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Prioritizing the Effective Capital Components in the Agricultural Sector by Fuzzy Analytical Hierarchy Process

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Abstract

The purpose of this study is to prioritize the effective components of capital in the agricultural sector with a fuzzy approach. Because Given the limited resources of capital, and especially for a developing country, the emphasis on investment and its allocation to key sectors is very important. Also, by paying more attention to the sectors with higher priority for investment, while benefiting from some savings, domestic needs can be met and the ground for presence and competition in global markets can be provided. The role of investment in the agricultural sector in creating job opportunities is undeniable, and growth of GDP and economic growth depends on investment. To achieve this goal this method has been used for the first time and is innovative in terms of theme and fuzzy conceptual model used and includes previous research and documentation, interviewing experts in agricultural sector and using MAXQDA 2018 software. And the reliability of the researcher-made questionnaire with Cronbach's alpha coefficient of 0.855 was obtained. The statistical population includes 62 people, who after studying and reviewing, identified four main criteria and eight sub-indicators. After performing Fuzzy Hierarchical Analysis (FAHP) using MATLAB software, finally, the prioritization of the eight identified sub-indices was obtained. According to the results, the highest weight belongs to the S criterion (technical reality) with a value of 0.554, and the lowest weight belongs to the W criterion (cultural and social) with a value of 0.031.

Keywords: Investment, FAHP, fuzzy approach

1. Introduction

The provision of the required capital is an important and effective way to support the agricultural sector, which is mainly provided by the Agricultural Bank as the only specialized agricultural bank. The credits are provided in three ways: internal sources, commentary sources or a combination of these sources. Agricultural Bank is the main economic institution responsible for meeting the financial needs of the agricultural sector. The bank, through achieving self-sufficiency, is to increase production, provide economic growth, transform and develop the agricultural sector, create employment and eliminate dependence (Agricultural Bank, 2018).

In Iran, because of the limitations in the financial and capital markets, banking resources (facilities) is one of the important capitals equipping factors in the agricultural sector. Providing the needed ground for increasing investment

and making a suitable platform for attracting capital to the agricultural sector is an indispensable precondition for sustainable agricultural development in Iran (Sameti & Framarzpour, 2004).

Since we always face risk and uncertainty of data and information in real- world problems, an innovative multidimensional (fuzzy) mathematical programming technique is used in this study.

As one of the major productive activities in most countries of the world, especially developing countries, agriculture occupies a special position (Mirahmadi & Torkamani, 2010). In today's world, despite stunning advances in other economic activities such as services and industry, agriculture still plays a significant role in economics (Kiani, Ghlami, & Moradi, 2013). Because it is an approach for living, the agricultural sector entails plenty of potential for economic development, and due to the very strong relationship between the agricultural sector and other economic sectors, the increased investment in this sector accelerates economic growth and indirectly contributes to country`s development and increased employment. However, reduced investment poses a threat to food security (Amini, 2013). In a study entitled "investment prioritization in agricultural sub-sectors of Mazandaran province," Gol Aghaei Darzi (2012) used numerical taxonomy, factor analysis and TOPSIS model. He used 22 indicators with the same weight, among which livestock and poultry have the highest priority.

Yunna et al (2019) in a study in China to investigate the shortcomings of the current investment decision-making process, set criteria for economic coverage, resources and risk factors and using the fuzzy method and analytical process and entropy in the method to deal with Uncertainty and uncertain information determined the weight of the criteria and measured the impact on the criteria on the investment at the same time and provided a more logical and scientific decision to invest.

Ouedraogo et al (2020) in a study entitled Private and Public Investment in Sub-Saharan Africa examined the impact of public investment on particularly high-risk private investment and concluded that if public investment were made with higher taxes, this would lead to Reduces aggregate demand and reduces profitability, and increases public investment in infrastructure has a positive and complementary effect of private investment.

Tambunan (2012) considered the achievement of positive investment results as a consequence of major reforms in land ownership, which grant the final permission to investors with the help of local authorities. It was studied agricultural investment in Romania by using international databases in order to explore an effective investment model by considering the growth rate, privatization and investment criteria (Feher et al., 2017).

