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## Effects of average production and price risk on gross margin for cereal products obtained in conventionally and organic farming

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# EFFECTS OF AVERAGE PRODUCTION AND PRICE RISK ON GROSS MARGIN FOR CEREAL PRODUCTS OBTAINED CONVENTIONALLY AND IN ORGANIC FARMING

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**Abstract:** *The study aims to present from a technical-economic point of view aspects related to the cost behaviour, according to the cost-volume-profit analysis model and the sensitivity analysis, of cereal products (maize and wheat) grown in conventional and organic farming systems. In Romania, according to EUROSTAT statistical data, in the period 2014-202, the production harvested with wheat was increasing, on average by 823 thousand t/year, compared to organic wheat, which decreased, on average by 3.3861 thousand t/year. Maize production harvested increased, on average, by 2771.3 thousand t/year, as production yield increased by 1.184 t/ha, while organic maize production decreased by 12.413 thousand t/year. Production costs vary according to planned production levels, with differences being determined by agro-technical conditions (irrigated/non-irrigated). Estimated profit for 2022 are €86/ha for non-irrigated wheat and €171/ha for irrigated wheat, and €91/ha (non-irrigated) and €161/ha (irrigated) for organic wheat. For maize, the estimated gross profit is 94 euro/ha for non-irrigated and 225 euro/ha for irrigated, and for organic maize the gross profit to be obtained is 125 euro/ha for non-irrigated and 181 euro/ha for irrigated. However, in the context of the 2021/2022 production year the effects of all factors (political conflict in Ukraine, grain market, price volatility, inflation, production costs and growing conditions - climate conditions, soil, pedological drought, a etc.) complete the economic risk profile for the studied cereals.*

**Keywords:** *cost-volume-profit analysis, sensitivity analysis, price volatility, wheat, maize*

**JEL classification:** O12, P50, Q18, Q57

## INTRODUCTION

Maize is the world's most widely grown cereal after wheat, and global trade in wheat is greater than all other crops combined. In 2020, global wheat production was 760 million tonnes. China, India and Russia are the world's largest individual wheat producers, accounting for about 41% of the world's total wheat production, followed by the United States which is the world's fourth largest individual wheat producer, and the European Union, if considered as a single country, its wheat production would exceed that of any country except China. (Wheat Production by Country, 2022). Romania accounts for 10% of the European Union's cereal and oilseed production. In Romania, maize is the main crop grown both in terms of area and production, followed by wheat and barley (Romania - Country Commercial Guide, 2022).

Why wheat and maize? The main objective of food security is to produce cereals worldwide to meet the growing demand for food, feed and biofuels. Global agricultural markets face new uncertainties, which on the supply side include regulatory responses to new plant breeding techniques and responses to the increasing likelihood of extreme events. (Patrick Kelly, 2019).

In the EU the cereals sector faces both structural challenges related to the reform of the Common Agricultural Policy - post 2020, and financial and climate challenges.

Russia's invasion of Ukraine has significantly disrupted world agricultural markets, creating more uncertainty about the future availability of cereals and oilseeds, as well as the EU's dependence on feed and fertiliser imports from Ukraine, Russia and Belarus. The EU's concerns relate to the

affordability of these products due to high market prices and inflationary trends. (European Commission, 2022).

## MATERIAL AND METHOD

In the present study we present issues related to the variability of gross margin generated by the increase/decrease of recovery prices and production yield, while variable costs remain constant. In the analysis model, fixed costs were also considered to see if the change in gross margin is large enough to cover them in order to make a profit. The input indicators in the cost-volume-profit analysis and the sensitivity analysis are: variable costs and fixed costs (based on the 2021-2022 production year, in phase 3 of Sectoral Project A.D.E.R. 23.1.1) for wheat and maize products, produced under conventional and organic farming, break-even point or breakeven point, prices and estimated revenues. Cost-volume-profit analysis, also called break-even analysis, is a way of determining how changes in costs (fixed and variable) and production volume affect the profit achieved. The analysis is very useful for assessing the relationship between production volume, production costs and profit (Letitia Zahiu et al., 1999).

