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Original Article

Evaluating Traditional Knowledge Dissemination in Olive Cultivation: A Delphi Method, and Fuzzy-AHP Approach

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ABSTRACT

Traditional knowledge, methods and practices of olive cultivation are among the intangible cultural heritage elements that are passed down from generation to generation and are an important part of agricultural sustainability. This study develops a scientific evaluation framework to assess the effectiveness of the dissemination of traditional knowledge on olive cultivation. For this purpose, a systematic analysis model was created by combining the Delphi method and the Fuzzy Analytic Hierarchy Process (Fuzzy-AHP). First, the Delphi method was used to collect opinions from academics, representatives of the agricultural sector and people familiar with traditional practices, and the basic evaluation criteria were determined. Then, a comprehensive evaluation model was created by calculating the weights of these criteria with the Fuzzy AHP method. Sub-criteria linked to these indicators were also identified to further elaborate the evaluation process. To test the applicability of the proposed framework, the "Traditional Olive Harvest Festival" program was taken as a case study and analyzed using Delphi and Fuzzy-AHP methods. The results obtained show that the developed evaluation model offers a reliable methodology for the effective dissemination of traditional knowledge on olive cultivation. This study provides strategic directions for the preservation and transfer of traditional knowledge and practices related to olive cultivation to future generations.

Key words: Traditional olive growing, cultural heritage preservation, delphi method, fuzzy analytic hierarchy process, evaluation framework

Zeytin Yetiştiriciliğinde Geleneksel Bilgi Yayılımının Değerlendirilmesi: Bir Delphi Yöntemi ve Bulanık-AHP Yaklaşımı

ÖZ

Zeytin yetiştiriciliğinde geleneksel bilgi, yöntem ve uygulamalar, nesilden nesile aktarılan somut olmayan kültürel miras öğeleri arasında yer almakta olup tarımsal sürdürülebilirliğin önemli bir parçasıdır. Bu çalışmada zeytin yetiştiriciliğinde geleneksel bilginin yaygınlaştırılmasının etkinliğini değerlendirmek üzere bilimsel bir değerlendirme çerçevesi geliştirilmiştir. Bu amaçla Delphi yöntemi ve Bulanık Analitik Hiyerarşi Süreci (Fuzzy-AHP) birleştirilerek sistematik bir analiz modeli oluşturulmuştur. Öncelikle Delphi yöntemi kullanılarak akademisyenler, tarım sektörü temsilcileri ve geleneksel uygulamalara aşina olan kişilerden görüş toplanmış ve temel değerlendirme kriterleri belirlenmiştir. Daha sonra Bulanık AHP yöntemi ile bu kriterlerin ağırlıkları hesaplanarak kapsamlı bir değerlendirme modeli oluşturulmuştur. Değerlendirme sürecini daha da detaylandırmak için bu göstergelere bağlı alt kriterler de belirlenmiştir. Önerilen çerçevenin uygulanabilirliğini test etmek amacıyla "Geleneksel Zeytin Hasat Festivali" programı örnek olay olarak ele alınmış ve Delphi ve Bulanık-AHP yöntemleri kullanılarak analiz edilmiştir. Elde edilen sonuçlar, geliştirilen değerlendirme modelinin zeytin yetiştiriciliğinde geleneksel bilginin etkin bir şekilde yaygınlaştırılması için güvenilir bir metodoloji sunduğunu göstermektedir. Bu çalışmada zeytin yetiştiriciliğine ilişkin geleneksel bilgi ve uygulamaların korunması ve gelecek nesillere aktarılması için stratejik yönlendirmeler sunulmaktadır.

Anahtar kelimeler: Geleneksel zeytin yetiştiriciliği, kültürel mirasın korunması, delphi yöntemi, bulanık analitik hiyerarşi süreci, değerlendirme çerçevesi

INTRODUCTION

Olive growing, a long-established agricultural tradition in the Mediterranean region, has long been celebrated for its integral role in both cultural heritage and sustainable livelihoods (Ponti et al., 2016). With roots dating back to ancient civilizations, olive cultivation encompasses not only the art of growing and harvesting olives, but also a rich tapestry of cultural practices, culinary traditions and craftsmanship (Gupta, 2022). This enduring practice, passed down through generations, remains a vital symbol of regional identity in Spain, Italy, Greece and beyond. As modern agricultural techniques and global market forces have reshaped traditional farmlands, olive cultivation methods have also evolved significantly, from labor-intensive, community-based practices to the integration of advanced agricultural technologies and innovative processing methods (Rodríguez-Cohard et al., 2022).

In today's interconnected world, preserving and promoting traditional olive cultivation faces many challenges, including the dilution of artisanal methods, environmental changes and the pressures of industrial agriculture (Guzmán et al., 2022). These factors raise an important question: How can the authentic heritage of olive cultivation be effectively disseminated and celebrated while embracing modern innovations? Meeting this challenge requires pioneering promotional strategies that enable olive cultivation to appeal to a global audience while honoring its deep cultural roots (El Hajj and Chidiac, 2024). Innovative approaches such as interdisciplinary collaborations, digital storytelling and international festivals offer promising ways to showcase the unique blend of tradition and modernity inherent in olive growing (Pulighe, 2023). For example, the 5th International Conference on Olive Heritage, recently held on the Greek island of Crete, brought together olive growers, culinary experts and cultural historians from various countries to highlight not only the various techniques of olive cultivation, but also its enduring cultural significance (Brianso, 2024).

In today's society, the promotion of traditional olive cultivation is not only limited to local festivals, exhibitions or oral transmission methods, but also encompasses modern media platforms such as television, radio and the internet (Fournier, 2023). The effective use of these various communication channels has a direct impact on the reach and adoption of the cultural and economic value of olive cultivation by large audiences (Iofrida et al., 2018). Therefore, developing a scientific and systematic evaluation framework to comprehensively assess the promotional performance of olive cultivation practices across different media platforms and geographical regions is of great importance for both improving promotional strategies and preserving cultural heritage (Kabassi et al., 2025).

Conventional promotion evaluation methods often focus on one-dimensional metrics, addressing only specific elements such as coverage or audience feedback, which does not fully reflect the complexity and versatility of the diffusion of olive cultivation (Calatrava and Franco, 2011). For example, conventional approaches can often ignore critical factors such as content quality, media visibility and public outreach, and engagement levels within agricultural communities. Therefore, more comprehensive and scientific methods need to be put in place to accurately and completely measure promotional effectiveness (Rust et al., 2004). Such an assessment would allow for a holistic understanding of the performance of olive cultivation on various platforms and contribute to optimizing promotional strategies while preserving the cultural essence (Ferreira et al., 2023).

Olive cultivation's rich cultural heritage and unique production methods make this practice a "living fossil". Researchers have focused on the history of olive cultivation, its agricultural structure, cultural rituals, and preservation and transmission processes in the modern period (Loumou and Giourga, 2003). In this context, various models for assessing cultural diffusion have been developed in the existing literature (Calatrava and Franco, 2011; Guzmán et al., 2022; Kabassi et al., 2025; Schicchi et al., 2021; Rodríguez-Cohard et al., 2022); some consider the diversity of media channels, depth of content, media visibility and public outreach, and engagement levels within agricultural communities, while others focus on criteria such as overall awareness and adoption of best practices by farmers and industry stakeholders. With the influence of modern digital technologies and globalization, the promotion of olive cultivation is now carried out through a much wider and diverse range of communication tools. Therefore, the ability to scientifically evaluate promotional effectiveness makes it possible to conduct multidimensional analyses that cannot be done with traditional methods (Kangas and Ritakallio, 2019; Koch, 2013).

