

Grey Relational Analysis of the Determinants of Direct Sales of Food Crops in India

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Abstract

To achieve higher levels of sales, the agricultural crop farms depend exclusively on the direct-to-consumer channels. Many existing research studies discussed and answered various issues on the production and human consumption of the food crops. Also, several studies discussed the factors affecting the direct sales of the food crops. However, it is very much essential to calculate the expectations on the direct sales from the farmers' perspective. This paper explored the factors which influence the direct sales of the food crops by following the exploratory factor analysis (EFA). The study also proposed a prioritization methodology of those factors that affected the direct sales of food crops in the Indian context based on a survey administered on the local farmers who produce food crops. We followed the grey relational analysis for arranging the scale items for the production variables in ascending or descending order. The findings of the study will allow the farmers, researchers, and managers to explore the relationship among the items in terms of the degree of importance to each other.

Keywords : direct sales, grey relational analysis, exploratory factor analysis

JEL Code : C15, M310, M370, M110

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Increased food crop production and growing consumption have not led the local food growth. For the growth of the local food crop production, the marketing channels and supply chain infrastructure in addition to the favorable conditions should be more comprehensive. Farmers selling the grown food crops directly to the consumers and grocers have become popular. The success of any agricultural crop or fruits and vegetables in terms of the sales, including the various operations and decisions made, depends on the producer of the crop. Marketing is one of the most important factors in achieving the success. The crop producers decide on starting from identifying a crop which is most profitable to how to achieve efficient and economic delivery of the same. The direct farmer to consumer marketing is the method where the farmers sell their food crops to the consumers directly.

This direct marketing includes the sales to restaurants, retail stores, and to the final consumers as well. The sales can be done through various marketing channels such as farmers' markets, subscription farming or community supported agriculture (CSA) programs, and roadside markets. The major advantages of farm direct

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marketing are : the small producers can participate, more control on pricing of the products, and instant feedback and payment. It gives the farmers better profit margin than wholesaling because of the absence of middlemen.

The Government of India is facilitating the direct selling of fruits and vegetables by implementing the Agricultural Produce Marketing Committee (APMC) Act, which allows the farmers to save the intermediation costs through direct selling. The industry bodies like Confederation of Indian Industries (CII) echoes for more freedom to farmers and allow them to sell directly. Companies like FarmerFriend (www.farmerfriend.info) establish the importance of direct selling by the farmers to the customers in India. Recently, the Maharashtra State Agricultural Marketing Board (MSAMB) is on the expansion of the farmers' markets by increasing the number of farmers' market from 25 at present to 100. According to a report by Federation of Indian Chambers of Commerce and Industry (FICCI), the sales in the Indian direct selling market are projected to be around 10 billion USD by the year 2025 (FICCI reports). A study on the incomes of peri-urban vegetable farmers in Vietnam also revealed that the direct sales of vegetables positively impacted the farmers' income. It is also suggested that when the farmers and consumers deal directly, it enhances the consumer confidence in quality in comparison to the anonymous contracts or agreements (Wang, Moustier, & Loc, 2014).

These pieces of information joined together urged for a study on the direct sales of the food crops. There have been many studies in countries other than India on the farmer-to-consumer direct marketing. However, there is a scarcity of research studies in India on this trend of direct marketing of agriculture crops for human consumption. This study tries to understand the underlying structure of the factors influencing the direct sales of the agricultural products and how the farmers or crop producers see their relative importance. By finding the underlying structure and ranking the factors of direct sales, the study can provide significant information to the farmers and the regulators of the production and distribution in the ecosystem of direct marketing of food crops.

Review of Literature

This section provides a discussion for the selection of the variables for the empirical exploration. Extant literature in the direct marketing of food crops evaluates the factors which influence the direct sales.