Formula for calculating the break-even point:

$$PR = \frac{CF}{MCV(\%)}$$

where:

PR= break-even point is that level of production activity from which profit starts to be made

CF= fixed costs

MCV= variable cost margin = revenue - total variable costs

For a crop to be profitable, the variable cost margin must exceed total fixed costs.

The unit variable cost margin is calculated as the difference between the unit selling price and the unit variable cost. The contribution margin ratio is determined by dividing the contribution margin by the total revenue.

## RESULTS AND DISCUSSIONS

From a statistical point of view, conventional wheat shows increases both in cultivated area (+7.8452 thousand ha/year) and harvested production (+823.1 thousand tonnes/year). The situation is reversed for organic wheat, with reductions in both area cultivated (-4.8311 thousand ha/year) and harvested production (-3.3861 thousand tonnes/year). It is worth noting that the production yield increased both for conventional wheat (+0.419 kg/ha/year) and for organic wheat (+0.4214 kg/ha/year), being even better for organic wheat.

Conventional maize shows reductions in area cultivated (-33.4411 thousand ha/year) and increases in harvested production (+2771.3 thousand tonnes/year), amid an increase in average production of 1.1849 kg/ha/year. For organic maize there are reductions both in cultivated areas (-4.3629 thousand ha/year) and in harvested production (-12.413 thousand tonnes/year). It is worth noting that the production yield increased on average by 0.9584 kg/ha/year.

**Table 1. Summary techno-economic indicators for wheat, 2021-2022**

Nr. crt.	Indicators	Non-irrigated wheat conventional		Non-irrigated organic wheat		Conventional irrigated wheat		Organically irrigated wheat	
1	Average yield (kg/ha)	4400		3700		6150		4600	
2	UM	lei	euro	lei	euro	lei	euro	lei	euro
3	Price (lei/t)	958	194	1228	248	958	194	1228	248
4	Revenue	4215	852	4543	918	5892	1191	5648	1142
5	- Variable costs	3470	701	3453	698	4359	881	3758	760
6	=Margin of variable costs (MCV)	745	151	1090	220	1533	310	1890	382
7	MCV (%)	17.7	17.7	24.0	24.0	26.0	26.0	33.5	33.5
8	- Fixed costs	324	65	636	129	689	139	1093	221
10	= Gross result	421	86	454	91	844	171	797	161
11	Break-even point (break-even)	1833	370	2651	536	2648	536	3266	661
12	PR tonnes/ha	1.91		2.16		2.76		2.66	

Source: own calculations, ADER Project 23.1.1 - Phase Report No 3/2021

1 euro=4,9475 lei

Making a profit depends on production costs and the volume of sales of a product. These components help determine the break-even point. The break-even point is an economic indicator necessary in the conduct of economic activities in order to know what measures need to be taken in production planning so that total costs are covered and the profitability of crops is increased. For conventional wheat the profitability threshold is reached at a production yield of 1.91 tonnes/ha for non-irrigated wheat and 2.76 tonnes/ha for irrigated wheat. For organic wheat the break-even point is 2.16 tonnes/ha for non-irrigated organic wheat and 2.66 tonnes/ha for irrigated organic wheat.

**Table 2. Maize summary indicators, 2021-2022**

Nr. crt.	Indicators	Conventional non-irrigated maize		Non-irrigated organic maize		Conventionally irrigated maize		Organic irrigated maize	
1	Average yield (kg/ha)	5500		5400		7700		6700	
2	UM	lei	euro	lei	euro	lei	euro	lei	euro
3	Price (lei/t)	850	172	1149	232	850	172	1149	232
5	Revenue	4677	945	6203	1254	6548	1324	7697	1556
6	- Variable costs	3514	710	4431	896	4443	898	5521	1116
7	=Margin of variable costs (MCV)	1163	235	1772	358	2105	426	2176	440
8	MCV (%)	24.9	24.9	28.6	28.5	32.1	32.2	28.3	28.3
9	- Fixed costs	696	141	1152	233	994	201	1281	259
10	= Gross result	467	94	620	125	1111	225	895	181
11	Break-even point (break-even)	2799	567	4033	816	3092	625	4531	916
12	PR tonnes/ha	3.29		3.51		3.64		3.94	

Source: own calculations, ADER Project 23.1.1 - Phase Report No 3/2021

1 euro=4,9475 lei

In conventional maize, revenue equals production costs at a yield of 3.29 tonnes/ha for non-irrigated maize and 3.64 tonnes/ha for irrigated maize. For organic maize the break-even point is 3.51 tonnes/ha for non-irrigated organic maize and 3.94 tonnes/ha for irrigated organic maize.