Table 1. Important and Basic Concepts in the Study of Investment Research in Agriculture

Concepts	Presenters
Allocation of investment plans using GLP linear planning	Caplin and Cornblatt (2004)
Optimal allocation of bank credits in agricultural sub-sectors using fuzzy logic	Karimi and Zahedikeyvan (2010)
Determining the optimal pattern of allocation of bank facilities using fuzzy logic by considering risk conditions (Case study: facilities granted by Tehran Keshavarzi Bank)	Makian et al. (2011)
The effect of equalization of bank advance rates on the allocation of credits to the agricultural sector	Eshraghi and Salami (2005)
Theories and models of agricultural development with maintenance of the environment	Demzu and Ozgebu (2018)
The effect of investment the Iranian agricultural sector on employment	Poursafar and Mohammadi (2015)
Determining the rate of return on capital in the agriculture	Soltani (2004)
Agricultural investment models	Tambunan (2012)

2. Materials and Methods

The study is to identify the effective capital components in the agricultural sector by a fuzzy analytical hierarchy process. The statistical population includes the deputies and managers of Khuzestan Agricultural organization and Khuzestan Agricultural Bank`s deputies and managers. Khuzestan province, in southwestern Iran and north of the Persian Gulf, is located between 30 and 33 degrees' north latitude and 47 to 50 degrees' east longitude of the Greenwich meridian. Significant area of agricultural lands (agricultural, orchard) which is about 1325,000 hectares and the number of active agricultural sector includes 262 thousand people of the potential of this sector in Khuzestan province.

Data collection:

The use of available information and research records in books, endings of Latin and Persian articles and articles, and any other valid and scientific documents related to the subject.

Classification and introduction of research literature in the form of comprehensible summarized texts and tables.

Conducting initial interviews with informants, stakeholders and activists in the agricultural sector in order to identify the current situation and effective factors in investing in the agricultural sector and using MAXQDA 2018 software.

Design and preparation of a researcher-made questionnaire.

Distribution between experts and modification of the questionnaire, including eliminating possible problems and ambiguities (in selecting these people, an attempt has been made to select a complete set of qualified people so that their scientific and experimental characteristics and work relationship with the research subject are approved, and respondents have the ability to properly answer research questions).

Distribution and collection of questionnaires.

Data analysis:

A researcher-made questionnaire was used to collect data the validity of which was confirmed by Agricultural experts. There are several methods for determining the reliability coefficient, one of the common methods is the use of Cronbach's alpha coefficient. This method is one of the methods for determining the reliability or reliability that is used to calculate the internal consistency of measuring instruments such as questionnaires.

In this method, first the variance on the scores of each subset of the questionnaire questions and the total variance must be calculated and then using a special formula; the Cronbach's alpha value is obtained, which is 0.855 "good" and is a sign of the reliability of the questionnaire (Table2).

Table 2 . Determining reliability based on Cronbach's alpha coefficient (Lee Cronbach,1951)

Internal reliability	Cronbach's alpha coefficient
Excellent	$\alpha \geq 0.9$
good	$0.9 > \alpha \geq 0.8$
acceptable	$0.8 > \alpha \geq 0.7$
Question	$0.7 > \alpha \geq 0.6$
Weak	$0.6 > \alpha \geq 0.5$
unacceptable	$0.5 > \alpha$

In these research, first articles and other issues related to the topic of optimal allocation of capital in the agriculture were reviewed. After categorizing the content and initial reviews with experts in agricultural sector and writers, four criteria were identified:

1)Technical and economic, including 12 sub-indicators.

2)Political with 11 sub-indicators.

3)Structural with 12 sub-indicators.

4)Socio-cultural with 11 sub-indicators.

Pair comparisons between different decision options are made based on each indicator and judgment about the importance of the decision indicator, so that the recipient must numerically determine the relative importance or relative superiority of the indicators over each other and each decision option. Measures were performed according to the indicators compared to the options of others. This is done by making two-to-two comparisons between the elements of the decision (pair wise comparison) and by assigning numerical points that indicate the priority or importance between the two elements of the decision.

To do this, we usually compare the options with the, i-th indicators to the j-th options or indicators, which are shown in the table below.

