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Research article

Comparison between key crop production and farmers' perspectives in Eastern Hungary: A regional study

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Abstract: Agricultural production and technology are crucial in supplying agricultural commodities and ensuring food security. Farmers are pivotal in this process. However, there is a noticeable gap in research: While numerous researchers focus on the national perspective, there is a relative scarcity of research conducted at the regional level. This lack of regional-scale studies highlights the need for more localized research to understand and address the unique agricultural challenges and opportunities in specific areas. We aimed to analyze wheat and maize production in a county in Eastern Hungary. We also aimed to delve into farmers' perspectives regarding the agricultural sector and research. Key findings included the average maize, with a yield at 5,896.2 ± 1,624.2kg/hectare (2000–2020), which appeared to be superior to wheat, which had a mean yield of 4,135.7 kg/hectare with a standard deviation of 788.4. The Tukey test confirmed significant differences between wheat and maize in terms of harvested area, production, and yield, highlighting distinct performance variations of these crops in the region. Moreover, we identified a weak but significant correlation between the value of the golden crown and aspects such as cost-effective crop protection, reduced tillage costs, and increased production value and income. A similar weak significant relationship was found between farmers' age and research topics related to increasing sales revenue. We aimed to analyze wheat and maize production in Szabolcs-Szatmár-Bereg County in Eastern Hungary. We found that 58% of farmers did not maintain accurate records of production-related costs and income, which could have significant implications for revenue calculation and decision-making. The outcomes of this research are instrumental for decision-makers, providing insights that could guide the development and implementation of agricultural policies and practices at a regional scale.

Keywords: agricultural sociology; SDG; regional research; Hungary

1. Introduction

The consumption of cereals has been integral to human development since the dawn of agriculture. The shift from a hunter-fisher-gatherer lifestyle to one centered around farming and animal husbandry significantly reduced human dependency on nature's varying resources. Over time, technological advancements have introduced a broader array of tools for cultivation. However, with the increasing global population, challenges in plant cultivation have intensified. These include the need to sustain a growing number of residents on progressively diminishing farmland.

In the past few decades, Earth's population has increased rapidly and is projected to increase between 9.6 and 12.3 billion by the year 2100 [1]. As of March 18, 2023, the global population stands at 8.077 billion [2]. The United Nations projects that this number will rise to 9.8 billion by 2050 [3]. The current global population exerts considerable pressure on the environment. Forests, meadows, and pastures are being rapidly converted for agricultural purposes to meet the food demands of the growing population. This growth is most pronounced in developing countries, while the population in developed countries is, on average, decreasing [4]. The rate of urbanization in developing countries continues to pose serious challenges.

With the economic advancement of industrialized countries, a range of environmental challenges have emerged, including water and air pollution, land degradation, and the adverse effects on wildlife and plant life due to agricultural chemicals [5,6]. Given the rapid increase in the projected global population, enhancing agricultural commodities to meet world needs has become imperative. Consequently, improving and intensifying agricultural practices is crucial to sustainably feed the growing population. Rapid and innovative agricultural research is essential to address the dual challenges of an increasing population and ongoing climate change. In this context, risk management aimed at mitigating climate change and securing stable crop production is crucial. Hence, Adnan et al. (2018) reported that farmers tended to employ multiple risk-minimizing strategies to mitigate the impacts of various hazards. However, Akhtar et al. (2019) recommend diversification as a risk management tool for mitigating risk in the agricultural sector.

Scientifically, most researchers focus on the national or global scale, often overlooking the potential impact on local scales or individual farmers. The literature is replete with analyses of agricultural practices and recommendations for food security, mostly at the national or global level. For instance, [7] predicted a 69% increase in global agricultural consumption from 2010 to 2050. Researchers [8] focused on analyzing global greenhouse technology, while others [9] examined global greenhouse gas emissions. These examples illustrate that most of this research adopts a global perspective.

However, local governance has received comparatively less attention. For instance, a [10] reviewed literature about food security at the farm and regional levels, suggesting a need for more in-depth analysis of agricultural systems. In this context, the role of agrarian policy and sociology is to identify and address these inequalities and seek systemic solutions. Agriculture's primary purpose, in its simplest definition, is to supply the population with sufficient food and organic raw materials. Beyond its economic role, it is also responsible for maintaining ecological balance. This includes efficient use of scarce resources, enhancing management efficiency, and reducing production and distribution costs [11]. Moreover, agriculture faces the challenges of competitive markets, both domestic and international, marked by increasing competition and protectionism [12].

An integrated scientific approach, incorporating spatial perspectives and complex impacts, can form the foundation for a systematic, comprehensive, interdisciplinary study of regional scale region [13]. This approach should consider the interrelationships between environmental, social, and technical factors, creating a multifaceted agro-ecological system. In such a system, well-informed decisions by agricultural producers can help alleviate social tensions. Current trends in agricultural technology may, however, exacerbate inequalities [14]. On the other hand, innovation plays a key role in leveraging local resources and advancing social infrastructure development. This includes enhanced education, entrepreneurial skills, market access, and the effective employment of available labor [15]. Agricultural policy must aim to coordinate these processes, aligning them more closely with principles of justice, legal frameworks, and information accessibility. Furthermore, the parameters of food policy, encompassing production and distribution issues, must be clearly defined and structured around these concepts [16–18].

