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Organic Farming by Analytic Hierarchy Process (AHP)

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Abstract: Nowadays, the consumption of organic food has become more beneficial for human health. Organic food is produced by organic farming. In this paper, a methodology is proposed to identify the land for organic farming and to find out which organic food has to be grown using Analytical Hierarchy Process (AHP) over various attributes such as economic attributes and finally in terms of intake and human health. The AHP method is used to select the best organic food to be grown on the selected and suitable land by considering various criteria and sub-criteria over all probable prospects.
Keywords: Multi-Criteria Decision Making (MCDM), Analytic Hierarchy Process (AHP), Agricultural land, Organic farming.

Article type: Research article

1. Introduction

In Operation Research, the concept of Multi-Criteria Decision Making (MCDM) concept is most commonly used to solve multi-criteria problems and provides more relevant and higher quality results, especially when selecting the best among a number of alternatives. In the theory of decision making, the Analytic Hierarchy Process (AHP), also called Analytical Hierarchy Process is a structured technique for organizing and analyzing complex decisions based on mathematics and psychology. It was developed by Thomas L. Saaty in the 1970s. Later, Saaty and Ernest Forman developed Expert Choice Software in 1983. Since then, AHP has been extensively studied and refined. It basically has three parts, such as the ultimate goal, the generations of all possible alternatives and the work on the criteria by which the considered alternatives are judged. It is commonly used to prioritize and select projects. It is a precise approach to assigning weights to the criteria considered. Rather than prescribing a "correct" decision, the AHP helps to find the best option for the stated goal among all the alternatives considered by the decision makers. The reasons for the widespread use of AHP are that it has a proven, broad range of applications, intuitive and easy to use, designed for multi-criteria, builds alignment between criteria priorities and validates consistency.

The AHP technique is used to find the best agricultural land for organic farming and to select the organic food to be grown. Before buying agricultural land for farming, there are few key things that need to be taken care of such as the impact of cost and income, area, approvals and resources. Some people will even take care of the facing according to themselves and the availability like transportation will vary as it may be easy or difficult depending on the type of facing. Now, the resources are considered as availability of water, availability of electricity, availability of road, soil fertility and the climate changes. Water availability is considered because the quality of water is more important and if the neighbours have a borewell then, we need to check the quantity of water in our field and the level of flow. If there is a pipeline then, how much water is coming to the field. The availability of electricity is taken into account for water supply motors, etc., good roads are essential for transporting the finished product. Soil fertility is one of the most important factors to consider. If the soil is less fertile or not suitable, there will be big a loss as the plants will not grow successfully. Climate is very important for growing different crops or plants in different areas. There will be few permits and legal procedures (approvals)

for cultivation. If they are not done properly then, it can lead to many problems in the future. Here, the area for farming should be one acre. Based on all the above prospects, the suitable land is selected and bought.

Now, the decision maker will be given to the owner as a rent to maintain the field and in return to get the income out of all the expenses. Now, the decision maker has to choose the type of farming to be done such as vegetables, fruits, animal husbandry, flowers and crops. After this selection, the decision maker has to select the food for organic farming in especially in the above-mentioned types of farming based on the good income. Organic vegetables include cabbage, cauliflower, beans, tomato, okra, etc., Organic fruits include sapota, grapes, pomegranate, watermelon, mango, etc., Animal husbandry includes animals like cows, sheep, goats, hens, etc., where the out products be milk, meat, eggs, ghee, etc., Flowers include roses, sunflowers, anthurium, lily, jasmine, etc., Organic crops include cereals, millets, sugarcane, pulses, paddy, etc., Now, organic food farming is chosen by the AHP method and the decision maker intimates the owner and gets a good income. Analytic hierarchy process: An overview of applications by Omkar prasad S Vaidya, Sushil Kumar [1] in the year 2006 presents a literature review of the applications of Analytic Hierarchy Process (AHP). In this paper, a total of 150 application papers are referenced in this work out of which 27 are critically analyzed. This work will provide a ready reference on AHP and act as an informative summary kit for researchers and practitioners for their future work. The Modern Science of Multi criteria Decision Making and Its Practical Applications: The AHP/ANP Approach by Thomas L. Saaty [2] in the year 2013 presents a summary of the discrete mathematical part of my work, the Analytic Hierarchy Process (AHP), and its generalization to dependence and feedback, the Analytic Network Process (ANP), for measuring tangible and intangible factors, particularly as applied to decision making. In this paper, there has been a variety of applications over the last 30 to 40 years, some of which are reported here. A brief mention is made of other methods of decision making and how AHP/ANP can be compared to them. A review of applications of Analytic Hierarchy Process in operations management by Nachiappan Subramanian, Ramakrishnan Ramanathan [3] in the year 2012 presents a comprehensive list of AHP applications in operations management and develops a framework for identifying the decision areas that have better research gaps to be studied by future researchers. Application of AHP Technique by Valentinas Podvezko [4] in the year 2009 tells about the application of AHP technique to more complicated cases is considered and some algorithms are offered. The Analytic Hierarchy Process-A Survey of the Method and its Applications by Fatemeh Zahedi [5] in the year 1986 gives a brief overview of the Analytic Hierarchy Process (AHP) and its applications to various decision problems. It also discusses some of the major extensions and criticisms of the method. Application of the AHP in project management by Kamal M. Al-Subhi Al-Harbi [6] in the year 2001 presents the Analytical Hierarchy Process (AHP) as a potential decision-making method for use in project management. The problem of contractor prequalification is used as an example. This work is intended to promote the use of AHP by project management professionals. Cross-border shipment route selection utilizing analytic hierarchy process (AHP) method by Veeris Ammarapala, Thanwadee Chinda, Pimnapa Pongsayaporn, Wit Ratanachot, Koonnamas Punthutaecha, Koson Janmontain [7] the year 2018 aims to select potential rural roads to support cross-border shipment using the analytic hierarchy process (AHP) method. Interviews are conducted with the experts based on seven key factors to collect data for the AHP analysis. In this paper, the results identify the weight of each factor with an acceptable consistency ratio. It shows that the value of cross-border trade is the most important factor as it achieves the highest weight. The Department of Rural Roads could use the results to select suitable roads and plan road improvements to support cross-border transport when the AEC is fully implemented. How to make a decision: The Analytic Hierarchy Process by Thomas L. Saaty [8] in the year 1990 serves as an introduction to the Analytic Hierarchy Process. This work summarizes the principles and philosophy of the theory and provides general background information on the type of measurement used, its properties and applications. On the invalidity of fuzzifying numerical judgments in the Analytic Hierarchy Process by Thomas L. Saaty, Liem T. Tran [9] in the year 2007 presents how making judgments fuzzier can worsen the validity of the result when the actual result is known, as shown by several examples in this paper. Also, improving the consistency of a judgment matrix does not necessarily improve the validity of the result. An example of this is also included in this paper. Analytic Hierarchy Process (AHP) to Solve Complex Decision Problems by E. Terzi [10] in the year 2019 covers two different examples that we have solved with Analytic Hierarchy Process (AHP). In this paper, AHP is explained mathematically and allows us to find out which alternative is the optimum in the problem. Criteria in AHP: a Systematic Review of Literature by Rosaria de F.S.M. Russo, Roberto Camanho [11] in the year 2015 studies

