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AGRICULTURAL DECISION-MAKING CONCERNING CROP SELECTION USING ANALYTIC HIERARCHY PROCESS (AHP) IN TRAKYA REGION OF TÜRKIYE

[1*]Okan GAYTANCIOĞLU, [2]Fuat YILMAZ

[1]Ph.D. in Agricultural Economics Tekirdağ Namık Kemal University Tekirdağ Namık Kemal University, Faculty of Agriculture, Department of Agricultural Economics, 59030, Değirmenaltı, Tekirdağ, Turkey*

[2]Ph.D. in Agricultural Economics Tekirdağ Namık Kemal University Tekirdağ Namık Kemal University, Faculty of Agriculture, Department of Agricultural Economics, 59030, Değirmenaltı, Tekirdağ, Turkey, E-mail: fuatyilmaz@nku.edu.tr

Corresponding Author:
ogaytancioglu@nku.edu.tr

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SUMMARY

The multitude of factors that can influence decision-making in agricultural production may have a negative impact on the outcome. Therefore, it is necessary to have access to information and a decision-making process that can facilitate the decision-making process. The Analytic Hierarchy Process (AHP) is a valuable decision-making methodology that can be applied not only in agricultural production but also in various other fields.

This research evaluates four products using the AHP method based on criteria determined by 330 producers and specialists in an area with equal irrigation opportunities for each product. The goal is to determine the most suitable products to plant in these areas. We found rice as the crop offering the highest profit levels. The AHP model employed in this study primarily serves to ascertain the significance levels of various criteria, demonstrating its effectiveness as a decision-making tool in crop selection when the right set of criteria is applied.

KEY WORDS: *Government support, marketing possibility, irrigation management.*

INTRODUCTION

The choice of crops to cultivate in the upcoming growing season is crucial for farmers. Making this decision becomes more straightforward when they can predict the revenue from their crops. However, because of environmental considerations, this procedure is still full of unknowns and hazards, which is a problem that faces farmers everywhere, not just in Türkiye.

In Turkiye, a developing country, farmers often choose crops that yield higher returns. They also favor crops that are easy to market, and for such products, public institutions sometimes intervene as buyers. Certain crops may also receive targeted support based on their specific attributes. However, farmers typically base their planting decisions on the earnings from previous years, rather than relying on scientific data. This approach aligns with the classical Spider Web Theory, which can be observed in the agricultural sector of Turkiye. For instance, this theory is evident in the price fluctuations of onions and potatoes, as noted in the SETA 2021 report.

The outcomes of this study conducted in the Thrace region are relevant for multiple years. Wheat and sunflower cultivation are particularly suitable for regions with deficient irrigation systems due to the adaptability of these crops to dry farming conditions. Furthermore, the market demand for these crops reinforces their suitability. Turkiye has a notable public agency dedicated to wheat-related products. The agency collaborates with a producers' union and sunflower oil mills to provide guidance to farmers on production decisions. The objective is to manage the quantities of wheat and sunflower produced, aiming for a harmonious balance. In areas where irrigation is less than ideal, farmers are generally limited to a narrow selection of crops, predominantly wheat and sunflowers.

In regions with adequate irrigation, a competitive dynamic exists among four primary crops: sunflowers, corn, rice, and sugar beets, all of which offer substantial profitability. Producers make cultivation decisions based on various factors, including government subsidies, marketability, and, predominantly, the revenue they have previously generated from these crops.

The primary objective of this study is to assess the factors that farmers in irrigated regions consider when choosing which crops to cultivate. For this purpose, we employ the Analytic Hierarchy Process (AHP), as it offers a mathematical approach to addressing multi-criteria decision-making issues, uniquely incorporating qualitative data. Other multi-criteria decision-making methods, like goal programming, lack the capability to integrate qualitative data. Since agricultural production choices represent a critical decision-making process, the utilization of AHP enables the identification of the most advantageous crop selections based on a comprehensive set of criteria.

