_1 - C_0) \times q_1 \quad (7)$$

The works of the local scientists D. Parmacli, A. Stratan showed that in order to ensure extended reproduction in agriculture the increase in profit under the influence of increasing yield per hectare must exceed or be equal to the increase in profit under the influence of the unit cost reduction, inequality $\Delta Bq \geq \Delta Bc$ would be preferred [3].
If the profit increases equally under the influence of both factors the expression $\Delta Bq = \Delta Bc$ can be presented:

$$(q_1 - q_0) \times (P_0 - C_0) = -(C_1 - C_0) \times q_1 \quad (8)$$

Substituting the unit cost (C) according to formula 3 we obtain:

$$(q_1 - q_0) \times \left[P_0 - \left(CV_{p(0)} + \frac{CF_h}{q}(0)\right)\right] = -\left[\left(CV_{p(1)} + \frac{CF_h}{q}(1)\right) - \left(CV_{p(0)} + \frac{CF_h}{q}(0)\right)\right] \times q_1 \quad (9)$$

Thus, we can conclude that for a certain level of activity the profit under the influence of the increase of the yield per hectare is equal to its size obtained under the influence of the unit cost reduction [8].
At the same time, we would like to mention that the experience of many agricultural enterprises has shown that only at the expense of improving the technologies of cultivation and harvesting of agricultural crops without additional costs it is possible to increase the yield and profit, respectively.
In this case the change in profit as a result of the increase in yield per hectare (ΔB_p^q) is proposed to be calculated by dividing $Bp_{(0)}$ and B_p'.
Thus, we obtain:

$$\Delta B_p^q = B_p' - B_{p(0)} = \left[P_0 - CV_{p(0)} - \frac{CF_{h(0)}}{q'}\right] - \left[P_0 - CV_{p(0)} - \frac{CF_h}{q}(0)\right] = CF_h\left(\frac{1}{q_0} - \frac{1}{q'}\right) =$$

$$= \frac{CF_h}{q_0^2+q'} = \frac{CF_h}{[q_0^2+(q_0+1)]} \quad (10)$$

where:
q' – the yield obtained as a result of the improvement of cultivation technologies or q '= q_0 + 1, which attests to the increase of the yield by one unit compared to the base period;
B'_p – profit obtained as a result of the increase in yield per hectare q '.

RESULTS AND DISCUSSIONS

Based on formula 10 we will calculate the profit increase per 1q of corn as a result of increasing the yield per hectare by 1q if it is known that on average on the totality selected by enterprises the constant costs per hectare constituted 5,997.8 lei.
Thus, at the level of yield 30-31 q/ha, the profit per 1 q will increase by 6.44 lei.

$$\Delta B_p = \frac{5,997.8}{30^2+30} = +6.44 \text{ lei}$$

At the level of yield 40-41 q/ha, the profit increase will be 3.65 lei.

$$\Delta B_p = \frac{5,997.8}{40^2+40} = +3.65\ lei$$

In the case of the yield of 50-51 q / ha, the profit per 1 q will increase by 2.35 lei.

$$\Delta B_p = \frac{5,997.8}{50^2+50} = +2.35\ lei$$

Following these calculations, we delimited three areas of profit elasticity per a quintal of corn: moderate, increased, high. The area of moderate elasticity located in the range of yield of 30-31 q/ha is characterized by the fact that the increase of average production per hectare by one quintal (1q) ensures the highest increase in profit by 6.44 lei. In the areas of increased elasticity (40-41 q/ha) and high elasticity (50-51 q/ha) the increase of the yield per 1 q contributes to the increase of the respective unit profit by 3.65 lei and 2.35 lei.
The investigations of the authors Parmacli D. and Tcaci N., demonstrated the multiplicative effect of crop yield on profit change. Simultaneously with the direct influence of yield on profit, its increase also contributes to the reduction of unit cost. These authors identified that the increase in profit due to the reduction of unit cost may outpace the increase in profit obtained from the increase in sales volume and productivity per hectare [4].
In arguing these results we performed the calculations according to the proposed method (formulas 3-7), where we determined the profit increase under the action of increasing the yield - direct effect and reducing the unit cost - complementary effect.
On average for the years 2015-2017 in the studied agricultural enterprises, the cost of 1q of wheat was:

$$C_0 = \frac{1,976.83}{34.05} + 118.09 = 176.15\ lei$$

The increase of the yield by 3.2%, i.e. up to 35.15 q / ha will lead to the decrease of the cost from 176.15 to 174.33 lei:

$$C_1 = \frac{1,976,83}{35,15} + 118,09 = 174.33\ lei$$

The profit calculated per hectare in the basic period and after the increase of the yield will constitute:

Bh(0) = 34.05 (224.35 – 118.09) – 1,976.83 = 1,641.32 lei

Bh(1) = 35.15 (224.35 – 118.09) – 1,976.83 = 1,758.21 lei

Thus, ΔBh = +116.89 lei.

We would like to mention that the increase of the efficiency also contributes to the reduction of the unit cost. This implies the need to know the share of the increase in yield (ΔB^q) and the reduction of the unit cost (ΔB^c) when changing the profit.
Therefore, the increase of yield from 34.05 to 35.15 q will contribute to the increase of profit per hectare by 53.02 lei:

$\Delta B^q = (q_1 - q_0) \times (P_0 - C_0)$ = (35.15 – 34.05)×(224.35 – 176.15) = +53.02 lei.

Due to the reduction of the unit cost from 177.15 lei to 174.33 lei, the profit per hectare increased by 63.87 lei:

$\Delta B^c = q_1 \times [-(C_1 - C_0)]$ = 35.15× [-(174.33 – 176.15)] = +63.87 lei.

From the performed calculations, it results that due to the increase of productivity per hectare, i.e. the direct effect, the profit per hectare increased by 53.02 lei or by 45.4%.

The reduction of the unit cost - of the complementary effect- conditioned the profit increase by 63.87 lei or by 54.6%. These data confirm the results of the investigations of the nominated authors, as well as the fact that the complementary effect occupies a larger share in increasing the profit compared to the direct effect.

In Table 1 we present the contribution of the direct and complementary effects at different levels of yield.

Table 1. Change in profit under the influence of yield and unit cost of wheat production in agricultural enterprises in the Central region on average 2015-2017

Yield, q/ha	Cost 1q, lei	Profit (loss) in calculation:		Profit change, ±				
		per 1 ha, lei	per 1q, lei	In calculation per ha – total, lei	including under the influence of			
					yield increase		unit cost reduction	
					lei/ha	share,%	lei/ha	share,%
5	513.46	-1,445.55	-289.11	-	-	-	-	-
10	315.77	-914.2	-91.42	1,519.8	-457.1	-30.08	+1976.9	+130.08
15	249.88	-382.95	-25.53	860.7	-127.65	-14.83	+988.35	+114.83
20	216.93	+148.4	+7.42	696.1	+37.1	+5.33	+659.0	+94.67
25	197.16	+679.75	+27.19	630.2	+135.95	+21.57	+494.25	+78.43
30	183.98	+1,211.1	+40.37	597.25	+201.85	+33.8	+395.4	+66.2
35	174.57	+1,742.3	+49.78	578.25	+248.9	+43.04	+329.35	+56.96
40	167.51	+2,273.6	+56.84	566.6	+284.2	+50.16	+282.4	+49.84
45	162.02	+2,804.85	+62.33	558.7	+311.65	+55.78	+247.05	+44.22
50	157.63	+3,336.0	+66.72	553.1	+333.6	+60.31	+219.5	+39.69

Source: Authors' calculation.

