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Relationship between Indigenous Knowledge Development in Agriculture and the Sustainability of Water Resources

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Abstract: The relationship between agricultural knowledge and water management is very important. Indigenous knowledge in agriculture can improve the water crisis situation and alleviate water stress from dry and semi-arid areas. Therefore, the combination of these two impacts can improve the agricultural sector and reduce the effects of drought. The purpose of this study was to investigate the factors affecting indigenous knowledge and the sustainable management of water resources for optimal water use in agriculture in the Sistan region of Iran. Alongside field research and interviews with 40 indigenous experts and experts from the Jihad-e-Agriculture sector of the Sistan region, the required information was collected by means of a questionnaire. Using the fuzzy hierarchy process (FAHP), the factors affecting indigenous knowledge and the sustainable management of water resources for optimal water use in the Sistan region were ranked. The final rankings of the factors influencing indigenous knowledge for optimal agricultural use of water resources indicate that the educational-extensional factor, with a final weight of 0.37, is the first priority, while social factors, government support, economics, farmers' knowledge, and information, with weights of 0.24, 0.21, 0.13, and 0.03, respectively, are the next priorities. It is recommended that the indigenous knowledge of local authorities be augmented, and that farmers be encouraged to use modern irrigation techniques to optimize the agricultural irrigation of water.

Keywords: indigenous knowledge; sustainable water resources management; optimal consumption; fuzzy hierarchy technique (FAHP)

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1. Introduction

On a planet where more than two thirds of its surface is covered by water, there is a misconception that water resources cannot be scarce. In order for the use of water to continue, it cannot be withdrawn from reservoirs or other water sources at a rate faster than its natural cycle is capable of restoring and reproducing [1]. Hydrologists and specialists are of the opinion that whenever the ratio of population to volume of renewable freshwater resources exceeds a certain limit, noticeable increases in water scarcity and the pressure and stress caused by water shortage are inevitable. Over the last few decades, this ratio has reached or exceeded the critical limit in more than 24 countries across the world [2,3]. The realities of today's world show that a scarcity of any resource increases tensions and creates new ones. Water is not humane, and today, with a deficiency of water resources, along with the rapid increase in consumption demand in the urban, industrial, and agricultural sectors, water shortage has become the biggest nightmare and challenge for governments. Today, tension over the distribution of freshwater resources across the world, which spans all regions of the world, comes in various forms, creating of conflict between the urban and agricultural need for water and the environment [4,5]. With the growing population, increasing living standards, and increasing attention paid to environmental issues, the attention paid to water resource management has increased. On the other hand, in many countries, water has become a scarce resource. This has been due to population growth on the one hand and to the rapid growth of economic, commercial, and developmental activities on the other [6]. Therefore, when striving for water sustainability, there is a continuous need for long-term agricultural policies, and the correct and optimal use of renewable resources is one of the goals of many governments, including that of Iran [7]. In the current situation, across the world, the issue of water has become one of the main problems and crises and has played an important role in human life compared to previous years. In the vast and rainy country of Iran, farmers face the challenge of dealing with water scarcity. The water factor, its economic role, and its effect on social formation are some of the most important factors affecting the complexities of rural Iran. How water resources should be managed mainly depends on economic indicators, but the idea of sustainable development and the sustainable use of water resources has been considered, which plays a major role in planning and legislation. Therefore, across the world, different methods regarding the exploitation of water resources have been defined, according to the socio-economic and indigenous status of communities [8].

Some analysts and experts consider food and job security to be the main prerequisite for the realization of "national security"; while these two factors are dependent on "water security", this issue is much more prominent in countries and regions whose economies are dependent on agriculture. In terms of national security, the management and planning of water resources in border areas is more important than in other areas [9]. The most important economic sector for villages is the agricultural sector, which depends on the natural potential of the environment for development, progress, and both quantitative and qualitative increase. For sustainable rural development to take place, any development program must be based on a mutual understanding of local needs and resources. In addition, water resources are the most important and basic environmental potential for the development of the agricultural sector. On the other hand, water security improves the economic and social situation of farmers. This means that if the role of human resources in society has been the main axis of development, the role and position of water resources among natural resources is the center of development and has the highest effect on the development of human society and rural areas [10].

Part of the national capital of any ethnic group is indigenous knowledge, which encompasses indigenous beliefs, values, and ecological knowledge of their living environment, which has been the result of years of trial and error in the natural, economic, and social environment. Indigenous knowledge is highly vulnerable to extinction due to its oral nature; however, there are still ambiguities in the knowledge of odor in each region that must be examined to help overcome the problems inflicted by water shortage and drought in a region [11]. The drying up of water sources in big cities is considered to be one of the reasons for migration, which causes many jobs to disappear in water-scarce regions. The lack of a systemic approach, inefficient policy making, inappropriate laws, and pressure put on the agricultural sector under the pretext of increasing employment are among the main causes of the water crisis. The most important advantage of modern knowledge is the ability to create new technologies and transfer them from one environment to another, and one of the important characteristics of indigenous knowledge is its simplicity and compatibility with the environment. Therefore, the two sources of knowledge can be complementary, and a combination of the two can be effective in achieving success and progress. Now it seems that, for several reasons, addressing indigenous knowledge is not a choice but a necessity [12]. Due to its biological nature, agriculture is the largest consumer of water resources. In Iran, most water extraction (87 billion out of 95 billion cubic meters) is consumed by the agricultural sector, a large volume of which (63 billion cubic meters) is wasted due to improper irrigation methods [13].

The agricultural sector in Iran is in a good position with regard to its potential compared to other countries. In terms of irrigated land, Iran ranks fifth after India, China, America, and Pakistan, and in terms of the total area of agricultural land (rain-fed and irrigated) it ranks twentieth. The per-capita area of irrigated land (8 million hectares) is equal to 115 hectares per 1000 people, which is 2.5 times more than the per-capita irrigated land in the world, which is about 45 hectares per 1000 people. On the other hand, the low yield per unit area has caused the efficiency and productivity to decrease despite the land and water resources. For example, the yield of wheat in America is 14 tons per hectare, while in Iran, it is 5.3 tons. The main driver of agriculture across the world is water, so in order to increase the production of agricultural products, irrigation projects have played an essential role throughout the last half century. The production of agricultural products in countries located in arid and semi-arid regions is highly dependent on water, which accounts for more than 90% of the raw production of agricultural products. The agricultural sector is considered to be the most important and main source of food supply in the world; therefore, it plays a significant role in maintaining the balance of food, social, and political security of countries. In past years, agriculture has faced many fluctuations in the area of cultivated land and the yield of crops. Many factors, such as lack of water and salinity, poor management, lack of knowledge and awareness, the existence of competition between different sectors (environment, industry, and household) with the agricultural sector, the wear and tear of water facilities, slow development of grain-cultivated land, and land use change, cause a decrease agricultural product have been produced [2].

In the Sistan region in the southeast of Iran, about 90% of the residents are employed in agriculture. Due to frequent droughts over the last 20 years, the agricultural sector in this region has been almost destroyed. Therefore, the study and analysis of water input as a strategic resource is of great interest to researchers, who can take important steps in improving the conditions of this region by modeling and predicting the future.