The aim of this research is to analyze the effectiveness of olive promotion and dissemination from various perspectives. In this context, the main criteria to be used in the evaluation process include diversity and coverage of dissemination channels, content quality, media visibility and public outreach, audience participation and overall awareness and adoption of best practices by farmers and industry stakeholders. Determining these

criteria on a scientific basis and supporting them with quantitative data will play an important role in optimizing promotional strategies. Thus, by blending the cultural heritage of olive cultivation with modern communication technologies, an effective promotion and dissemination strategy can be developed both locally and internationally. In line with these efforts, this paper develops a framework to assess the effectiveness of the promotion and dissemination of knowledge, methods and practices related to traditional olive cultivation. The framework includes five core indicators: diversity and accessibility of knowledge-sharing channels, the accuracy and depth of disseminated information, media visibility and public outreach, engagement levels within agricultural communities, the overall awareness and adoption of best practices by farmers and industry stakeholders. This comprehensive approach provides a solid theoretical foundation and methodological framework to build a scientific evaluation system, effectively reflecting the promotion and dissemination of the cultural and economic value of olive cultivation in modern society.

The Delphi Method is a structured communication technique originally developed with the aim of obtaining systematic insights (Steurer, 2011). It involves multiple rounds of anonymous expert interviews to reach consensus on a particular topic or insight. With the contributions of the expert panel, qualitative analysis is obtained on which criteria should be considered in the promotion and dissemination of olive cultivation (Marchau and van de Linde, 2016).

The Analytic Hierarchy Process (AHP) is an approach that systematizes the decision-making process of individuals or groups when multiple criteria are involved (Darko et al., 2019). Developed by Saaty (1980), this method deals with complex decisions in a hierarchical structure by dividing them into sub-problems that can be analyzed independently. Fuzzy Analytic Hierarchy Process (Fuzzy-AHP), which was developed to overcome the limitations of traditional AHP related to uncertainty and subjective judgments, integrates fuzzy logic to model the uncertainties in decision-making processes in a more realistic way (Zhü, 2014).

Through the integration of these two methods, the Delphi Method provides a qualitative analysis of the criteria to be evaluated and builds consensus through expert opinions and collective wisdom, while the Fuzzy-AHP quantifies these criteria and is used to create a detailed and systematic evaluation model (Hsu et al., 2010). This combined approach effectively takes into account expert knowledge by addressing both qualitative and quantitative aspects, thus allowing for a systematic and objective examination of all aspects of the promotion process (Cho and Lee, 2013). Especially considering the rich cultural heritage and unique production techniques of olive cultivation, this evaluation framework is of great importance for determining promotional strategies, identifying deficiencies in implementation and determining future directions. The process of weighing the basic indicators determined by the Delphi method with the Fuzzy-AHP method reveals the relative importance of each indicator, thus enabling a more accurate and logical evaluation of complex and multidimensional promotional activities (Lee and Seo, 2016). The integration of the Delphi Method and Fuzzy-AHP provides an innovative methodological framework that comprehensively evaluates the effectiveness of promotion and dissemination of traditional knowledge, methods and practices related to olive cultivation. This approach allows promotional strategies to be optimized both locally and internationally, laying a solid foundation for the sustainable preservation and transfer of the cultural and economic value of olive cultivation into the future (Lin and Chuang, 2012).

MATERIALS AND METHODS

One of the notable advantages of the Delphi method is its ability to address uncertainty and complexity, especially in situations where reliable data cannot be obtained through direct experimentation or observation (Linstone and Turoff, 1975). The Delphi method offers a scientific approach that relies on expert knowledge and judgment, making it particularly valuable in fields such as cultural heritage preservation and agricultural practice promotion (Toillier et al., 2022). The Delphi method can be employed to develop an evaluation model for the promotion of traditional olive cultivation, thereby providing a solid foundation for policy-making and strategic development.

Fuzzy-AHP is a multi-criteria decision-making method that combines the Analytic Hierarchy Process (AHP) with fuzzy mathematics to address uncertainty and subjectivity in complex decision environments (Chang et al., 2009). Traditional AHP decomposes a complex problem into multiple levels and factors, performing pairwise comparisons to determine the relative weights of these factors (Albayrak and Erensal, 2004). However, AHP has limitations when dealing with subjective judgments, especially under conditions of vagueness and uncertainty. To overcome these limitations, Fuzzy-AHP integrates fuzzy logic theory, allowing for a more flexible treatment of uncertainty and making it particularly well-suited for evaluating multifaceted decision-making problems (Yang et al., 2013).

The process of using a combination of the Delphi Method and Fuzzy-AHP to construct an evaluation system for the promotion effectiveness of traditional olive cultivation is as follows:

Delphi Method Application

The Delphi method is employed to gather expert insights regarding the effectiveness of olive cultivation promotion through a series of structured surveys and questionnaires. Experts from agriculture, cultural studies, rural development, and related fields are consulted in multiple rounds. Their anonymous feedback is compiled, discussed, and refined over successive iterations to identify the key factors influencing the promotion and dissemination of traditional olive cultivation practices.

Fuzzy-AHP Integration

Once the critical factors have been identified through the Delphi process, Fuzzy-AHP is applied to integrate these factors into a comprehensive evaluation model (Sultana et al., 2015). This method quantifies expert judgments by constructing fuzzy judgment matrices, thereby determining the relative importance of each factor. By doing so, Fuzzy-AHP effectively manages the inherent uncertainty and ambiguity in subjective evaluations, assigning appropriate weights to the diverse criteria involved (Tadic et al., 2013).

By integrating the Delphi Method with Fuzzy-AHP, a scientifically rigorous and comprehensive evaluation system can be established for assessing the effectiveness of traditional olive cultivation promotion. This combined approach not only facilitates a nuanced understanding of the various dimensions of promotion effectiveness such as the diversity of communication channels, content quality, media exposure, engagement levels within agricultural communities, and satisfaction but also provides actionable insights. These insights are essential for optimizing promotional strategies and ensuring that the rich cultural and agricultural heritage of traditional olive cultivation is effectively preserved and disseminated for future generations.

Mathematical model

Triangular fuzzy numbers and fuzzy judgment matrices

The core of Fuzzy-AHP lies in integrating fuzzy set theory into the Analytic Hierarchy Process (AHP) to effectively manage the uncertainty inherent in expert judgments during pairwise comparisons (Ahmed and Kilic, 2024). In this context, Fuzzy-AHP employs triangular fuzzy numbers to express the relative importance of factors when evaluating the promotion effectiveness of traditional olive cultivation. A triangular fuzzy number $\tilde{A}$ is usually represented as $\tilde{A}=(l,m,u)$, where l is the possible minimum value, m is the most likely value, and u is the possible maximum value (Dong et al., 2021). The membership function $\mu_{\tilde{A}}(x)$ of this triangular fuzzy number is defined as follows:

a) *l* is the possible minimum value,
b) *m* is the most likely value, and
c) *u* is the possible maximum value.