From the calculations performed in Table 1 we found out that in the range of yield from 5 to 15q/ha the agricultural enterprises bear losses per hectare in the amount of 382.95 - 1,445.55 lei. Wheat production is profitable when the yield per hectare reaches only 20q. Increasing the yield from 25q/ha to 50q/ha, ensures the increase of the profit per hectare more than 3.9 times. But the highest level of profitability is found when the yield is in the range of 40-50 q/ha. At this level, the rate of wheat profitability varies from 33.93% to 42.33%. When wheat production reaches 40q/ha, the equality between the share of direct effect (50.16%) and of the complementary effect (49.84%) occurs. The increase of the yield over 40q / ha leads to the increase of the share of the direct effect (55.78% - 60.31%) in the profit formation.

The data in Fig. 1 state the fact that below the productivity level of 40q/ha the predominant share in profit formation belongs to the complementary effect which varies from 57% to 94.7%. These data confirm that the complementary effect occupies a higher share in the profit increase, which attests that its influence can be much stronger in relation to the direct effect.

The effect structure in profit formation is presented in Figure 1.

From the graphic presentation (Fig. 1) we can deduce that the increase of yield per hectare from 20 to 50q conditions the reduction of the unit cost by 59.3 lei and respectively the reduction of the complementary effect's share in profit formation per 1 hectare by almost 55 percentage points.

Our calculations show that in agricultural enterprises from the Central region of the Republic of Moldova more than 75% of gross profit is obtained from the sale of cereals and sunflower. In this context, it is necessary to determine the amount of the minimum profit calculated per one hectare that allows simple and extended reproduction.

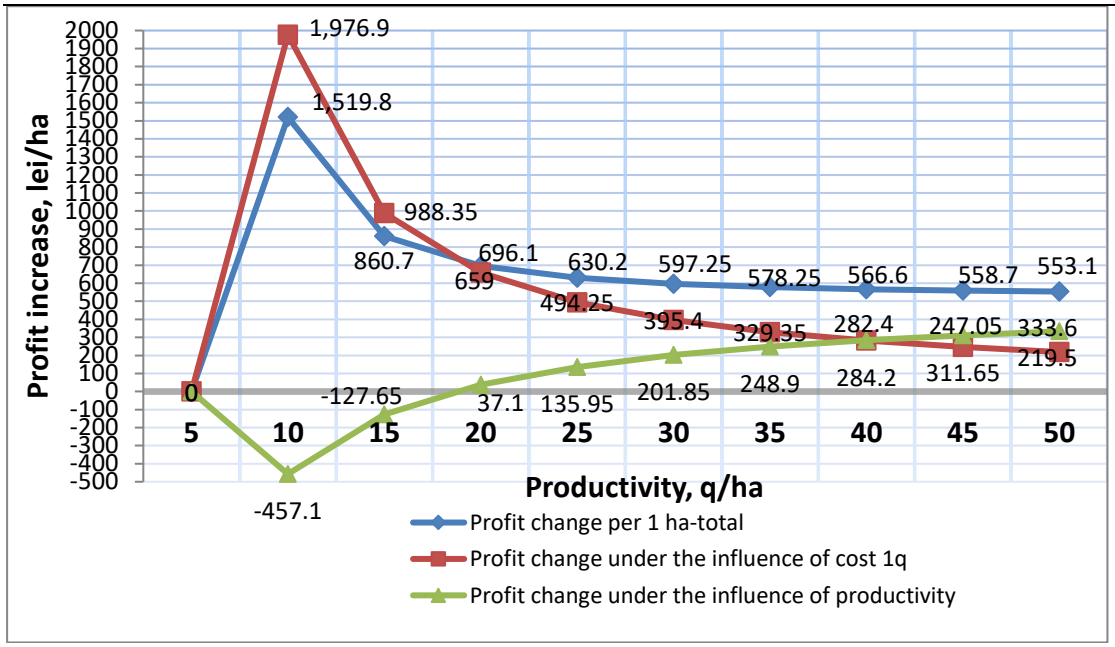

Fig. 1. Profit change per 1 hectare of wheat under the influence of direct and complementary effects on average 2015-2017
Source: Elaborated based on the data from Table 1.