The Analytic Hierarchy Process (AHP), developed by Dr. Thomas L. Saaty, has a wide range of applications that demonstrate its validity. A key advantage of AHP is that it enables decision-makers to compare the relative significance of each factor against all others, establishing priorities for the relative importance of all the factors involved. Agriculture can benefit greatly from this capability as it not only evaluates the importance of different factors but also helps determine the optimal quantities of crops to cultivate each year. The quantitative results obtained from AHP can significantly improve the quality of decision-making.

AHP can be an effective decision support system for shaping agricultural policies, particularly in countries like Turkey. It can guide the formulation of national agricultural production strategies. In this specific case study, we found that the most important factor for growers is the highest return on investment. By using AHP, policymakers can gain insights into decision-making trends and create agricultural policies that better meet economic objectives and farmers' needs.

METHODOLOGY

RESEARCH MATERIAL

The target audience of the research consists of producers in irrigated agriculture villages in the Thrace Region. Since it is impossible to examine all the producers in these villages, a sample was taken to represent the main population. The following formula was used to determine the sample volume (Collins 1986).

$$n = \frac{p * q * z_{\alpha/2}^2}{D^2}$$

n = Number of samples

$z_{\alpha/2}^2$= Confidence coefficient (for 90% confidence interval, this coefficient is taken as 1.645)

p = Probability of the unit being examined among the main population (Those who have a positive approach to irrigated agriculture)

q = 1-p (Proportion of those who have no knowledge about irrigated agriculture and have a negative opinion)

D = 5% (Error rate)

The probability (p) of the unit being examined within the population was taken as 0.50 in order to reach the highest sample that would represent the population. In other words, the rate of those who had a positive view of irrigated agriculture was accepted as 50%, and the rate of those who had no opinion and had a negative view was accepted as 50%. In this type of sampling, (p) = (q) = 0.5 is accepted. In this way, the largest possible sample volume is obtained. While the confidence level was accepted as 90% (z = 1.645), the minimum number of producer surveys (sample volume) that needed to be conducted was found to be 270. This value gives the minimum number of surveys that need to be done. The research was conducted using data gathered from 270 producers in the Trakya region, complemented by insights from 5 agricultural experts who possess extensive knowledge of both the region and the agricultural sector. A review of the literature reveals that AHP has been employed in a diverse range of decision-making scenarios, as documented in Zahedi's 1986 study. This breadth of application underscores the versatility and effectiveness of AHP in addressing complex decision-making problems.

LITERATURE SUMMARY

The Analytic Hierarchy Process (AHP), introduced by mathematician Thomas L. Saaty in 1971, has evolved significantly since its theoretical and practical applications began in 1973. Initially used in developing a transportation system in Sudan for agricultural exports, AHP's versatility was quickly recognized. Saaty and Bennett applied it in 1976 to predict the outcome of the U.S. presidential election, illustrating its potential in socio-political realms. By 1982, Saaty and Vargas extended its application to various sectors, including economic and technological decision-making. The method's widespread adoption was highlighted in Fountzoula and Aravossis's 2021 research, reflecting its robustness in diverse decision-making fields.

AHP has been significantly useful in agriculture. Alphonce's (1997) article highlighted its role in agricultural decision-making in developing countries, including the selection of optimal farm locations and crop production technologies. Guo and He (1999) integrated AHP with Goal Programming to address grain losses and production costs in developing countries. This integration demonstrated AHP's ability to blend qualitative and quantitative criteria, enhancing its effectiveness in agriculture. Furthermore, the adaptability of AHP to modern agricultural challenges is demonstrated by its application in biofuel efficiency assessment by Acaroglu et al. in 1999 and its ongoing relevance, as noted by Kumar and Pant in 2023 for sustainable agriculture. The practical utility of AHP across various organizational contexts is further indicated by the development of decision support software such as Expert Choice and Decision Lens.