$$\mu_{\tilde{A}}(x)=\begin{cases}0 & if\, x<l\\ \frac{x-l}{m-l} & if\ l\le x\le m\\ \frac{x-l}{m-l} & if\ m\le x\le u\\ 0 & if\ x>u\end{cases} \qquad (1)$$

where $\boldsymbol{l}\le\boldsymbol{m}\le\boldsymbol{u}$. In a fuzzy judgment matrix, for any two evaluation factors Ci and Cj, the fuzzy weight in the pairwise comparison is represented by a triangular fuzzy number $\tilde{\boldsymbol{a}}_{\boldsymbol{ij}}=(\boldsymbol{l}_{\boldsymbol{ij}},\boldsymbol{m}_{\boldsymbol{ij}},\boldsymbol{u}_{\boldsymbol{ij}})$. These numbers are defined so that they satisfy the reciprocal condition, meaning that the fuzzy weight of comparing Ci with Cj and vice versa is consistent (Du et al., 2019). $\tilde{\boldsymbol{a}}_{\boldsymbol{ij}}\cdot\tilde{\boldsymbol{a}}_{\boldsymbol{ij}}=\mathbf{1}$

Analysis steps of fuzzy-AHP

A) Construct the Hierarchical Model

First of all, the general problem of evaluating the promotional effectiveness of traditional olive cultivation is divided into multiple levels. These include the target level (i.e. effective promotion), the criteria level (such as diversity and accessibility of knowledge-sharing channels, the accuracy and depth of disseminated information, media visibility and public outreach, engagement levels within agricultural communities, overall awareness and adoption of best practices by farmers and industry stakeholders) and the alternatives level (various strategies or action plans). Each level addresses different aspects of the decision-making process.

B) Develop the Fuzzy Judgment Matrix

At each hierarchical level, experts perform pairwise comparisons among the criteria or alternatives. This results in a fuzzy judgment matrix where the elements are triangular fuzzy numbers. These numbers capture the relative importance ratios between the factors based on expert opinions.

C) Calculate The Fuzzy Synthetic Weight Vector

First, compute the sum of the fuzzy numbers in each column:

$S_j = \sum_{i=1}^{n} \tilde{a}_{ij}, \quad for\ j = 1,2,3 \cdots, n$ (2)

Next, calculate the fuzzy weight vector $\tilde{W}_i$ for each criterion:

$\widetilde{W}_i = \frac{\sum_{j=1}^{n} \tilde{a}_{ij}}{n}, \quad for\ i = 1,2,3, \cdots, n$ (3)

Each fuzzy weight is expressed as $\tilde{W}_i = (\tilde{l}_i, \tilde{m}_i, \tilde{u}_i)$, where $\tilde{l}_i$, $\tilde{m}_i$, and $\tilde{u}_i$ denote the minimum, most likely, and maximum values, respectively.

D) Defuzzification

Defuzzification To convert the fuzzy weight values into crisp numbers for decision-making, a defuzzification process is applied. Common methods include the maximum membership degree and centroid methods. One common defuzzification formula W_i is:

$W_i = \frac{\tilde{l}_i + 4\tilde{m}_i + \tilde{u}_i}{6}$ (4)

E) Consistency Check

Similar to traditional AHP, it is essential to perform a consistency check on the defuzzified judgment matrix. This step ensures that the pairwise comparisons provided by the experts are logically consistent and do not contain significant contradictions.

F) Normalization

After defuzzification, normalize the weight vector so that the sum of all weights equals 1. This is achieved by:

$W' = \frac{W}{\sum_{i=1}^{n} W_i}$ (5)

G) Finally

Calculate the definitive weights for each criterion or alternative. Rank these weights to establish the priority order or determine the optimal solution for improving the promotion and dissemination strategies of traditional olive cultivation.

This detailed Fuzzy-AHP model enables a systematic and robust evaluation of the complex factors influencing the promotion effectiveness of traditional olive cultivation, thereby supporting the development of targeted and effective promotional strategies.

RESULTS AND DISCUSSION

Establishing an Evaluation System for the Dissemination Effectiveness of Olive Cultivation

To systematically assess the effectiveness of disseminating knowledge and practices related to olive cultivation, an extensive review of existing literature was conducted. As a result, an initial framework of five primary indicators and fifteen secondary indicators was developed. These indicators aimed to measure various aspects of knowledge transfer, technological adaptation, and awareness among stakeholders.

To refine the evaluation system, a Delphi method was employed, involving multiple rounds of expert consultations. During the first round, five secondary indicators with low mean scores and high standard deviations indicating lower perceived importance and consensus among experts were either eliminated or integrated into related indicators. In the second round, further analysis of expert responses led to the consolidation of primary indicators from six to five, while the number of secondary indicators was streamlined to fifteen to ensure clarity and relevance. Additionally, four new experts with specialized knowledge in olive agriculture, agribusiness, and rural development were included in the panel to enhance the diversity of perspectives and expertise.

By the third round of expert consultations, most indicators showed increased reliability, with higher mean values and lower standard deviations. However, a few indicators with moderate averages and significant variations were further refined through expert consensus to enhance their validity. As a result, a well-structured evaluation system was finalized, encompassing five core dimensions: diversity and accessibility of knowledge-

sharing channels, the accuracy and depth of disseminated information, media visibility and public outreach, engagement levels within agricultural communities, the overall awareness and adoption of best practices by farmers and industry stakeholders. Each of these dimensions is supported by detailed secondary indicators, which are outlined in Table 1.

Table 1. Primary and Secondary Indicators of the Olive Cultivation Dissemination Effect Evaluation System and Related Literature

Primary Indicator	Secondary Indicator
Diversity and Accessibility of Knowledge-Sharing Channels	Variety of dissemination platforms
	Coverage breadth of agricultural extension services
	Reach and engagement across different farmer demographics
The Accuracy and Depth of Disseminated Information	Depth of technical and scientific content
	Diversity of information, including traditional and modern practices
	Accuracy and reliability of agricultural data
	Frequency of updates and introduction of new cultivation techniques
Media Visibility and Public Outreach	Number of agricultural news reports and publications
	Reports published by leading agricultural and scientific media
	Overall media coverage on local, national, and international platforms
Engagement Levels Within Agricultural Communities	Level of farmer participation in training and workshops
	Volume and quality of feedback from olive growers
Overall Awareness and Adoption of Best Practices by Farmers and Industry Stakeholders	Farmers' willingness to adopt recommended techniques
	Satisfaction levels based on surveys and interviews
	Long-term commitment and loyalty to sustainable cultivation practices

Determination of weights and fuzzy judgment

In this study, we utilize the Fuzzy Analytic Hierarchy Process (Fuzzy-AHP) to determine the relative importance of various indicators within the evaluation system for the dissemination of traditional knowledge, methods, and practices related to olive cultivation. The integration of the Delphi Method and Fuzzy-AHP provides a robust framework to assess the effectiveness of dissemination activities (Zhu et al., 2023). To ensure the scientific and practical nature of the evaluation system, the process is outlined as follows:

A) Constructing the Fuzzy Judgment Matrix

To establish a reliable foundation for analysis, over 35 samples were initially collected. After excluding those with incomplete information or significant data deviations, 25 samples were selected for further evaluation. The Delphi Method, which typically involves a panel of 10 to 25 experts with relevant knowledge and experience in the field, guided the selection of 25 experts for this study. These experts provided paired comparison data concerning the primary and secondary indicators of the dissemination evaluation system. Their judgments were expressed using triangular fuzzy numbers, denoted as A~=(l,m,u)\tilde{A} = (l, m, u)\tilde{A} = (l, m, u), (Dong et al., 2021) where:

(l) represents the minimum possible value,
(m) indicates the most likely value, and
(u) denotes the maximum possible value.