For non-irrigated conventional maize, Table 3 shows the gross margins at different production levels (from 3.08 tonnes/ha to 5.72 t/ha). Gross margins vary both with production levels and with market prices. In the case of non-irrigated conventional wheat, the gross margin is sensitive to price decreases of 10%, especially at 766 lei/t. When yields fall below 5.28 t/ha the sensitivity of the gross margin is very high, fixed costs are not covered and no profit is made. When the price rises to 1054 lei/tonne the gross margin is sensitive when the yield rises above 3.52 tonnes/ha.

**Table 3. Sensitivity analysis - effect of average output and the gross margin for non-irrigated wheat**

Non-irrigated conventional wheat, 2021-2022					
Average production (t/ha)		4,40			
Farm price (lei/t)		958			
A. Main product revenue (lei)		4215			
B. Total variable costs (lei)		3470			
Gross margin (A-B)		745			
Fixed costs		324			
Average production t/ha	Farm price lei/tonne				
	766	862	958	1,054	1,150
3.08	-1111	-815	-519	-224	72
3.52	-774	-436	-98	240	578
3.96	-437	-56	324	704	1084
4.40	-100	323	745	1168	1590
4.84	237	702	1167	1631	2096
5.28	574	1081	1588	2095	2602
5.72	912	1461	2010	2559	3108

Source: own calculations

*Irrigated conventional wheat:* Table 4 shows the gross margins at different production levels (from 4.31 tonnes/ha to 8.00 t/ha) as a function of the variation in the recovery price (from 766 lei/tonne to 1150 lei/tonne). A 10% decrease in the recovery price results in a decrease in the gross margin, especially when the price falls to 766 lei/tonne, when the yield falls below 6.77 tonnes/ha. At this price and yield level fixed costs (689 lei) are covered, resulting in a gross profit of 134 lei.

**Table 4. Sensitivity analysis - effect of average output and the gross margin for irrigated wheat**

Irrigated conventional wheat, 2021-2022					
Average production (t/ha)		6,150			
Farm price (lei/t)		958			
A. Main product revenue (lei)		5892			
B. Total variable costs (lei)		4359			
Gross margin (A-B)		1,533			
Fixed costs		689			
Average production t/ha	Farm price lei/tonne				
	766	862	958	1,054	1,150
4.31	-1061	-648	-235	178	592

<b>4.92</b>	-590	-118	354	827	1299
<b>5.54</b>	-119	412	944	1475	2006
<b>6.15</b>	352	942	<b>1533</b>	2123	2714
<b>6.77</b>	823	1472	2122	2771	3421
<b>7.38</b>	1294	2003	2711	3420	4128
<b>8.00</b>	1765	2533	3300	4068	4835

Source: own calculations

*Non-irrigated organic wheat:* Table 5 shows the gross margins at different production levels (from 2.59 t/ha to 4.81 t/ha). For non-irrigated organic wheat the safety intervals at the recovery prices differ from the safety interval for conventional wheat. We assume that the recovery prices for organic wheat are 28% higher than for conventional wheat (1.288 lei/kg compared to 0.958 lei/kg for organic wheat). In this context we say that the gross margin is sensitive to a 10% increase for a production level of 2.96 t/ha, in the context of covering fixed costs (689 lei/ha) and obtaining a gross result of 92 lei/ha (18.6 euro/ha).

**Table 5. Sensitivity analysis - effect of average output and the gross margin for non-irrigated organic wheat**

Non-irrigated organic wheat, 2021-2022					
Average production (t/ha)	3,70				
Farm price (lei/t)	1228				
A. Main product revenue (lei)	4543				
B. Total variable costs (lei)	3453				
Gross margin (A-B)	1091				
Fixed costs	454				
Average production t/ha	Farm price lei/tonne				
	<b>982</b>	<b>1,105</b>	<b>1,228</b>	<b>1,351</b>	<b>1,474</b>
<b>2.59</b>	-910	-591	-272	46	365
<b>2.96</b>	-546	-182	182	546	910
<b>3.33</b>	-183	227	636	1046	1455
<b>3.70</b>	180	636	<b>1091</b>	1546	2001
<b>4.07</b>	544	1044	1545	2046	2546
<b>4.44</b>	907	1453	1999	2545	3092
<b>4.81</b>	1270	1862	2454	3045	3637

