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Research Article

DETERMINING THE FACTORS THAT INFLUENCE THE SELECTION OF THE OPERATION AGRICULTURAL MACHINES AND THEIR RANKING WITH TOPSIS TECHNIQUE (CASE STUDY OF ALBORZ PROVINCE)

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ABSTRACT

Identifying and analyzing factors that affect agricultural machines chosen is the main subject of this article. The operating system means legal or customary practices, of access to the machinery services. The main factors affecting the selection and performance of operating systems after extraction of the questionnaire using the technique of multi-criteria decision-making (TOPSIS) was categorized. The most important factors affecting the choice of operating system of agricultural machines include: Technical factors (timely agricultural operations, the quality of machinery operations, easy access to the machinery services, the size of the farm or operation, etc.). Economic factors (cost of supplying agricultural machinery, the cost of the machinery services, the operator's annual income, the situation of employment in the region, etc.) Social factors (the exploitation of agricultural systems, the independence of the decision-making and the sense of satisfaction, qualitative and quantitative composition of the population of the studied area, etc) the effectiveness of each of the operating systems of Alborz province, which includes three systems:

1 - Dedicated system operation

2- Professional operating system

3- Dedicated - professional operation system

They were evaluated and it was identified that the following factors have the most important roles in choosing each of the operating agricultural machinery system.

1. Easy access; 2 - The timely operation; 3 – The size of farms and the kind of operating system; 4. Supplying spare parts; 5- The level of users income; 6 - access to the repair shop; 7- The cost of machines ownership; 8 - The type of agricultural operation; 9. The sense of satisfaction of having agricultural machinery

Among the operation systems of agricultural machinery, the dedicated operation system has the most influence of technical, economic and social factors.

Keywords: *Agricultural Machinery Operating System, Efficiency of Operation Systems, TOPSIS Technique*

INTRODUCTION

Operational management, correct and consistent use of agricultural machinery is one of the main goals of agricultural mechanization. Failure to achieve this has been one of the most serious structural problems in the agricultural mechanization, that directly and indirectly influence on the development of this sector. Despite the problems of mechanization in the country, there are fundamental weaknesses in the foundations and structure of management and operating systems has led exploitation of agricultural machines, in some systems, such as dedicated and public systems, some part of the available capacity due to the mismatch between the capacities of the machine remains unused.

Or in some other systems, such as operation systems and professional co-operation because of congestion during work and low power performance of these systems, agricultural operation is delayed. The cost of

operation is not carried out on time. So the correct and principled operational management of agricultural machines require an optimized, efficient and effective operation system, in the resolution of structural factors such as education and promotion, technology, standards and engineering services, support services and subsidies, Law and macroeconomic management, unions, and organizations associated with mechanization and the document units.

The operation of agricultural machinery for agriculture is a way of access to the machinery services, are influenced by various factors, technical, economic, social, cultural and political which can include such factors as: the timely agricultural operations, the quality of machine operation, the cost of the supplying machines, the level of users' income, a sense of satisfaction, ownership, social relations, and so on.

The necessary items to improve continuous management are selection and application of agricultural machines, modifying the ways to access agricultural machines or to modify the way to reform the management of agricultural machinery.

Undoubtedly, no strategic plan will lead to the result without knowing the exact and lack of awareness of how impact and effective interaction parameters of the program. Thus improving the operational management of agricultural machines requires, identifying factors affecting the operation of systems of agricultural machines.

Therefore, to determine and evaluate the technical and economic analysis of the impact of various factors technical- social- economical on the performance of operation of agricultural machines. Should after identifying the factors we should evaluate the effectiveness of each of the factors on the systems of operation of agricultural machinery seems to be necessary.

In this article we tried to identify the factors affecting the operation of agricultural machinery and the effects of each of the factors on the system in Alborz province were investigated.

MATERIALS AND METHODS

This study is a survey and two questionnaires were used for data collection. The first questionnaire was designed to identify factors in the choice of agricultural machinery operation system.

The second questionnaire was designed to assess the effect of technical, economic, social on agricultural machinery operation systems and rating systems operation.

