



Measurement of Perceived Factors Influencing Diversification Towards Seasonal Commercial Crops Through Analytic Hierarchy Process

J. Kavipriya¹, K. Mahandrakumar², M. Kavinila³

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ABSTRACT

Background: In the Cauvery Delta Zone farmers faced a lot of hurdles to get involved in the production of food grain crops. So far, the farmers in the Cauvery Delta Zone have moved away from paddy to other crops for at least one season. Farm diversification is the product of both internal and external factors. Since, Diversification is an inevitable phenomenon in the Cauvery Delta Zone due to situational, economic, technological, and administrative factors, but the influence of such variables on the decision-making of farmers is not yet known.

Methods: This study analyses the weight coefficients of perceived factors influencing diversification towards seasonal commercial crops through the Analytic Hierarchy Process (AHP).

Result: The result of the study shows that the economic dimension in seasonal commercial crops was the most important criterion which implies the highest weightage score of 0.328.

Key words: Analytic hierarchy process, Cauvery delta zone, Decision-making pattern, Farm diversification, Perceived factors.

INTRODUCTION

Farm diversification is a universal phenomenon being observed in developed, developing, and underdeveloped countries alike. The increase in population naturally demands a change in the present agricultural production system by altering the crops (Acharya *et al.*, 2011; Gupta and Tewari, 1985). Moreover, urbanization and people's movement towards urban led to an alteration in consumption patterns that necessarily demands modification in the agricultural production system (Wikmette *et al.*, 2008; Halliday, 1989). Apart from that, increased events of drought and flood as a result of climate change, the decline in water resources, depletion of ground water, unpredictability of weather conditions in production of diversified crops also exerts influence in cropping pattern (Kumar and Sakshi Gupta, 2015; Jamagani and Bivan, 2013). The non-availability of manual labourers, high cost of critical farm inputs, accelerating cost of labourers in crop production, the availability of draft energy, family work, land quality, the experience and education of farmers, also promoted lot of modification in cropping sequences (Singh, 1995; Meert *et al.*, 2005; Effiong *et al.*, 2024).

In recent years the Delta Zones, particularly Cauvery Delta Zone farmers faced lot of hurdles to get involved in the production of food grain crops. Already the farmers in the Cauvery Delta Zone have moved away from paddy to other crops at least in one season. Tamil Nadu Agricultural University (TNAU) is promoting alternative crops for the Cauvery Delta Zone through their publications and programs. For instance, the implementation of Tamil Nadu Irrigated Agricultural Modernization Programme (TNIAMP) under the guidance of TNAU demonstrated cultivation of

¹Department of Agricultural Extension, Krishna College of Agriculture and Technology, Srirangapuram, Madurai-625 532, Tamil Nadu, India.

²Department of Agricultural Extension and Rural Sociology, Agricultural College and Research Institute, Kudumiyamalai-622 104, Tamil Nadu, India.

³Department of Agricultural Extension, Adhiyamaan College of Agriculture and Research, Athimugam, Shoolagiri, Krishnagiri-635 105, Tamil Nadu, India.

Corresponding Author: J. Kavipriya, Department of Agricultural Extension, Krishna College of Agriculture and Technology, Srirangapuram, Madurai-625 532, Tamil Nadu, India.

Email: kavipriyajayamoorthy@gmail.com

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commercial crops such as maize and cotton gives more profit than the paddy (Renganathan, 2017). The former vice chancellor of Tamil Nadu Agricultural University quoted that cotton area was around 17 lakh acres in delta district during 2016-2017 planned to extend upto 21 lakhs acres in the upcoming years (Ramakrishnan, 2018). Diversification is an inevitable phenomenon in Cauvery Delta Zone due to situational, economical, technological and administrative factors, but the influence of such variables on the decision making of farmers is not yet known. Diversification not only guaranteed food security for the family throughout the year, but also provided them with nutritious food (Wondimagegn

Mesfin *et al.*, 2011; Sammauria, *et al.*, 2019; Talukdar, P *et al.*, 2023). Hence, it is necessary to study the extend of contribution of both internal and external factors in a farm management decision of farmers related to farm diversification (Ashfaq 2008; Fernando, *et al.*, 2009; Ray Prabuddha, 2022). This study analyses the weight coefficients of perceived factors influencing diversification towards seasonal commercial crops.