Hungary, a central European country, has an agricultural sector that contributes significantly to its economy, though the exact percentage to the national GDP may vary. Maize and wheat are among the main cereal crops produced in Hungary [19]. As in many parts of the world, Hungary faces a decline in per capita availability of arable land, attributed to a combination of diminishing arable land and population growth [20,21]. The area available for crop production in Hungary has decreased from 0.42 hectares per person in 1961 to 0.20 hectares per person in 2010. Previous studies conducted at a national scale have highlighted the vulnerability of Hungary's agricultural sector to climate change. However, there has been a lack of regional studies examining the implementation of agricultural research and farmers' opinions on agricultural practices. We aim to provide a detailed overview of wheat and maize production in a specific county in Eastern Hungary. It also seeks to gather insights into farmers' perspectives on the agricultural sector and research within the country. We have a dual focus: One aspect is to investigate agricultural development for maize and wheat at a regional level in Hungary, and the other is to explore the sociological dimension by examining farmers' opinions.

2. Materials and methods

2.1. Collection and analysis of data

Data for maize and wheat production in the study area were collected for the period from 2000 to 2020 (https://www.ksh.hu/?lang=en) in Szabolcs-Szatmár-Bereg County (eastern Hungary). This included information on harvested area (in hectares), total harvested production (in tons), and average yield (in kg/hectare). The data, which is freely available, was verified for accuracy by the Hungarian Central Statistical Office (KSH).

The Mann-Kendall test, a nonparametric method for identifying trends in time series data, was selected for its robustness against outliers and its flexibility in handling datasets without requiring them to follow a specific distribution. This makes it particularly suitable for analyzing agricultural data, which can be influenced by a variety of unpredictable environmental factors. Furthermore, the nonparametric nature of the MK test means it does not assume a normal distribution of the residuals, which is often a limiting factor in parametric tests.

To complement the MK test, Sen's Slope Estimator was employed to quantify the magnitude of trends detected by the MK test. Unlike linear regression that assumes a linear relationship and is sensitive to outliers, Sen's Slope Estimator provides a more resilient measure of trend magnitude in data with non-linear trends or heavy-tailed distributions commonly found in environmental and agricultural studies.Additionally, the Tukey test was used to analyze differences between wheat and maize production, aiming to identify any significant disparities. The Tukey test was utilized to compare means between groups, determining if there are any statistically significant differences [22]. Furthermore, Principal Component Analysis (PCA) was utilized to summarize the data into new, representative components, facilitating a more comprehensive understanding of the dataset.

2.2. Survey Analysis of Agricultural Entrepreneurs in Szabolcs-Szatmár-Bereg county

The target population for the survey comprises agricultural entrepreneurs in Szabolcs-Szatmár-Bereg county. Access to this group was facilitated by sixty village farmers affiliated with the National Chamber of Agriculture (NAK), who are active within the county. Their active participation ensured that the survey could capture a broad spectrum of opinions from farmers. The questionnaire was distributed online, and 59 of the 60 solicited village farmers responded. To enhance the response rate, I employed several methods, including motivational strategies, sending an invitation letter via management, and conducting telephone or in-person Q&A sessions.

The basic population of the investigation is the world of agricultural entrepreneurs in Szabolcs-Szatmár-Bereg County, where research was conducted among the organizations dealing with grain cultivation. In this paper, the county's agriculture, through the opinions and experiences of the farmers, was examined and gained access to the sixty village farmers of the National Agrarian Chamber in the Szabolcs-Szatmár-Bereg County. Farmers were contacted electronically with the help of NACh's county directorate, using an open-ended questionnaire with Excel. The questionnaire was sent to the village farmers in electronic form and the answers were sent back in the same form. It was not possible to determine the representativeness of this study because there was no official data available for the characteristics of the county's farmers.

The village farmers helped to fill out the questionnaire for one farmer in their customer base who was randomly selected and engaged in field crop cultivation. Farmers had the opportunity to answer the questions on a 5-point rating scale (a measurement scale between two extreme values) by giving a multiple-choice numerical value [23]. I worked with a five-point rating scale, where 1 meant "not at all" and 5 meant "very important".

There were almost four times as many men (80%) as women (20%) among those who completed the questionnaire and sent back accordingly. In the county's agriculture, men typically work in a higher proportion.

Based on age distribution: 11 farmers were found under 40 (19%) and 48 farmers over 40 (81%). The average age of farmers is 49.06 years. The participants in the survey were divided into four groups according to their educational level. Ten farmers were under higher education (17%), 39 farmers with secondary education (66%), 7 farmers with elementary education (12%) and 3 farmers with no education (5%). A very big majority (90%) of them showed agricultural education while 10% didn't have any agricultural education.