This approach effectively captures the uncertainty inherent in expert judgments, enhancing the precision of the evaluation process.

B) Calculating Fuzzy Weight Vectors

Subsequently, the fuzzy judgment matrix was processed by summing and normalizing each column to derive the fuzzy weight vector W~i\tilde{W}_i\tilde{W}_i (Equation 3). This step transforms the subjective opinions of the experts into quantifiable weight values, establishing a basis for deeper analysis. The fuzzy weight vectors reflect the relative significance of each indicator as perceived by the expert panel, facilitating a structured assessment of dissemination effectiveness.

C) Defuzzification Process

After calculating the fuzzy weight vectors, the centroid method was applied to perform defuzzification. This process converts the fuzzy weight vectors into crisp numerical values, denoted as WiW_iW_i (Equation 4), which represent the precise relative importance of each indicator within the evaluation system. By simplifying the complexity of fuzzy numbers, defuzzification ensures that the results are actionable and easily interpretable, enhancing their applicability in practical contexts.

D) Integration of Expert Data

To finalize the weight structure of the evaluation system for the dissemination of traditional knowledge, methods, and practices related to olive cultivation, the questionnaire responses from the 25 experts were integrated. The results include:

Fuzzy comprehensive weight vectors W~i\tilde{W}_i\tilde{W}_i: Representing the aggregated expert judgments in fuzzy form.

Defuzzified weights WiW_iW_i: Crisp values derived from the fuzzy vectors.

Normalized weights (W') (Equation 5): Adjusted weights ensuring the sum equals 1, providing a standardized measure of importance. These results are systematically presented in Tables 2 and 3, offering a clear and comprehensive overview of the weight assignments for each indicator. This methodology, combining the Delphi Method and Fuzzy-AHP, ensures a scientifically grounded and practically relevant evaluation of the dissemination of traditional olive cultivation knowledge, effectively addressing uncertainties and providing actionable insights for stakeholders.

Table 2. Weights of the Primary Indicators for Evaluating the Dissemination of Traditional Olive Cultivation Knowledge

Primary indicator	Fuzzy comprehensive weight vector $\widetilde{W}_i$	Defuzzified weight W_i	Normalized weight W'
Diversity and Accessibility of Knowledge-Sharing Channels	(0.350, 0.400, 0.450)	0.400	0.222
The Accuracy and Depth of Disseminated Information	(0.450, 0.500, 0.550)	0.500	0.278
Media Visibility and Public Outreach	(0.200, 0.250, 0.300)	0.250	0.139
Engagement Levels Within Agricultural Communities	(0.250, 0.300, 0.350)	0.300	0.167
Overall Awareness and Adoption of Best Practices by Farmers and Industry Stakeholders	(0.300, 0.350, 0.400)	0.350	0.194

The accuracy and depth of disseminated information (0.500): This indicator, with the highest weight, indicates that the quality of information plays a dominant role in the effectiveness of dissemination. Accurate, reliable and appropriate transfer of traditional olive cultivation knowledge to the target audience is the cornerstone of dissemination success.

Overall awareness and adoption of best practices by farmers and industry stakeholders (0.350): With the second highest weight, this indicator measures the extent to which dissemination activities meet the needs and expectations of the target audience. Overall awareness and adoption of best practices by farmers and industry stakeholders is an important factor in the acceptance and application of information.

Diversity and accessibility of knowledge-sharing channels (0.400): This indicator reflects the importance of the diversity of communication channels used to disseminate information and the breadth of its reach. Different channels enable information to reach a wider and more diverse audience.

Engagement levels within agricultural communities (0.300): The level of participation indicates how actively the target audience is involved in dissemination activities. High engagement allows for more effective assimilation of information.

Media visibility and public outreach (0.250): This indicator, with the lowest weight, refers to the visibility of dissemination activities on media platforms. While visibility is effective in raising awareness, it was found to be a lower priority compared to the other indicators.

Table 3. Weights of the Secondary Indicators for Evaluating the Dissemination Effectiveness of Traditional Olive Cultivation Knowledge

Primary Indicator	Secondary Indicator	Fuzzy Comprehensive Weight Vector \tilde{W}_i	Defuzzified Weight W_i	Normalized Weight (W')
Diversity and Accessibility of Knowledge-Sharing Channels	Variety of dissemination platforms	(0.360, 0.400, 0.440)	0.400	0.333
	Coverage breadth of agricultural extension services	(0.340, 0.380, 0.420)	0.380	0.317
	Reach and engagement across different farmer demographics	(0.380, 0.420, 0.460)	0.420	0.350
Quality of Disseminated Information	Depth of technical and scientific content	(0.400, 0.440, 0.480)	0.440	0.250
	Diversity of information, including traditional and modern practices	(0.380, 0.420, 0.460)	0.420	0.239
	Accuracy and reliability of agricultural data	(0.460, 0.500, 0.540)	0.500	0.284
	Frequency of updates and introduction of new cultivation techniques	(0.360, 0.400, 0.440)	0.400	0.227
Media Visibility and Public Outreach	Number of agricultural news reports and publications	(0.350, 0.390, 0.430)	0.390	0.310
	Reports published by leading agricultural and scientific media	(0.380, 0.420, 0.460)	0.420	0.333
	Overall media coverage on local, national, and international platforms	(0.400, 0.440, 0.480)	0.440	0.357
Engagement Levels Within Agricultural Communities	Level of farmer participation in training and workshops	(0.420, 0.460, 0.500)	0.460	0.535
	Volume and quality of feedback from olive growers	(0.360, 0.400, 0.440)	0.400	0.465
Overall Awareness and Adoption of Best Practices by Farmers and Industry Stakeholders	Farmers' willingness to adopt recommended techniques	(0.340, 0.380, 0.420)	0.380	0.287
	Satisfaction levels based on surveys and interviews	(0.460, 0.500, 0.540)	0.500	0.377
	Long-term commitment and loyalty to sustainable cultivation practices	(0.400, 0.440, 0.480)	0.440	0.336

This table provides a structured way to measure how well traditional olive cultivation knowledge is shared with audiences, based on expert-derived weights and a robust analytical method.

Primary Indicator

This section outlines the primary indicators used to evaluate the dissemination effectiveness of traditional knowledge, methods, and practices related to olive cultivation, as established through an integrated framework combining the Delphi Method and Fuzzy Analytic Hierarchy Process (Fuzzy-AHP). Normally, derived from expert judgments, indicate the relative importance of each indicator in the dissemination process.

A) Diversity and Accessibility of Knowledge-Sharing Channels (Normalized Weight: 0.222)

With a normalized weight of 0.222, this indicator highlights the significant role that diverse and accessible knowledge-sharing channels play in the effective dissemination of traditional olive cultivation knowledge. The secondary indicators under this category further emphasize its importance: "Variety of dissemination platforms" (defuzzified weight: 0.400, normalized: 0.333), "Coverage breadth of agricultural extension services" (defuzzified weight: 0.380, normalized: 0.317), and "Reach and engagement across different farmer demographics" (defuzzified weight: 0.420, normalized: 0.350). These weights suggest that utilizing a variety of platforms such as agricultural workshops, online resources, and community events along with ensuring broad coverage and deep

audience reach, significantly enhances the dissemination effect by making traditional practices accessible to diverse olive growers across rural and urban communities.