THE ANALYTIC HIERARCHY PROCESS

Decision-making is a fundamental aspect of both personal and public spheres. In addressing decision-making challenges, numerous factors influence the optimal outcome, with various potential results being prioritized based on these factors. Organizing these factors and outcomes to clearly depict their interrelationships is crucial. A hierarchical structure proves exceptionally beneficial for this purpose.

The Analytic Hierarchy Process (AHP), as elaborated by Saaty and Vargas in 1987, doesn't impose predetermined factors on users. Instead, it offers the flexibility to identify and tailor a decision-making framework specific to the user's needs. The initial step in applying AHP, as Saaty noted in 1982, involves a comprehensive identification of all factors impacting the decision.

These identified factors are then systematically arranged in a hierarchical order, typically consisting of the goal, criteria, sub-criteria, and alternatives, as outlined by Zahir in 1991. This hierarchical setup should clearly represent the functional dependency relationships among the elements. Such an organized structure allows for clear and distinct judgments on the various factors that influence the decision, facilitating a thorough and systematic approach to complex decision-making scenarios.

An example of a hierarchical structure is shown in Figure 1.

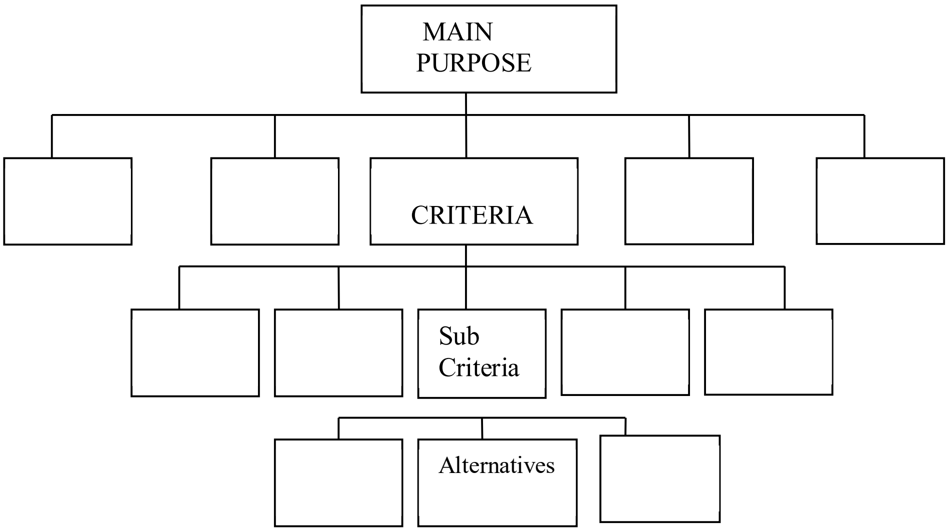

Figure 1 Hierarchical Organization Example

Once the hierarchical structure is established in the Analytic Hierarchy Process (AHP), the next step involves constructing pairwise comparison matrices. These matrices are crucial for determining the relative importance of the criteria and sub-criteria within the hierarchy. In pairwise comparisons, the decision-maker evaluates two factors at a time, using one as a reference and estimating how much more significant the other is concerning a goal, or in the case of alternatives, with respect to a criterion. This process of comparing each element against numerous others enhances the accuracy and consistency of the decision-making process, as noted by Saaty in 1980.

For making these paired comparisons, Saaty's 1-9 scale is employed, which is based on stimulus-response theory. The validity of this scale has been established through various applications and theoretical comparisons with other scales, as discussed by Saaty and Vargas in 1991. The scale's numbers are absolute, indicating the dominance of one element over another by a specific factor, and they are not convertible like numbers in ratio scales such as pounds to kilograms. Absolute numbers are invariant under the identity transformation.

In scenarios involving multiple decision-makers, differing opinions can arise regarding judgments. Aczel and Saaty, in 1983, demonstrated that the geometric average should be used for aggregating the judgments of several individuals for each pairwise comparison.