how to develop a systematic review of literature on the real cases that have applied AHP to evaluate how the criteria are being defined and measured. In this paper, 33 cases are selected, they mainly used literature to build the criteria and AHP or Fuzzy AHP to calculate their weight, while other techniques were used to evaluate alternatives. Using Geometric Mean Method of Analytical Hierarchy Process for Decision Making in Functional Layout by Anupma Yadav, Dr. S.C Jayswal [12] in the year 2013 shows that the geometric mean method a mathematical process of Analytical Hierarchy Process (AHP) is used for analyzing the parameters of functional layout i.e whether it can be implemented or not under the considered condition. Estimation of the effectiveness of multi-criteria decision analysis and machine learning approaches for agricultural land capability in Gangarampur Subdivision, Eastern India by Sunil Saha, Prolay Mondal [13] in the year 2022 aims to identify potentially viable agricultural land in Gangarampur Subdivision (West Bengal) using multiple criteria decision making (MCDM) and machine learning techniques and to evaluate the effectiveness of the methods used. This study will make an important contribution to the assessment of soil fertility and site suitability and will help local government officials, academics and farmers to use land scientifically. Applying Analytic Hierarchy Process (AHP) to identify decision-making in soybean supply chains: a case of Mato Grosso production by Toloi, R. C., Reis, J. G. M., Toloi, M. N. V., Vendrametto, O., Cabral, J. A. S. P. [14] in the year 2022 aims to identify and analyze the factors that influence the decision of Mato Grosso farmers to produce soybean using the Analytic Hierarchy Process (AHP). In this paper, it shows the results of the impact of logistics in the soybean decision process. This study has an exploratory character and presents empirical results that can contribute to the understanding of soybean production in the country. Evaluation of risk factors in agriculture: an application of the analytical hierarchical process (AHP) methodology by Roger Toledo, Alejandra Engler, Víctor Ahumada [15] in the year 2011 studies the prioritization of risk factors that are highly relevant for farmers in Central South Chile. In this work, the multi-criteria Analytical Hierarchical Process (AHP) methodology was used to define a decision structure with four risk factors or criteria: climate, price and direct cost variability, human factor and commercialization, which determine different levels of risk for the respective agricultural activities according to the geographical region. Developing and quantifying indicators of organic farming using analytic hierarchy process" by Masoud Sajadian, Korous Khoshbakht, Houman Liaghati, Hadi Veisi, Abdolmajid Mahdavi Damghani [16] in the year 2017 studies to develop and quantify organic farming indicators to determine the relative importance of each. In this study, the analytic hierarchy process (AHP) was used for this purpose. The results of this study can be useful for both inspection bodies and organic farmers, farmers can reduce the risks associated with transitioning to organic farming and minimize the probability of failure by monitoring these indicators in their fields. Identifying Suitable Areas for Plantation of Organic Products Using GIS and AHP by J C Mohd Zaini, N Mohamed Saraf, N Naharudin, A R Abdul Rasam, N Hashim [17] in the year 2021 studies the use of GIS and AHP technique to identify suitable areas for organic farming in Sabak Bernam, Malaysia. In this work, it is shown that the majority of the land in Sabak Bernam district is suitable for organic farming if the land is far from road networks, has high organic matter content, gentle slopes with flat aspects, low elevation and less than 10 meters from drains. Choosing between Alternative Farming Systems: An Application of the Analytic Hierarchy Process by Mwana N. Mawapanga, David L. Debertin [18] in the year 1996 presents about the issues related to farmer health, farm family and consumer concerns. This study uses the Analytic Hierarchy Process (AHP) to analyse farmers' opinions on how they weigh different objectives in choosing a farming system from a set of three alternatives. These alternatives are: (1) a conventional farming system that relies heavily on agricultural chemicals; (2) an organic farming system that does not use any purchased agricultural chemicals; and (3) an organic farming system in which commercial fertilizers are replaced primarily, but not exclusively, with natural nutrients and in which biological controls are preferred to chemical pesticides. Investigating consumer attitudes toward food produced via three production systems: Conventional, sustainable and organic by Terrence Thomas, Cihat Gunden [19] in the year 2012 presents consumer attitudes towards the following food production systems, conventional, sustainable and organic, along five criteria: environmental concerns, food safety, food quality, wellness and community development concerns. In this study, an Analytic Hierarchy Process is used to derive a measure of an individual consumer's preference for production systems in terms of the selected criteria. It shows that consumers consider food safety and wellness to be more important attributes of a food production system.

2. Data Collection Through Survey

In the paper, the data for the buying of agricultural land and selection of organic food farming is collected through an online survey. Online survey is conducted through the forms and received responses individually from the total of 130 people including 72 men and 58 women. The data is collected through all the care, gathered accurate information and their expectations.