Omani [14] studied the effective factors in the sustainable management of agricultural resources in the northern part of the Modaress watershed in the Khuzestan province. The results indicate that five factors, including economic characteristics, variables of educational and extension activities, the social, knowledge and information, and government support, together account for 71% of changes in the level of sustainable management of agricultural water resources. Arfai [15] studied the factors affecting indigenous knowledge in the optimal use of water in the agricultural sector. Their results indicate that there is a positive and significant relationship between independent variables—educational-promotional, cultural-social, economic, and managerial factors—, and the use of indigenous knowledge for optimal water consumption. Additionally, indigenous knowledge of efficient water use showed that educational-extension factors and economic factors have a positive role in optimal water use. Panahi [7] analyzed the factors affecting the optimal management of water resources in the Iranian agricultural system. In explaining the component of optimal management of agricultural water using structural equation modeling, it was found that 37% of the total variable dependent changes for the optimal management of agricultural water resources could be explained by four factors: government activities, extension services, individual and physical factors, and the use of management mechanisms by the producers. Bandani et al. [16] studied and analyzed the role of indigenous knowledge in the sustainable rural development of the Ghaemabad rural district of the Sistan region. The results show that being involved in the culture of the villagers and the participatory aspect of indigenous knowledge has been more effective than other factors in this village. Indigenizing and organizing various resources, including manpower and material capital, along with other experiences in the villages, is a complex and difficult task, but a possible one. Bouzarjomehri et al. [11] studied the local role and local traditions of women in the production and management of livestock products in the village of Abu Nasr, Bavanat city. The results indicate that there is a rich local knowledge and local traditions among rural women in the region, which is due to the traditional (rich) milking system and milk and dairy management mechanism. Rahimian [17], in a study, investigated the factors affecting the sustainable management of water resources among irrigated wheat farmers in the city of Koohdasht. The results, based on a correlation test, indicated that the relationship between sustainable water resource management and annual income varies according to the agricultural sector, the area under total wheat land, training provided to farmers in water management, and farmers' perception of direct and significant water shortage crisis, with variables such as the farmers' plots and percentage of farm slope being reversed and significant. Akhavan and Behbahaninia [18] studied the economic factors affecting the sustainable development and management of water resources in the agricultural sector. The collective effect of independent variables on the dependent variable through multiple regression indicated that from the perspective of experts on economic factors, farmers' knowledge and experts' insights have had a positive effect on the sustainable development and management of water resources in agriculture. Afshari et al. [19] investigated the determinants of farmers' attitudes towards sustainable water resource management in Komijan city. The results show that there was a significant difference between farmers' attitudes towards water resource management according to the type of water source ownership, so that farmers with private property had a more desirable attitude than farmers with common ownership. Hassani et al. [20] studied the factors affecting the water resource management behaviors of farmers in the Hamadan-Bahar plain. Based on their results, the perception of vulnerability, perception of severity of degradation, perception of barriers to water resource protection and responsibility had a significant correlation with water resource management behaviors at a level of one percent. Iglesia and Garot [21] examined adaptation strategies for managing agricultural water under climate change in Europe. The results indicate that the greatest opportunities to take action to improve compliance capacity and respond to change according to water needs are to reform water policy, provide adequate training for farmers, and provide effective financial instruments. Valipour [22] examined land use policy and agricultural water management in the first half of the present century in Africa. The results show that Africa needs government policies to encourage farmers to use irrigation systems and increase cultivation intensity for the irrigated area. In the same study by Valipour et al. [23], the results showed that trial and error policies should be avoided, and expert opinion applied to irrigation systems for each crop. Jacob et al. [6] investigated the relationship between knowledge and practice in sustainable water resource management. Their research shows that participatory processes in short-term decisions, such as water allocation decisions, are modifiable and are not suitable for long-term infrastructure decisions. Another important result indicated that capacity construction costs for stakeholders in the water management decision-making process are not known. Thus, a lack of understanding of the costs and associated complexities may contribute to citizens' lack of successful acceptance of infrastructure decisions. Kernecker et al. [24] examined women's local knowledge of water resources and adaptation to changing landscapes in the Veracruz Mountains in Mexico. This study shows that women in the study area have acquired their water management by relying on their local knowledge about landscape, climate and social networks. These results suggest that women's local knowledge can play an important role in planning development projects and helping women to adapt to sudden changes. Greenland et al. [25] examined in a study the improvement of agricultural water sustainability using farm water management strategy and encouraging drip irrigation. Research findings show that farmers do not accept drip irrigation due to cost and a lack of understanding, as well as problems with installation and maintenance. The solution proposed was to promote effective training programs for drip irrigation. Shahbakhsh et al. [1] conducted a piece of research titled "assessment of modern approach of water governance in the development of water exploitation systems in Sistan region". The simple additive weighting (SAW) method that is used here is one of the multiple attribute decision-making (MADM) methods. The indicators of water governance principles were derived from the opinions of 30 water experts, faculty members, and water users in the Sistan region using the SAW method, and weights were assigned to them to form MADM matrices. According to the results, six indicators were derived as the indicators determining the principles of water governance. 'Traditional users' was selected as the strongest system and 'irrigation and drainage networks exploitation companies' as the weakest system. Additionally, according to the results obtained from water experts, the first rank was assigned to 'irrigation and drainage networks exploitation companies' (A2) with a final crisp score of 6.818, followed by 'water user cooperatives' (A4) with a final crisp score of 6.515 in the second rank, and 'private firms' (A6) with a final crisp score of 6.308 in the third rank. Farrokhzadeh et al. [2] studied sustainable water resource management in an arid area using a coupled optimization-simulation modeling technique. In the study, a multi-objective optimization model was linked with the water evaluation and planning (WEAP) software to optimize water allocation decisions over multiple years. The results were analyzed by comparing purely economic versus multi-objective scenarios on the Pareto front. Finally, the disadvantages and advantages of these scenarios were also qualitatively described to assist the decision process for water resource managers. Abbasian et al. [3] examined a research paper about the economic management of water using valuation policy in mango orchards, with an emphasis on environmental inputs in Chabahar County. The study used cross-sectional data for the 2018–2019 crop years in order to estimate the price of water for mango, and to also estimate its demand, with an emphasis on environmental inputs. To this end, the real price of water was determined using the residual method, and the demand function was estimated using the translog cost function and the equations of the contribution of inputs to cost. The results support the good fit of the model used for the cost function of mango in the studied county. The results of the coefficients in Chabahar County indicate that water cost has a positive relationship with the prices of manure, water, seedling, and crop yield, and a negative relationship with the prices of pesticides and chemical fertilizers. Based on the results of the water demand function, water is a substitute for manure, chemical fertilizer, and seedling with partial elasticities of >1, revealing the impact of water use management and economic valuation on improving the use of other environmental inputs (pesticides, manure, and chemical fertilizers) and seedling, as well as the water itself, in mango production in this region. It is recommended that policies such as optimal pricing of inputs including pesticides, manure, chemical fertilizers, and seedling be adopted in order to curb the resulting environmental pollution.

This literature review shows that proper management is essential to deal with the water crisis. The objectives of water resource management include improving the allocation of water resources, improving consumer behavior, promoting methods to reduce water losses and prevent drought in agricultural activities, and improving the efficiency of water resource capacity and facilities. On the other hand, indigenous knowledge systems have much power in the field of sustainable development in rural areas. Looking at the characteristics of indigenous knowledge systems indicates that indigenous knowledge will be able to use water more effectively, as it is systematic, preserves biodiversity, relies on needs, is participatory, accessible and multi-dimensional, and adapts to people's culture. Indigenous knowledge can play an important role in the process of the sustainable development of a village. For this purpose, one of the objectives of this study was to investigate the factors affecting indigenous knowledge in water consumption in agriculture, while our other purpose was to investigate the factors affecting the sustainable management of agricultural water resources in the Sistan region. Figure 1 shows the geographical location of the study area.

This paper aims to study the factors affecting indigenous knowledge in the optimal use of water in the agricultural sector and the factors affecting the sustainable management of agricultural water resources, and to apply a multi-indicator decision-making modeling under fuzzy logic.