The conceptual and practical date of the start of the research was December 12, 2018, which ended on September 15, 2019. For the analyses, Guilford's scale was employed to characterize the closeness of relationships [24].

3. Results

Results contained in Table 1 present a basic statistical analysis of maize and wheat production from 2000 to 2020 in Szabolcs-Szatmár-Bereg County, Eastern Hungary. The statistics include harvested area (in hectares), production (in tons), and yield (in kg/hectare). For wheat, the harvested area has a mean of 30,737.7 hectares with a standard deviation of 5,003.9. The minimum and maximum harvested areas are 22,376.0 and 43,378.0 hectares, respectively. In contrast, for maize, the harvested area ranges from 73,222.0 to 117,975.0 hectares, with a mean of 101,461.7 and a standard deviation of 10,463.7.

Regarding production, wheat shows a minimum production of 71,625.0 tons and a maximum of 172,132.0 tons, with a mean of 125,106.2 tons and a standard deviation of 22,508.7. Maize production, on the other hand, has a mean of 600,574.6 tons with a standard deviation of 180,763.6.

For yield, wheat has a mean yield of 4,135.7 kg/hectare with a standard deviation of 788.4, whereas maize has a mean yield of 5,896.2 kg/hectare with a standard deviation of 1,624.2. These indicators suggest that maize is superior to wheat in this region, reflecting its importance in local agriculture.

Table 1. Basic statistical analysis for maize and wheat production.

Indicators	**Harvested area (hectares)**		**Production (tons)**		**Yield (kg/hectare)**	
Statistic	Wheat	Maize	Wheat	Maize	Wheat	Maize
Minimum	22376.0	73222.0	71625.0	288505.0	2550.0	3460.0
Maximum	43378.0	117975.0	172132.0	917550.0	5480.0	8470.0
Range	21002.0	44753.0	100507.0	629045.0	2930.0	5010.0
Median	30364.0	102481.0	123146.0	627945.0	4360.0	6110.0
Mean	30737.7	101461.7	125106.2	600574.6	4135.7	5896.2
SD (n)	5003.9	10463.7	22508.7	180763.6	788.4	1624.2
Skewness (Pearson)	0.6	-0.8	0.2	-0.1	-0.4	-0.1
Kurtosis (Pearson)	0.3	0.6	0.3	-1.2	-0.8	-1.3
Standard error of the mean	1118.9	2339.8	5033.1	40420.0	176.3	363.2

Figure 1 illustrates the evolution of wheat and maize production characteristics in the study area from 2000 to 2020. The Mann-Kendall test results indicate significant trends in these characteristics. For wheat, there was a significant decrease in the harvested area, with Sen's Slope showing a decline of -533.3 hectares per year (p-value = 0.0005). In contrast, the decrease in maize's harvested area was not statistically significant, with Sen's Slope at -202.1 hectares per year. Regarding production, both wheat and maize showed increases, but these were not statistically significant. The Sen's Slope for wheat production was 150.3 tons, while 13,856.7 tons for maize. However, the yield for both wheat and maize increased significantly. Wheat yield increased by 74.6 kg/hectare (p = 0.0005), and maize yield by 139.5 kg/hectare (p = 0.0201) (Table 2). In this context, the Tukey test, as illustrated in Figure 2, reveals significant differences between wheat and maize in all examined characteristics. These include harvested area (measured in hectares), production (measured in tons), and yield (measured in kg/ha). This indicates distinct variations in the performance of wheat and maize crops in the study region across these key agricultural metrics.

Table 2. MK and Sen's slope results of the wheat and maize in the study area.

Indicators	Series\Test	Kendall's tau	p-value	Sen's slope
while harvested area, (ha)	Wheat	-0.5524	0.0005	-533.3000
	Maize	-0.1048	0.5260	-202.0747
production (tons)	Wheat	0.0190	0.9278	150.2577
	Maize	0.3048	0.0571	13856.7079
yield (kg/ha)	Wheat	0.5585	0.0005	74.6429
	Maize	0.3714	0.0201	139.5000