Survey link –

https://docs.google.com/forms/d/e/1FAIpQLSfhNMctbSQ6_RqfjlfmPQZmhDtdFUhom1GRagHd9CfcymCXxA/viewform?usp=sf_link

3. Methodology

The AHP makes the decision in the following steps:-

1. Defining the problem and alternatives
2. Defining the criteria and sub-criteria related to the problem
3. Constructing the comparison matrices
4. Checking the consistency
5. Evaluating the relative weights to the criteria and sub-criteria

According to the criteria or sub-criteria, the comparison has been done by assigning the scale of values from 1 to 9. The scale of values and their definition was given by Saaty.[7]

Intensity of importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance of one over another	Experience and judgment strongly favor one activity over another
5	Essential of strong importance	Experience and judgment strongly favor one activity over another
7	Very strong importance	An activity is strongly favored and its dominance demonstrated in practice
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2, 4, 6, 8	Intermediate values between the two adjacent judgment	When compromise is needed

Table for scale of AHP

The consistency is calculated as the ratio of consistency index and random index, is also called as consistency ratio.

Consistency ratio = (Consistency index)/(Random index)

Consistency index is given by,

Consistency index = $((\lambda\_max-n))/((n-1))$

where, λ_max is the average value of A4 matrix.

n is the number of criteria or sub-criteria

According to number of criteria or sub-criteria, the random index value are also given by Saaty.[2]

Number of criteria or sub-criteria	1	2	3	4	5	6	7	8	9	10
Random index	0	0	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49

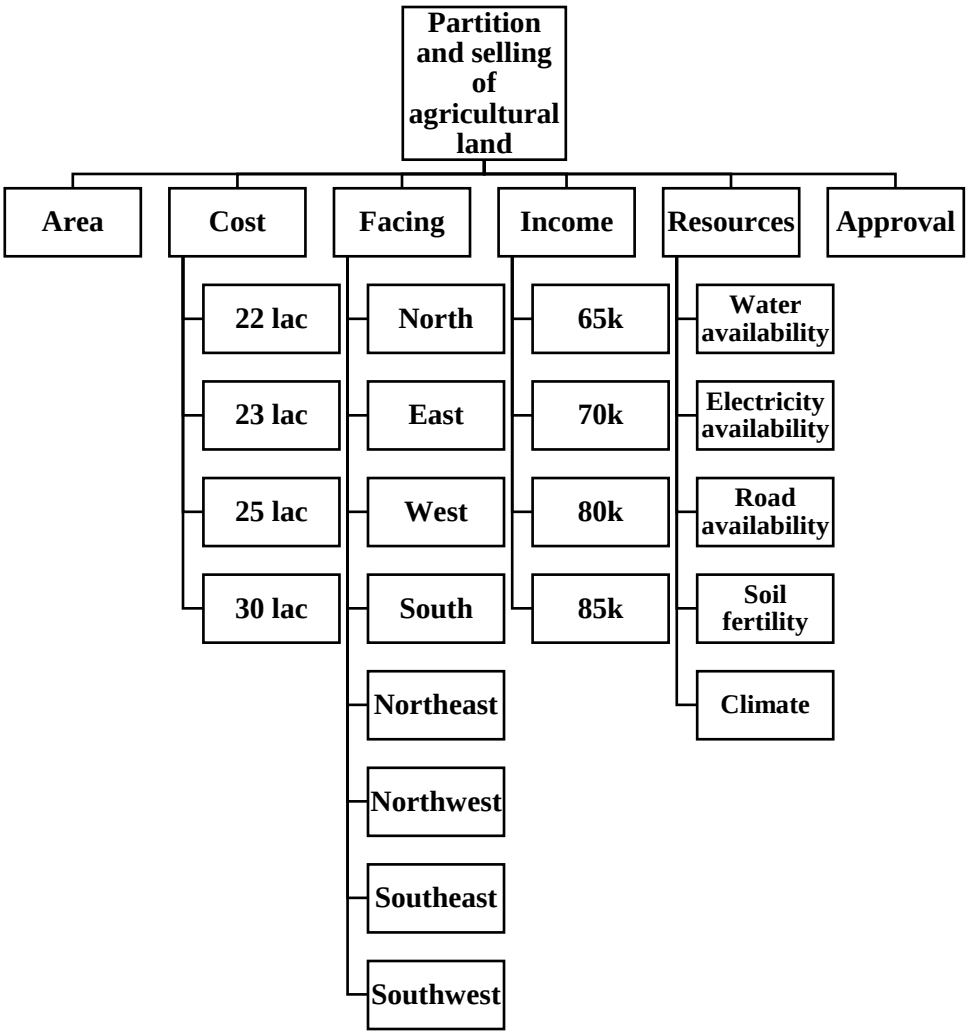
Table for Random index

Goals

1. Partition and selling of agricultural land over various criteria and sub criteria
2. Maintenance of the agricultural land through organic farming
   i. Selection of the type of organic farming
   ii. Selection of organic food that has to be grown on the agricultural land particularly