There are extant literature on the direct marketing strategies which are mainly focused on the consumer perspectives like the consumer preferences (Kuches, Toensmeyer, German, & Bacon, 1999 ; Thilmany & Watson, 2004) and characteristics (Govindasamy & Nayga 1997 ; Wolf 1997). Housing value, diversity in fruits and vegetable production, and proximity are few important factors that positively influence the direct sales (Brown, Gandee, & D'Souza, 2006). A systematic review of farmers' reliance on direct sales by Monson, Mainville, and Kuminoff (2008) showed that the factors like farm size, organic production methods, and high value crop positively influence the direct sales. Low and Vogel (2011) identified climate, proximity, topography favoring the production of fruits and vegetables, availability of transportation, and information access as the major factors associated with the high direct-consumer sales. It was also found that the small and medium-sized farms use direct-to-consumer channels predominantly. The farmers selling their crops through the various farmers' markets such as roadside outlets are also characterized to influence the direct to consumer sales. A study of milk farmers in Punjab by Brar, Kaur, Singh, and Kaur (2017) emphasized the need of awareness of the milk farmers on the marketing policies. It also highlighted the important factors such as the yield, production pattern, and price received by the farmers in Punjab. Extant literature reveals that in developing countries, low income of the farmers is due to poor access to markets (Nguyen, Dzator, & Nadolny, 2015).

A study on milk marketing and dairy co-operatives taken up by Rajendran and Mohanty (2004) reviewed the future challenges to conclude that milk quality, product development, adequate infrastructure, and global marketing hold the key in future. They highlighted the importance of co-operatives in the rural milk production and marketing. In an investigation into the well-being of the U.S. farmers, Uematsu and Mishra (2011) found that direct marketing strategy is a risk management tool and not a strategy to maximize profits. The reason may be the

additional labor required and the unique skill set they possess.

An analysis on sales per capita of more than 100 farmers suggested that the more the urban characteristics, the higher is the sales per capita. The other factors having positive influence on sales per capita are the population size of the locale, the proximity from other competing markets, and per capita income of residents. Coordination and scheduling of market days of the local market are also important (Varner & Otto, 2008). Giri and Biswas (2018) highlighted the importance of marketing support the farmers are provided in order to sell their products in the dry fish market in India.

An investigation by Govindasamy, Hossain, and Adelaja (1999) revealed that direct retailing to customers, selling value added products, and urban location of farmers' markets positively resulted in a higher income for the farmers. The close proximity and thus access to the metropolitan areas reduce the transportation costs incurred in the direct marketing (Morgan & Alipoe, 2001). Brown, Miller, Boone, Boone, Gartin, and McConnell (2007) found that when the farmers' market is closer to the farm operations, the sales are higher.

The extant literature shows the potential for further research on the farmer-to-consumer direct sales and the factors linked to it. Though the previous studies are majorly based on the national datasets, research on the farmers' perspective of direct sales and research on the regional and state factors will give deeper insights. This survey based study makes significant contribution by studying the prioritization of the factors from the producer or farmer's point of view and tries to understand the underlying structure of the variables influencing the farmer-to-consumer direct sales.

Objectives of the Study

The objectives of the study are the following :

- (1) To find the underlying structure of the direct sales of food crops.
- (2) To explore the direct sales of food crops and the factors affecting the same.
- (3) To find the degree of importance of each of the factors.

Research Method

(1) Research Design : Both exploratory research and descriptive research are followed for this study. Exploratory research was done to get deeper insights into the determinants of the direct to consumer sales. A descriptive study was conducted to collect the data.

(2) Sampling Design : The study follows simple random sampling to identify the sample respondents. Thirty two farmers or crop producers were surveyed with the questionnaire having 15 questions on the importance of each in influencing the farmer-to-consumer direct sales. The respondents were selected from the Rajendra Nagar Mandal of Hyderabad and only those who agreed to participate in the survey were considered. The survey was administered during March – June 2019.