After studying and reviewing the articles, documents and conducting initial interviews with experts and informants in the agricultural sector, four main criteria and 46 sub-criteria were obtained.

Then it was distributed and collected in the form of a researcher-made questionnaire in the statistical community (including 62 experts and informants of Jihad-e-Agriculture Organization and Khuzestan Agricultural Bank).

Then, a two-to-two comparison of the main criteria was performed, and in the next stage, a pair wise comparison of each of the sub-criteria was performed separately for each criterion and the person responding to the questionnaire.

Table 3. Evaluation of indicators relative to each other

Preferential value	Comparison of i to j	Explain
1	Equal importance	Option or index i are of equal importance to j or have no precedence over each other.
3	Relatively more important	Option or index i is slightly more important than j
5	More importantly	Option i is more important than j.
7	Very important	Option or index i have a much higher priority than j
9	Completely important	Option or index i is absolutely not more important than j and comparable to j.
2,4,6,8	intermediate values	It Shows the intermediate values between the preferred values. For example, 8 indicated a value greater than 7 and lower than 9 for i.

Table 4. Description of Sub-criteria

Technical and Economic Sub-indicators	
S1	Return time of principal and subsidiary capital in the relevant production subsector
S2	The status of capital return rate in each sub-sector
S3	Priority of semi-finished design with physical progress of at least 60%
S4	Existence of appropriate technical, financial and economic justification in the relevant production sub-sector
S5	Placing the relevant production subsection in the list of conversion and complementary industries
S6	Placing the relevant production subsection in the list of greenhouse industries
S7	10% increase in production and employment compared to the previous year in the relevant production sub-sector.
S8	Ensuring the supply of raw materials for the relevant production sub-sector
S9	Validation and accounting of the applicant for the implementation of the relevant production subsection
S10	Financial risk in the relevant manufacturing subsector
S11	Prioritize working capital in the relevant manufacturing sector
S12	Prioritize the development of production technologies in the relevant manufacturing subsector
Policy Sub-indicators	
O1	existence the incentive system for private sector participation and commercialization of production in the agricultural sector
O2	Political stability of the monetary and financial sector in the country
O3	Status of government development credits in the infrastructure affairs of each subdivision
O4	More attention of governments and their supportive approaches to each agricultural sub-sector
O5	Political and economic power of organizations and the private sector in each agricultural sub-sector

O6	Prioritizing underdeveloped and less- developed areas in implementing the relevant production plan
O7	Putting relevant production sub-sectors in the ten priorities of the Ministry of Agricultural Organization (greenhouse, fisheries, mechanization, technical services, livestock products, conversion industries, etc.)
O8	The amount of approved and necessary capital requirements in each subsector
O9	Development and completion of pre-production value chains to market products under the relevant manufacturing sector
O10	Prioritize the provision of capital in accordance with the studies of dynamics for the relevant production sub-sector
O11	Restrictions announced by the bank's board of directors regarding the capital range in each subsection.
Structural Sub-indicators	
T1	Existence of organizations needed to invest in the agricultural sector, especially the Fund for Supporting the Development of the Agricultural Sector.
T2	Efficiency and adequacy of facilities granted by banks to the agricultural sector
T3	Existence of appropriate market structure of inputs and products in each subsector
T4	Low costs of initial and infrastructure measures in each sub-sector
T5	Percentage of facility benefits in each subsector
T6	Applied research related to the transfer of technology and knowledge in agriculture (agricultural education and extension)
T7	The existence of necessary administrative structure to benefit from the loans in each sub-sector
T8	Ensuring the sale and non-accumulation of manufactured products
T9	The amount of capital available in the bank for distribution among the subdivisions
T10	Prioritize development and complementary projects over creative projects
T10	Fee for receiving facilities in each subdivision
T11	Investments made so far in each subsector.
Socio-Cultural Sub-indicators	
W1	Qualification and ability of the investor (applicant) in the relevant production sub-sector.
W2	Legal, social and physical support through the provision of free economic and technical consulting services
W3	Banking of the relevant production sub-sector by the agent bank (preferred by bank experts)
W4	Organizable of the relevant production sub-sector (preferred by the experts of Agricultural Organization)
W5	Extent of environmental considerations in each subsector
W6	Obtaining the sufficient guarantees from the applicant to implement the relevant production sub-sector to guarantee the principal and sub-capital.
W7	Number and density of applicants in each subsection