Source: own calculations

**Table 6. Sensitivity analysis - effect of average output and the gross margin of irrigated organic wheat**

Irrigated organic wheat, 2021-2022					
Average production (t/ha)	<b>4,6</b>				
Farm price (lei/t)	1228				
A. Main product revenue (lei)	5648				
B. Total variable costs (lei)	3758				
Gross margin (A-B)	<b>1891</b>				
Fixed costs	<b>797</b>				
Average production t/ha	Farm price lei/tonne				
	<b>982</b>	<b>1,105</b>	<b>1,228</b>	<b>1,351</b>	<b>1,474</b>
<b>3.22</b>	-596	-200	196	592	988
<b>3.68</b>	-144	308	761	1214	1666

<b>4.14</b>	307	817	1326	1835	2344
<b>4.60</b>	759	1325	<b>1891</b>	2457	3022
<b>5.06</b>	1211	1833	2456	3078	3700
<b>5.52</b>	1663	2342	3021	3700	4378
<b>5.98</b>	2114	2850	3585	4321	5057

Source: own calculations

*Irrigated organic wheat:* Table 6 shows the gross margins at different production levels (from 3.68 t/ha to 5.52 t/ha). For irrigated organic wheat we analyse the situation where the gross margin is sensitive to a 10% price reduction (1105 lei/tonne) when yield falls below 4.14 t/ha.

*Non-irrigated conventional maize:* Table 7 shows the gross margins at different production levels (from 3.85 tonnes/ha to 7.15 t/ha), depending on the variation in the recovery price (from 680 lei/tonne to 1020 lei/tonne). A 10% decrease in the recovery price results in a decrease in the gross margin, especially when the price falls to 680 lei/tonne, when the yield falls below 6.60 tonnes/ha. Since fixed costs (696 lei) were also taken into account, a gross profit of 278 lei (56.1 euro/ha) is obtained from a yield of 6.60 tonnes/ha.

**Table 7. Sensitivity analysis - effect of average output and on the gross margin of non-irrigated conventional maize**

Non-irrigated conventional maize, 2021-2022					
Average production (t/ha)		5,50			
Farm price (lei/t)		850			
A. Main product revenue (lei)		4677			
B. Total variable costs (lei)		3514			
Gross margin (A-B)		1161			
Fixed costs		696			
Average production t/ha	Farm price lei/tonne				
	<b>680</b>	<b>765</b>	<b>850</b>	<b>935</b>	<b>1,020</b>
<b>3.85</b>	-896	-569	-242	86	413
<b>4.40</b>	-522	-148	226	600	974
<b>4.95</b>	-148	273	694	1114	1535
<b>5.50</b>	226	694	<b>1161</b>	1629	2096
<b>6.05</b>	600	1114	1629	2143	2657
<b>6.60</b>	974	1535	2096	2657	3218
<b>7.15</b>	1348	1956	2564	3171	3779

Source: own calculations

**Table 8. Sensitivity analysis - effect of average output and price on gross margin for irrigated maize**

Irrigated conventional maize, 2021-2022					
Average production (t/ha)		7,7			
Farm price (lei/t)		850			
A. Main product revenue (lei)		6548			
B. Total variable costs (lei)		4443			
Gross margin (A-B)		2,102			
Fixed costs		994			
Average production t/ha	Farm price lei/tonne				
	680	765	850	935	1,020
5.39	-778	-320	139	597	1055

<b>6.16</b>	-254	269	793	1317	1840
<b>6.93</b>	269	858	1448	2037	2626
<b>7.70</b>	793	1448	<b>2102</b>	2757	3411
<b>8.47</b>	1317	2037	2757	3476	4196
<b>9.24</b>	1840	2626	3411	4196	4982
<b>10.01</b>	2364	3215	4066	4916	5767

Source: own calculations

*Conventional irrigated maize.* Table 8 shows gross margins at different production levels (from 5.39 tonnes/ha to 10.01 t/ha) and recovery prices (from 680 lei/tonne to 1020 lei/tonne). Increasing the recovery price by 10% results in an increase in the gross margin, especially when increasing the price to 1020 lei/tonne, starting from a yield of 5.39 tonnes/ha. Since fixed costs (994 lei) were also taken into account, starting from a yield of 5.39 tonnes/ha and a price of 1020 lei/tonne, a gross profit of 61 lei (12.3 euro/ha) is obtained. We thus say that the gross margin is sensitive to price increases and for a lower production level.