The pairwise comparison matrix is underpinned by four main axioms that validate its theoretical foundation, as detailed by Saaty in 1986. These axioms ensure that the matrix reliably reflects the relative importance and relationships between the various factors in the decision-making process.

$$A = \begin{bmatrix} 1 & a_{12} & \dots & a_{1n} \\ 1/a_{12} & 1 & \dots & a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ 1/a_{1n} & 1/a_{2n} & \dots & 1 \end{bmatrix} \quad (1)$$

Once the pairwise comparison matrices are completed, the next step in the Analytic Hierarchy Process (AHP) is to extract priorities for the criteria, sub-criteria, and alternatives. These priorities are derived from separate matrices for each category. The key mathematical concept used in this step is the principal eigenvector, which corresponds to the principal eigenvalue of the matrix.

The principal eigenvector is crucial as it represents the relative weights or priorities of the elements being compared. The principal eigenvalue, on the other hand, is the largest eigenvalue of the matrix and is integral in the calculation of the principal eigenvector. This eigenvector essentially summarizes the information contained in the pairwise comparisons, providing a consistent ranking of the criteria, sub-criteria, or alternatives based on the judgments made.

The use of the principal eigenvector in AHP is not arbitrary; it has been theoretically justified as the most appropriate method for representing the derived priorities. It captures the essence of the relative importance assigned to various factors in the decision-making process, allowing for a structured and quantitative approach to complex decisions.
If λ_{max} is the principal eigenvalue, the priority vector W is obtained by solution of the homogeneous linear system of equations.

$$(A-\lambda_{max}I)\ W = 0 \qquad (2)$$

In scenarios where computer access is limited or unavailable, an alternative, simpler method can be employed for approximate calculations instead of solving the equation system (2). This method, as suggested by Saaty (2000), involves normalizing the columns of the matrix and then calculating the average. To achieve this, each element in a column of the matrix is divided by the total sum of that column's elements. Subsequently, the sum of the elements in each row of the newly formed matrix is divided by the number of elements in that row. The outcome of this process provides an approximation of the priority vector.

The final weights of the alternatives are derived by multiplying the priority of each alternative with respect to a given criterion by the weight of that criterion, and then summing these values across all criteria. The alternative with the highest cumulative value is selected for the decision, or a proportionate combination based on the priorities is used.

At this stage, assessing whether the decision-maker is making coherent comparisons between factors is crucial. To evaluate this coherence, the consistency ratio (CR) of each comparison matrix is calculated. This calculation employs a Random Index based on the number of decision alternatives (n), as proposed by Saaty and Ozdemir in 2003.

If the CR is 0, it indicates "complete consistency in the decision maker's judgments." As the ratio approaches 1, it implies that "the matrix reflects random judgments according to the decision maker's evaluations."
A consistency ratio of 0.1 or less suggests that "the result falls within acceptable consistency limits." If the consistency ratio exceeds 0.1, the comparison matrix needs to be re-examined.
Should the consistency ratio not meet the desired standard, the initial step is to rank activities based on the weights derived from a simple line, and then refine the second comparison matrix using this ranking information. This approach can lead to improved consistency (Saaty, 1988).

RESEARCH RESULTS

THE DETERMINATION OF THE FACTORS AFFECTING CROP PREFERENCE

As previously mentioned, a crucial step in resolving decision-making issues using the Analytic Hierarchy Process (AHP) is identifying the factors that influence the decision. Accordingly, interviews were conducted with agricultural producers throughout the region and five experts specializing in crop selection within the research area. The selection of these experts was based on their expertise in the subject matter, their familiarity with the problem, and their knowledge of the region. From the data gathered, it was established that crop choices are made based on the following criteria:

a) Income from the crop (I)
b) Governmental support (GS)
c) Guarantee of marketing (GM)
d) Need of irrigation (NI)
e)