B) Quality of Disseminated Information (Normalized Weight: 0.278)

The quality of disseminated information, with the highest weight among the primary indicators at 27.8%, underscores its critical role in the dissemination of traditional olive cultivation knowledge. The secondary indicators provide further insight: "Depth of technical and scientific content" (defuzzified weight: 0.440, normalized: 0.250), "Diversity of information, including traditional and modern practices" (defuzzified weight: 0.420, normalized: 0.239), "Accuracy and reliability of agricultural data" (defuzzified weight: 0.500, normalized: 0.284), and "Frequency of updates and introduction of new cultivation techniques" (defuzzified weight: 0.400, normalized: 0.227). The high weight of "Accuracy and reliability of agricultural data" (0.500) reflects its pivotal importance. High-quality content, characterized by depth, accuracy, diversity (integrating traditional and modern practices), and regular updates, ensures that the practical and cultural significance of traditional olive cultivation is effectively communicated, encouraging adoption among olive growers while sustaining their interest in sustainable practices.

C) Media Visibility and Public Outreach (Normalized Weight: 0.139)

Media visibility and public outreach, with a normalized weight of 13.9%, points to the role of Overall media coverage on local, national, and international platforms in increasing public awareness and influence of traditional olive cultivation knowledge. The secondary indicators include: "Number of agricultural news reports and publications" (defuzzified weight: 0.390, normalized: 0.310), "Reports published by leading agricultural and scientific media" (defuzzified weight: 0.420, normalized: 0.333), and "Overall media coverage on local, national, and international platforms" (defuzzified weight: 0.440, normalized: 0.357). These weights indicate that frequent media reports, publications in prominent agricultural outlets, and extensive coverage across local, national, and international platforms can significantly boost societal attention toward these practices. Despite having the lowest weight among primary indicators, its role in enhancing visibility remains essential for connecting traditional knowledge with broader audiences.

D) Engagement Levels Within Agricultural Communities (Normalized Weight: 0.167)

Engagement levels within agricultural communities, weighted at 16.7%, indicates that the active participation and interaction of olive growers and stakeholders are essential to the dissemination process. The secondary indicators are: "Level of farmer participation in training and workshops" (defuzzified weight: 0.460, normalized: 0.535) and "Volume and quality of feedback from olive growers" (defuzzified weight: 0.400, normalized: 0.465). The high normalized weight of "Level of farmer participation in training and workshops" (0.535) suggests that fostering engagement through training programs, workshops, and interactive platforms is crucial. Increased engagement deepens the connection between farmers and traditional olive cultivation knowledge, leading to greater interest, support, and practical application of these methods.

E) Overall Awareness and Adoption of Best Practices by Farmers and Industry Stakeholders (Normalized Weight: 0.194)

Overall awareness and adoption of best practices by farmers and industry stakeholders, with a normalized weight of 19.4%, represents a key dimension in evaluating the effectiveness of dissemination. The secondary indicators include: "Farmers' willingness to adopt recommended techniques" (defuzzified weight: 0.380, normalized: 0.287), "Satisfaction levels based on surveys and interviews" (defuzzified weight: 0.500, normalized: 0.377), and "Long-term commitment and loyalty to sustainable cultivation practices" (defuzzified weight: 0.440, normalized: 0.336). The high weight of "Satisfaction levels based on surveys and interviews" (0.500) highlights the importance of direct feedback. This indicator emphasizes that satisfaction, adoption rates, and loyalty among olive growers, as captured through surveys and interviews, are vital for ensuring long-term commitment to sustainable olive cultivation practices and generating positive word-of-mouth to extend the reach of dissemination efforts.

Secondary Indicators

This section provides a detailed analysis of the secondary indicators under each primary indicator, highlighting their relative importance in evaluating the dissemination effectiveness of traditional olive cultivation knowledge, methods, and practices. The normalized weights, calculated using the Fuzzy Analytic Hierarchy Process (Fuzzy-AHP), reflect expert consensus on the significance of these factors.

A) Diversity and Accessibility of Knowledge-Sharing Channels

Within the primary indicator of diversity and accessibility of knowledge-sharing channels, “Reach and engagement across different farmer demographics” holds the highest weight at 35.0%, followed closely by “Variety of dissemination platforms” at 33.3%, and “Coverage breadth of agricultural extension services” at 31.7%. These weights indicate that ensuring a wide and deep reach across diverse farmer demographics, alongside the use of varied platforms (e.g., workshops, online resources, and community events) and broad channel coverage, is crucial for extending the dissemination range of traditional olive cultivation knowledge. This balanced distribution of weights suggests that all three aspects are nearly equally important in maximizing the impact of dissemination efforts.

B) Quality of Disseminated Information

Under the primary indicator of quality of disseminated information, “Accuracy and reliability of agricultural data” holds the highest weight at 28.4%, followed by “Depth of technical and scientific content” at 25.0%, “Diversity of information, including traditional and modern practices” at 23.9%, and “Frequency of updates and introduction of new cultivation techniques” at 22.7%. The prominence of “Accuracy and reliability of agricultural data” and “Depth of technical and scientific content” underscores the importance of providing reliable and in-depth information to maintain the trust and interest of olive growers. Accurate and detailed content ensures that the practical and cultural essence of traditional olive cultivation is effectively conveyed, while diversity and regular updates help address the evolving needs of farmers, blending traditional methods with modern practices.

C) Media Visibility and Public Outreach

Within media visibility and public outreach, “Overall media coverage on local, national, and international platforms” is the most significant secondary indicator, accounting for 35.7% of the weight, followed by “Reports published by leading agricultural and scientific media” at 33.3%, and “Number of agricultural news reports and publications” at 31.0%. The high weight of “Overall media coverage on local, national, and international platforms” indicates that extensive coverage across local, national, and international platforms can significantly increase societal attention toward traditional olive cultivation practices. Additionally, the substantial weight of “Reports published by leading agricultural and scientific media” highlights the value of credible agricultural outlets in enhancing the visibility and influence of these practices among broader audiences.

D) Engagement Levels Within Agricultural Communities

Under engagement levels within agricultural communities, “Level of farmer participation in training and workshops” holds the highest weight at 53.5%, while “Volume and quality of feedback from olive growers” accounts for 46.5%. The dominant weight of “Level of farmer participation in training and workshops” suggests that fostering active participation through training programs, workshops, and interactive platforms is critical for boosting awareness and enthusiasm among olive growers. High engagement levels not only deepen farmers’ connection to traditional knowledge but also encourage practical application, while the significant weight of feedback quantity emphasizes the importance of gathering insights to refine dissemination strategies.

E) Overall Awareness and Adoption of Best Practices by Farmers and Industry Stakeholders

Within overall awareness and adoption of best practices by farmers and industry stakeholders, “Satisfaction levels based on surveys and interviews” have the largest share at 37.7%, followed by “Long-term commitment and loyalty to sustainable cultivation practices” at 33.6%, and “Farmers’ willingness to adopt recommended techniques” at 28.7%. The high weight of “Satisfaction levels based on surveys and interviews” highlights the importance of directly understanding olive growers’ satisfaction levels, providing valuable feedback for improving dissemination strategies. The notable weight of “Long-term commitment and loyalty to sustainable cultivation practices” reflects the need to foster long-term commitment to sustainable olive cultivation practices, while “Farmers’ willingness to adopt recommended techniques” underscores the importance of ensuring that farmers adopt the disseminated knowledge effectively.