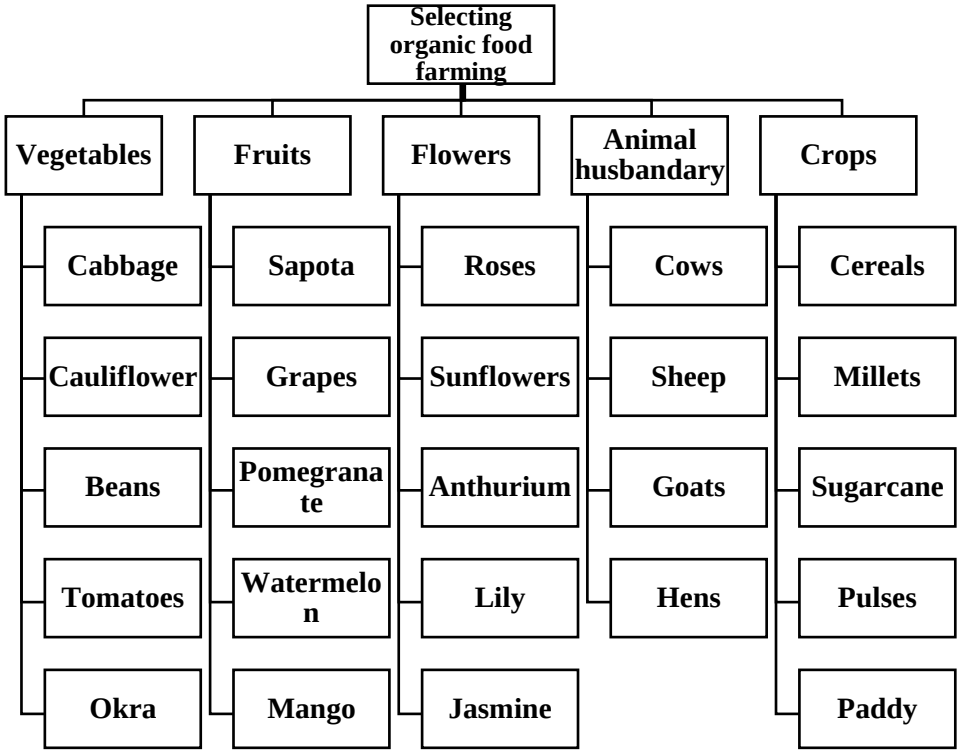
Problem Formulation

1. Hierarchical structure for the partition and selling of agricultural land and the possible alternatives over various criteria and sub criteria.



Alternatives/Criteria	Area	Cost	Facing	Income	Resources	Approval
Field 1	43560 sq.ft	25 lac	Northeast	80k	Water availability, Electricity availability, Road availability, Soil fertility	Yes
Field 2	43560 sq.ft	25 lac	North	80k	Water availability, Electricity availability, Soil fertility, Climate	Yes
Field 3	43560 sq.ft	30 lac	East	85k	Water availability, Electricity availability, Soil fertility, Climate	Yes
Field 4	43560 sq.ft	23 lac	Southeast	70k	Water availability, Soil fertility, Climate	No
Field 5	43560 sq.ft	23 lac	West	70k	Water availability, Soil fertility, Climate	Yes
Field 6	43560 sq.ft	30 lac	South	85k	Water availability, Electricity availability, Road availability, Soil fertility, Climate	No
Field 7	43560 sq.ft	22 lac	Northwest	65k	Water availability, Soil fertility	Yes
Field 8	43560 sq.ft	22 lac	Southwest	65k	Water availability, Electricity availability, Road availability, Soil fertility, Climate	Yes

structure for the maintenance of the agricultural land through organic farming Hierarchical



4. Solution And Discussion

1. Partition and selling of agricultural land

A1 MATRIX						
Criteria	Area	Cost	Facing	Income	Resources	Approval
Area	1	2	2	$\frac{1}{2}$	$\frac{1}{5}$	$\frac{1}{3}$
Cost	$\frac{1}{2}$	1	2	$\frac{1}{2}$	$\frac{1}{8}$	$\frac{1}{4}$
Facing	$\frac{1}{2}$	$\frac{1}{2}$	1	2	$\frac{1}{8}$	$\frac{1}{5}$
Income	2	2	$\frac{1}{2}$	1	$\frac{1}{6}$	$\frac{1}{3}$
Resources	5	8	8	6	1	2
Approval	3	4	5	3	$\frac{1}{2}$	1

Geometric mean(GM)
0.7148
0.5000
0.4817
0.6934
3.9572
2.1169
$sum = 8.4640$

A2 MATRIX =GM/sum
0.0844
0.0591
0.0569
0.0819
0.4675
0.2501
$sum = 1$

A3 MATRIX =A1*A2
0.5343
0.3771
0.4010
0.5587
2.8094
1.5039

A4 MATRIX =A3/A2
6.3267
6.3829
7.0450
6.8203
6.0090
6.0128
$\lambda_{max} = 6.4328$

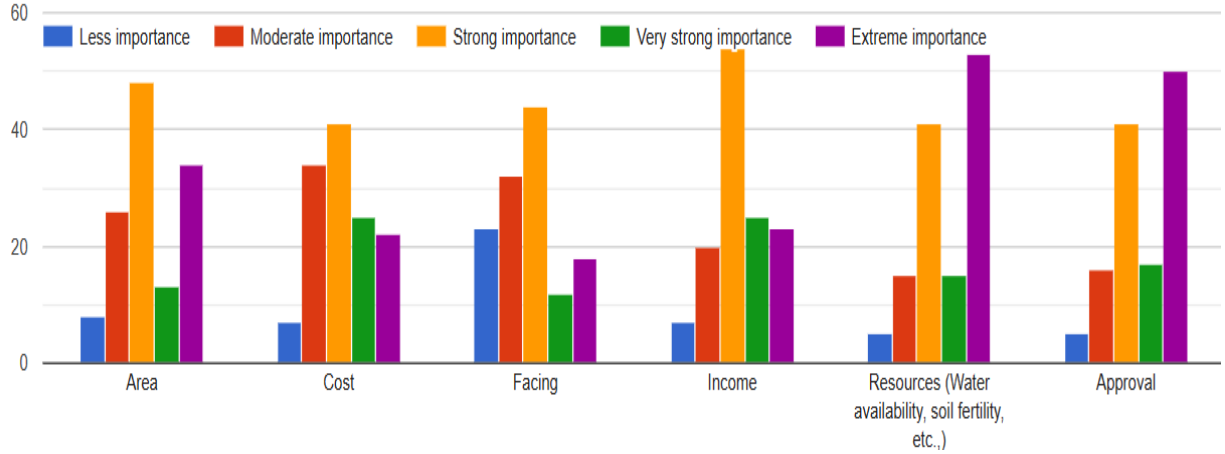
Here, the number of criteria's (n) are 6.

Consistency index = $\frac{(\lambda_{max}-n)}{(n-1)} = \frac{6.4328-6}{6-1} = 0.0866$

Random index = 1.25

Consistency ratio = $\frac{consistency\ index}{random\ index} = \frac{0.0866}{1.25} = 0.0692<0.1$

According to the survey, the following result has been obtained for the criteria of partition and selling of agricultural land.