The Population and the Size of Sample

Comprehensive statistics to identify important factors in choosing operating systems, agricultural machinery were professors, scholars and experts in the field of agricultural mechanization, whose number was, estimated 55 people, using the formula mentioned bellow which is a common method for determining the sample size (n).

The sample volume

Sample volume was determined using Sharb Cochrane. To use this formula according to population size (N = 55) number of the samples (n) was determined. Cochran's original formula to calculate the sample volume is as follows:

$$n = \frac{\frac{z^2 pq}{d^2}}{1 + \frac{1}{N}\left(\frac{z^2 pq}{d^2} - 1\right)}$$

Measuring Instrument and Data Collection

The first questionnaire included 60 closed questions and three open questions to provide the possibility of obtaining the views of the elite for the introduction of the fact or factswhich probably was probably not recognized by the researcher.

The questionnaire used in this research consists of two general and expertise questions. The first set of questions about respondents' demographic characteristics such as work experience, age, education, scientific degree and field of study. The second set of questions that are specific questionnaires designed to test research hypotheses. For scoring and evaluating the technical questions Likert scale is used.

Likert scale questions scoring table

The selected choice	Too low	low	Medium	High	Very high
Score	1	2	3	4	5

The second questionnaire was designed to compare the operation of agricultural machinery of Alborz province and ranking them according to the risk factors identified in the first phase of research considering the 20 items according to 20 factors identified in the first phase.
The scoring table of the questionnaire was adjusted as below

The selected choice	Too low	low	Medium	High	Very high
Score	1	3	5	7	9

The Reliability and Validity of the Questionnaire

Validity means that the measuring device could measure the desired properties and characteristics. The importance of that is because the inadequate and inappropriate validity of the measurements can make any scientific research worthless.
In a study to assess the validity of the questionnairethe content validity, criterion and construct validity are used. The content validity has the most usage to determine the validity of a scale. Content validity of an instrument for measuring depends on the questions forming it. To determine the validity of the questionnaire we consulted with a number of experts and professors, including the supervisor and advisor of the Agricultural Mechanization department and they were asked about the questions and assessed the validity of the hypotheses and confirmed all of them.

Reliability of the Questionnaire

Reliability is one of the technical characteristics of measurement toolindicating that how many same results it has in a similar situation. Retest, matching test, control, composed, Koder- Richardson and Cronbach's alpha are measurement methods of reliability. In this research, Cronbach's alpha was used. Calculation methods of reliability using Cronbach's alpha coefficient as follows:
First the variance for each question of the questionnaire was calculated and then the total variance of the test was calculated.

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\sum s_i^2}{s_x^2}\right)$$

α = Cronbach's alpha coefficient
k = the number of questions in the questionnaire
s_i^2 = Variance related to the question i
s_x^2 = Variance of the test
In this research, Cronbach's alpha coefficient, with a preliminary study of the distribution of 20 to 30 questionnaires were analyzed.

Case Processing Summary

		N	%
Cases	**Valid**	**48**	**100.0**
	Excluded[a]	**0**	**.0**
	Total	**48**	**100.0**

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.773	24

Thus, Cronbach's alpha coefficient was calculated, more than 7.0.
The reliability of the questionnaire was evaluated well.

Case Processing Summary

		N	%
Cases	Valid	74	100.0
	Excluded	0	.0
	Total	74	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
0/753	18

Regarding the results (Cronbach's alpha = 753/0) the reliability of the second questionnaire was accepted.

Data Analysis

In this article, the data analysis is done in two ways:
First the data were analyzed using descriptive statistics. Then, Technique for Order Preference by Similarity to Ideal Solution method (TOPSIS), agricultural machinery operational systems was ranked.
It means the preferred methods based on similarity to ideal solution.. This model was proposed by Huang and ions in 1981. In the ranking of options TOPSIS method options that have the greatest similarity with the ideal solution, are ranked the higher grade.
TOPSIS Algorithm Techniques
1 - Forming a decision matrix
2 - Normalizing the decision matrix
Vector method unlike the simple linear normalization is as follows:

$$r_{ij} = \frac{X_{ij}}{\sqrt{\sum_{i=1}^{m} X_{ij}^{2}}}$$

3 – Organizing weighted normalize decision matrix
4 - Calculating the positive and negative ideals
In this step for each indicator a positive (A +) and a negative ideal, were calculated.
5. The space from positive and negative ideals and calculate the ideal solution
In this step, relative proximity of each option to the ideal solution is calculated. Euclidean distance of each option from the positive and negative ideal will be calculated using the following formula.
The final step is to calculate the ideal solution. In this step, the relative proximity of each option to ideal solution is calculated. To do so, we benefit from the following formula:

$$d_i^+ = \sqrt{\sum_{j=1}^{n} (V_{ij} - V_j^+)^2}$$

$$d_i^- = \sqrt{\sum_{j=1}^{n} (V_{ij} - V_j^-)^2}$$

$$CL_i^* = \frac{d_i^-}{d_i^- + d_i^+}$$

The value of CL is between zero and one. As this amount is closer to one, the answer is closer to ideal solution and is a better solution.

RESULTS AND DISCUSSION

After extracting data using descriptive statistical techniques factors influencing the selection of operating systems of agriculture machinery was calcified as mentioned in the Table and the abundance, average,and the percentage of each of the factors respectively technical, social, and economical were identified. According to Table 1 among all the identified factors the timely operation and ease of access to the machines have the highest average. It seems that these two important technical have the most active shares in selecting the operating systems. Among the economic factors, cost of ownership and the level of users' income are more effective from other economic factors, while these economic factors in order to rank the factors are 3 and 7. The kind of exploitation of agricultural machinery and feeling of satisfaction deriving from the ownership of agriculture machinery are most important social factors effective in the operation of agricultural machinery systems. These factors allocated the 5th and 6th among the 10 total factors.

1: rating factors in the choice of operating systems of Alborz Province in Agricultural Machinery

Row	Kind of factor	The name of factor	Ave rage	percent age
1	Technical	The timely agricultural operations	4/73	4/25
2	Technical	Ease of access to agricultural machinery	4/63	4/15
3	Economical	Agricultural Machinery ownership costs	4/63	4/15
4	Technical	Facility to supply spare parts	4/52	4/04
5	Social	Type of agricultural operation system	4/50	4/04
6	Social	Satisfied feeling of machines ownership	4/44	3/98
7	Economical	The level of users' income	4/40	3/95
8	Technical	Easily access to repair shops	4/40	3/95
9	Technical	The size of the field	4/38	3/93
10	Social	The users'independence of the decision-making	4/25	3/82
11	Economical	The cost of machinery services (rent)	4/06	3/65
12	Technical	Scattering of fields	4/02	3/61
13	Technical	Density in agricultural operations in a year	3/96	3/55
14	Social	Bureaucratic, administrative and regulatory measures governing the agricultural sector		
15	Economical	The qualitative combination the population (education - skills)	3/88	3/48
16	Technical	Supplying the quality of agricultural operations	3/83	3/44
17	Technical	The potential and capabilities of agricultural lands	3/75	3/37
18	Social	community participation among exploiters	3/67	3/29
19	Economical	Employment (unemployment) in the region	3/56	3/20
20	Technical	Topographical conditions of farm lands	3/54	3/18
21	Technical	Climate and weather conditions	3/50	3/14
Total				77/71

Of the 30 identified factors influencing the selection of the agricultural machinery operation systems, 21 items have the mean score higher than 3, This quantity of factors have an effect of 77.71%. Following a detailed examination of the factors relating to each of the technical, economic and social Tables 2-4 were examined separatelyand the overall contribution of each factor was determined:
Technical factors %46.25
Social %31.16
Economical %22.59

Respectively are the most important factors in choosing agricultural machinery operation system. The identified factors were classified in the three technical, social and economic, and the importance of each of the categories identified respectively. The most important technical factors that include:

1. Timely agricultural operations
2. Ease of access to agricultural machinery
3. Simplicity of supplying spare parts
4. 4. access to authorized repair shops
5. The size of the field
6. Distribution of farm (number of pieces)
7. Accumulation in annual agricultural operations
8. The quality of agricultural machinery operation

Other technical factors including the ability of farm lands, the topography of the land and etc. were ranked next. Generally technical factor with a total of 46.25% have the highest effect in the selection of utilized agricultural operation machinery systems.