The aforementioned factors are categorized based on their impact levels: High (H), Medium (M), and Low (L). During the crop selection process, the favored crops identified were corn, sunflower, rice, and sugar beet. These selections were made considering the varying degrees of influence each factor has on the decision-making process.

a) Crop Income (I): The preferred crop should yield the highest income per unit area for the producer during the production period. The net profit, after deducting all costs from the revenue, should be at its maximum.
b) Governmental Support (GS): In Turkiye, agricultural support is not considered adequate. The support ratios fluctuate yearly, but governmental assistance generally hovers around 0.35-0.40% of the GNP (Turkish Statistical Institute, 2022). This support is provided based on the cultivated land area and agricultural inputs (Republic of Turkiye Ministry of Agriculture and Forestry, 2023). A significant benefit of this policy is the recording of all producers, enhancing transparency. In the past, public institutions guaranteed market prices, but this practice has been discontinued, leading to a shift in market dynamics. The government's involvement in the market as a buyer was seen to negatively affect competition. These support mechanisms are constrained by the WTO agricultural agreement.

The absence of additional policy tools to complement these supports is a notable shortcoming. A primary issue for Turkish farms is their small scale and low income. Due to limited earnings, Turkish farmers often commence a new production cycle in debt. In 2019, a policy change eliminated the government's role as a market buyer, leading to a decrease in farmers' income.

Additionally, premium payments are made for certain crops like sunflower, soybean, and corn, along with land support, as their production in Turkiye is insufficient. The objective of this policy is to boost the production of these crops (İnan, H., 2016).

c) **Guarantee of Marketing (GM):** A critical concern for producers is securing buyers post-harvest, given that agricultural products are seasonally produced but consumed year-round. It is vital for producers to promptly receive payment for their crops to sustain their livelihood. A major challenge arises from the necessity to sell the entire harvest at once, requiring a substantial amount of money to be injected into the market simultaneously. Consequently, buyers often opt to purchase crops in phases, leading to additional storage costs for producers. To mitigate this issue, public institutions occasionally step in to purchase the unsold produce. For certain products, marketing is not a problem as they serve as raw materials for existing industries, thus ensuring automatic market guarantees.

d) **Need for Irrigation (NI):** Water is a key element that enhances the yield of agricultural products. Different crops have varying water requirements. Adequately meeting these needs significantly boosts productivity. Regional governments invest in irrigation infrastructure, such as barrages and canals, to support crop irrigation requirements. An increase in yield through improved irrigation directly contributes to the nation's overall agricultural production.

Here is an overview of the crops examined in this study, along with their distinct characteristics:
Sunflower: Sunflower is often chosen in dry farming areas as a rotational crop, grown biennially. In such areas, sunflower yield is approximately 1500 kg per hectare (Trakyabirlik, 2022). Producers may choose not to cultivate sunflowers following an overproduction of other crops in previous years. However, failing to rotate crops can lead to issues like wheat crop maggots and Eurygaster ssp. With irrigation, as in the areas studied, sunflower yield can reach 3000-3500 kg per hectare, enhancing producer income. Market prices and government premium payments from previous years become more significant. Due to Turkiye's balance of payments issues, there can be delays in these payments. In such cases, income from other crops gains importance.

The region hosts numerous sunflower-processing facilities and a cooperative union of 40,000 producers. Despite being a crucial crop, Turkiye's sunflower production is insufficient for domestic needs, facilitating market access for producers. However, low export gains lead to a preference for importing sunflowers, causing marketing issues for domestic production. Sunflower's irrigation needs are lower compared to other studied crops.

Corn: Corn, another significant crop with production deficits in Turkiye, saw imports of 3.5 billion tons in 2023 (TUİK, 2022). There is a constant demand for corn from animal feed factories in the region. The government, through the Turkish Grain Board, provides market guarantees and price support for corn production, yet production remains inadequate. Additionally, the government offers premiums to stimulate corn production. Despite these efforts, corn production in the area and across Turkiye cannot meet demand. Producer income often remains at government-set levels. Corn production tends to decrease following years of low government-declared prices. In the region, corn yield is 3000-3500 kg per hectare without irrigation and increases to 6000-6500 kg with irrigation.