*Non-irrigated organic maize:* Table 9 shows the gross margins at different production levels (from 3.78 t/ha to 7.02 t/ha). For non-irrigated organic maize the safety intervals at the value price differ from the safety interval for conventional maize. We assume that the recovery prices for organic maize are 35% higher than for conventional maize (1.149 lei/kg compared to 0.850 lei/kg for conventional maize). In this context we say that the gross margin is sensitive to a 10% increase for a production level of 4.86 t/ha at a recovery price of 1264 lei/tonne, when fixed costs are covered (1152 lei/ha), resulting in a gross profit of 520 lei/ha (113 euro/ha).

**Table 9. Sensitivity analysis - effect of average output and on the gross margin of non-irrigated organic maize**

Non-irrigated organic maize, 2021-2022					
Average production (t/ha)	5,40				
Farm price (lei/t)	1149				
A. Main product revenue (lei)	6205				
B. Total variable costs (lei)	4431				
Gross margin (A-B)	<b>1774</b>				
Fixed costs	1152				
Average production t/ha	Farm price lei/tonne				
	<b>919</b>	<b>1,103</b>	<b>1,149</b>	<b>1,264</b>	<b>1,390</b>
<b>3.78</b>	-957	-522	-88	347	782
<b>4.32</b>	-461	36	533	1029	1526
<b>4.86</b>	35	594	1153	1712	2271
<b>5.40</b>	532	1153	<b>1774</b>	2395	3016
<b>5.94</b>	1028	1711	2394	3077	3760
<b>6.48</b>	1524	2269	3015	3760	4505
<b>7.02</b>	2020	2828	3635	4442	5250

Source: own calculations



**Table 10. Sensitivity analysis - effect of average output and on the gross margin of irrigated organic maize**

Irrigated organic maize, 2021-2022					
Average production (t/ha)	<b>6,70</b>				
Farm price (lei/t)	1149				
A. Main product revenue (lei)	7698				
B. Total variable costs (lei)	5521				
Gross margin (A-B)	<b>2177</b>				
Fixed costs	<b>1281</b>				
Average production t/ha	Farm price lei/tonne				
	<b>919</b>	<b>1,103</b>	<b>1,149</b>	<b>1,264</b>	<b>1,390</b>
<b>4.69</b>	-1211	-672	-132	407	947
<b>5.36</b>	-595	21	638	1254	1870
<b>6.03</b>	21	714	1407	2101	2794
<b>6.70</b>	636	1407	<b>2177</b>	2948	3718
<b>7.37</b>	1252	2100	2947	3795	4642
<b>8.04</b>	1868	2792	3717	4642	5566
<b>8.71</b>	2483	3485	4487	5488	6490

Source: own calculations

*Irrigated organic maize.* Table 10 shows gross margins for different production levels (from 4.69 tonnes/ha to 8.71 t/ha) and recovery prices (from 919 lei/tonne to 1390 lei/tonne). We say that the gross margin is sensitive to a 10% price increase, starting from a production level of 6.70 t/ha and a valorisation price of 1103 lei/tonne, when fixed costs are covered (1281 lei/ha) and the gross result is 126 lei/ha (25 euro/ha).

## CONCLUSIONS

Gross margin is an economic indicator that shows whether the revenue from the sale of a product is sufficient to cover operating costs. From the analysis of wheat and maize products produced in conventional and organic farming, it was found that the gross margin is sensitive to both price and yield changes in the same proportion, which means that product profitability depends on both production yield increase and price increase.

We mention that the study has its limitations, in the sense that sensitivity analysis has to be carried out periodically due to: market price fluctuations, inflation - which changes production costs, growing conditions - climate, soil, pedological drought conditions - which affect the yields obtained.

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