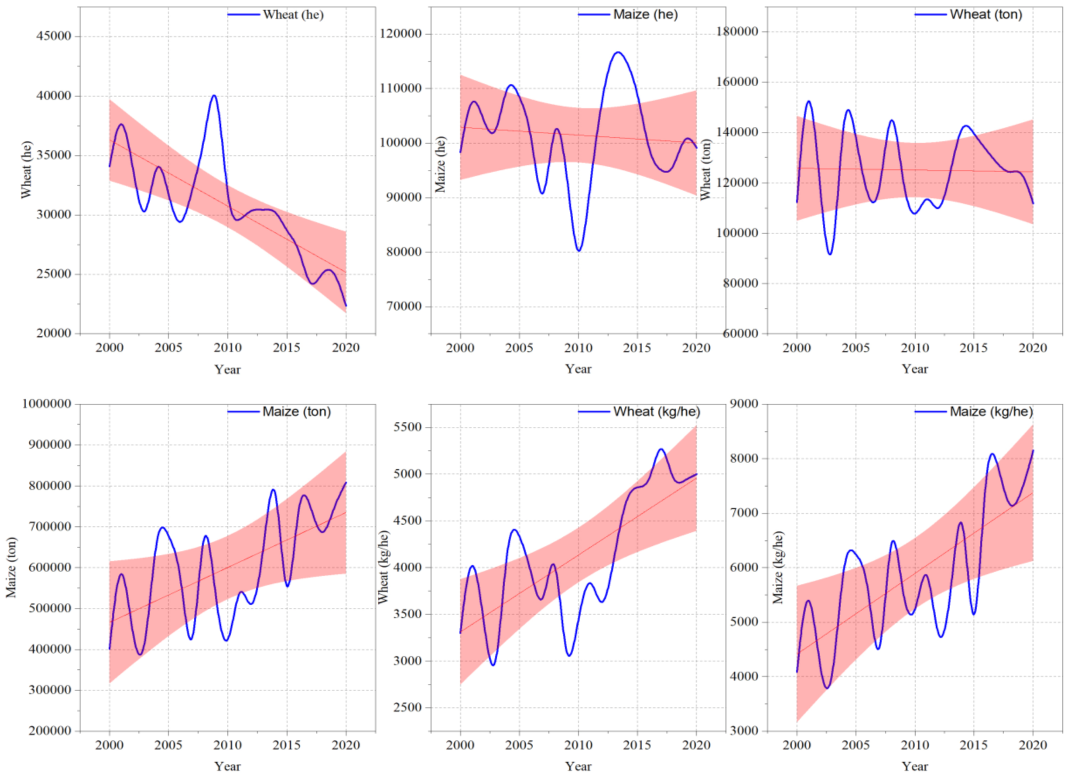

Figure 1. Time series evolution for maize and wheat production charachterstics in study area during 2000–2020.

The PCA (Principal Component Analysis) reveals that the first principal component (PC1) accounted for 55.7% of the total variance, while the second principal component (PC2) accounted for 26.6%, together explaining 82.1% of the total variance. This indicates that these two components capture a significant portion of the data's variability.

The alignment of variables in the PCA is noteworthy. Wheat and maize harvested areas (measured in hectares) are aligned together, as of the yields (measured in kg/hectare) of wheat and maize. This suggests a similarity in the variance patterns of these specific characteristics for both crops (Figure 3).

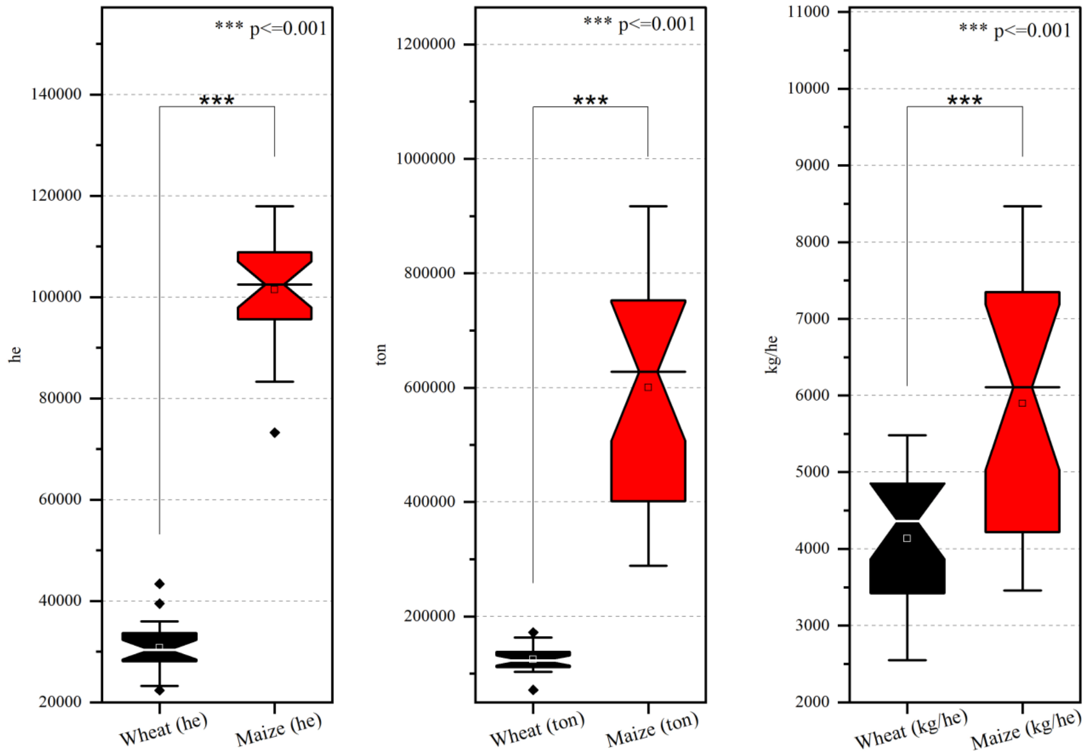

Figure 2. Tukey test output for wheat and maize during 2000–2020.