Ranking of social factors in the choice of operating system is as follows:

1. The type of agricultural operation system
2. Satisfaction from ownership of machines
3 - The independence of the users' decision-making
4- Bureaucratic administrative measures and regulations governing the agricultural sector
5-Bureaucratic administrative measures and regulations governing the agricultural sector

The most important economic factors affecting the choice of operating systems were ranked as follows:

1. The cost of ownership of agricultural machinery
2. The level of users' operating income
3. The cost of supplying machinery services (rent)
4. Qualitative combination the population (education - skills)
5. Employment (unemployment) situation in the region

Identifying important factors in choosing agricultural machinery operation systems make it possible to assess the impact of each factor in the operation of agricultural machinery systems to rank the systems using TOPSIS techniques. The results are as follows:

1- Decision matrix

Factors/systems	**Facilities to provide spare parts**	**Access to the repair shops**	**Ease of access to agricultural machinery**	**The timely operation**	**….**
Dedicated (D)	8/2	7/5	8/7	8/65	….
Professional(P)	5/6	6/2	6/8	6/4	….
Dedicated-Professional(DP)	7	4/3	6/8	7/78	….

2-Normalized decision matrix

Factors/systems	**Facilities to provide spare parts**	**Access to the repair shops**	**Ease of access to agricultural machinery**	**The timely operation**	**….**
D	0.675	0.705	0.671	0.651	….
P	0.461	0.705	0.583	0.461	….
DP	0.576	0.404	0.524	0.586	….

3-The none-scale weighted decision matrix

Factors/systems	**Facilities to provide spare parts**	**Access to the repair shops**	**Ease of access to agricultural machinery**	**The timely operation**	**….**
D	0.038	0.039	0.046	0.038	….
P	03026	0.032	0.036	0.028	….
DP	0.032	0.022	0.036	0.035	….
Ideal solution (A *)	0.038	0.039	0.046	0.038	
Anti-ideal solution (A^-)	0.026	0.022	0.036	0.028	….
Calculating the distance from the ideal $d^{\times}_1$	0.00000	0.00000	0.00000	0.00000	….
Distance from the ideal $d^{\times}_2$	0.00014	0.00005	0.00010	0.00010	….
Distance from the ideal $d^{\times}_3$	0.00003	0.00027	0.00010	0.00001	….
d^-_1 calculating the distance from the anti-ideal	0.00014	0.00027	0.00010	0.00010	….
d^-_2 calculating the distance from the anti-ideal	0.00000	0.00010	0.00000	0.00000	….
d^-3 calculating the distance from the anti-ideal	0.00004	0.00000	0.00000	0.00004	….

Calculating the similarity index (CL^*_i):

CL^*_1=0.726 **CL^*_2=0.029** **CL^*_3= 0.0516**

$CL^*_1 > CL^*_3 > CL^*_2$

Based on this the first agricultural machinery operation systems in Alborz province is following as bellow:

1 = Dedicated operating system
2= Dedicated-Professional operating system
3=Professional operating system

Conclusions

The results of the comparison of agricultural machinery operating systems in Alborz province, consisting 21 factors: technical factor, economic and social show that dedicated agricultural operating system is the most sensitive system to the factors and ranks the first grade based on the TOPSIS technique. The dedicated-professional operating system ranks the second grade it seems that as the percentage of ownership, in the other hand the users' ownership of agricultural machinery increases, and the user utilizes machines for their own field crop operations, will be more affected by technical, economic and social factors but professional operating system is far less affected by these factors.

This may be due to the fact that professional users in accordance with the terms of economic, social and technical have more versatility and are less affected by factors, because there is the possibility of transmission of side effects caused by some factors such as costs and farmers on their own account. Therefore, if each of the first and second systems identified as the optimum or desirable, proper management of affecting factors can help planners and policy makers in the agricultural sector,

particularly the management of large-scale agricultural mechanization in achieving the goals and programs.

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