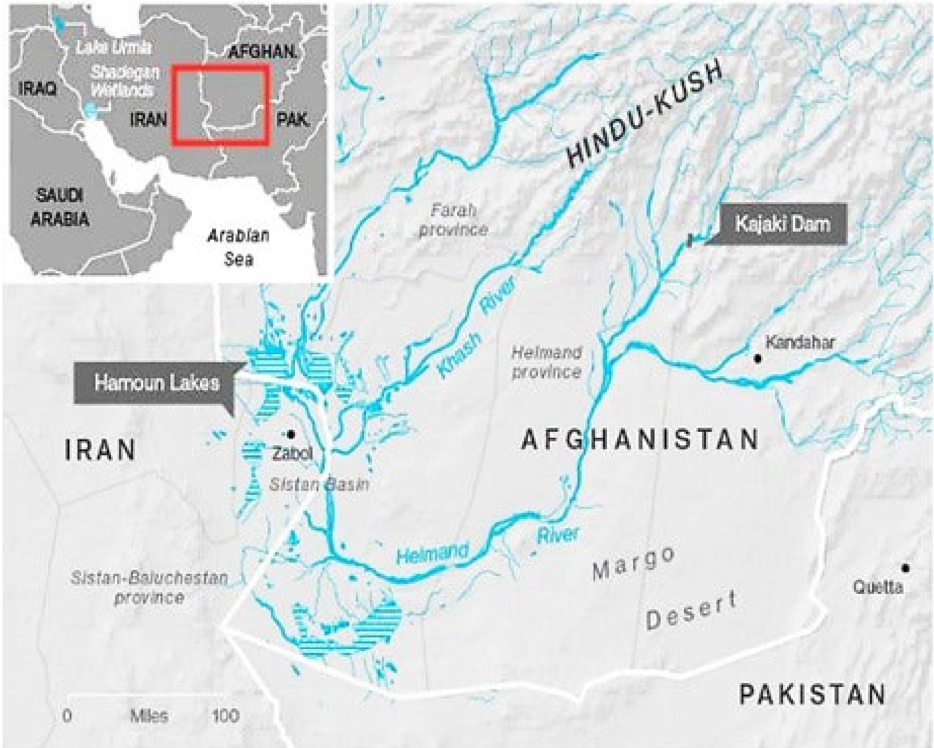

Figure 1. The location of the Sistan region in the southeast of Iran [1].

2. Materials and Methods

When using the fuzzy analytic hierarchy process (FAHP), the first step is to determine the pairwise comparison matrix in FAHP, as follows [26]:

$$A = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ a_{21} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & 1 \end{bmatrix} = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ 1/a_{12} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ 1/a_{1n} & 1/a_{2n} & \cdots & 1 \end{bmatrix} \tag{1}$$

The pairwise comparison matrix is based on the opinion of the decision maker and the elements of each level, considered separately. Matrices include pairwise comparisons between the criteria considered and pairwise comparison matrices of the options under consideration for each criterion.

In general, if the number of options and criteria are M and N, respectively, the pairwise comparison matrices of the options will be M × M and the pairwise comparison matrix of the criteria will be an N × N matrix. The elements of the pairwise comparison matrices with A_{ij} are shown. In the FAHP method, it is assumed that $A_{ij} = 1/A_{ji}$. To perform the relative measurement (or degree of importance) of option M, the comparison operation is performed in pairs. This means that each specific option is not compared to the other available options at the same time; at any given time, it can only be compared to another option [26].

In the present study, the Chang (1996) method was used to perform the FAHP technique. In this method, each criterion is assigned to a fuzzy set of 4, Mi (Li Mi, Ui) is converted, and after drawing a hierarchical tree, the target levels, criteria, and options are determined. In the next step, the matrices are agreed upon according to the decision tree, and, using the opinions of experts in the form of fuzzy triangular numbers in the form of matrices, Equation (2) is formed [26].

$$A = \begin{bmatrix} (1,1,1) & \begin{Bmatrix} \tilde{a}_{121} \\ \tilde{a}_{122} \\ \vdots \\ \tilde{a}_{12p_{12}} \end{Bmatrix} & \ldots & \ldots & \begin{Bmatrix} \tilde{a}_{1n1} \\ \tilde{a}_{1n2} \\ \vdots \\ \tilde{a}_{1np_{1n}} \end{Bmatrix} \\ \begin{Bmatrix} \tilde{a}_{211} \\ \tilde{a}_{212} \\ \vdots \\ \tilde{a}_{21p_{21}} \end{Bmatrix} & (1,1,1) & \ldots & \ldots & \begin{Bmatrix} \tilde{a}_{2n1} \\ \tilde{a}_{2n2} \\ \vdots \\ \tilde{a}_{2np_{2n}} \end{Bmatrix} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ \begin{Bmatrix} \tilde{a}_{n11} \\ \tilde{a}_{n12} \\ \vdots \\ \tilde{a}_{n1p_{n1}} \end{Bmatrix} & \begin{Bmatrix} \tilde{a}_{n21} \\ \tilde{a}_{n22} \\ \vdots \\ \tilde{a}_{n2p_{n2}} \end{Bmatrix} & \ldots & \ldots & (1,1,1) \end{bmatrix} \quad (2)$$

In the next step, the arithmetic mean of decision makers' opinions is calculated as relation (2):

$$\tilde{A} = \begin{bmatrix} (1,1,1) & \tilde{a}_{12} & \ldots & \tilde{a}_{1n} \\ \tilde{a}_{21} & (1,1,1) & \ldots & \tilde{a}_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ \tilde{a}_{n1} & \tilde{a}_{n2} & \ldots & (1,1,1) \end{bmatrix} \quad (3)$$

The arithmetic mean matrix of decision makers' opinions (*jia*) is calculated according to the following equation [26].

$$\tilde{S}_i = \sum_{j=1}^{n} \tilde{a}_{ij} \; i = 1,2,\ldots,n \quad (4)$$

The next step is to calculate the sum of the row elements of the matrix obtained from the arithmetic mean [26]. In the the next step, Equation (4) is used to normalize the matrix of rows:

$$\tilde{M}_i = \tilde{S}_i \otimes \left[\sum_{i=1}^{n} \tilde{S}_i\right]^{-1} \; i = 1,2,\ldots,n \quad (5)$$

Now, according to the mathematical relations governing triangular fuzzy numbers, if it is represented as (Li, Mi, Ui), the above relation is adjusted in the following order:

$$\tilde{M}_i = \left(\frac{l_i}{\sum_{i=1}^{n} u_i}, \frac{m_i}{\sum_{i=1}^{n} m_i}, \frac{u_i}{\sum_{i=1}^{n} l_i}\right) \quad (6)$$

Determining the degree of probability as being larger, (degree of probability) $M_2 = (L_2, M_2, U_2) \geq M_1 = (L_1, M_1, U_1)$ is calculated as follows:

$$VM_2 \succ M_1 = Suby \geq x[Min(\mu M_1, \mu M_2)] \quad (7)$$

where Y and X are the values of the membership functions of each criterion on the fuzzy function axis.

$$V(M_2 \geq M_1) = \mu(d) = \begin{cases} 1 \; if \; m_2 \geq m_1 \\ 0 \; if \; l_1 \geq u_2 \\ \frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} \; otherwise \end{cases} \quad (8)$$

Here, d is the maximum distance between the two membership functions 1 M and 2 M. To compare M_1 and M_2, the value of V ($M_2 \geq M_1$); V ($M_1 \geq M_2$) is needed and K is estimated as follows:

$$V(M \geq M_1, M_2, M_3, \ldots, M_k) = V[(M \geq M_1)\&(M \geq M_2)\&(M \geq M_3)\&\ldots\&(M \geq M_k)] = \Rightarrow MinV(M \geq M1) \quad (9)$$

It can thus be written as follows:

$$d'(A_i) = MinV(M_i \geq M_k)k = 1, 2, 3, \ldots, n; k \neq i \quad (10)$$

Thus, the weight of each vector is obtained as follows:

$$W' = \left(d'(A_1), d'(A_2), d'(A_3), \ldots, d'(A_n)\right)^T \quad (11)$$

Here, W′ is a non-fuzzy number. By normalizing the obtained weights, the final weights can be obtained:

$$W' = \left[\frac{d'(A_1)}{\sum_{i=1}^{n} d'(A_i)}, \frac{d'(A_2)}{\sum_{i=1}^{n} d'(A_i)}, \ldots, \frac{d'(A_n)}{\sum_{i=1}^{n} d'(A_i)}\right]^T \quad (12)$$

The above weights are definite (non-fuzzy). The last step is the combination of weights; by combining each of the weights of the options and criteria, the final weight of the options is obtained [26].

$$\tilde{U}_i = \sum_{j=1}^{n} \tilde{W}_i \tilde{r}_{ij} \quad (13)$$

In multi-criteria decision-making models (MCDM), questionnaires and surveys completed by experts and top experts are used to complete the data. Therefore, in the first stage, experts related to the subject under study were selected and the questionnaires were distributed and completed by them. In this study, according to the objectives, 40 experts from the Agriculture and Water Resource Management Organization were identified, and a questionnaire was distributed among them to complete the information. FUZZY AHP software was used for data analysis. The opinions of experts regarding the identification of factors affecting indigenous knowledge in the optimal use of water in the agricultural sector and the study of factors affecting the sustainable management of agricultural water resources are given in Table 1.