Sugar Beet: Sugar beet production has exceeded domestic needs despite quota applications. The state has promoted sugar beet farming since the 1930s, leading to unexpected increases in planting. To control production, the state limited its purchasing guarantees and ceased offering incentives since 2019. The state's support is limited to agricultural input aids. Nonetheless, due to high yield and low irrigation needs, sugar beet remains a preferred crop in irrigated farming areas.

Rice: Turkiye imports 40% of its rice. Rice is highly favored by Turkish consumers, with per capita consumption rising from 3 kg in 1980 to 7 kg in 2022 (TUIK, 2022). Rice offers the highest income for producers. The state minimally intervenes, but numerous specialized rice factories alleviate marketing issues. State incentives for rice are limited to agricultural inputs and a small, stagnant support per kilogram. Rice requires more water compared to other crops, necessitating river and barrage water sources in rice-farming areas.

FORMULATION AND SOLUTION OF A HIERARCHICAL MODEL FOR THE PROBLEM

After identifying the factors and alternatives that influence the decision, we structured these elements hierarchically. The hierarchy spans from the main objective (Crop Preference) to criteria, sub-criteria, and alternatives. This resulted in a four-level hierarchical model, as shown in Figure 2.

The hierarchy generally comprises several levels, increasing in number with the complexity of the decision. The Analytic Hierarchy Process (AHP) offers flexibility in formulating the decision hierarchy. A logically modeled hierarchy aids in understanding the problem and serves as a valuable guide in assessing the relative importance of criteria during the judgment process.

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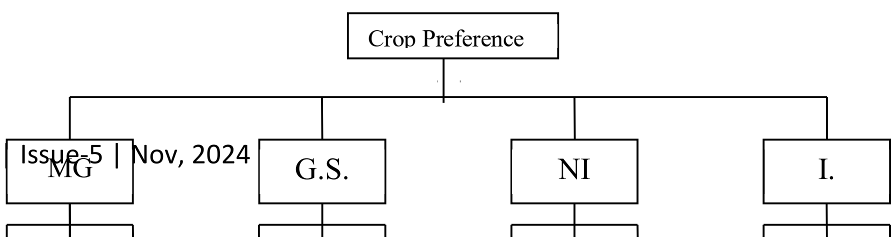

Figure 2: Crop Preference Hierarchy

The top level of this four-level hierarchy represents the "Crop preference," our primary objective. The second level encompasses criteria impacting crop selection, as determined by experts. The third level indicates the extent to which each criterion is fulfilled, and the fourth level lists the alternatives.

The hierarchical structure was formulated first, followed by step-by-step comparisons down the hierarchy, starting from the goal.

Initially, product preference was considered as the main goal. The second level below this goal includes factors affecting product selection, which were compared in pairs. This approach ensures that the evaluator is not influenced by other factors and focuses solely on the two factors being compared. This method of paired comparisons is advantageous for its precision. Inconsistencies in responses are flagged by the computer program, highlighting judgments needing the most adjustment to enhance consistency. This feature is another benefit of using AHP.

Producers and specialists participating in the survey compared two criteria based on their contribution to the objective. These judgments were converted into numerical data using a comparison scale, forming a comparison matrix.

Table 2 presents the outcomes related to the hierarchical structure evaluations, incorporating geometric averages from data collected from surveyed producers and opinions of five specialists. The calculations were performed using a custom-designed MS Excel spreadsheet. The consistency ratio for each matrix is displayed below it, with all matrices showing a consistency ratio below 0.10.