Our investigations have shown that the minimum level of profitability of crop production in order to ensure simple reproduction in agricultural enterprises of the Central region is 19.0–23.0%, and for extended reproduction - 30.0-33.0% [10]. We used these figures as a basis in determining the amount of the minimum profit from the sale of certain products per hectare appling formula:

$$B_{h(min)} = R \times \frac{CP}{S} \quad (11)$$

where:
R - rate of return, coefficient;
CP – production costs;
S – area, ha.
Applying formula 11 we calculated the minimum amount of profit per hectare in the profile of agricultural crops (Table 2).

Table 2. Determination of the minimum profit quantum per hectare of productive area in the profile of agricultural crops in the enterprises of the Centeal region

Crop	Actual profit, lei/ha		The minimum profit quantum calculated per hectare (lei) aiming at the insurance of				Financial security reserve in 2016-2017, ±%	
			simple reproduction		*extended reproduction*			
	on average 2014-2015	*on average 2016-2017*	*on average 2014-2015*	*on average 2016-2017*	*on average 2014-2015*	*on average 2016-2017*	to ensure simple reproduction	to ensure extended reproduction
Wheat	1,562.04	2,608.46	1,178.5	2,955.5	1,537.15	3,855.0	-13.3	-47.79
Barley	1,058.68	1,374.13	896.7	912.5	1,169.65	1,190.24	+33.6	+13.38
Corn	1,291.77	979.47	1,793.1	1,831.9	2,338.82	2,389.46	-87.03	-143.95
Sunflower	3,516.41	3,726.67	1,395.7	1,600.1	1,820.52	2,087.1	+57.06	+44.00
On average	**2,169.25**	**2,694.09**	**1,335.08**	**2,122.76**	**1,741.41**	**2,768.82**	**+21.21**	**-2.77**

Source: Authors' calculation.

From the calculations made in Table 2 it follows that in the reference periods sufficient profit was obtained for simple and extended reproduction only for barley and sunflower. On the average 2016-2017, the actual amount of profit from the sale of sunflower exceeded the minimum amount by 57.06 and 44.00%. This overrun resulted in sufficient profitability to ensure simple reproduction on average across all crops. In this situation, the minimum amount was exceeded by 21.21%.
At the same time, from the data presented in Table 2 we find out that the actual profit obtained from the sale of wheat and corn is not sufficient even for simple reproduction. On the average 2016-2017, less profit was

obtained than the minimum quantum for simple reproduction of wheat by 347.04 lei/ha or by 11.74%. An aggravating situation is found in corn, where the insufficiency of profit for simple reproduction is 87.03%, and extended reproduction - almost 144%. The calculations show us that in order to reach the rate of return of 20-23%, the agricultural enterprises in the Central region must obtain a profit per 1 hectare of area sown with wheat and corn of not less than 2,955.5 lei and 1,831.9 lei respectively. It is obvious that these results can be obtained if agricultural enterprises with their own efforts but also with the support of the state will ensure the increase of yields per hectare.

CONCLUSIONS

The development of the profitable activity in the agricultural enterprises implies the quantification of the profit sensitivity to the variation of the yields per hectare and to the unit costs through the prism of the profitability threshold. The application of this method of analysis allowed the identification of the link between the level of activity, variable costs, constant costs and profit from the sale of agricultural products. Three areas of profit elasticity were delimited: moderate, increased, high. The highest level of the unit profit increase (6.44 lei) is provided by the moderate area with the lowest yield (30-31 q/ha). In the area of high elasticity (50-51 q/ha) the increase of the yield by a quintal contributes to the profit increase only by 2.35 lei or 1.74 times less than in the moderate area. The minimum amount of profit per hectare of productive area was determined. It was found out that the minimum profit amount was exceeded only for barley and sunflower. For wheat and corn, the minimum profit amount has not been reached, which does not allow agricultural enterprises to perform even simple reproduction.

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