The questionnaire was also translated into the native language Telugu for the convenience and easy understanding of the items in the questionnaire. Each of the respondents was given sufficient time and were oriented to understand the questions and the scale. The survey questionnaire encompassed a total of 15 items. The items which were of Likert - type scale item contained five options. The options ranged from 1 to 7, where 1 represented “*not important at all*” and 7 represented “*extremely important*” on the respondents' opinion. The questionnaire was pretested for the appropriateness of the items. The survey items are listed in the Appendix.

Data Analysis and Results

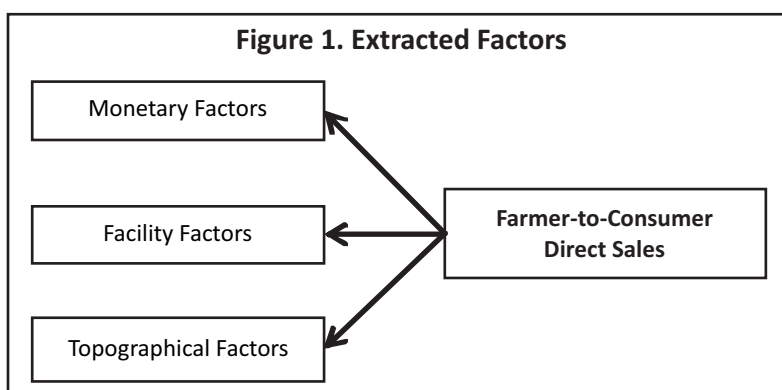
(1) Plan for Data Analysis : The exploratory factory analysis (EFA) is done on the items to determine the underlying structure. The second step involves grey relational analysis (GRA) wherein the items are prioritized based on the computed values of grey relational grades.

Exploratory factor analysis is conducted to find out the underlying structure of the variables under study. Before running the exploratory factor analysis, the adequacy of the samples was ascertained by using the Kaiser – Meyer – Olkin (KMO) measure of sampling adequacy. Bartlett's test of sphericity is performed on the sample. The KMO was found to be 0.771 and Bartlett's test of sphericity also supported the appropriateness of using exploratory factor analysis. The significant p -value of $.000 < 0.05$ indicates the validity of the factor analysis. Only the Eigen values greater than 1 are considered for the determination of the factors. The factor analysis of the 15 items is done by using principal component extraction and the varimax rotation. Varimax rotation is the preferred method of rotation as it gives a better separation of the factors as compared to the other orthogonal rotation methods. Table 1 shows the rotated component matrix which presents the extracted factors. After selecting the highest values in each row, the 12 items are grouped into three components or factors.

Table 1. Rotated Component Matrix

ROTATED COMPONENT MATRIX			
	1	2	3
FCDS5	0.87		
FCDS6	0.75		
FCDS8	0.892		
FCDS7	0.888		
FCDS2		0.813	
FCDS11		0.753	
FCDS1		0.68	
FCDS9		0.865	
FCDS10			0.778
FCDS12			0.779
FCDS3			0.822
FCDS4			0.709

Note. Rotation converged in five iterations. The extraction method was principal component analysis and the rotation method was varimax with Kaiser Normalization (Using SPSS 20.0).



Three factors result with Eigen values of 3.805, 1.699, and 1.172. The total variance explained after the rotation is 64.977%. Only the variables for which the communality is above 0.4 are considered as significant loading. The study used SPSS version 20.0 for the exploratory factor analysis. All the three factors are labelled as : Monetary Factors, Facility Factors, and Topographical Factors.

The factors are labelled as Monetary Factors (Cronbach's $\alpha = .758$; four items), Facility Factors (Cronbach's $\alpha = .736$; four items), and Topographical Factors (Cronbach's $\alpha = .802$; four items). The overall Cronbach's alpha of .638 shows that the questionnaire was capable enough in capturing the variables in a meaningful way. Figure 1 presents the factors of farmer-to-consumer direct sales.