Criteria's for the cost

A1 MATRIX				
Cost Criteria	22 lac	23 lac	25 lac	30 lac
22 lac	1	2	4	7
23 lac	$\frac{1}{2}$	1	3	6
25 lac	$\frac{1}{4}$	$\frac{1}{3}$	1	3
30 lac	$\frac{1}{7}$	$\frac{1}{6}$	$\frac{1}{3}$	1

Geometric mean(GM)
2.7356
1.7321
0.7071
0.2985
$sum = 5.4732$

A2 MATRIX =GM/sum
0.4998
0.3165
0.1292
0.0545
$sum = 1$

A3 MATRIX =A1*A2
2.0312
1.2812
0.5232
0.2217

A4 MATRIX =A3/A2
4.0640
4.0484
4.0500
4.0662
$\lambda_{max} = 4.0571$

Here, the number of cost criteria's (n) are 4.

Consistency index = $\frac{(\lambda_{max}-n)}{(n-1)} = \frac{4.0571-4}{4-1} = 0.019$

Random index = 0.89

Consistency ratio = $\frac{consistency\ index}{random\ index} = \frac{0.019}{0.89} = 0.0214<0.1$

Criteria of the facing

A1 MATRIX

Facing Criteria	North	East	West	South	Northeast	Northwest	Southeast	Southwest
North	1	$\frac{1}{3}$	2	$\frac{1}{2}$	2	4	3	3
East	3	1	6	2	4	9	7	9
West	$\frac{1}{2}$	$\frac{1}{6}$	1	$\frac{1}{4}$	$\frac{1}{2}$	2	2	2
South	2	$\frac{1}{2}$	4	1	2	7	4	6
Northeast	$\frac{1}{2}$	$\frac{1}{4}$	2	$\frac{1}{2}$	1	3	2	3
Northwest	$\frac{1}{4}$	$\frac{1}{9}$	$\frac{1}{2}$	$\frac{1}{7}$	$\frac{1}{3}$	1	$\frac{1}{2}$	$\frac{1}{2}$
Southeast	$\frac{1}{3}$	$\frac{1}{7}$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{2}$	2	1	2
Southwest	$\frac{1}{3}$	$\frac{1}{9}$	$\frac{1}{2}$	$\frac{1}{6}$	$\frac{1}{3}$	2	$\frac{1}{2}$	1

Geometric mean(GM)	A2 MATRIX =GM/sum	A3 MATRIX =A1*A2	A4 MATRIX =A3/A2
1.4877	0.1324	1.0778	8.1390
4.1114	0.3660	2.9538	8.0710
0.7330	0.0652	0.5341	8.1855
2.4607	0.2190	1.7654	8.0599
1.1067	0.0985	0.8015	8.1360
0.3367	0.0300	0.2449	8.1706
0.5747	0.0512	0.4195	8.2001
0.4232	0.0377	0.3100	8.2285
$sum = 11.2342$	$sum = 1$		$\lambda_{max} = 8.1488$

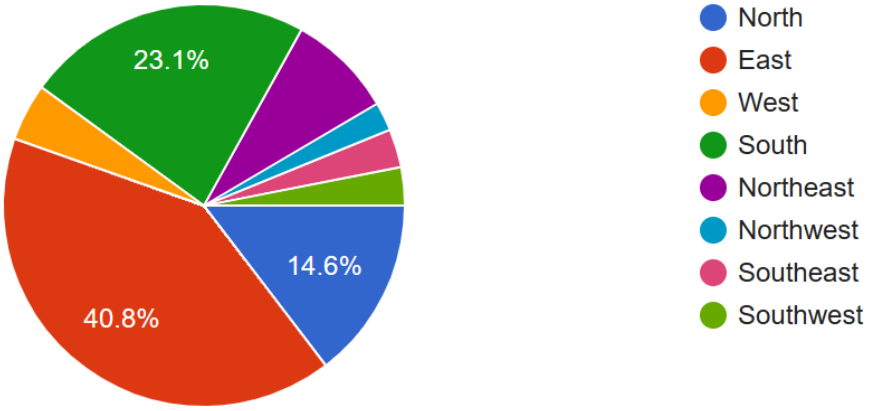
Here, the number of facing criteria's (n) are 8.

Consistency index = $\frac{(\lambda_{max}-n)}{(n-1)} = \frac{8.1488-8}{8-1} = 0.0213$

Random index = 1.4

Consistency ratio = $\frac{consistency\ index}{random\ index} = \frac{0.0213}{1.4} = 0.0152<0.1$

According to the survey, the following result has been obtained for the facing criteria of partition and selling of agricultural land.



Criteria of the income

A1 MATRIX				
Income Criteria	65k	70k	80k	85k
65k	1	$\frac{1}{2}$	$\frac{1}{3}$	$\frac{1}{7}$
70k	2	1	$\frac{1}{2}$	$\frac{1}{7}$
80k	3	2	1	$\frac{1}{4}$
85k	7	7	4	1

Geometric mean(GM)
0.3928
0.6148
1.1067
3.7417
$sum = 5.8559$

A2 MATRIX =GM/sum
0.0671
0.105
0.189
0.639
$sum = 1$

A3 MATRIX =A1*A2
0.2738
0.4249
0.7599
2.5993

A4 MATRIX =A3/A2
4.0824
4.0474
4.0211
4.0681
$\lambda_{max} = 4.0548$

Here, the number of income criteria's (n) are 4.

Consistency index = $\frac{(\lambda_{max}-n)}{(n-1)} = \frac{4.0548-4}{4-1} = 0.0183$

Random index = 0.89

Consistency ratio = $\frac{consistency\ index}{random\ index} = \frac{0.0183}{0.89} = 0.0205<0.1$

Criteria of the resources

A1 MATRIX					
Resources criteria	Water availability	Electricity availability	Road availability	Soil fertility	Climate
Water availability	1	2	3	$\frac{1}{2}$	2
Electricity availability	$\frac{1}{2}$	1	2	$\frac{1}{4}$	$\frac{1}{2}$
Road availability	$\frac{1}{3}$	$\frac{1}{2}$	1	$\frac{1}{6}$	$\frac{1}{2}$
Soil fertility	2	4	6	1	3