W8	Prioritize projects with more production capacities and employment in the relevant production sector (based upon the number of jobs per unit and the full price of each job)
W9	Prioritize rural and nomadic border areas and rural industrial areas and cities with a population of less than ten thousand people
W10	Prioritize cities with higher unemployment rates
W11	Prioritize the development of gardens in the border provinces

After designing the model and entering the data in MATLAB software and based on the opinions of experts, a hierarchical process analysis was performed. In this software, the eigenvector technique is used to measure the total weights of the criteria and calculate the instability index, and other methods such as geometric mean were not used. At first, according to the purpose, the pair wise comparison of the main criteria was used. Table (5) shows the comparison results without considering the dependencies between them.

Table 5. Pair wise Comparison of the Importance of the Main Criteria

	S			O			T			W		
S	1.0	1.0	1.0	0.6	0.7	0.8	0.8	0.9	0.9	0.8	0.9	0.9
O	0.2	0.1	0.1	1.0	1.0	1.0	0.4	0.5	0.6	0.4	0.5	0.6
T	0.1	0.1	0.1	0.3	0.2	0.2	1.0	1.0	1.0	0.6	0.7	0.8
W	0.1	0.1	0.1	0.3	0.2	0.2	0.2	0.1	0.1	1.0	1.0	1.0

In the next step, pair wise comparison of each sub-criterion was performed separately for each criterion and expert. In addition, the relative priority of each sub-criterion was determined. Then, according to the fuzzy AHP method, in the completed forms of the expert team interview, the analysis of the dependence of internal and external environments between the main criteria was used.

In the following, the rows of sub-criteria matrices from pair wise comparison matrices are added together to obtain the inverse matrix. Table (6) shows the matrices of the sum of the rows obtained from the previous step.

Table 6. Matrix of Sum of the Main Criteria Rows

	L	M	U
S	23.0	26.0	27.0
O	9.2	11.1	13.1
T	7.4	8.3	9.3
W	1.5	1.5	1.4

In the following, by obtaining the inversed matrices and multiplying them in the matrix of the sum of the rows, new matrixes will be obtained to find the weight of matrixes, which are shown in Table (7).

Table 7. The Inverse Product in the Matrix of the Sum of the Main Criteria Rows

	L	M	U
S	0.56	0.55	0.53
O	0.22	0.24	0.26
T	0.18	0.18	0.18
W	0.04	0.03	0.03

By using the matrix obtained from the previous step (multiplication of the inverse matrix as the matrix of rows) and based on figure (1), a new matrix is formed and then the weights of each of the main and sub-criteria will be obtained.

In general, if *M1=(l1,m1,u1)* and *M2=(l2,m2,u2)* are two triangular fuzzy numbers, the magnitude of *M1* relative to *M2* is defined as follows:

$$V(M_2 \geq M_1) = hgt(M_1 \cap M_2) = \mu_{M_2}(d) = \begin{cases} 1 & \text{if } m_2 \geq m_1 \\ 0 & \text{if } l_1 \geq u_2 \\ \dfrac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} & \text{otherwise} \end{cases}$$

Figure 1. Calculate the magnitude

3. Results and Discussion

Table 8 shows the ranking of the main criteria:

Table 8. Normalized weights for each of the main criteria

Symbol	Normalized weights	Rank
S	0.554	1
O	0.238	2
T	0.177	3
W	0.031	4

Now, the obtained results will be analyzed and evaluated based on the previous tables for mathematical modeling in the next stage and optimization of the capital allocation model in the agricultural sector. For pair wise comparison of four criteria and 46 sub-indicators and after entering the data in the software, the fuzzy analytic hierarchy process (FAHP) was performed and the results of the relative priority of each criterion were prepared under the relevant indicators. The identified factors are listed in Table (9).