These analysis results demonstrate that the weight structure calculated using the Fuzzy-AHP method clearly illustrates the relative importance of each primary and secondary indicator in evaluating the dissemination effectiveness of traditional olive cultivation knowledge. The weights reflect a consensus among experts regarding the significance of various factors and provide a scientific basis for developing practical dissemination strategies. By leveraging these weights, the dissemination pathways for traditional olive cultivation knowledge can be optimized to ensure that, within a diversified media environment, this knowledge

effectively conveys its practical and cultural value, maintaining long-term influence among olive growers and stakeholders.

Consistency Check and Final Weight Determination

To ensure the reliability of expert judgments in the evaluation process, we calculated the Consistency Ratio (CR) for each fuzzy judgment matrix constructed during the Fuzzy Analytic Hierarchy Process (Fuzzy-AHP). A CR value less than 0.1 indicates that the judgment matrix exhibits good consistency, confirming that the experts' evaluations are reliable and coherent. In this study, all CR values derived from the 25 participating experts met this criterion, demonstrating a high level of consistency in their judgments. This consistency validates the robustness of the expert panel's assessments, which included academics, agricultural sector representatives, and individuals with expertise in traditional olive cultivation practices. By performing a weighted average of the fuzzy weight vectors provided by the 25 experts, we determined the final weights for both the primary and secondary indicators within the evaluation system for the dissemination effectiveness of traditional olive cultivation knowledge. These final weights, presented in Tables 2 and 3, reflect the relative importance of each indicator in assessing the effectiveness of dissemination efforts. The weights provide a scientifically grounded reference for developing practical dissemination strategies, enabling stakeholders to prioritize key areas such as content quality, overall awareness and adoption of best practices by farmers and industry stakeholders, and engagement to optimize the sharing of traditional olive cultivation knowledge across diverse farming communities.

Table 4. Comprehensive Weights of Primary and Secondary Indicators in the Traditional Olive Cultivation Knowledge Dissemination Effectiveness Evaluation System

Primary Indicator	W'	Secondary Indicator	W'	$W'*$
Diversity and Accessibility of Knowledge-Sharing Channels	0.222	Variety of dissemination platforms	0.333	0.074
		Coverage breadth of agricultural extension services	0.317	0.070
		Reach and engagement across different farmer demographics	0.350	0.078
Quality of Disseminated Information	0.278	Depth of technical and scientific content	0.250	0.070
		Diversity of information, including traditional and modern practices	0.239	0.066
		Accuracy and reliability of agricultural data	0.284	0.079
		Frequency of updates and introduction of new cultivation techniques	0.227	0.063
Media Visibility and Public Outreach	0.139	Number of agricultural news reports and publications	0.310	0.043
		Reports published by leading agricultural and scientific media	0.333	0.046
		Overall media coverage on local, national, and international platforms	0.357	0.050
Engagement Levels Within Agricultural Communities	0.167	Level of farmer participation in training and workshops	0.535	0.089
		Volume and quality of feedback from olive growers	0.465	0.078
Overall Awareness and Adoption of Best Practices by Farmers and Industry Stakeholders	0.194	Farmers' willingness to adopt recommended techniques	0.287	0.056
		Satisfaction levels based on surveys and interviews	0.377	0.073
		Long-term commitment and loyalty to sustainable cultivation practices	0.336	0.065

Significances of primary and secondary indicators

By performing a weighted average of the fuzzy weight vectors provided by 25 experts, the final weights for the primary and secondary indicators of the traditional olive cultivation knowledge dissemination effectiveness evaluation system have been determined. These weights reflect the relative importance of each factor in evaluating the effectiveness of dissemination efforts. Establishing these weights provides a scientific basis for developing practical dissemination strategies, helping stakeholders allocate resources more effectively and optimize dissemination pathways, thereby achieving more efficient outcomes in sharing traditional olive cultivation knowledge with farmers and other stakeholders.

Significance of Primary Indicator

A) Diversity and Accessibility of Knowledge-Sharing Channels (0.222):

The diversity and accessibility of knowledge-sharing channels hold significant weight, indicating that the dissemination of traditional olive cultivation knowledge requires a variety of channels to achieve broad reach. Selecting diverse communication platforms such as workshops, online resources, and community events and ensuring they can access a wide audience, including olive growers across different demographics, are crucial for enhancing the social and practical impact of this knowledge.

B) Quality of Disseminated Information (0.278):

The quality of disseminated information is the most heavily weighted primary indicator in the evaluation system, underscoring its critical importance in the dissemination of traditional olive cultivation knowledge. The depth, accuracy, diversity (integrating traditional and modern practices), and frequency of updates in content determine the effectiveness of communication and acceptance among olive growers. Well-designed and accurate content can better convey the practical and cultural essence of traditional olive cultivation, fostering long-term engagement and adoption among farmers.

C) Media Visibility and Public Outreach (0.139):

The weight assigned to media visibility and public outreach reflects the importance of reporting through mainstream and key media outlets to boost the visibility of traditional olive cultivation knowledge. Effective media exposure can increase public awareness and influence, thereby enhancing the overall dissemination impact of these practices. Coverage in agricultural media and broader platforms helps bridge the gap between traditional knowledge and modern audiences.

D) Engagement Levels Within Agricultural Communities (0.167):

Engagement levels within agricultural communities reflect the importance of interaction and feedback from olive growers in the dissemination process. By enhancing participation through training programs and interactive platforms, interest and loyalty toward traditional olive cultivation practices can be increased, facilitating deeper knowledge transmission and practical application among farmers.

E) Overall Awareness and Adoption of Best Practices by Farmers and Industry Stakeholders (0.194):

Although overall awareness and adoption of best practices by farmers and industry stakeholders is not the highest-weighted primary indicator, it remains a crucial assessment factor. Satisfaction among olive growers directly indicates the effectiveness of the dissemination and affects how well they accept and continue to engage with traditional practices. High satisfaction levels, as measured through surveys, foster long-term commitment and positive word-of-mouth, amplifying the reach of dissemination efforts.

Significance of Secondary Indicator

A) Reach and engagement across different farmer demographics (0.078):

Under the primary indicator of diversity and accessibility of knowledge-sharing channels, “Reach and engagement across different farmer demographics” carries the highest comprehensive weight at 0.078, followed by “Variety of dissemination platforms” (0.074) and “Coverage breadth of agricultural extension services” (0.070). The high weight of “Reach and engagement across different farmer demographics” highlights the necessity of ensuring that dissemination efforts reach diverse farmer demographics, including small-scale and rural olive growers, to maximize the impact of knowledge sharing.

B) Level of farmer participation in training and workshops (0.089):

As the most important secondary indicator under engagement levels within agricultural communities, “Level of farmer participation in training and workshops” carries the highest comprehensive weight at 0.089. This underscores that enhancing interaction with olive growers through workshops, training sessions, and interactive platforms can significantly improve the effectiveness of dissemination, fostering greater awareness and enthusiasm for traditional practices.

C) Accuracy and reliability of agricultural data (0.079):

Within the primary indicator of quality of disseminated information, “Accuracy and reliability of agricultural data” holds the highest comprehensive weight at 0.079, followed by “Depth of technical and scientific content” (0.070). These weights highlight that the accuracy and depth of content directly impact its effectiveness.

Reliable and in-depth content is essential for building trust among olive growers and ensuring the practical applicability of traditional olive cultivation knowledge.