MATERIALS AND METHODS

Since farm diversification is an already existing phenomenon in the Cauvery Delta Zone over a period of time, the *ex post - facto* type of research was employed. In this study, the Analytic Hierarchy Process (AHP), introduced by Saaty (1988), was also known as a multi-criteria decision-analysis method was employed to establish weights for factors influencing the farm diversification as perceived by the farmers in Cauvery Delta Zone. Purposive sampling was followed in the selection of district, taluks, blocks and revenue villages. For selection of respondents random sampling method was employed. In this study the districts which are having more area under Cauvery delta zone were chosen. The selected districts are Trichy, Thanjavur, Thiruvavur, Nagapattinam, Cuddalore and Ariyalur. By considering the time constraints, it was decided to choose 40 respondents from the selected districts. A list of farmers was obtained from the village level extension workers (AAO) from the selected villages of the selected districts from which 40 farmers were randomly chosen and thus totally 240 farmers from six districts of Cauvery delta zone were chosen.

The steps followed in AHP methodologies are:

1. Hierarchy construction.
2. Pairwise Comparison Matrix.
3. Normalizing the Matrix.
4. Obtaining the Corresponding Rating by Averaging the Values in Each Row.
5. The Consistency Ratio: Calculation and Checking.
6. Random Index (RI).

RESULTS AND DISCUSSION

Farm diversification is the product of both internal and external factors. The internal factors are the crop production factors in which farmers choice of crop depends on different aspects like economy, agro-meteorology and farm management. The external factors are the situational factors that had indirect influence in the farm diversification such as government policies, extension supports, socio personal and mental aspects. The perceived response of farmers towards these dimensions are obtained through paired comparison method as portrayed below. Further, the sub factors that qualify each aspects against which responses are obtained through paired comparison to ascertain the important one. The responses were analyzed through multi-criteria decision analysis otherwise known as Analytical Hierarchy Process (AHP).

Hierarchy construction

The hierarchy is defined by breaking down the overarching objective of farm diversification into basic elements such as agro-meteorology dimension (C1), farm management dimension (C2), economic dimension (C3), policy dimension (C4) and extension dimension (C5). The review of literature and authors' critical judgments has led to the suggestion of the hierarchical model by grouping the dimensions into two major factors such as internal and external factors. The sub factors that constituted each dimension which was identified during pre-survey viz. suitable for diverse soil type (C11), suited for winter season (C12), short duration (C13), suitable for dry spell (C14), less no. of irrigation (C21), less investment (C22), suitable for infertile land (C23), nearby market vicinity (C24), high returns (C31), less labour requirement (C32), less input cost (C33), availability of infrastructural facilities (C41), access to institutional credit (C42), Employment opportunity (C43), availability of schemes (C44), availability of adequate training (C45), availability of procurement centre (C51), attractive MSP (C52), guidance from extension staff (C53), timely supply of seed material (C54) and adequate marketing support (C55) are placed in the following (Fig 1).