Climate	$\frac{1}{2}$	2	2	$\frac{1}{3}$	1

Geometric mean(GM)
1.4310
0.6598
0.4251
2.7019
0.9221
$sum = 6.1399$

A2 MATRIX =GM/sum
0.2331
0.1075
0.0692
0.4401
0.1502
$sum = 1$

A3 MATRIX =A1*A2
1.1761
0.5476
0.3491
2.2020
0.7668

A4 MATRIX =A3/A2
5.0463
5.0959
5.0416
5.0039
5.1057
$\lambda_{max} = 5.0587$

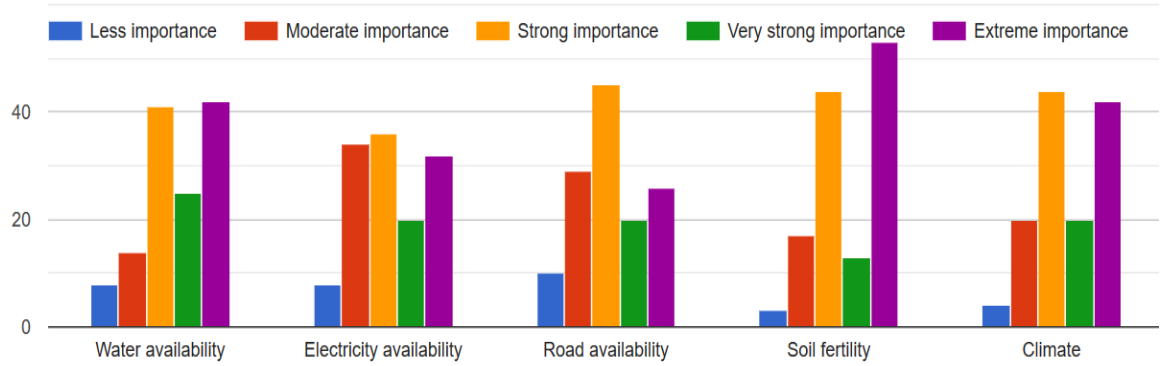
Here, the number of resources criteria's (n) are 5.

Consistency index = $\frac{(\lambda_{max}-n)}{(n-1)} = \frac{5.0587-5}{5-1} = 0.0147$

Random index = 1.11

Consistency ratio = $\frac{consistency\ index}{random\ index} = \frac{0.0147}{1.11} = 0.0132<0.1$

According to the survey, the following result has been obtained for the resources criteria of partition and selling of agricultural land.



The A2 matrix is the weights for all the respective criteria's and sub-criteria's.

Global weights are calculated by multiplying the local weights of criteria with local weight of their sub-criteria.

Criteria local weights	Sub-criteria weights	Global weights
Area 0.0844	–	0.0844
Cost 0.0591	22 lac-0.4998	0.0295
	23 lac-0.3165	0.0187
	25 lac-0.1292	0.0076
	30 lac-0.0545	0.0032
Facing 0.0569	North-0.1324	0.0075
	East-0.3660	0.0208
	West-0.0652	0.0037
	South-0.2190	0.0125
	Northeast-0.0985	0.0056
	Northwest-0.0300	0.0017
	Southeast-0.0512	0.0029
	Southwest-0.0377	0.0021
Income	65k-0.0671	0.0055

0.0819	70k-0.1050	0.0086
	80k-0.1890	0.0155
	85k-0.6390	0.0523
Resources 0.4675	Water availability-0.2331	0.1090
	Electricity availability-0.1075	0.0503
	Road availability-0.0692	0.0324
	Soil fertility-0.4401	0.2051
	Climate-0.1502	0.0702
Approval 0.2501	–	0.2501

Now, let's calculate the overall weights and give ranking to all the alternatives.

Alternatives/criteria	Area	Cost	Facing	Income	Resources	Approval	Total weight	Rank
Field 1	0.0844	0.0076	0.0056	0.0155	0.3974	0.2501	0.7606	4
Field 2	0.0844	0.0076	0.0075	0.0155	0.4352	0.2501	0.8003	3
Field 3	0.0844	0.0032	0.0208	0.0523	0.4352	0.2501	0.8460	1
Field 4	0.0844	0.0187	0.0029	0.0086	0.3849	0.0000	0.4995	8
Field 5	0.0844	0.0187	0.0037	0.0086	0.3849	0.2501	0.7504	5
Field 6	0.0844	0.0032	0.0125	0.0523	0.4676	0.0000	0.6200	7
Field 7	0.0844	0.0295	0.0017	0.0055	0.3147	0.2501	0.6859	6
Field 8	0.0844	0.0295	0.0021	0.0055	0.4676	0.2501	0.8392	2

Based on the ranking, it's best to sell the field 3 for the decision maker.

2. Maintenance of the agricultural land through organic farming

i. Selection of the type of organic farming

A1 MATRIX					
Criteria	Vegetables	Fruits	Flowers	Animal husbandry	Crops
Vegetables	1	2	7	4	2
1Fruits	$\frac{1}{2}$	1	3	2	$\frac{1}{2}$
Flowers	$\frac{1}{7}$	$\frac{1}{3}$	1	$\frac{1}{2}$	$\frac{1}{5}$
Animal husbandry	$\frac{1}{4}$	$\frac{1}{2}$	2	1	$\frac{1}{3}$
Crops	$\frac{1}{2}$	2	5	3	1

Geometric mean(GM)
2.5695
1.0845
0.3432
0.6084
1.7188
$sum = 6.3243$

A2 MATRIX =GM/sum
0.4063
0.1715
0.0543
0.0962
0.2718
$sum = 1$

A3 MATRIX =A1*A2
2.0574
0.8657
0.2719
0.4826
1.3778

A4 MATRIX =A3/A2
5.0640
5.0485
5.0107
5.0172
5.0697
$\lambda_{max} = 5.0420$

Here, the number of criteria's for selecting type of farming are 5.