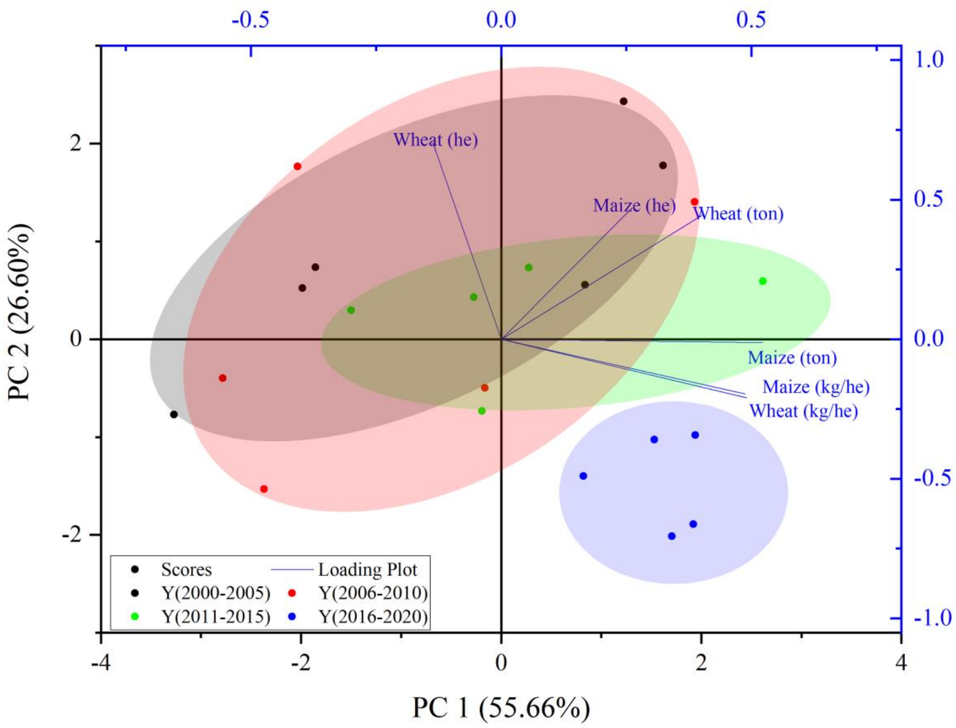

Figure 3. PCA output of the analyzed data.

3.1. Farmers' prospective on agricultural activities in the study area

The farmers evaluated their importance assessment of the given research area on a five-point rating scale (Table 3).

Table 3. Assessment of the importance of individual research topics (person).

Score	Increasing the utilization of feed	Improving seed quality	Making plant protection cheaper	Reduction of tillage costs	Precision-site-specific-farming
1	16	1	1	2	4
2	4	3	7	6	7
3	25	15	11	15	20
4	11	29	21	21	22
5	3	11	19	15	6
Average	2.68	3.78	3.85	3.69	3.32
Score	Increasing of sales	Use of subsidies	Increasing of production value	Increasing of income	Cost-proportionate profitability
1	1	2	3	2	1
2	6	1	3	4	5
3	10	15	12	13	19
4	21	17	23	19	20
5	21	24	18	21	14
2	3.93	4.02	3.85	3.90	3.69
Score	Cost level reduction	Self-cost reduction	Production quantities	Specific profitability	Reduction of machine operating costs
1	2	2	1	3	2
2	9	7	1	3	7
3	19	14	15	18	16
4	17	22	25	22	21
5	12	14	17	13	13
Average	3.47	3.66	3.95	3.66	3.61

From analysis of the data, it can be concluded that the attention to feeding was the least. It received nearly 40% of the lowest ratings. None of the questions received nearly as many points as '1'. The second highest precision farming, which received 1 point, received only four evaluations, which is a quarter. The reason for this is the very low number of farm animals in the county.

The order of the values receiving 2 points was led by the reduction of the cost level. This raises the question, why do farmers not consider research related to this factor more important? Proper cost management would be a basic condition for further improvement, however, according to this study, in the basic population of this sample, in the absence of continuously maintained cost records per plant, this was not consciously implemented. Among the research evaluated at '3' points, which were in the last third according to the averages, they received the most points in their evaluation in this category.

Among the topics that received '4' points, the highest value (29) of the entire survey, the improvement of seed quality research was the most watched by arable farmers. This is followed by the production quantities (25) evaluated in second place, which, when examined together, show that the most important factor in profitable production is the production of as many products as possible. We would like to point out that the low number of companies keeping cost records can be explained by the fact that, according to the ranking shown in Table 2, only the reduction of the cost level is listed in 14th place. The utilization of these research received the most points only in category 3.

Table 4. Assessment of the usefulness of research results in practice.