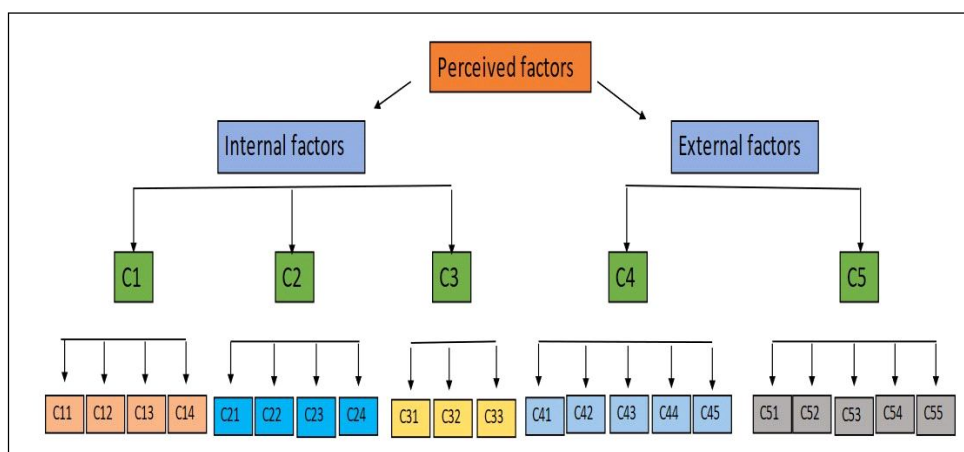


Fig 1: Construction of a hierarchy of factors contributing to farm diversification.

Pairwise comparison matrix

The contribution of one component over another must be assessed using a psychological scale that progresses along the psychological continuum, with the components ordered using the psychophysical approach. A total of 240 diversified farmers took part in this research, which aimed to compare the relative importance of influencing factors related to diversification. For the AHP analysis, the extended average of values was used. Saaty's (1988) suggested range of 1-9 was used to achieve pairwise comparisons of major elements. There are two equally relevant things. One object has a significant advantage over another.

The weightage scores assigned by the various diversified farmers were pooled together and a pairwise average score was calculated. The pairwise score was represented as a matrix. Table 1 revealed the AHP scale values.

$$\text{Matrix of pair wise element} = \begin{bmatrix} C_{11} & C_{12} & C_{13} \\ C_{21} & C_{22} & C_{23} \\ C_{31} & C_{32} & C_{33} \\ C_{41} & C_{42} & C_{43} \\ C_{51} & C_{52} & C_{53} \\ C_{61} & C_{62} & C_{63} \end{bmatrix}$$

Sum the values in each column of the pair wise matrix =

$$\sum_{i=1}^n C_{ij}$$

The pairwise comparison matrix shows the importance of the factors influencing diversification towards seasonal commercial crops. From Table 1, it reviewed that economic dimension are equally to moderately importance than agro- meteorological dimension so, the mean value

is 1.25, at the same time the opposite of reciprocal value is $1/1.25 = 0.800$, following that policy dimension, extension dimension and farm management dimension are moderately to strongly important than agro- meteorological dimension so, the mean value is 3.2, 3.4 and 3.3 and the reciprocal value is 0.435, 0.455 and 0.455 respectively. At the same time policy dimension, extension dimension and farm management dimension are moderately important preferred than economic dimension, the mean value is 2.3, 2.2 and 2.2 and the opposite reciprocal value is 0.308, 0.294 and 0.303 respectively. Similarly, the pairwise comparison matrix method was completed for seasonal commercial crops (Table 1).

Normalizing the matrix

The average score of pairwise items in the normalised matrix was used to determine the overall value of one variable over another. Each element in the matrix was divided by its column total to create a normalised pairwise matrix as shown in the (Table 2).

$$x_{ij} = \frac{C_{ij}}{\sum_{i=1}^n C_{ij}}$$

Obtaining the corresponding rating by averaging the values in each row

The weighted matrix was generated by dividing the sum of the normalised column of the matrix by the number of parameters used to create it. Furthermore, this average score indicates the percentage contribution of each element to the overall target.

$$w_{ij} = \frac{\sum_{j=1}^n x_{ij}}{n} \begin{bmatrix} W_{11} \\ W_{12} \\ W_{13} \end{bmatrix}$$

Table 1: Mean score for the selected criteria of seasonal commercial crops based on farmer's perception.

Dimension	AMD	ECD	POD	EXD	FMD
Agro-meteorology dimension	1.000	1.250	3.250	3.400	3.300
Economic dimension	0.800	1.000	2.300	2.200	2.200
Policy dimension	0.435	0.308	1.000	1.250	1.750
Extension dimension	0.455	0.294	0.800	1.000	5.800
Farm management dimension	0.455	0.303	0.571	0.172	1.000
Total	3.144	3.155	7.921	8.022	14.05

Table 2. Normalization matrix for the criteria of seasonal commercial crops.