(2) Grey Relational Analysis : Grey relational analysis (GRA) originated with Ju - Long (1982) to solve the uncertainty problems in cases with discrete data and incomplete information. It can be used to capture the correlations between the reference factors and other compared factors of a system. GRA can be used for forecasting, data processing, modelling, and decision making.

Table 2. Reference Data Series

FCDS1	7	7	6	4	4	6	4	7	4	6	4
FCDS2	7	7	6	5	5	6	4	7	4	4	4
FCDS3	7	6	6	6	6	6	4	6	4	4	4
FCDS4	7	7	6	6	6	4	4	6	4	4	4
FCDS5	7	6	6	5	5	4	4	6	4	4	4
FCDS6	7	4	6	5	5	4	4	7	6	6	6
FCDS7	7	6	6	6	6	6	6	6	6	6	6
FCDS8	7	4	6	6	6	6	6	6	6	6	4
FCDS9	7	6	6	5	5	6	6	7	6	6	6
FCDS10	7	6	6	6	6	6	6	7	6	6	6
FCDS11	7	5	4	6	6	5	2	6	6	3	7
FCDS12	7	6	6	6	4	4	3	6	4	2	6

Note. FCDS : Farmer-to-consumer direct sales, 1 to 12 is to represent the variables.

Table 3. Difference Data Series

Variables	Δ_1	Δ_2	Δ_3	Δ_4	Δ_5	Δ_6	Δ_7	Δ_8	Δ_9	Δ_{10}
FCDS1	0	1	3	3	1	3	0	3	1	3
FCDS2	0	1	2	2	1	3	0	3	3	3
FCDS3	1	1	1	1	1	3	1	3	3	3
FCDS4	0	1	1	1	3	3	1	3	3	3
FCDS5	1	1	2	2	3	3	1	3	3	3
FCDS6	3	1	2	2	3	3	0	1	1	1
FCDS7	1	1	1	1	1	1	1	1	1	1
FCDS8	3	1	1	1	1	1	1	1	1	3
FCDS9	1	1	2	2	1	1	0	1	1	1
FCDS10	1	1	1	1	1	1	0	1	1	1
FCDS11	2	3	1	1	2	5	1	1	4	0
FCDS12	1	1	1	3	3	4	1	3	5	1

The major advantage of using GRA is that using small amount of data or with great variability in factors, it can generate satisfactory outcomes. It measures the degree to which two sequences are similar or different based on grey relational grade.

The procedure to carry GRA consists of seven steps : (a) generate reference data series, (b) generate comparison data series, (c) compute difference data series, (d) find the global maximum and minimum values in the above series, (e) compute the grey relational coefficients, (f) compute grey relational grade for each difference data series, and (g) sort the grey relational grade values.

Grey relational analysis helps to find out the importance or the agreement of the scale items with the reference data sets. Reference data series consist of the most favored values for each factor.

The data extracted from the survey is from an actual Likert scale regarding the factors those influence the farmer-to-consumer direct sales. Grey relational analysis has been used to rank the factors influencing the farmer-to-direct consumer direct sales. The scale is described briefly in the appendix.

Ten valid and complete cases in the data file were selected randomly and used for the analysis. Table 2 shows the reference data series. As the farmer-to-consumer direct sales scale is a 7 - point Likert scale, the first column is set to contain the values of 7. The variables which are denoted as farmer-to-consumer direct sales $FCDS1 - FCDS12$ are the comparison data series that contain the responses from the farmers. The difference data series are shown in Table 3. For example $\Delta_1 = |2 - 7| = 5$. From the same table, we can find the Δ_{max} and Δ_{min} .