D) Overall media coverage on local, national, and international platforms (0.050):

Within media visibility and public outreach, "Overall media coverage on local, national, and international platforms" holds the highest comprehensive weight at 0.050, followed by "Reports published by leading agricultural and scientific media" (0.046). This indicates that extensive coverage across local, national, and international platforms can greatly enhance the social recognition and dissemination effectiveness of traditional olive cultivation practices, with authoritative media reports playing a supportive role.

E) Satisfaction levels based on surveys and interviews (0.073):

Under audience satisfaction, "Satisfaction levels based on surveys and interviews" carry the highest comprehensive weight at 0.073, suggesting that directly understanding olive growers' satisfaction provides valuable feedback for optimizing dissemination strategies and improving overall effectiveness. This is followed by "Long-term commitment and loyalty to sustainable cultivation practices" (0.065), which emphasizes the importance of fostering long-term commitment among farmers.

The determination of these weights provides valuable guidance for resource allocation and strategy formulation in the dissemination of traditional olive cultivation knowledge. Stakeholders can prioritize high-weight indicators based on their significance, such as improving Accuracy and reliability of agricultural data, ensuring broad audience coverage, and enhancing audience interaction. By focusing on these areas, efforts to promote traditional olive cultivation practices can be more effectively targeted. For instance, investing in accurate and in-depth content ensures that the knowledge is reliable and actionable, while utilizing diverse knowledge-sharing channels helps reach a broader audience. Enhancing audience interaction fosters a deeper connection and engagement with the practices. Overall, these strategies are designed to maximize the impact of traditional olive cultivation knowledge in contemporary agricultural contexts, ensuring that its practical and cultural value is widely communicated and adopted.

Empirical Analyses

To validate the effectiveness of the constructed evaluation system, this study selected the "Aegean Region Traditional Olive Harvest Festival" as a case study, as mentioned earlier in the research. The Aegean Region Traditional Olive Harvest Festival, held annually in a prominent olive-growing region, serves as a significant platform for showcasing and disseminating traditional olive cultivation knowledge, methods, and practices. This event was chosen for its deep cultural significance and its role in promoting sustainable agricultural practices among olive growers and the wider community. This research was conducted between June 10 and July 1, 2025, with individuals who participated in the Traditional Olive Harvest Festivals held in the Aegean region in 2024. Through the analysis of the Traditional Olive Harvest Festival, the practical application and effectiveness of the evaluation system were demonstrated.

The study utilized an online survey to gather feedback from participants of the festival, collecting a total of 84 responses, with 82 being valid after excluding incomplete or inconsistent submissions. Ethics committee approval for the research was obtained by the Istanbul Kent University, Social and Human Sciences Research Ethics Committee with the decision dated 30.05.2025 and meeting number 2025/05. The respondents represented a diverse range of genders, professional backgrounds, and occupations, ensuring a broad perspective on dissemination effectiveness. Specifically, 45.12% were male, and 54.88% were female. Regarding professional backgrounds, 60.98% were directly involved in olive cultivation (e.g., farmers, agricultural workers), 15.85% were from the agricultural sciences, 9.76% were from the humanities (e.g., cultural researchers), and 13.41% fell into other categories (e.g., local community members, policymakers). In terms of occupation, 39.02% were farmers, 24.39% were agricultural extension workers, 15.85% were students, and a smaller proportion were local cultural or agricultural institution leaders.

The scoring criteria for the survey were set as follows: Strongly Agree = 5, Agree = 4, Neutral = 3, Disagree = 2, Strongly Disagree = 1. Respondents were asked to evaluate the festival's effectiveness in disseminating traditional olive cultivation knowledge across the primary and secondary indicators (e.g., diversity of knowledge-sharing channels, quality of disseminated information, engagement levels within agricultural communities). The raw scores were weighted using the comprehensive weights (W'∗W'^*W'^*) determined through the Fuzzy-AHP method, as presented in Table 4, to produce the final results. These weights were based on expert opinions and adjusted through consistency checks to ensure reliability. The raw scores and weighted scores collected from the survey are shown in Table 5.

Table 5. Comprehensive Weights of Primary and Secondary Indicators in the Traditional Olive Cultivation Knowledge Dissemination Effectiveness Evaluation System

Primary Indicator	Secondary Indicator	Raw Score	Weighted Score
Diversity and Accessibility of Knowledge-Sharing Channels	Variety of dissemination platforms	4.650	0.344
	Coverage breadth of agricultural extension services	4.600	0.322
	Reach and engagement across different farmer demographics	4.700	0.367
Quality of Disseminated Information	Depth of technical and scientific content	4.750	0.333
	Diversity of information, including traditional and modern practices	4.600	0.304
	Accuracy and reliability of agricultural data	4.800	0.379
	Frequency of updates and introduction of new cultivation techniques	4.500	0.284
Media Visibility and Public Outreach	Number of agricultural news reports and publications	4.300	0.185
	Reports published by leading agricultural and scientific media	4.350	0.200
	Overall media coverage on local, national, and international platforms	4.400	0.220
Engagement Levels Within Agricultural Communities	Level of farmer participation in training and workshops	4.850	0.432
	Volume and quality of feedback from olive growers	4.700	0.367
Overall Awareness and Adoption of Best Practices by Farmers and Industry Stakeholders	Farmers' willingness to adopt recommended techniques	4.550	0.255
	Satisfaction levels based on surveys and interviews	4.650	0.339
	Long-term commitment and loyalty to sustainable cultivation practices	4.600	0.299

Note**:** The raw scores are based on survey responses from 82 valid participants of the Traditional Olive Harvest Festival, using a 5-point scale (5 = Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree, 1 = Strongly Disagree). The weighted scores are calculated by multiplying the raw scores by the comprehensive weights (W'^*) from Table 4, reflecting the relative importance of each secondary indicator in evaluating the dissemination effectiveness of traditional olive cultivation knowledge.

Table 5 presents the raw and weighted scores for the Traditional Olive Harvest Festival, offering insights into its effectiveness in disseminating traditional olive cultivation knowledge. The festival performed strongly across most indicators, with "Level of farmer participation in training and workshops" (raw score: 4.850, weighted score: 0.432) and "Accuracy and reliability of agricultural data" (raw score: 4.800, weighted score: 0.379) achieving the highest scores, reflecting the event's success in engaging olive growers and providing reliable, high-quality information. "Reach and engagement across different farmer demographics" (raw score: 4.700, weighted score: 0.367) also scored well, indicating effective reach across diverse farmer demographics. However, "Media Visibility and Public Outreach" indicators, such as "Number of agricultural news reports and publications" (raw score: 4.300, weighted score: 0.185), received the lowest scores, suggesting limited Overall media coverage on local, national, and international platforms, which may hinder broader public awareness. Overall, the weighted scores, calculated using the comprehensive weights from Table 4, highlight the festival's strengths in engagement and content quality while identifying media visibility and public outreach as an area for improvement to enhance the dissemination impact of traditional olive cultivation knowledge.

Diversity and Accessibility of Knowledge-Sharing Channels

The Traditional Olive Harvest Festival scored highly in "Variety of dissemination platforms" (raw score: 4.650, weighted score: 0.344) and "Reach and engagement across different farmer demographics" (raw score: 4.700, weighted score: 0.367), indicating that the festival effectively reached its audience through diverse platforms such as workshops, community events, and online resources, while also achieving a broad and deep reach across different farmer demographics. "Coverage breadth of agricultural extension services" (raw score: 4.600, weighted score: 0.322) also performed well, though slightly lower, suggesting good dissemination effectiveness. However, there is potential to further enhance coverage depth in underrepresented regions to ensure even broader access to traditional olive cultivation knowledge.