Consistency index = $\frac{(\lambda_{max}-n)}{(n-1)} = \frac{5.0420-5}{5-1} = 0.0105$

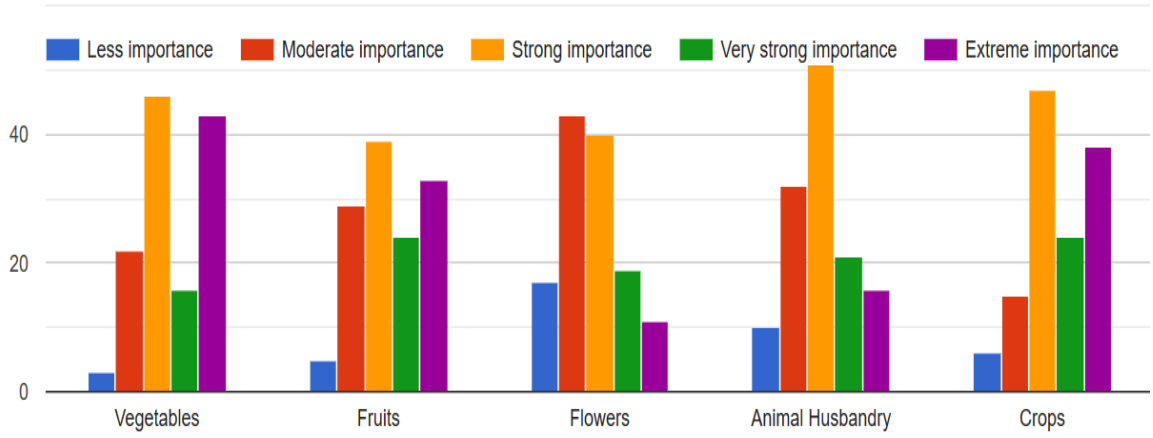
Random index = 1.11

Consistency ratio = $\frac{consistency\ index}{random\ index} = \frac{0.0105}{1.11} = 0.0095<0.1$

The A2 matrix gives the weights for the respective criteria.

From A2 matrix, we can observe that the weight of vegetables are more. Therefore, the type of organic farming selected is vegetables.

According to the survey, the following result has been obtained for the criteria for selection of the type of organic farming.



ii. Selection of organic food that has to be grown on the agricultural land particularly

A1 MATRIX					
Vegetables criteria	Cabbage	Cauliflower	Beans	Tomato	Okra
Cabbage	1	$\frac{1}{5}$	$\frac{1}{2}$	$\frac{1}{5}$	$\frac{1}{2}$
Cauliflower	5	1	2	$\frac{1}{2}$	5
Beans	2	$\frac{1}{2}$	1	$\frac{1}{2}$	6
Tomato	5	2	2	1	7
Okra	2	$\frac{1}{5}$	$\frac{1}{6}$	$\frac{1}{7}$	1

Geometric mean(GM)
0.3981
1.9037
1.2457
2.6867
0.3942
$sum = 6.6285$

A2 MATRIX =GM/sum
0.0601
0.2872
0.1879
0.4053
0.0595
$sum = 1$

A3 MATRIX =A1*A2
0.3223
1.4634
0.0112
2.0722
0.3263

A4 MATRIX =A3/A2
5.3658
5.0956
5.3804
5.1124
5.4855
$\lambda_{max} = 5.2880$

Here, the number of criteria's for vegetables are 5.

Consistency index = $\frac{(\lambda_{max}-n)}{(n-1)} = \frac{5.2880-5}{5-1} = 0.0720$

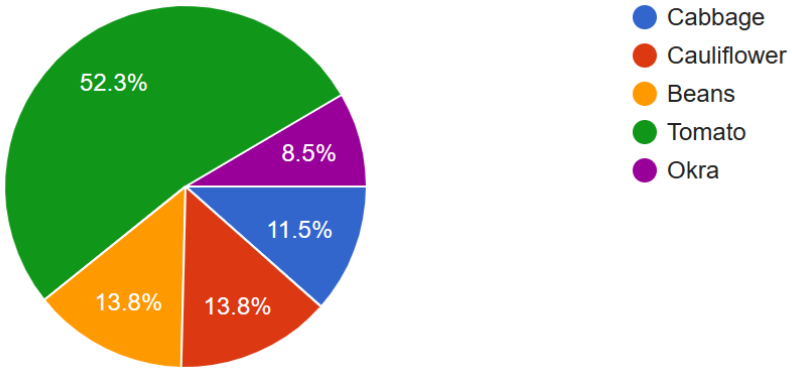
Random index = 1.11

Consistency ratio = $\frac{consistency\ index}{random\ index} = \frac{0.0720}{1.11} = 0.0649<0.1$

The A2 matrix gives the weights for the respective criteria for vegetables.

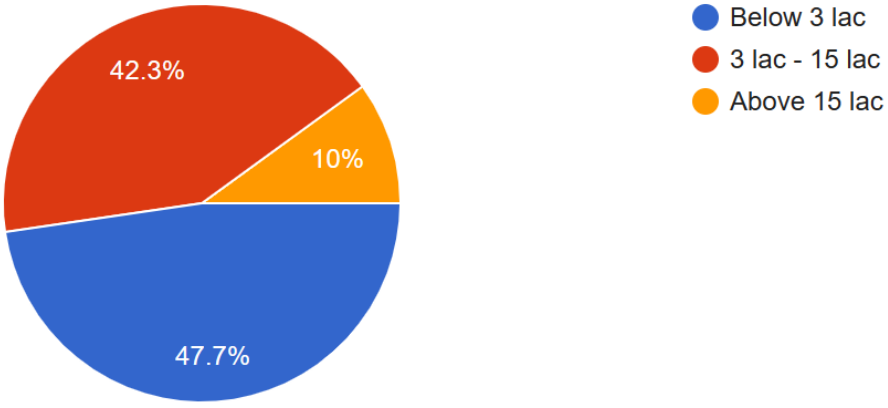
From A2 matrix we can observe that the weight of tomato is more.

According to the survey, the following result has been obtained for the criteria for selection of organic food that as to be grown on the agricultural land particularly.



5. Conclusion

From the above, results are found for the mentioned objectives with comparison of the survey. In the survey, three different classes of family chosen based on their annual income as shown below:



The result of the first objective is that partition and selling the field 3 is best. As the survey also shows that the responses of the criteria's and sub criteria's of the field 3 is more among all different classes of family.