Serial number	Research results	Average
1	Use of subsidies	4,02
2	Production quantities	3,95
3	Increasing of sales	3,93
4	Increasing of income	3,90
5	Increasing of production value	3,85
6	Reduction of plant protection costs	3,85
7	Improving seed quality	3,78
8	Reduction of tillage costs	3,69
9	Cost-proportionate profitability	3,69
10	Specific profitability	3,66
11	Self-cost reduction	3,61
12	Reduction of machine operating costs	3,61
13	Cost level reduction	3,47
14	Precision farming	3,32
15	Increasing the utilization of feed	2,68

In the Szabolcs-Szatmár-Bereg County, which provides the geographic framework of the survey, the order of the results calculated by averaging based on the values provided by the 59 participating farmers is illustrated in Table 4.

The ranking formed based on the average calculation shows that research related to tasks that generate direct income are the focus of the farmers' attention the most. In the back tract, the respondents classified research requiring significant investment and expertise.

Investigations of the relationship between the various characteristics of the sample population and the opinions about the usability of individual research results yielded the following results, assuming a significance level of 5% and independence (Tables 5 and 6).

The results show the following correlations (Table 5):

- A weak significant relationship is shown between the value of the golden crown and the research topics of making crop protection cheaper, reducing tillage costs, increasing production value and income,
- A weak significant relationship is demonstrated between age and increasing sales revenue research topics.

Table 5. Calculated linear correlation coefficients (sign. $p < 0.05$).

Factor	Increasing the utilization of feed	Improving seed quality	Making plant protection cheaper	Reduction of tillage costs	Precision-site-specific-farming
Golden crown	-0,004	-0,170	-0,340	-0,260	-0,034
Area	-0,176	-0,026	0,146	0,105	0,098
Age	-0,08	-0,19	-0,25	-0,15	-0,19
Factor	Increasing of sales	Use of subsidies	Increasing of production value	Increasing of income	Cost-proportionate profitability
Golden crown	-0,182	-0,135	-0,323	-0,220	-0,164
Area	0,086	0,074	0,114	0,013	-0,015
Age	-0,28	-0,24	-0,23	-0,18	-0,15
Factor	Cost level reduction	Self-cost reduction	Production quantities	Specific profitability	Reduction of machine operating costs
Golden crown	-0,119	-0,153	-0,098	-0,142	-0,192
Area	0,044	0,019	0,027	0,018	0,004
Age	-0,04	-0,02	-0,10	-0,11	-0,04

Table 6. Calculated standard deviation indicators (sign. $p < 0.05$).

Factor	Increasing the utilization of feed	Improving seed quality	Making plant protection cheaper	Reduction of tillage costs	Precision-site-specific-farming
District	0,51	0,45	0,62	0,62	0,46
Soil	0,29	0,13	0,27	0,22	0,22
Degree in agriculture	0,23	0,15	0,05	0,10	0,06
Education	0,34	0,18	0,17	0,09	0,24
Gender	0,30	0,41	0,11	0,02	0,04
Factor	Increasing of sales	Use of subsidies	Increasing of production value	Increasing of income	Cost-proportionate profitability
District	0,55	0,37	0,45	0,51	0,40
Soil	0,22	0,30	0,20	0,26	0,23
Degree in agriculture	0,07	0,06	0,10	0,14	0,22
Education	0,19	0,06	0,18	0,19	0,19
Gender	0,22	0,43	0,35	0,41	0,25
Factor	Cost level reduction	Self-cost reduction	Production quantities	Specific profitability	Reduction of machine operating costs
District	0,47	0,46	0,26	0,40	0,49
Soil	0,27	0,24	0,14	0,13	0,14
Degree in agriculture	0,32	0,23	0,08	0,16	0,23
Education	0,29	0,15	0,06	0,09	0,08
Gender	0,14	0,12	0,41	0,36	0,18

The results of the correlation tests show the following correlations (Table 6):

- A moderately significant relationship is demonstrated between district location and most research topics (except for the use of subsidies, profitability of cost ratios, production volumes, and specific profitability),
- A weak significant relationship is shown between educational level and the utilization of animal feed and the reduction of cost level research topics,
- A moderately significant relationship is shown between gender and most research topics (except for making plant protection cheaper, reducing tillage costs, precision farming, reducing cost levels, and reducing cost).

In Tables 7 and 8, we illustrate the individual results of the topics showing a significant relationship, broken down according to the gender of the respondent and the geographical location of the farm. Examining the results of the answers according to the gender of the respondents, it can be established that men rated them higher in all topics and use individual research better in everyday farming (Table 7). The biggest difference in the responses of the two genders was measured in the question of increasing income. The smallest average difference is between the responses to reduce machine operating costs.

Over 50% of the farmers in the county believe it is important to process cereals to increase their added value, allowing them to sell these products at a higher price to the end consumer. However, the findings of this research indicate that a significant proportion, 45.8%, prefer not to produce processed products with higher added value. Instead, they are oriented towards the production of raw materials.

3.2. Evaluation of the role of the factors underlying the production decision

Production decision is the most important and critical task for agricultural producers. The assessment and determination of the weight of the factors underlying the decision is one of the most sensitive data on which the production structure of the following year or years is based. Its role is primary in the entire vertical of agriculture. It is important to learn whether the cropping structure of their farm is formed according to market needs or only according to the possibilities. They keep accurate records of the costs and revenues related to the activities of their business, and these data play a role in the preparation of plans, the development of the strategy, or the implementation.