Table 1. The factors affecting indigenous knowledge and the level of sustainable management of agricultural water resources in the optimal use of water in agriculture.

Factors Affecting Indigenous Knowledge in Optimal Water Consumption	Indicators
Visiting programs for farmers regarding indigenous knowledge	Educational-promotional
Training classes on the use of indigenous knowledge	Educational-promotional
Practical projects about indigenous knowledge projects	Educational-promotional
Using publications	Educational-promotional
Codified training packages, e.g., movies, books, tapes, etc.	Educational-promotional
Special seminars for promoting the development of indigenous knowledge	Educational-promotional
Internet network and eLearning	Educational-promotional
Beliefs about indigenous knowledge	Cultural-social
Farmers' interest in using indigenous knowledge	Cultural-social
Positive attitude towards indigenous knowledge	Cultural-social
Communication with neighbors regarding the use of indigenous knowledge	Cultural-social
Interest in joining social groups	Cultural-social
Membership with the water cooperatives association	Cultural-social
Providing special human resources for indigenous knowledge projects	Managerial

Table 1. *Cont.*

Factors Affecting Indigenous Knowledge in Optimal Water Consumption	Indicators
Organizing financial mechanisms for officials regarding to indigenous knowledge	Managerial
Managers' attitude toward indigenous knowledge	Managerial
Practical participation of managers in indigenous knowledge	Managerial
Assigning powers and decisions to farmers and bottom-up decision making	Managerial
Transfer of powers and decisions to farmers in decision making up and down	Economic
Farmers' income	Economic
Insurance for agricultural products at risk of drought	Economic
Extension of drought loan repayment	Economic
Drought loans	Economic
Bank facilities for purchasing pomp motors and machines	Economic
Using publications	Educational-promotional
The rate of use of radio and television	Educational-promotional
Holding classes and training courses	Educational-promotional
Distribution of educational magazines and publication promoting	Educational-promotional
Using educational workshops	Educational-promotional
Communication with specialists (agriculture promoters)	Educational-promotional
Social participation	Social
Social status	Social
Delivery of subsidized inputs to recipients of water resources management	Government support
Material and spiritual incentives for water resource recipients	Government support
Farmer's crop area	Economic
Type of exploitation system	Economic
Farmers' income	Economic
Mechanization level	Economic

3. Discussion

3.1. Identifying the Factors Affecting Indigenous Knowledge of the Optimal Use of Water in the Agricultural Sector

According to Table 2, it is observed that in the matrix of pairwise comparison of indices of factors affecting indigenous knowledge in optimal water consumption in the agricultural sector of Sistan, according to experts of Jihad Keshavarzi, the area of relations with neighbors regarding the use of indigenous knowledge, membership in the aquifer organization, farmers' incomes, and drought loans (11, 13, 19, and 23) are superior to other indicators. Meanwhile, visitation programs for farmers on indigenous knowledge, training classes on the use of indigenous knowledge, practical projects around indigenous knowledge projects, and the provision of specialized human resources in terms of indigenous knowledge projects (1, 2, 3, and 14) have a weak advantage over other indicators.

Table 2. Paired comparison matrix of indicators of factors affecting indigenous knowledge in optimal water consumption in the Sistan agricultural sector.