Paired comparisons, as inputs of the AHP, were used to calculate the comparative priority and weights of each alternative. The priorities column in a comparison matrix indicates the normalized weights of factors compared within the matrix. According to these priorities, the crop preferences of farmers are: Income from the crop (63%), Guarantee of marketing (22%), Governmental support (11%), Need for irrigation (4%).

Producers and specialists have identified that the most significant factor in decision-making is 63% of the income from unit land. Thus, irrigation was considered by respondents to be a less significant factor in crop selection. However, the specialists have acknowledged the specific irrigation needs of each crop.

Subsequently, producers provided their opinions on the intensity levels of the aforementioned features or criteria.
In the fourth level of the hierarchy, four products were selected by specialists as alternatives. The specialists compared these products based on each factor determined at the second level of the hierarchy. Tables below illustrate pairwise comparisons.

As evident from the priorities (Table 7), the product with the highest guarantee of marketing is sugar beet. This is attributed to various agricultural inputs provided by sugar factories in the area, along with purchasing guarantees, akin to contractual farming. The low guarantee of marketing for sunflower is explained by Turkiye's foreign trade policy. Due to insufficient domestic production, Turkiye imports sunflowers, with the main reason being the higher cost of domestic production compared to imported sunflowers. This situation leads to hesitancy among producers to cultivate sunflowers, despite the presence of oil factories that could provide a market guarantee. However, these factories often prefer imported sunflowers due to their cost advantage.

The state support criteria ratios for corn and sunflower are similar (Table 8), as production is carried out uniformly with support provided to registered producers. While many products receive per kg support to boost production, other products like sugar beet and corn do not receive such support.

Producers and specialists indicated that rice has the highest irrigation need, as it is a water-intensive crop (Table 9). Rice also yields the highest profit (Table 10). In Turkiye, local rice is preferred by consumers, leading to increased market prices during harvest periods, thereby benefiting producers with higher profits. This scenario is not replicated for sunflower, which also faces a production deficit. Imported sunflower, being cheaper, is preferred by the industry over domestic production.

After weighting and summing operations, the overall product priorities are as shown in Table 11. Rice emerges as the most preferred product with a 49% priority.

In this study, the criteria and alternatives were limited to those deemed important by the specialists. However, other criteria not considered in this study could influence the production decision. The solution could vary with changes in the criteria and alternatives forming the hierarchical structure. Therefore, it's important to note that the solution is based on the chosen alternatives and criteria in this specific application.

DISCUSSION AND CONCLUSION

In countries where agricultural policymakers do not control the market, where there are no contractual agreements between sellers and buyers, and where farmers independently decide on crop production, a multitude of options are available to the farmers. This scenario is particularly relevant in Turkiye, where agricultural support is almost equally distributed across all product types. In such settings, where production decisions are left to the farmers, they are empowered to base their choices on various criteria. This study conducted an analysis of crop preferences in the irrigated lands of Turkiye's Trakya region, utilizing the Analytic Hierarchy Process (AHP) to examine four criteria influencing production decisions. Globally, and in the study region, farmers tend to prefer crops that yield higher profits, as they seek substantial returns for their efforts.

This research has identified rice as the crop offering the highest profit levels. This conclusion, theoretically supported by the AHP, is corroborated by the reality that rice generates the highest profit in the research area. Furthermore, producers are inclined to cultivate rice even in areas with limited irrigation facilities, resorting to the use of costly underground water sources. The AHP model employed in this study primarily serves to ascertain the significance levels of various criteria, demonstrating its effectiveness as a decision-making tool in crop selection when the right set of criteria is applied.

Policy makers, who guide national agricultural policies, could utilize the AHP for production planning and orientation. By determining the production criteria and weights for a region based on annual values, they can direct production potential and focus. A critical aspect here is the nature of state support, tailored to the characteristics of each product. Different forms of state support can alter the perception and preference for certain crops. This study illustrates such a phenomenon: Sunflower, despite receiving support per land and per kg, is the least preferred crop. While governmental support has remained constant over the years, rice emerges as the most favored crop due to its high profitability and substantial market opportunities. It is apparent that current policies for sunflower cultivation are not well-received by farmers. To enhance the appeal of sunflower, the value derived from this crop should be closely aligned or equivalent to the support provided by the state.