According to the present survey, 58% of farmers do not keep accurate records of production-related costs and income. The result of this study is that 42% of the farmers keep records related to the cultivated plants, broken down into plant cultures.

According to the results of the question “Do you keep a record of expenses and income for all crops in his management?”, the majority of those without a school or specialized education gave a yes answer. According to the other group breakdowns, most results were “not leading” (Table 9). In the districts, the farmers of Baktalórántháza, Csenger, and Nyíregyháza districts mostly prepare such records. In the other districts, a significant number of farmers do not.

Table 7. Assessment of the usefulness of research results according to averages, broken down by gender.

Gender	Increasing the utilization of feed	Improving seed quality	Increasing of sales	Use of subsidies	Increasing of production value	Increasing of income	Cost-proportionate profitability	Production quantities	Specific profitability	Reduction of machine operating costs
Man	2,83	3,91	4,02	4,17	3,98	4,06	3,79	4,09	3,81	3,68
Woman	2,08	3,25	3,58	3,42	3,33	3,25	3,33	3,42	3,08	3,33

Table 8. Evaluation of the usefulness of research results according to averages, broken down by districts.

District	Increase utilization of feed	Improving seed quality	Making plant protection cheaper	Reduction of tillage costs	Precision-site-specific-farming	Increase sales	Increase production value	Increase income	Cost level reduction	Self-cost reduction	Reduction of machine operating costs	Sum
Baktalórántháza	3,50	4,00	4,00	4,00	3,75	4,00	4,00	4,00	4,00	4,00	4,00	3,93
Csenger	2,63	3,50	2,50	2,38	2,50	2,63	2,88	2,75	2,25	2,38	2,38	2,62
Fehér-gyarmat	2,43	4,14	4,57	4,71	3,86	4,57	4,43	4,43	3,57	3,86	4,00	4,05
Ibrány	3,67	4,33	4,33	4,67	4,00	4,67	3,33	3,67	4,00	4,00	4,33	4,09
Mátészalka	2,20	3,80	4,00	3,20	3,40	4,20	4,20	4,20	3,20	3,60	3,40	3,58
Nagykálló	2,10	4,00	4,40	3,90	3,20	4,10	4,10	3,90	3,60	3,60	3,60	3,68
Nyíregyháza	3,46	3,85	3,46	3,46	3,62	3,85	3,92	4,23	3,92	3,92	3,92	3,78
Tisza-vasvári	1,50	2,50	3,50	3,75	3,50	3,50	3,00	3,00	3,25	3,50	3,25	3,11
Vásárosnamény	2,40	3,60	4,60	4,20	2,40	4,60	4,40	4,60	3,60	4,00	4,00	3,85
Sum	2,65	3,75	3,93	3,81	3,36	4,01	3,81	3,86	3,49	3,65	3,65	3,63

Table 9. Cost-income record, cell values (sign. $p < 0.05$).

Characteristic	Factor				Sum
	No	Yes	No	Yes	
Under 40	6	5	55%	45%	11
Over 40	28	20	58%	42%	48
Sum	34	25			59
Woman	9	3	75%	25%	12
Man	25	22	53%	47%	47
Sum	34	25			59
None	0	3	0%	100%	3
Elementary	4	3	57%	43%	7
Secondary	24	15	62%	38%	39
Higher	6	4	60%	40%	10
Sum	34	25			59
Graduated in agriculture	32	21	60%	40%	53
Non-graduated in agriculture	2	4	33%	67%	6
Sum	34	25			59
Baktalórántháza	2	2	50%	50%	4
Csenger	2	6	25%	75%	8
Fehérgyarmat	4	3	57%	43%	7
Ibrány	2	1	67%	33%	3
Mátészalka	3	2	60%	40%	5
Nagykálló	7	3	70%	30%	10
Nyíregyház	6	7	46%	54%	13
Tiszavasvár	4	0	100%	0%	4
Vásárosnamény	4	1	80%	20%	5
Sum	34	25			59

3.3. Evaluation of research results, discussion, conclusions

It is typical that the results showed that research results related to income are the focus of the farmers' attention. From the results shown in Table 4, it is clear that the easily quantifiable, measurable, income-generating aspects (use of subsidies (4.02), production volumes (3.95), increasing sales (3.93), increasing income (3.90), and increasing production value (3.85) is considered the most important by the farmers, in which we think we can discover ignorance.

A lack of information may be the reason that they see the use of scientific research as an opportunity. The less important nature of costs is also evident in this survey. They primarily have an influence on their costs and they could influence them but not their incomes. Considering that most farmers do not keep records of their costs, their average assessment becomes understandable. The three results at the end of the list show how little attention is paid to the scientific knowledge of animal husbandry and precision farming. They are not present in everyday planning and thinking.

Based on the results of the relationship tests, it can be concluded that, overall, gender and district location influenced the differences of opinion in the sample about the utilization of research results.