Comparison	Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6	Criterion 7	Criterion 8	Criterion 9	Criterion 10	Criterion 11	Criterion 12
Criterion 1	1, 1, 1	3, 5, 7	1, 3, 5	1, 3, 5	2, 4, 6	1, 2, 4	2, 4, 6	3, 5, 7	5, 7, 9	4, 6, 8	5, 7, 9	1, 2, 4
Criterion 2	0.2, 0.33, 0.14	1, 1, 1	1, 1, 1	2, 4, 6	1, 1, 1	1, 2, 4	1, 3, 5	1, 2, 4	1, 3, 5	1, 3, 5	1, 1, 1	1, 2, 4
Criterion 3	0.33, 1, 0.2	1, 1, 1	1, 1, 1	3, 5, 7	1, 1, 1	3, 5, 7	3, 5, 7	1, 2, 4	1, 2, 4	2, 4, 6	2, 4, 6	1, 1, 1
Criterion 4	0.33, 1, 0.2	0.2, 0.5, 0.16	0.2, 0.33, 0.14	1, 1, 1	2, 4, 6	4, 6, 8	1, 1, 1	1, 3, 5	3, 5, 7	3, 5, 7	1, 1, 1	3, 5, 7
Criterion 5	0.2, 0.5, 0.16	1, 1, 1	1, 1, 1	0.2, 0.5, 0.16	1, 1, 1	1, 3, 5	3, 5, 7	1, 1, 1	1, 1, 1	1, 1, 1	2, 4, 6	1, 1, 1
Criterion 6	0.5, 1, 0.25	0.5, 1, 0.25	0.2, 0.33, 0.14	0.16, 0.25, 0.12	0.33, 1, 0.2	1, 1, 1	1, 3, 5	1, 2, 4	1, 1, 1	1, 1, 1	4, 6, 8	1, 1, 1
Criterion 7	0.2, 0.5, 0.16	0.33, 1, 0.2	0.2, 0.33, 0.14	1, 1, 1	0.2, 0.33, 0.14	0.33, 1, 0.2	1, 1, 1	3, 5, 7	1, 1, 1	1, 1, 1	1, 1, 1	2, 4, 6
Criterion 8	0.2, 0.33, 0.14	0.5, 1, 0.25	0.5, 1, 0.25	0.33, 1, 0.2	1, 1, 1	0.5, 1, 0.25	0.2, 0.33, 0.14	1, 1, 1	1, 1, 1	1, 1, 1	7, 9, 11	1, 1, 1
Criterion 9	0.14, 0.2, 0.11	0.33, 1, 0.2	0.5, 1, 0.25	0.2, 0.33, 0.14	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 2, 4	5, 7, 9	1, 1, 1
Criterion 10	0.16, 0.25, 0.12	0.33, 1, 0.2	0.2, 0.5, 0.16	0.2, 0.33, 0.14	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	0.5, 1, 0.25	1, 1, 1	5, 7, 9	4, 6, 8
Criterion 11	0.14, 0.2, 0.11	1, 1, 1	0.2, 0.5, 0.16	1, 1, 1	0.2, 0.5, 0.16	0.16, 0.25, 0.12	1, 1, 1	0.11, 0.14, 0.09	0.14, 0.2, 0.11	0.14, 0.2, 0.11	1, 1, 1	7, 9, 11
Criterion 12	05, 1, 0.25	0.5, 1, 0.25	1, 1, 1	0.2, 0.33, 0.14	1, 1, 1	1, 1, 1	0.25, 0.5, 0.16	1, 1, 1	1, 1, 1	0.11, 0.14, 0.09	0.11, 0.14, 0.09	1, 1, 1
Criterion 13	0.16, 0.25, 0.12	0.11, 0.14, 0.09	0.5, 1, 0.25	1, 1, 1	0.12, 0.16, 0.1	0.11, 0.14, 0.09	0.16, 0.25, 0.12	0.11, 0.14, 0.09	0.14, 0.2, 0.11	0.2, 0.33, 0.14	0.11, 0.14, 0.09	1, 1, 1
Criterion 14	1, 1, 1	1, 1, 1	1, 1, 1	0.33, 1, 0.2	1, 1, 1	0.11, 0.14, 0.09	0.16, 0.25, 0.12	0.2, 0.33, 0.14	1, 1, 1	0.11, 0.14, 0.09	0.11, 0.14, 0.09	1, 1, 1
Criterion 15	0.33, 1, 0.2	0.5, 1, 0.25	1, 1, 1	0.5, 1, 0.25	0.16, 0.25, 0.12	0.14, 0.2, 0.11	1, 1, 1	0.14, 0.2, 0.11	0.14, 0.2, 0.11	0.16, 0.25, 0.12	1, 1, 1	0.2, 0.33, 0.14
Criterion 16	0.333, 1, 0.2	0.5, 1, 0.25	1, 1, 1	0.5, 1, 0.25	1, 1, 1	0.16, 0.25, 0.12	0.14, 0.2, 0.11	0.14, 0.2, 0.11	0.14, 0.2, 0.11	0.14, 0.2, 0.11	1, 1, 1	0.14, 0.2, 0.11
Criterion 17	0.5, 1, 0.25	0.33, 1, 0.2	0.33, 1, 0.2	0.14, 0.2, 0.11	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1
Criterion 18	0.11, 0.14, 0.09	0.11, 0.14, 0.09	1, 1, 1	0.33, 1, 0.2	0.11, 0.14, 0.09	0.16, 0.25, 0.12	1, 1, 1	0.16, 0.25, 0.12	0.14, 0.2, 0.11	0.16, 0.25, 0.12	0.14, 0.2, 0.11	1, 1, 1
Criterion 19	0.11, 0.14, 0.09	0.12, 0.16, 0.1	1, 1, 1	1, 1, 1	0.11, 0.14, 0.09	0.14, 0.2, 0.11	0.14, 0.2, 0.11	0.16, 0.25, 0.12	0.16, 0.25, 0.12	0.11, 0.14, 0.09	0.11, 0.14, 0.09	0.12, 0.16, 0.1
Criterion 20	0.5, 1, 0.25	0.5, 1, 0.25	1, 1, 1	0.2, 0.33, 0.14	0.25, 0.5, 0.16	0.2, 0.33, 0.14	1, 1, 1	0.2, 0.33, 0.14	0.16, 0.25, 0.12	0.11, 0.14, 0.09	1, 1, 1	0.11, 0.14, 0.09
Criterion 21	1, 1, 1	0.5, 1, 0.25	0.33, 1, 0.2	0.12, 0.16, 0.1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1
Criterion 22	0.33, 1, 0.2	0.11, 0.14, 0.09	1, 1, 1	0.25, 0.5, 0.16	0.16, 0.25, 0.12	0.16, 0.25, 0.12	0.5, 1, 0.25	0.16, 0.25, 0.12	0.14, 0.2, 0.11	0.11, 0.14, 0.09	1, 1, 1	0.16, 0.25, 0.12
Criterion 23	0.11, 0.14, 0.09	0.11, 0.14, 0.09	1, 1, 1	0.16, 0.25, 0.12	0.11, 0.14, 0.09	0.14, 0.2, 0.11	1, 1, 1	0.16, 0.25, 0.12	0.14, 0.2, 0.11	0.14, 0.2, 0.11	1, 1, 1	0.14, 0.2, 0.11
Criterion 24	0.33, 1, 0.2	1, 1, 1	1, 1, 1	1, 1, 1	0.33, 1, 0.2	0.33, 1, 0.2	0.11, 0.14, 0.09	0.11, 0.14, 0.09	0.11, 0.14, 0.09	0.11, 0.14, 0.09	0.33, 1, 0.2	0.11, 0.14, 0.09
Comparison	**Criterion 13**	**Criterion 14**	**Criterion 15**	**Criterion 16**	**Criterion 17**	**Criterion 18**	**Criterion 19**	**Criterion 20**	**Criterion 21**	**Criterion 22**	**Criterion 23**	**Criterion 24**
Criterion 1	4, 6, 8	1, 1, 1	1, 3, 5	1, 3, 5	1, 2, 4	2, 4, 6	7, 9, 11	1, 2, 4	1, 1, 1	1, 3, 5	7, 9, 11	1, 3, 5
Criterion 2	7, 9, 11	1, 1, 1	1, 2, 4	1, 2, 4	1, 3, 5	2, 4, 6	6, 8, 10	1, 2, 4	1, 2, 4	2, 4, 6	2, 4, 6	1, 1, 1
Criterion 3	1, 2, 4	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 3, 5	1, 1, 1	1, 1, 1	1, 1, 1
Criterion 4	1, 1, 1	1, 3, 5	1, 2, 4	1, 2, 4	5, 7, 9	1, 3, 5	1, 1, 1	3, 5, 7	6, 8, 10	2, 4, 6	4, 6, 8	1, 1, 1
Criterion 5	6, 8, 10	1, 1, 1	4, 6, 8	1, 1, 1	1, 1, 1	2, 4, 6	7, 9, 11	2, 4, 6	1, 1, 1	3, 5, 7	2, 4, 6	4, 6, 8
Criterion 6	7.9, 11	2, 4, 6	5, 7, 9	4, 6, 8	1, 1, 1	4, 6, 8	5, 7, 9	3, 5, 7	1, 1, 1	4, 6, 8	5, 7, 9	1, 3, 5
Criterion 7	4, 6, 8	4, 6, 8	1, 1, 1	5, 7, 9	1, 1, 1	1, 1, 1	5, 7, 9	1, 1, 1	1, 1, 1	1, 2, 4	1, 1, 1	2, 4, 6

Table 2. *Cont.*

Comparison	Criterion 13	Criterion 14	Criterion 15	Criterion 16	Criterion 17	Criterion 18	Criterion 19	Criterion 20	Criterion 21	Criterion 22	Criterion 23	Criterion 24
Criterion 8	7, 9, 11	3, 5, 7	5, 7, 9	6, 8, 10	1, 1, 1	4, 6, 8	4, 6, 8	3, 5, 7	1, 1, 1	4, 6, 8	4, 6, 8	7, 9, 11
Criterion 9	5, 7, 9	1, 1, 1	6, 8, 10	5, 7, 9	1, 1, 1	5, 7, 9	4, 6, 8	4, 6, 8	1, 1, 1	5, 7, 9	6, 8, 10	7, 9, 11
Criterion 10	3, 5, 7	2, 4, 6	4, 6, 8	6, 8, 10	1, 1, 1	4, 6, 8	7, 9, 11	4, 6, 8	1, 1, 1	7, 9, 11	5, 7, 9	7, 9, 11
Criterion 11	7, 9, 11	7, 9, 11	1, 1, 1	1, 1, 1	1, 1, 1	5, 7, 9	7, 9, 11	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 3, 5
Criterion 12	1, 1, 1	1, 1, 1	3, 5, 7	5, 7, 9	1, 1, 1	1, 1, 1	6, 8, 10	7, 9, 11	1, 1, 1	4, 6, 8	5, 7, 9	7, 9, 11
Criterion 13	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	3, 5, 7	6, 8, 10	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1
Criterion 14	1, 1, 1	1, 1, 1	3, 5, 7	2, 4, 6	1, 1, 1	2, 4, 6	7, 9, 11	1, 1, 1	1, 1, 1	2, 4, 6	1, 2, 4	4, 6, 8
Criterion 15	1, 1, 1	0.2, 0.33, 0.14	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	7, 9, 11	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	2, 4, 6
Criterion 16	1, 1, 1	0.25, 0.5, 0.16	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	6, 8, 10	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	3, 5, 7
Criterion 17	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	5, 7, 9	7, 9, 11	7, 9, 11	1, 1, 1	4, 6, 8	4, 6, 8	7, 9, 11
Criterion 18	0.2, 0.33, 0.14	0.25, 0.5, 0.16	1, 1, 1	1, 1, 1	0.14, 0.2, 0.11	1, 1, 1	7, 9, 11	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	3, 5, 7
Criterion 19	0.12, 0.16, 0.1	0.14, 0.11, 0.09	0.14, 0.11, 0.09	1, 1, 1	0.14, 0.11, 0.09	0.14, 0.11, 0.09	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1
Criterion 20	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	0.14, 0.11, 0.09	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	4, 6, 8	1, 2, 4	3, 5, 7
Criterion 21	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	7, 9, 11	1, 1, 1	7, 9, 11
Criterion 22	1, 1, 1	0.25, 0.5, 0.16	1, 1, 1	1, 1, 1	0.25, 0.5, 0.16	1, 1, 1	1, 1, 1	0.25, 0.5, 0.16	0.14, 0.11, 0.09	1, 1, 1	7, 9, 11	2, 4, 6
Criterion 23	1, 1, 1	0.5, 1, 0.25	1, 1, 1	1, 1, 1	0.25, 0.5, 0.16	1, 1, 1	1, 1, 1	0.5, 1, 0.25	1, 1, 1	0.14, 0.11, 0.09	1, 1, 1	2, 4, 6
Criterion 24	1, 1, 1	0.16, 0.25, 0.12	0.25, 0.5, 0.16	0.2, 0.33, 0.14	0.14, 0.11, 0.09	0.2, 0.33, 0.14	1, 1, 1	0.2, 0.33, 0.14	0.14, 0.11, 0.09	0.25, 0.5, 0.16	0.25, 0.5, 0.16	1, 1, 1