S.No	AMD	ECD	POD	EXD	FMD	Average
1.	0.318	0.396	0.290	0.274	0.157	0.287
2.	0.254	0.317	0.410	0.424	0.235	0.328
3.	0.138	0.098	0.126	0.156	0.125	0.128
4.	0.145	0.093	0.101	0.125	0.413	0.175
5.	0.145	0.096	0.072	0.021	0.071	0.081
Total	1.000	1.000	1.000	1.000	1.000	1.000

The consistency ratio: calculation and checking

The pairwise matrix scale can be assigned by diversified farmers in cauvery delta zone without regard for the relative value of each variable. If this is the case, one's initial score will not accurately represent fact. A consistency check is required to assess the score's validity and reliability. To ensure that the original preference ratings remained consistent, the consistency calculation is done.

The consistency ratio is calculated in three steps:

Calculation of consistency measure, consistency vector and λ

For actual rows with the average column, the matrix multiplication function =MMULT() is used to calculate the consistency test. The weights vector is multiplied by the pairwise matrix to determine the consistency measure.

$$\begin{bmatrix} C_{11} & C_{12} & C_{13} \\ C_{21} & C_{22} & C_{23} \\ C_{31} & C_{32} & C_{33} \\ C_{41} & C_{42} & C_{43} \\ C_{51} & C_{52} & C_{53} \\ C_{61} & C_{62} & C_{63} \end{bmatrix} * \begin{bmatrix} w_{11} \\ w_{21} \\ w_{31} \end{bmatrix} = \begin{bmatrix} C_{M11} \\ C_{M21} \\ C_{M31} \end{bmatrix}$$

The consistency vector is determined by dividing the consistency measure by the weight of the average criterion.

$$c_{v11} = \frac{1}{w_{11}} [C_{11}w_{11} + C_{12}w_{21} + C_{13}w_{31}]$$

$$c_{v21} = \frac{1}{w_{21}} [C_{21}w_{11} + C_{22}w_{21} + C_{23}w_{31}]$$

$$c_{v31} = \frac{1}{w_{31}} [C_{31}w_{11} + C_{32}w_{21} + C_{33}w_{31}]$$

λ was determined by averaging the consistency vector's value as shown in Table 3.

$$\lambda = \frac{\sum_{i=1}^n cv_{ij}}{n}$$

From the Table 3, it showed that economic dimension in seasonal commercial crops was the most important criteria which imply highest weightage score with 0.328. Following

that agro-meteorological dimension, extension dimension, policy dimension, farm management dimension got the weightage score of 0.288, 0.175, 0.128, 0.081 respectively.

Calculation of consistency index (CI)

AHP's accuracy review is a must-have method. AHP allows for valuation inconsistencies, but they should not be more than 10%. The following formula was used to measure consistency index:

$$CI = \frac{\lambda \max - n}{n - 1}$$

$\lambda \max$ = Averaging the value of the consistency vector.

n = Number of criteria.

CI for seasonal commercial crops = $5.491 - 5/4 = 0.123$

Calculation of consistency ratio (CR)

consistency ratio was obtained by using the formula below:

$$CR = \frac{CI}{RI}$$

CI = Consistency index value.

RI = Table value.

Random Index (RI)

The RI was obtained from the random inconsistency indices given by Satty (1988), which is furnished below.

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

Consistency ratio for seasonal commercial crops $CR = 0.123/1.12 = 0.110$ which shows that the ratio is lesser than 10% as the set of judgements made by farmers are reliable. Similarly, the weights are calculated for sub factors are shown in the Table 4. The results of the analysis are presented in Table 4, denoting the important factors responsible for farm diversification as perceived by the farmers.

Farmers are getting low returns in the cultivation of paddy but in the case of seasonal commercial crops they are getting high returns. According to the farmers perception there is steady decline in yield, income from cultivation of paddy is very made the farmers to shift.