Based on district data, the utilization of research in practice is between 2.69 and 4.09 averages. The sample's average assessment of the practical usefulness of research is 3.63. Based on the responses of the farmers in the sample, men are more interested in the latest research results than women.

4. Discussion

We focus on wheat and maize production and farmers' perspectives at a regional scale in Eastern Hungary. Results indicate an increasing trend in maize production (Table 1, Figures 1 and 2, and Table 2), while the area dedicated to wheat is decreasing. These findings are consistent with a previous study [19], which reported an expansion of maize cultivation in Hungary. However, several factors such as climate change and rising agricultural input costs have negatively impacted maize production, highlighting the need for government subsidies.

On the other hand, it was observed that farmers often do not maintain accurate records of production-related costs and income. This lack of detailed record-keeping adversely affects the calculation of revenue and underscores the importance of enhancing farmers' knowledge and management skills. Additionally, we found a general lack of interest among farmers in adopting new technologies. This is in line with findings [25] who reported that the adoption of new technologies among farmers remains low.

It would be a useful task to conduct the research in other counties so that the results can be compared with each other. With the help of professional organizations (National Chamber of Agriculture), it would be possible to get to know the opinions of a larger population to check and further develop the database of our research. Based on national data, it would be possible to establish proposals that would help to review, modify or even strengthen research directions. The professional organizations would get data on how they can more effectively help and represent the interests of their members. All in all, it would benefit the economic society if the systems that produce background knowledge and transmit it would help their practical problems, their plans set up over several time frames, and their profitable production.

In the future, we would like to ask farmers in the national survey about the research conducted in the field of environmental protection and sustainability. We consider it important to quantitatively assess how closely the results of scientific work are being monitored in this direction and how willing the involved parties are to implement them into practical management.

The needs of the economy in relation to environmental conflicts, the characteristics of agriculture, and the characteristics of the settlement network, society, landscape, and cultural division can be evaluated in a system of mutual relations, considering the various territorial problems of modernization, due to the multidisciplinary nature of the topic. In other words, this methodological approach can become the central issue of forming a collective consensus built on regionality, ecological, and economic complex systems as a strategic endeavor.

The most important task before us - even in the short term - is the creation of a complex strategy for food production, which provides close, mutually complementary systems-based solutions to produce sustainable, safe, healthy, and adequate amounts of food. They mutually affect each other in the social and economic space, which simultaneously deals with environmental problems, population growth, increasing demand, and spatial distribution problems.

5. Conclusions

Our findings underscore the crucial role of localized agricultural research and the direct engagement of farmers with these insights to enhance crop production efficiency in Szabolcs-Szatmár-Bereg County. We observed a notable variance in the adoption of new technologies and methodologies among farmers, which directly impacts the region's agricultural productivity and sustainability. This aligns with the broader challenge of meeting the increasing demand for healthy food produced efficiently on a diminishing land area. Our research suggests that the path forward involves not only advancing agricultural research but also ensuring the practical application of these advancements by the farming community.

We emphasize the importance of bridging the gap between theoretical knowledge and its practical application. Our findings reveal that while some farmers are keen on integrating scientific research into their practices, others rely on traditional knowledge, highlighting the need for targeted educational and extension services to facilitate the adoption of innovative practices.

Therefore, our conclusion calls for a concerted effort to make agricultural research more accessible and applicable to farmers, thereby enhancing profitability and sustainability. By focusing on the specific challenges and opportunities identified in our study, we contribute to the broader discourse on how to ensure the future viability of agriculture in regions similar to Szabolcs-Szatmár-Bereg County and beyond. In relation to the topic, it can be said that a thorough assessment of the situation is necessary, because it is a challenge for our modern agriculture that the demand for healthy food of a population with increasing demands and numbers must be produced more and more efficiently in an ever-shrinking area. The value of basic resources is increasing, and profitable agricultural activity can only be realized by managing them accordingly. The solution to this, as in the past, will be agricultural research. Closely related to this is the fact that the practical utilization of theoretical results must be evaluated. Therefore, mapping the extent to which farmers monitor scientific research is of elementary interest. Do they use it, or do they farm according to the old established knowledge? In our opinion, this has become a more important issue than theoretical knowledge. The role of habit is difficult to overcome in agriculture as well.

Between theoretical knowledge and practical use, it is necessary to find the ways that can make the latest results the focus of attention for the masses, in a practice-oriented way. It is in the interests of producers to obtain information, since profitability depends on the correct foundation of individual decisions.

Author contributions

István Takács: Conceptualization, Data curation, Formal Analysis, and Writing – original draft; Róbert Bársony: Writing – review & editing; Adrien Fenyvesi: Writing – review & editing; Viktória Erzsébet Mazák: Writing – review & editing. All authors have read and agreed to the published version of the manuscript.

Use of AI tools declaration

The authors wish to declare that OpenAI's ChatGPT was utilized for reviewing and ensuring consistency in the English language, and sentence structure.

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Conflict of Interest

The authors declare that they have no conflicts of interest.

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