3.2. Investigating the Factors Affecting the Sustainable Management of Agricultural Water Resources for the Optimal Use of Water in the Agricultural Sector

The results of Table 3, which were obtained from the pairwise comparison matrix of the studied indicators, show the factors affecting the sustainable management of agricultural water resources in the optimal use of water in the agricultural sector. Acceptors of water resources management, the type of exploitation system, farmers' income, and the level of mechanization (criteria 4, 9, 12, 13, and 14) were preferable to other criteria.

According to the results related to the pairwise comparison of visit program indicators for farmers regarding indigenous knowledge, the prevalence of training classes on the use of indigenous knowledge, practical projects on indigenous knowledge projects, the use of publications, written training packages (film, books, tapes, etc.), specialized seminars on promotional projects for the development of indigenous knowledge, and the use the internet and e-learning, which are related to the educational-promotional factor, show that the socio-cultural factor has a relative superiority over other indicators.

According to the results of a pairwise comparison of belief options towards indigenous knowledge, farmers' interest in using indigenous knowledge, communication with neighbors regarding the use of indigenous knowledge, interest in membership in social groups (baneh) and membership in the water organizations branch were related to the socio-cultural factor. The managerial factor is superior over other criteria.

The results of pairwise comparison of criteria related to the managerial factor—providing specialized manpower for indigenous knowledge projects, organizing financial mechanisms of officials regarding indigenous knowledge, the attitudes of managers towards indigenous knowledge projects, the practical participation of officials and managers in indigenous knowledge promotion projects, transferring powers and decisions to farmers, bottom-up decision-making—show that the economic factor is relatively superior over other factors.

The results of a pairwise comparison of options related to the economic factor—farmers' income, insurance for agricultural products at risk of drought, drought grants, the extension of drought loan repayment, drought loans, bank facilities for the purchase of pump motors and machines, show that the socio-cultural factor is relatively superior.

According to the opinions of experts in the Sistan region, indicators have been identified to investigate the factors affecting indigenous knowledge in the optimal use of water in the agricultural sector and have been fitted using the analytic hierarchy process (FAHP) model. Considering that the purpose of this study was to investigate the factors affecting indigenous knowledge in the optimal use of water in the agricultural sector, prioritization has been conducted and, as can be seen in Figure 2, the educational-extension factor, with a final weight of 0.46, has had the greatest impact on indigenous knowledge in the optimal use of agricultural water, followed by socio-cultural (0.33), managerial (0.15), and economic (0.06) factors.

According to the results obtained from a pairwise comparison of educational-promotional factors—the use of publications, the use of radio and television, holding classes and training courses, the distribution of magazines and educational publications, the use of training workshops, and communication with relevant specialists (agricultural promoters)—the factor (option) of farmers' knowledge and information was superior. A pairwise comparison of the criteria for government support—the delivery of subsidized inputs to the recipients of water resources management and the material and spiritual incentives of the recipients of water resources—showed that the knowledge and information of farmers was superior over other factors.

Table 3. Paired comparison matrix of indicators for determining the factors affecting the sustainable management of agricultural water resources in the optimal use of water in the agricultural sector of Sistan.

Comparison	Criterion1	Criterion2	Criterion3	Criterion4	Criterion5	Criterion6	Criterion7	Criterion8	Criterion9	Criterion10	Criterion11	Criterion12	Criterion13	Criterion14	Criterion15	Criterion16
Criterion 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 3, 5	1, 1, 1	2, 4, 6	1, 1, 1	1, 1, 1	3, 5, 7	1, 1, 1	1, 1, 1	4, 6, 8	6, 8, 10	7, 9, 11	1, 1, 1	5, 7, 9
Criterion 2	1, 1, 1	1, 1, 1	1, 1, 1	1, 2, 4	1, 1, 1	3, 5, 7	1, 1, 1	1, 1, 1	3, 5, 7	1, 1, 1	1, 1, 1	4, 6, 8	5, 7, 9	7, 9, 11	1, 1, 1	5, 7, 9
Criterion 3	1, 1, 1	1, 1, 1	1, 1, 1	1, 3, 5	1, 1, 1	2, 4, 6	1, 1, 1	1, 1, 1	4, 6, 8	1, 1, 1	1, 1, 1	5, 7, 9	6, 8, 10	7, 9, 11	1, 1, 1	6, 8, 10
Criterion 4	0.33, 1, 0.2	0.5, 1, 0.25	0.33, 1, 0.2	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 3, 5	1, 1, 1	1, 1, 1	1, 3, 5	3, 5, 7	3, 5, 7	1, 1, 1	1, 3, 5
Criterion 5	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	4, 6, 8	1, 1, 1	1, 1, 1	3, 5, 7	1, 1, 1	1, 1, 1	3, 5, 7	5, 7, 9	7, 9, 11	1, 1, 1	5, 7, 9
Criterion 6	0.25, 0.16, 0.12	0.33, 1, 0.2	0.25, 0.16, 0.12	1, 1, 1	0.25, 0.16, 0.12	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 3, 5	7, 9, 11	1, 2, 4	1, 1, 1	1, 3, 5
Criterion 7	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	4, 6, 8	1, 1, 1	1, 1, 1	5, 7, 9	3, 5, 7	7, 9, 11	1, 1, 1	6.8, 10
Criterion 8	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	4, 6, 8	1, 1, 1	1, 1, 1	4, 6, 8	4, 6, 8	7, 9, 11	1, 1, 1	6, 8, 10
Criterion 9	0.33, 0.2, 0.14	0.33, 0.2, 0.14	0.25, 0.16, 0.12	0.33, 1, 1, 0.2	0.25, 0.16, 0.12	1, 1, 1	0.25, 0.16, 0.12	0.25, 0.16, 0.12	1, 1, 1	1, 1, 1	1, 1, 1	1, 2, 4	1, 3, 5	3, 5, 7	1, 1, 1	1, 1, 1
Criterion 10	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	5, 7, 9	5, 7, 9	7, 9, 11	1, 1, 1	7, 9, 11
Criterion 11	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	6, 8, 10	5, 7, 9	7, 9, 11	1, 1, 1	7, 9, 11
Criterion 12	0.25, 0.16, 0.12	0.25, 0.16, 0.12	0.2, 0.14, 0.11	0.33, 1, 0.2	0.33, 0.2, 0.14	0.33, 1, 0.2	0.2, 0.14, 0.11	0.25, 0.16, 0.12	0.5, 1, 0.25	0.2, 0.14, 0.11	0.2, 0.14, 0.11	1, 1, 1	1, 2, 4	1, 2, 4	1, 1, 1	1, 1, 1
Criterion 13	0.2, 0.14, 0.11	0.2, 0.14, 0.11	0.2, 0.14, 0.11	0.33, 0.2, 0.1	0.2, 0.14, 0.11	0.14, 0.11, 0.09	0.33, 0.2, 0.14	0.2, 0.14, 0.11	0.33, 1, 0.2	0.2, 0.14, 0.11	0.2, 0.14, 0.11	0.5, 1, 0.25	1, 1, 1	7, 9, 11	1, 1, 1	1, 1, 1
Criterion 14	0.14, 0.11, 0.09	0.14, 0.11, 0.09	0.14, 0.11, 0.09	0.33, 0.2, 0.1	0.14, 0.11, 0.09	0.2, 0.14, 0.11	0.2, 0.14, 0.11	0.14, 0.11, 0.09	0.33, 0.2, 0.14	0.14, 0.11, 0.09	0.14, 0.11, 0.09	0.5, 1, 0.25	0.14, 0.11, 0.09	1, 1, 1	1, 1, 1	1, 1, 1
Criterion 15	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	1, 1, 1	7, 9, 11
Criterion 16	0.2, 0.14, 0.11	0.2, 0.14, 0.11	0.2, 0.14, 0.11	0.33, 1, 0.2	0.2, 0.14, 0.11	0.33, 1, 0.2		0.14, 0.11, 0.09	1, 1, 1	0.14, 0.11, 0.09	0.14, 0.11, 0.09	1, 1, 1	1, 1, 1	1, 1, 1	0.14, 0.11, 0.09	1, 1, 1