Each of the data points in the difference data series is then transformed to grey relational coefficient. Grey relational coefficient expresses the relation between the ideal and actual normalized experimental results. The grey relational coefficient can be defined as follows :

If $\gamma_i(j)$ is the grey relational coefficient of the j_{th} data point in the i_{th} difference data series, it can be defined as :

$$\gamma_i(j) = (\Delta_{min} + \zeta \Delta_{max}) / (\Delta_i(j) + \zeta \Delta_{max}), \quad \dots\dots\dots (1)$$

where, $i = 1, \dots, k$. k is the number of scale items, that is, 12 in this study, Δ_{min} and Δ_{max} are the global minimum value and maximum value in the table of difference data series, ζ is the distinguishing coefficient or identification coefficient and is a value ranging between 0 and 1. $\Delta_i(j)$ is the deviation sequence of the corresponding reference data point. Assuming all the parameters of equal preference, ζ is taken as 0.5. The coefficient is used to compensate the effect of Δ_{max} . Δ_{min} and Δ_{max} are found to be 0 and 5, respectively from Table 4.

Table 4. Table of Grey Relational Coefficients

Items	Grey Relational Coefficients									
<i>FCDS1</i>	1.000	0.714	0.455	0.455	0.714	0.455	1.000	0.455	0.714	0.455
<i>FCDS2</i>	1.000	0.714	0.556	0.556	0.714	0.455	1.000	0.455	0.455	0.455
<i>FCDS3</i>	0.714	0.714	0.714	0.714	0.714	0.455	0.714	0.455	0.455	0.455
<i>FCDS4</i>	1.000	0.714	0.714	0.714	0.455	0.455	0.714	0.455	0.455	0.455
<i>FCDS5</i>	0.714	0.714	0.556	0.556	0.455	0.455	0.714	0.455	0.455	0.455
<i>FCDS6</i>	0.455	0.714	0.556	0.556	0.455	0.455	1.000	0.714	0.714	0.714
<i>FCDS7</i>	0.714	0.714	0.714	0.714	0.714	0.714	0.714	0.714	0.714	0.714
<i>FCDS8</i>	0.455	0.714	0.714	0.714	0.714	0.714	0.714	0.714	0.714	0.455
<i>FCDS9</i>	0.714	0.714	0.556	0.556	0.714	0.714	1.000	0.714	0.714	0.714
<i>FCDS10</i>	0.714	0.714	0.714	0.714	0.714	0.714	1.000	0.714	0.714	0.714
<i>FCDS11</i>	0.556	0.455	0.714	0.714	0.556	0.333	0.714	0.714	0.385	1.000
<i>FCDS12</i>	0.714	0.714	0.714	0.455	0.455	0.385	0.714	0.455	0.333	0.714

For example: $\gamma_1(2) = (0 + (0.5 \times 5) / (1 + 0.5 \times 5)) = 0.714$.

Grey relational coefficients are calculated and are presented in Table 4. For each difference data series, the grey relational grade is computed. The grey relational grade can be obtained by averaging the grey relational coefficient for each of the direct-to-consumer sales factors. The coefficient signifies the overall extent to standardized deviance of the data series from the reference data series. A high value of the coefficient indicates that most of the respondent farmers agreed on the particular item to influence the direct-to-consumer sales. A higher value represents that the corresponding response is closer to the ideally normalized value. The grey relational grade is calculated by using the below equation :

$$\Gamma_i = \frac{1}{m} \sum_{n=1}^m \gamma_i(n), \quad \dots\dots\dots (2)$$

where, m is the number of respondents, Γ is the grey relational grade, and γ_i is the grey relational coefficient of the i_{th} difference data series.

For example, Γ_1 is calculated as, $\Gamma_1 = (1.000 + 0.714 + 0.455 + \dots\dots + 0.455) / 10 = 0.6416$.

As per the Table 5, which presents the Γ values of the scale items, the scale items can be arranged as below :

$FCDS12$ (0.7429) > $FCDS1$ (0.7143) > $FCDS10$ (0.7111) > $FCDS9$ (0.6623) > $FCDS5$ (0.6416) > $FCDS6$ (0.6358) > $FCDS11$ (0.6332) > $FCDS3$ (0.6141) > $FCDS7$ (0.6130) > $FCDS8$ (0.6104) > $FCDS4$ (0.5653) > $FCDS2$ (0.5527)

From this order, an insight can be derived that the farmers or the crop producers give more relative importance to the Monetary Factors and Facility Related Factors and least to the Topographical Factors.