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Table 1 The AHP Pairwise Comparison Scale

The level of importance	DEFINITION	EXPLANATION
1	Equal importance of both elements	Two elements contribute equally to the property
3	Weak importance of one element over there	Experience and judgment slightly favor one element over another
5	Essential or strong importance of one element over another	Experience and judgment strongly favor one element over another
7	Demonstrated importance of one element over another	An element is strongly favored and its dominance is demonstrated in practice
9	Absolute importance of one element over another	The evidence favoring one element over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values between two adjacent judgments	Compromise is needed between two judgments

Table 2 Dual Comparison Matrix of Criteria

	GM	GS	NI	I	Priorities
GM	1	3,22	5,48	0,21	0.218
GS	0,31	1	4,23	0,15	0.114
NI	0,18	0,24	1	0,11	0,045
I	4,73	6,74	8,74	1	0,622

CR= 0,097

Table 3 Dual Comparison Matrix Guarantee of Marketing Governmental Support According to Sub Criteria

Table 4 Dual Comparison Matrix of According to Sub Criteria

GM	H	M	L	Priorities
H	1	4.73	7.74	0.72
M	0.21	1	3.72	0.21
L	0.13	0.27	1	0.07

CR=0.07

GS	H	M	L	Priorities
H	1	4.73	9	0.75
M	0.21	1	2.71	0.18
L	0.11	0.37	1	0.07

CR=0.01

Table 5 Dual Comparison Matrix of Need of Irragation Income from the Crop According to Sub Criteria

NI	H	M	L	Priorities
H	1	0.22	0.11	0.06
M	4.47	1	0.21	0.21
L	8.74	4.93	1	0.72

CR=0.08

Table 6 Dual Comparison Matrix of According to Sub Criteria

I.	H	M	L	Priorities
H	1	7.24	9	0.78
M	0.14	1	3.22	0.16
L	0.11	0.31	1	0.07

CR=0.09

Table 7
Dual Comparison of Products
According to Guarantee of Marketing

GM	Corn	Sunflower	Sugar beet	Rice	Priorities
Corn	1	1.68	0.21	0.66	0.13
Sunflower	0.59	1	0.16	0.24	0.07
Sugar beet	4.73	6.24	1	3.22	0.58
Rice	1.52	4.23	0.31	1	0.22

CR=0.02

Table 8
Dual Comparison of Crops
According to Governmental Support

G.S	Corn	Sunflower	Sugar beet	Rice	Priorities
Corn	1	1.41	8.74	8.24	0.49
Sunflower	0.71	1	8.49	8.49	0.41
Sugar beet	0.11	0.12	1	1.19	0.05
Rice	0.12	0.11	0.84	1	0.05

CR=0.01

Table 9
Dual Comparison of Products
According to Need of Irrigation

NI	Corn	Sunflower	Sugar beet	Rice	Priorities
Corn	1	3.22	0.24	0.15	0.10
Sunflower	0.31	1	0.21	0.11	0.05
Sugar beet	4.23	4.73	1	0.25	0.24
Rice	6.74	8.74	4	1	0.61

CR=0.08

Table 10
Dual Comparison of Products
According to Income

IC	Corn	Sunflower	Sugar beet	Rice	Priorities

Corn	1	4.73	3.22	0.19	0.20
Sunflower	0.21	1	0.29	0.11	0.05
Sugar beet	0.31	3.46	1	0.13	0.10
Rice	5.23	9.00	7.48	1	0.65

CR=0.09

Table 11
AHP Result Matrix

PRODUCT	*Priorities*
CORN	0.214
SUNFLOWER	0.092
SUGAR BEET	0.200
RICE	0.493