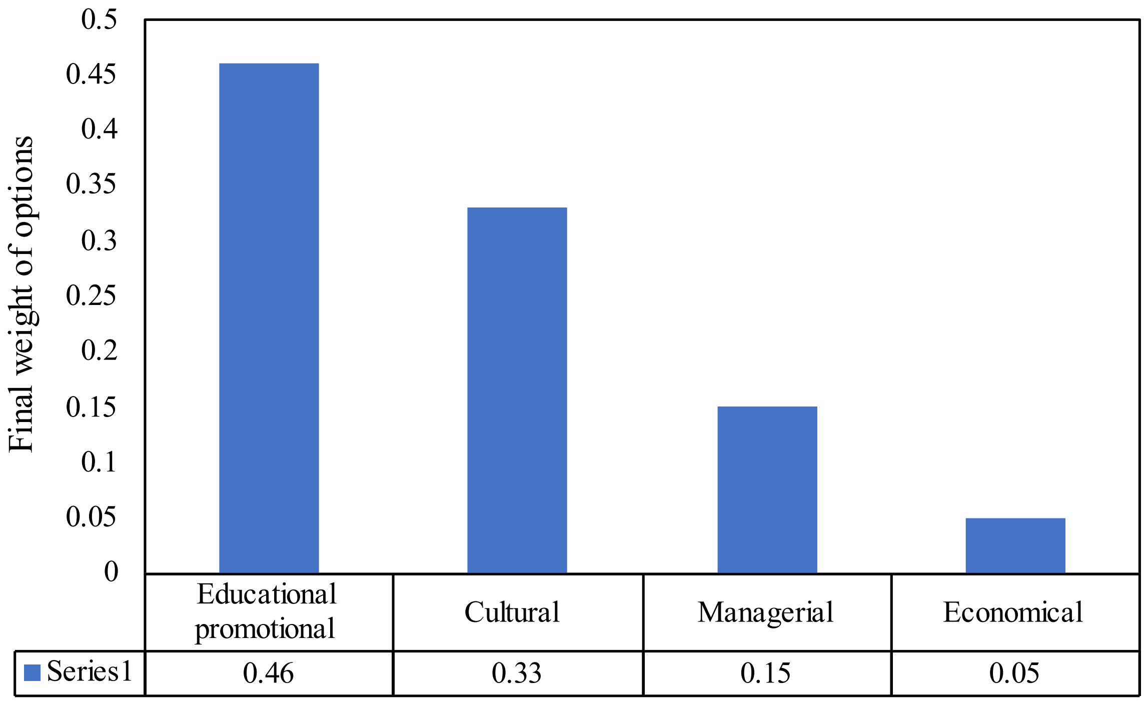

Figure 2. Weight of options based on indicators of factors affecting indigenous knowledge in optimal water consumption in agriculture.

The results of pairwise comparison of economic factors—the level of farmers' crop cultivation, the type of exploitation system, farmers' income, and the level of mechanization—showed that farmers' knowledge and information is superior to other options. Parallel comparison of options according to the criteria of farmers' technical knowledge of the stages up to harvest and their level of education, which are related to the factor of knowledge and information of farmers, showed that all education-extension, social, and government support factors are equally superior.

Scientific research is set up to discover the truth, find solutions to challenges, and improve human lives. Communication with neighboring countries and the use of their knowledge contributes to the optimal use of water in agriculture, and, by joining a aquifer organization, this creates the ground for correct and optimal consumption, as well as increasing farmers' incomes and the loans given to farmers during droughts. The above can be one of the most important factors affecting the indigenous knowledge of the region.

The results of evaluating the factors affecting the sustainable management of agricultural water resources in the optimal use of water in the agricultural sector showed that the distribution of educational magazines and publications, the delivery of subsidized inputs to recipients of water resources management, the type of exploitation system, farmers' income, and the level of mechanization were the preferred criteria. The results of this research confirm those of Shahbakhsh et al. [1], Abbasian et al. [2], and Farrokhzadeh et al. [3]. The existence of promotional activities, such as the distribution of magazines and publications, increases farmers' awareness of the sustainability of water resources, and authorities create incentive amongst designers to promote the sustainability and optimal use of water resources. Based on the factors affecting the sustainable management of agricultural water resources in the optimal use of water in the agricultural sector, the educational-extension factor, with a final weight of 0.37 is defined here as the first priority (Figure 3). The reason for the superiority of the criteria was due to the use of publications, the use of radio and television, holding classes and training courses, distributing educational-promotional magazines and publications, using training workshops, and communicating with specialists (agricultural promoters). Meanwhile, social factors, government, economic support, and farmers' knowledge and information, with final weights of 0.24, 0.21, 0.13, and 0.03, are the next priorities.

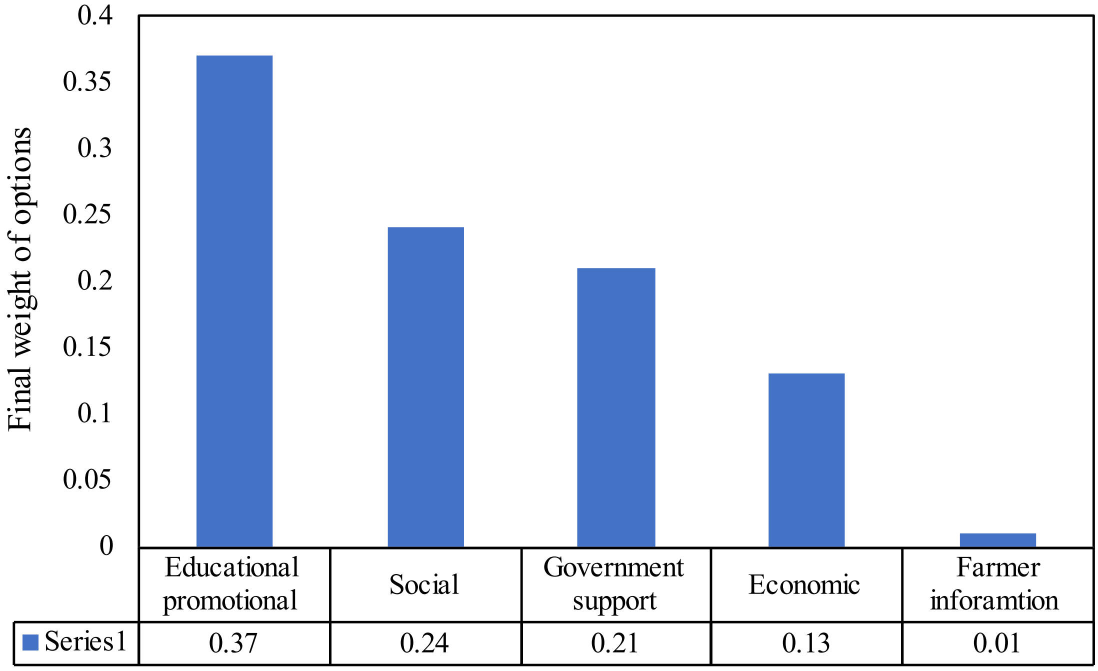

Figure 3. Final weight of options based on the indicators of factors affecting the sustainable management of agricultural water resources in the optimal use of water in agriculture.