The results of criteria's and sub criteria's in the survey for selling the field 3 among all different classes of family are shown below:

Area	Below 3 lac	3 lac - 15 lac	Above 15 lac	Grand total
Less importance	3	5	0	8
Moderate importance	10	12	4	26
Strong importance	26	17	5	48
Very strong importance	5	6	2	13
Extreme importance	18	15	2	35
Grand total	62	55	13	130

Cost	Below 3 lac	3 lac - 15 lac	Above 15 lac	Grand total
Less importance	4	3	0	7
Moderate importance	16	16	2	34
Strong importance	17	19	5	41
Very strong importance	12	9	4	25
Extreme importance	13	8	2	23
Grand total	62	55	13	130

Facing	Below 3 lac	3 lac - 15 lac	Above 15 lac	Grand total
Less importance	13	8	2	23
Moderate importance	17	10	5	32
Strong importance	14	27	3	44
Very strong importance	7	3	3	13
Extreme importance	11	7	0	18
Grand total	62	55	13	130

Income	Below 3 lac	3 lac - 15 lac	Above 15 lac	Grand total
Less importance	4	3	0	7
Moderate importance	12	5	3	20
Strong importance	22	26	6	54

Very strong importance	11	11	4	26
Extreme importance	13	10	0	23
Grand total	62	55	13	130

Resources	Below 3 lac	3 lac - 15 lac	Above 15 lac	Grand total
Less importance	3	2	0	5
Moderate importance	8	7	0	15
Strong importance	18	16	7	41
Very strong importance	8	6	1	15
Extreme importance	25	24	5	54
Grand total	62	55	13	130

Approval	Below 3 lac	3 lac - 15 lac	Above 15 lac	Grand total
Less importance	2	3	0	5
Moderate importance	11	5	0	16
Strong importance	15	19	7	41
Very strong importance	9	5	3	17
Extreme importance	25	23	3	51
Grand total	62	55	13	130

Facing criteria	Below 3 lac	3 lac - 15 lac	Above 15 lac	Grand total
North	6	10	3	19
West	3	3	0	6
East	23	24	6	53
South	19	9	2	30
Northeast	6	3	2	11
Northwest	2	1	0	3
Southeast	2	2	0	4
Southwest	1	3	0	4
Grand total	62	55	13	130

Resources criteria

Water availability	Below 3 lac	3 lac - 15 lac	Above 15 lac	Grand total

Less importance	5	2	1	8
Moderate importance	9	5	0	14
Strong importance	13	21	7	41
Very strong importance	15	8	2	25
Extreme importance	20	19	3	42
Grand total	62	55	13	130

Electricity availability	Below 3 lac	3 lac - 15 lac	Above 15 lac	Grand total
Less importance	5	2	1	8
Moderate importance	21	13	0	34
Strong importance	11	17	8	36
Very strong importance	10	8	2	20
Extreme importance	15	15	2	32
Grand total	62	55	13	130

Road availability	Below 3 lac	3 lac - 15 lac	Above 15 lac	Grand total
Less importance	6	3	1	10
Moderate importance	15	14	0	29
Strong importance	16	21	8	45
Very strong importance	11	8	1	20
Extreme importance	14	9	3	26
Grand total	62	55	13	130

Soil fertility	Below 3 lac	3 lac - 15 lac	Above 15 lac	Grand total
Less importance	2	1	0	3
Moderate importance	9	7	1	17
Strong importance	18	19	7	44
Very strong importance	7	6	0	13

Extreme importance	26	22	5	53
Grand total	62	55	13	130

Climate	Below 3 lac	3 lac - 15 lac	Above 15 lac	Grand total
Less importance	2	2	0	4
Moderate importance	12	7	1	20
Strong importance	16	21	7	44
Very strong importance	12	8	0	20
Extreme importance	20	17	5	42
Grand total	62	55	13	130

The result of the second objective is that vegetables is best type of the organic food farming and tomato is the best organic food for organic farming. As the survey also shows that the responses of the criteria's and sub criteria's of the organic food farming of vegetables particularly tomato is more among all different classes of family. The results of criteria's and sub criteria's in the survey for selecting the type of organic food as vegetables particularly tomato among all different classes of family are shown below:

Vegetables	Below 3 lac	3 lac - 15 lac	Above 15 lac	Grand total
Less importance	3	0	0	3
Moderate importance	12	10	0	22
Strong importance	17	22	7	46
Very strong importance	7	5	4	16
Extreme importance	23	18	2	43
Grand total	62	55	13	130
Fruits	Below 3 lac	3 lac - 15 lac	Above 15 lac	Grand total
Less importance	2	3	0	5
Moderate importance	19	10	0	29
Strong importance	13	17	9	39
Very strong importance	11	10	3	24
Extreme importance	17	15	1	33
Grand total	62	55	13	130

Flowers	Below 3 lac	3 lac - 15 lac	Above 15 lac	Grand total

Less importance	10	6	1	17
Moderate importance	20	20	3	43
Strong importance	16	19	5	40
Very strong importance	8	7	4	19
Extreme importance	8	3	0	11
Grand total	62	55	13	130

Animal husbandry	Below 3 lac	3 lac - 15 lac	Above 15 lac	Grand total
Less importance	4	5	1	10
Moderate importance	19	11	2	32
Strong importance	19	26	6	51
Very strong importance	10	7	4	21
Extreme importance	10	6	0	16
Grand total	62	55	13	130

Crops	Below 3 lac	3 lac - 15 lac	Above 15 lac	Grand total
Less importance	3	3	0	6
Moderate importance	11	3	1	15
Strong importance	15	26	6	47
Very strong importance	10	11	3	24
Extreme importance	23	12	3	38
Grand total	62	55	13	130

Vegetables criteria	Below 3 lac	3 lac - 15 lac	Above 15 lac	Grand total
Cabbage	8	7	0	15
Cauliflower	12	4	2	18
Beans	7	10	1	18
Tomato	30	29	9	68
Okra	5	5	1	11
Grand total	62	55	13	130

Finally, tomato is the best organic food farming for the maintenance of agriculture land over all the criteria's and sub-criteria's that has been considered successfully. With this model one can analyze the group of people preferences.

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