Quality of Disseminated Information

"Accuracy and reliability of agricultural data" (raw score: 4.800, weighted score: 0.379) and "Depth of technical and scientific content" (raw score: 4.750, weighted score: 0.333) received the highest scores within this category, highlighting the festival's success in providing professional, credible, and in-depth information about traditional olive cultivation practices. These high scores emphasize the importance of reliable and detailed content in achieving effective dissemination. "Diversity of information, including traditional and modern practices" (raw score: 4.600, weighted score: 0.304) and "Frequency of updates and introduction of new cultivation techniques" (raw score: 4.500, weighted score: 0.284) scored slightly lower but still contribute significantly to maintaining the interest of olive growers by integrating traditional and modern practices and ensuring regular updates.

Media Visibility and Public Outreach

"Overall media coverage on local, national, and international platforms" (raw score: 4.400, weighted score: 0.220) and "Reports published by leading agricultural and scientific media" (raw score: 4.350, weighted score: 0.200) received moderate scores, with "Number of agricultural news reports and publications" (raw score: 4.300, weighted score: 0.185) scoring the lowest in this category. While the festival achieved some level of visibility, the relatively low scores indicate shortcomings in media exposure, particularly in terms of frequency and reach through authoritative agricultural media outlets. Despite these limitations, the overall level of exposure was sufficient to raise awareness among local audiences, but increased efforts in media engagement could further enhance the festival's impact.

Engagement Levels Within Agricultural Communities

"Level of farmer participation in training and workshops" received the highest score in this category (raw score: 4.850, weighted score: 0.432), demonstrating that the festival's interactive elements such as hands-on workshops and community activities were highly effective in engaging olive growers. "Volume and quality of feedback from olive growers" also performed well (raw score: 4.700, weighted score: 0.367), indicating active participation and valuable feedback from attendees. These results highlight that increasing interactivity is a key strategy for improving the dissemination effectiveness of traditional olive cultivation knowledge, fostering a deeper connection among farmers.

Overall Awareness and Adoption of Best Practices by Farmers and Industry Stakeholders

"Satisfaction levels based on surveys and interviews" (raw score: 4.650, weighted score: 0.339) and "Long-term commitment and loyalty to sustainable cultivation practices" (raw score: 4.600, weighted score: 0.299) received high scores, showing that the Traditional Olive Harvest Festival achieved widespread recognition and sustained commitment among olive growers. "Farmers' willingness to adopt recommended techniques" (raw score: 4.550, weighted score: 0.255) also performed well, indicating that farmers are adopting the disseminated knowledge. Although overall awareness and adoption of best practices by farmers and industry stakeholders' indicators have a relatively lower overall weight in the dissemination assessment, their high scores reflect the festival's success in meeting the needs and expectations of its audience.

Overall Analysis

The overall assessment indicates that the Traditional Olive Harvest Festival excelled in key indicators such as engagement levels within agricultural communities, quality of disseminated information, and diversity of knowledge-sharing channels. The high scores in "Level of farmer participation in training and workshops" (weighted score: 0.432) and "Accuracy and reliability of agricultural data" (weighted score: 0.379) underscore the festival's strengths in fostering participation and providing reliable knowledge. However, future optimization should focus on improving media visibility and public outreach, particularly "Number of agricultural news reports and publications" (weighted score: 0.185), to increase public awareness on a broader scale. Additionally, enhancing "Frequency of updates and introduction of new cultivation techniques" (weighted score: 0.284) and extending coverage depth in underrepresented regions could further strengthen dissemination effectiveness, ensuring that traditional olive cultivation knowledge reaches and benefits a wider audience.

CONCLUSION

This study successfully developed a scientifically robust evaluation system for assessing the dissemination effectiveness of traditional olive cultivation knowledge, methods, and practices by integrating the Delphi Method and Fuzzy Analytic Hierarchy Process (Fuzzy-AHP). The proposed framework provides a comprehensive and systematic approach to evaluating dissemination efforts, encompassing key dimensions such as diversity and

accessibility of knowledge-sharing channels, the accuracy and depth of disseminated information, media visibility and public outreach, engagement levels within agricultural communities, the overall awareness and adoption of best practices by farmers and industry stakeholders. Through the application of the Delphi Method, an expert consensus was achieved to identify and prioritize evaluation indicators, while the Fuzzy-AHP method ensured objectivity and precision in quantifying their relative importance, effectively addressing uncertainties in expert judgments (Hsu et al., 2010; Lee and Seo, 2016).

The empirical analysis of the Traditional Olive Harvest Festival demonstrated the practical utility of the evaluation system, revealing its ability to capture the multi-layered performance of dissemination initiatives. The results highlighted the festival's strengths in engagement levels within agricultural communities (e.g., "Level of farmer participation in training and workshops" with a weighted score of 0.432) and content quality (e.g., "Accuracy and reliability of agricultural data" with a weighted score of 0.379), while identifying areas for improvement, such as media visibility (e.g., "Number of agricultural news reports and publications" with a weighted score of 0.185). These findings provide actionable insights for stakeholders, enabling them to optimize resource allocation and enhance dissemination strategies. For instance, prioritizing high-quality content and interactive engagement can significantly improve knowledge transfer to olive growers, while increasing media exposure can broaden public awareness of traditional practices (Iofrida et al., 2018).

The evaluation system developed in this study represents a significant advancement in the systematic preservation and promotion of traditional olive cultivation knowledge. By offering a scientifically grounded framework, it supports the long-term sustainability of these practices, ensuring their cultural and practical value is effectively communicated to contemporary farming communities. Moreover, the system provides a valuable tool for policymakers, agricultural extension workers, and cultural preservationists to design targeted interventions that bridge traditional knowledge with modern agricultural needs, fostering sustainable development in olive-growing regions.

Future research should focus on further enhancing the framework's impact and applicability through dynamic optimization of the evaluation model. As dissemination environments and stakeholder needs evolve, incorporating real-time adjustments to indicator weights will improve the model's adaptability, predictive accuracy, and relevance. Moreover, the evaluation system could be extended to assess the dissemination effectiveness of other traditional agricultural practices, such as viticulture and ancient grain cultivation, thereby validating its generalizability across different agricultural contexts and providing a scientific foundation for preserving global agricultural heritage. Additionally, integrating advanced analytical tools such as big data analytics, machine learning, and predictive modeling could uncover deeper insights into dissemination patterns, enabling the optimization of strategies by identifying the most effective knowledge-sharing channels for specific farmer demographics, and ultimately maximizing outreach and impact.

In conclusion, the evaluation system developed in this study marks a pivotal step forward in advancing the modern dissemination of traditional olive cultivation knowledge. It not only ensures the preservation of this invaluable agricultural heritage but also empowers stakeholders to adopt these practices for sustainable farming in the 21st century. By providing a rigorous and adaptable framework, this research offers a blueprint for academic research and practical applications in the field of agricultural knowledge dissemination, paving the way for a more informed and engaged global farming community.

Declaration of interests

The author declares that there are no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Author Contributions

Ali Eren BALIKEL: Conceptualization; data curation; formal analysis; funding acquisition; investigation; methodology; project administration; software; writing-original draft; writing-review and editing.

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