In the study area, the net income earned by the farmers from one acre of cotton and one acre of maize was around

Table 3. Matrix multiplication of row multiplied with average, using excel - MMULT() for seasonal commercial crops.

S.no	AMD	ECD	POD	EXD	FMD	Average	Consistency measure	Consistency vector	$\lambda \max$
1.	1.000	1.250	3.250	3.400	3.300	0.287	1.978	6.891	5.491
2.	0.800	1.000	2.300	2.200	2.200	0.328	1.417	4.320	
3.	0.435	0.308	1.000	1.250	1.750	0.128	0.715	5.567	
4.	0.455	0.294	0.800	1.000	5.800	0.175	0.975	5.565	
5.	0.455	0.303	0.571	0.172	1.000	0.081	0.415	5.113	
Total	3.144	3.155	7.921	8.022	14.05	1.000	5.501	5.491	

Table 4: Weight coefficients of perceived factors influencing diversification towards seasonal commercial crops.

	Components	Weight	Sub - Factor	Weight	Actual value contribution
Internal factor (0.697)	Agro-meteorology dimension (C1)	0.288	Suitable for diverse soil type (C11)	0.392	0.113
			Suited for winter season (C12)	0.352	0.101
			Short duration (C13)	0.169	0.049
			Suitable for dry spell (C14)	0.087	0.025
	Farm management dimension (C2)	0.081	Less no. of irrigation (C21)	0.496	0.040
			Less investment (C22)	0.271	0.022
			Suitable for infertile land (C23)	0.128	0.010
			Nearby market vicinity (C24)	0.105	0.009
	Economic dimension (C3)	0.328	High returns (C31)	0.408	0.134
			Less labour requirement (C32)	0.364	0.119
			Less input cost (C33)	0.228	0.075
External factor (0.303)	Policy dimension (C4)	0.128	Availability of Infrastructural facilities (C41)	0.278	0.036
			Access to institutional credit (C42)	0.277	0.035
			Employment opportunity (C43)	0.257	0.033
			Availability of Schemes (C44)	0.103	0.013
			Availability of adequate training (C45)	0.085	0.011
	Extension dimension (C5)	0.175	Availability of procurement centre (C51)	0.266	0.047
			Attractive MSP (C52)	0.257	0.045
			Guidance from extension staff (C53)	0.188	0.033
			Timely supply of seed material (C54)	0.154	0.027
			Adequate marketing support (C55)	0.135	0.024

Rs. 27000 and Rs. 15000 respectively. As far as the labour and input cost requirements are concerned, less labor and less inputs are sufficient for growing seasonal commercial crops. Moreover, farmers can easily manage these with the available family labour except at the time of sowing and harvesting.

Farmers felt that both maize and cotton are suitable for growing in alluvial and clay soil that prevalent in Cauvery Delta Zone. Seasonal commercial crops can withstand dry summer spell and cold winter seasons.

Moreover, Cotton crop fetches reasonable procurement price Rs. 50- 60 / kg. The minimum support price of Rs. 5255/ quintal which trigger the farmers to diversify to this crop.

CONCLUSION

This paper proposes the AHP move towards for decisive priorities and the weighted values of perceived factors that influence diversification towards seasonal commercial crops. From the results, it can be concluded that most important components, economic dimension, have the highest weightage scores of 0.328 followed by agro-meteorological dimension, extension dimension, policy dimension, farm management dimension got the weightage score of 0.288, 0.175, 0.128, 0.081 respectively. The actual value contribution of major sub factors influencing diversification towards seasonal commercial crops are high returns (0.134), less labour requirement (0.119), suitable for diverse soil type (0.113) and suited for

winter season (0.101). Farmers are aware of their preference for alternate crops after weighing the benefits and drawbacks.

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Authors' contribution statements

Kavipriya carried out the whole study and data analysis whereas Kavinila participated in the part of the work and Mahandrakumar contributed in planning, execution, writing and revision of the whole study.

Conflict of interest

The authors declare that there is no conflict of interest.

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