In this study, grey relational grade represents the degrees of agreement to the scale items. A large value of 'T' represents a high agreement degree. From this ranking, it can be inferred that the farmers, on an overall basis, agreed that the pricing of the crops, presence of cultivatable land, and the bargaining power they possessed are the top three determinants of the farmer-to-consumer direct sales.

Table 5. Grey Relational Grades

Scale Items	GRA Grade	Ranking
<i>FCDS5</i>	0.6416	5
<i>FCDS6</i>	0.6358	6
<i>FCDS8</i>	0.6104	10
<i>FCDS7</i>	0.6130	9
<i>FCDS2</i>	0.5527	12
<i>FCDS11</i>	0.6332	7
<i>FCDS1</i>	0.7143	2
<i>FCDS9</i>	0.6623	4
<i>FCDS10</i>	0.7111	3
<i>FCDS12</i>	0.7429	1
<i>FCDS3</i>	0.6141	8
<i>FCDS4</i>	0.5653	11

Conclusion and Implications

The present study is carried out to understand the factors which determine the farmer-to-consumer direct sales and their relative importance. Direct sales are influenced by many spatial factors correlated with the marketing opportunities and the conditions. The farmers should identify, evaluate, and assess the factors impacting the direct sales.

There are several factors which drive the farmer-to-consumers direct sales of agricultural products for the consumption of humans. The direct sales are influenced by the presence of cultivatable land ; highway connection between states, markets ; average wage or salary of the local individuals ; population density ; whether the area is metropolitan or non-metropolitan ; climate ; geography or landscape ; availability of infrastructure for collection, storage, transportation ; bargaining power of crop producers; Internet facility ; and the pricing of the food crops. The farmers can benefit from identifying the most important factor. This study suggests an appropriate method to assess and prioritize various determinants to manage improved direct sales from the agricultural crops. Grey relational approach is proposed for ranking based on the grey relational grades. It will help the managers and farmers to understand the direct-market consumers by providing insights in terms of the factors that influence the direct sales of food crops. Prioritization will help the farmers to take better decisions and in identifying the best way to improve the direct sales revenue.

Limitations of the Study and Scope for Further Research

There are few limitations in the present study. The ordinal responses analyzed in the present study are entirely based on the farmers' perception. The study has been carried out in the two villages and nearby areas, and the respondents for other geographies may consider a different set of new determinants such as enterprises' feasibility factors like insects, diseases, personal and family factors, any other market factors that may affect the direct sales. The study does not attempt to find out the relationship between the factors and the direct sales which can give the direction and degree to which the direct sales in terms of revenue is influenced. A research study with better selection of different geographies can be a representative across India and will give substantial insights.

The current research is more from the farmers' perspective. However, future research can be replicated from the customers' point of view and what makes them to buy from the direct channel from the farmers or crop producers. Future research can also be replicated for different segments of farmers and customers for more concrete insights. The relationship between the determinants and the long term farmers' value is also worth exploring.

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Appendix

Extracted Dimensions of Direct Sales of Food Crops

Item	Variable Description
<i>FCDS1</i>	Presence of cultivatable land (percent of crop land)
<i>FCDS2</i>	Interstate highway
<i>FCDS3</i>	Number of farmers' markets
<i>FCDS4</i>	Average wage of the labourer
<i>FCDS5</i>	Population density
<i>FCDS6</i>	Metropolitan area
<i>FCDS7</i>	Climate
<i>FCDS8</i>	Geography/ landscape
<i>FCDS9</i>	Processing infrastructure
<i>FCDS10</i>	Bargaining power of crop producers
<i>FCDS11</i>	Internet facility
<i>FCDS12</i>	Pricing of the food crops

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