Table 9. Identified Factors Based on their Priority

Symbol	Sub-criteria	Criteria
S1	Return time of principal and subsidiary capital in the relevant production subsector	Technical and economic
S3	Prioritize semi-finished design with physical progress of at least 60%	Technical and economic
O1	Existence of an incentive system for private sector participation and commercialization of production in the agricultural sector	Political
O2	Political stability of the monetary and financial sector in the country	Political
T2	Efficiency and adequacy of facilities granted by banks to the agricultural sector.	Structural
T3	Existence of appropriate market structure of inputs and products in each subsector	Structural
W1	Qualification and ability of the investor (applicant) in the relevant production sub-sector	Socio-cultural
W2	Necessary legal, social, physical support through the provision of free technical economic consulting services	Socio-cultural

4. Conclusion and Recommendations

This study aimed to identify and prioritize the effective components of capital in the agricultural sector in Khuzestan province with a fuzzy approach. To extract the criteria for designing the optimal capital allocation model in the agricultural sector, articles and research and all related documents were reviewed. Then, the opinions of experts and informants of the agricultural sector were collected through interviews and comments in the form of a researcher-made questionnaire.

Then, the relative priority of each sub-criterion was determined and then; according to the proposed design, dependency analysis was performed and after performing multi-criteria fuzzy analytical hierarchy process (FAHP), finally four main criteria and eight sub-indicators were identified and then normalized weight for each of the sub-criteria was obtained and the relative weight of each sub-indicator with other sub-indicators of that criterion and also the weight of each criterion in comparison with other criteria were calculated.

According to the results, the highest weight belongs to the S criterion (technical and economic) with a value of 0.555, and the lowest weight belongs to the W criterion (cultural and social) with a value of 0.031. Their most important sub-indicators are S1 (return time of principal and subsidiary capital in the relevant production sub-sector) This is the number of years required to receive the investment cost. S3 (priority of the semi-finished project with physical progress of at least 60%) The importance of this index is in relation to the effective use of capital tools so that agricultural production units that have no problems, mainly in terms of production capacity, technical knowledge, management capacity and market, will reach production by obtaining capital.

Other criteria such as O (political) with a weight of 0.238 are placed in the second rank and its sub-indicators such as O2 (political stability of the monetary and financial sector in the country)

Laying the ground for stable conditions in various sectors of the economy is one of the most important factors necessary to move towards sustainable growth and comprehensive development in the country. O1 (existence of an incentive system for private sector participation and commercialization) This index is emphasized in the Law on Removing Barriers to Competitive Production and Improving the Financial System of the Country, which according to Article 3 of the above-mentioned law, supports and incentives subject to the executive regulations of this law, Agricultural product insurance subsidies and other protections) are included. After that, there is the criterion T (structural) with a weight of 0.177 and sub-indicators T3.

Due to the change in the approach of the agricultural sector from traditional agriculture or production-oriented agriculture to agricultural businesses or market-based agriculture (Agribusiness) in recent years, establishing and strengthening links between farmers and agricultural industries as well as domestic and foreign markets have become inevitable. Contract farming the appropriate structure between input markets and supply and processing chains, warehousing, transportations, etc. are among the characteristics that determine the need to pay more attention to the creation of these structures. T2 (efficiency and adequacy of facilities granted by banks to the agricultural sector) Due to the fact that the operators of the agricultural sector are faced with a wide range of production and price risks, the reduction of their income will reduce or stop the repayment of facility installments and non-repayment of debts will limit the granting of new facilities and result in fluctuations in, Therefore, the adequacy and efficiency of capital has an irreplaceable role in the model of optimal capital allocation in the agricultural sector. W1 (Qualification and ability of the investor (applicant) in the relevant production sub-sector). The importance of this indicator is in the fact that the production units of the agricultural sub-sector should have a capable manager and a suitable situation in terms of readiness to fulfill obligations and perform production operations. W2 (Necessary legal, social, physical support through the provision of free economic and technical consulting services) In order to reduce the problems in the agricultural sector and in order to delegate affairs to the private sector and downsize the government, since 2007, the establishment and establishment of a non-governmental network of agricultural technical and engineering consulting services were implemented throughout the country.

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