4. Conclusions

Water shortage is one of the main limiting factors for the development of economic activities in the coming years. Iran is located in one of the driest regions in the world. Increasing population and the limitations of water resources make the targeted management of water resources even more necessary. Therefore, maintaining water resources and applying proper management in the exploitation of the above resources, especially in the agricultural sector, is of particular importance. The reason for this is that the production of agricultural products is intended to meet food needs, and in the future, due to population growth on the one hand and restrictions on arable land to limit water on the other hand, meeting the country's food needs will be a major problem.

Indigenous knowledge, which includes local beliefs, values and awareness, and their social knowledge, is a part of the national capital of any ethnic group and is of particular importance in the optimal use of water in the agricultural sector. In the present study, fuzzy hierarchical analysis (FAHP) was applied separately to the factors affecting local knowledge and sustainable management of agricultural water resources for the optimal use of water in the agricultural sector. The criteria and study options were grouped according to previous studies and using the opinions of experts, and the relationship between them was examined. The results of evaluation of factors affecting indigenous knowledge in optimal water consumption in agriculture indicated that, among the indicators used, indices of relations with neighbors regarding the use of indigenous knowledge, membership in water collectors, farmers' incomes and drought loans, were superior to other indicators.

Based on results of this research, the following suggestions are presented:

1. To increase the level of indigenous knowledge of regional officials in relation to the optimal and correct use of water in agriculture.
2. To use the experiences of neighboring countries for indigenous knowledge and optimal use of agricultural water in the region.
3. To establish research organizations on activities and studies of indigenous knowledge in the region with optimal water consumption.

4. To hold training classes related to the sustainability of water resources.
5. To encourage and support farmers in using new irrigation methods.

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References

1. Shahbakhsh, F.; Safdari, M.; Sardar Shahraki, A. Assessment of modern approach of water governance in the devel-opment of water exploitation systems in Sistan region. *J. Appl. Res. Water Wastewater* **2020**, *7*, 127–136.
2. Farrokhzadeh, S.; Hashemi Monfared, S.A.; Azizyan, G.; Sardar Shahraki, A.; Ertsen, M.W.; Abraham, E. Sustainable Water Resources Management in an Arid Area Using a Coupled Optimization-Simulation Modeling. *Water* **2020**, *12*, 885. [CrossRef]
3. Abbasian, M.; Shahraki, A.S.; Ahmadi, N.A. Economic Management of Water by Using Valuation Policy in Mango Orchards with an Emphasis on Environmental Inputs in Chabahar County. *Iran. Econ. Rev.* **2021**, *26*, 727–738. [CrossRef]
4. Trenčiansky, M.; Štěrbová, M.; Výbošt'ok, J. The Influence of the Transition to Ecological Farming on the Quality of Runoff Water. *Sustainability* **2022**, *14*, 15412. [CrossRef]
5. Trenčiansky, M.; Štěrbová, M.; Výbošt'ok, J.; Lieskovský, M. Impacts of forest cover on surface runoff quality in small catchments. *Bioresources* **2021**, *16*, 7830–7845. [CrossRef]
6. Jacobs, K.; Lebel, L.; Buizer, J.; Addams, L.; Matson, P.; McCullough, E.; Garden, P.; Saliba, G.; Rijsberman, F.; Manning, N.; et al. Increasing green and blue water productivity to balance water for food and environment. In Proceedings of the Final Report of the 4th World Water Forum Water, Food, and Environment Theme Baseline document, Mexico City, Mexico, 16–22 March 2006; pp. 139–143.
7. Panahi, F. Analysis of factors affecting the optimal management of water resources in the iranian agricultural system. *Agri-Cult. Ext. Educ. Res.* **2012**, *1*, 110–117.
8. Giupponi, C.; Mysiak, J.; Fassio, A.; Cogan, V. MULINO-DSS: A computer tool for sustainable use of water resources at the catchment scale. *Math. Comput. Simul.* **2004**, *64*, 13–24. [CrossRef]
9. Saffari, H. Identifying and explaining the factors affecting water resources management technology in agriculture and natural resources. *Res. Technol.* **2015**, *2*, 112–128.
10. Rashidipour, L.; Kalantari, K.; Rezvanfar, A. Investigating the problems and limitations of water resources and its impact on the socio-economic status of wheat farmers in the central part of Saqez. *Agric. Econ. Develop.* **2011**, *19*, 183–204.
11. Bouzarjomehri, K.A.; Mahsoumi Jashni, M.; Jahantigh, H.A. Investigating the indigenous role and local traditions of women in the production and management of livestock products (study case: Abu Nasr village, Bavanat city). *Bi-Q. J. Iran. Indig. Knowl.* **2016**, *6*, 91–120.
12. Bouzarjomehri, K. Handbook of strategies for optimizing water consumption in agriculture with emphasis on some indige-nous technologies in iran and other countries. *Iran. J. Agric. Econ. Dev. Res.* **2009**, *42*, 80–84.
13. CWWEC. *Country Water and Wastewater Engineering Company*; Information Center for Electricity, Water and Energy Engineering Services: Saba, The Netherlands, 2011.
14. Omani, A.R. Investigating the effective factors in sustainable management of agricultural resources in the northern part of Modares watershed in Khuzestan province. *Watershed Manag. Res.* **1950**, *88*, 27–34.
15. Arfai, M. Investigating the factors affecting indigenous knowledge in optimal water consumption in agriculture. *Agric. Ext. Educ. Res.* **2011**, *3*, 93–103.
16. Bandani, M.; Mir Lotfi, M.R.; Seibanishad, A. Study and analysis of the role of indigenous knowledge in sustainable rural development of Ghaemabad rural district of Sistan region. In Proceedings of the National Conference on Civil Engineering and Architecture with an Approach to Sustainable Development, Tehran, Iran, 1 October 2015.
17. Rahimian, M. Investigating the factors affecting the sustainable management of water resources among irrigated wheat farmers in Koohdasht. *Iran. Agric. Ext. Educ. Sci.* **2015**, *12*, 233–247.
18. Akhavan, M.; Behbahaninia, A. Investigating the economic factors affecting sustainable development and management of water resources in agriculture. *Sustain. Dev. Environ.* **2017**, *4*, 31–41.

19. Afshari, S.; Rezaei, R.A.; Gholizadeh, H.; Shaban Alifami, H. Factors determining farmers' attitudes towards sustainable management of water resources (case study: Komijan County). *Q. J. Environ. Educ. Sustain. Dev.* **2017**, *6*, 101–113.
20. Hassani, N.; Yadalahi, P.; Mortazavi, A.A. Investigating the factors affecting farmers' water resources management behaviors (case study: Hamadan-Bahar Plain). *J. Water Resour. Eng.* **2017**, *10*, 1–10.
21. Iglesias, A.; Garrote, L. Adaptation strategies for agricultural water management under climate change in Europe. *Agric. Water Manag.* **2015**, *155*, 113–124. [CrossRef]
22. Valipour, M. Land use policy and agricultural water management of the previous half of century in Africa. *Appl. Water Sci.* **2014**, *5*, 367–395. [CrossRef]
23. Valipour, M.; Ziatabar Ahmadi, M.; Raeini-Sarjaz, M.; Gholami Sefidkouhi, M.A.; Shahnazari, A.; Fazlola, R.; Darzi-Naftchali, A. Agricultural water management in the world during past half century. *J. Arch. Agron. Soil Sci.* **2015**, *61*, 657–678. [CrossRef]
24. Kernecker, M.; Vogl, C.R.; Meléndez, A.A. Women's local knowledge of water resources and adaptation to landscape change in the mountains of Veracruz. *Mexico. Ecol. Soc.* **2017**, *22*, 37. [CrossRef]
25. Greenland, S.J.; Dalrymple, J.; Levin, E.; O'Mahony, B. Improving Agricultural Water Sustainability: Strategies for Effective Farm Water Management and Encouraging the Uptake of Drip Irrigation. In *The Goals of Sustainable Development*; David, C., Shahla, S., Abdul, M., Eds.; Springer: Berlin/Heidelberg, Germany, 2018; pp. 111–123.
26. Ataie, M. *Fuzzy Multi Criteria Decision Making*; Shahrood University of Technology: Shahrood, Iran, 2009.