# An Empirical Study For Sustainable Development Of The Fruit Processing Industries In One Of The Indian Suburbs

R. Sengodi*[1], Dr.C.Madhesh[2], Dr.S.Deepa[3], P.Indumathi[4]

Research Department of Commerce, Government
Arts College (Autonomous), Salem- 636007, Tamil Nadu, India.
*Corresponding Author R Sengodi

Abstract

Globalization has led to the surge of the food processing industries in many parts of the world. As a result, over the last two decades, several food processing industries have been established in several states in India. Of them, Fruit Processing Industries (FPIs) are one of the leading preferences among Indian industrialists and entrepreneurs, due to the wider availability of the various seasonal fruits. In this article, we analyze(based on empirical study) the new emerging forms of globalization and sustainable development of the FPI sin one of the suburbs (i.e., Dharmapuri district in Tamil Nadu) in India for the fruits such as Mango, Tomato, Guava, Sapodilla and Papaya and the corresponding processed products i.e., pulp, sauce, sugar, and citric acid etc. In addition to this, various factors in relation to the problems faced during production, exporting, as well as the problems confronted by the labors have been detailed analyzed using various statistical approaches.

Key Words: Fruit Processing Industries, Globalization, Statistical analysis, Sustainability, Trade.

**Introduction**

Globalization can be defined as a process of international fusion produced by the exchanging the products, opinions, ideas, and other cultural aspects globally. While this is addressing several global-hunger problems, it also has some negative impacts on the global markets. For instance, local manufacturers can sell their products and provide necessary services to global customers, but, at the same time competing with larger companies becomes difficult as multinational industries can trade the same/ similar products and services for a

cheaper price which directly impacts the sales of local manufactures [1]. Fruit farming is one of the important branches of horticulture which has been practiced in India for several centuries. In general, the term fruit processing refers to the industries that process raw agricultural materials and their inter mediate products. Thus, the fruit processing industry (FPI), in general, refers to converting the products from forestry, agriculture, and fisheries into finalized products. In[2],authors discussed the recent methods and directions for managing fruits and vegetables residues and introduce the forms in which they can be added to food to enrich natural bioactive compounds and nutrients [2].

As mentioned earlier, India is one of the largest producers of (majority of) fruits and vegetables. It produces a variety of subtropical and tropical fruits and vegetables because of varied agro-climatic diversity [3].The total production of fruits and vegetables is estimated to be over 45 million and 85 million tons, respectively [4]. Out of which, 20-30 percent (approximately Rs. 230 billion) is estimated as loss due to lack of proper harvesting techniques, lack of advanced processing methods, and poor storage facilities[5, 6]. According to APEDA, India is the biggest producers of Ginger and Okra, and the second-largest producers of Onions, Cauliflower, Eggplant, Potatoes, and Cabbage [7].India is also cultivating of Papayas, various types of Bananas and Mangoes. It is estimated that the processed products from these fruits/vegetables have a great market [8]. Yet, there is a considerable room for expanding fruits and vegetables processing industries in India, due to various reasons. Nevertheless, establishing FPIs in a modern and scientific way will produce multiple benefits. For instance, (i) it will significantly reduce the post-harvest waste and losses, (ii) it will directly generate many employment opportunities and (iii) encourages large-scale intensive planting (production) of fruits and vegetables. Note that there are several limitations present in accomplishing this task. One of the main limitations is the availability of technologies. For example, for harvesting (in many parts of India) farmers still uses hands but not clippers or scissors. Then, the sorting of the items is done by visual inspection or by conventional weight-based grading systems. Similarly, pre cooling and storage facilities are very limited [8-11]. In addition to these, due to the recent global pandemic caused by COVID-19, many people have lost their livelihoods. It has also affected the dynamics and growth of multiple industries. The business activities of various end-user industries ceased, leading to shrinking demand in the fruit processing market and further reducing sales revenue [12].

To overcome these limitations, several research studies have been proposed in literature. For instance, Jill et al article reflects on the current situation of the employee development literature and proposes a new and broader concept of employee development, which is characterized by the partnership between employers and employees [13].Aziziet al study aims to integrate and evaluate the literature on human resource management (HRM) in entrepreneurial organizations [14]. Biron et al study addressed when and how organizations adopt a skunk-like structure to assist them cope with rapidly evolving human resource-based challenges [15].Ceballos et al conducted aphone-based survey to estimate the disruptions occurred in the agricultural production and food security in two of the Indian states [16]. Harris et al conducted a telephone survey with farmers from 4 Indian states to investigate the effects of production, sales, incomes and diets [17].Howe et al investigated the effects of COVID-19 across multiple domains such as job security, financial problems, remote working possibilities, workers wellbeing, and career attitudes [18]. Similarly, Hobbs studied the implication on food supply chains due to the COVID-19. This article also discussed the consumer's panic buying attitude, and the shift in consumption preferences from restaurants to home [19]. Inspired by these studies, in this work, we discuss the sustainable development of the fruit processing industries (FPIs) in India's one of the suburbs i.e., Dharmapuri district in Tamil Nadu. We identified the key problems faced by FPIs in this region and analyzed the effects using various standard statistical approaches.

The rest of the paper is presented as follows. In Section 2 and its subsections, we briefly introduce the major factors that are limiting production in Dharmapuri district and the statistical approaches we used to examine them. Recommendations for our study and conclusion are given in Section 3.

## 2. Methodologies

In recent years, the global market has ever increased demand for the fruit processing markets. To address this need, governments are investing huge sums of money (in terms of loans with lower interest rates and waivers) in micro, mini and small-scale industries which are engaged in processing food products. Such decisions are creating more growth opportunities for the global market during the forecast period. In addition to this, the ongoing extensive research and development activities by various investors also provide numerous growth opportunities for these industries. To note, such measures also increase the investment that is required for establishment and

manufacturing the processed foods, which results in a higher market price, not affordable by most of the consumers. Consequently, such processes hinder the market demand in the global market. In addition to these, in the Dharmapuri district, the fruit processing markets are shown to be growing in consequentially as the following major factors limit its market growth.

**Problems faced during production** (e.g., Lack of raw material, Shortage of workers, Heavy machine maintenance, Climate changes, Breakdown of machine).

**Problems regarding labor** (e.g., In adequate workers, Scarcity of workers during peak agri-season, Lack of industrial work culture, Absenteeism, High wages).

**Problems during export** (e.g., use of proper packaging to control premature deterioration, Operators free from contagious diseases, zero fault system, Total quality management).
In the following subsections, we discuss some standard statistical techniques such as Chi-square Analysis [20], Multiple Regression Analysis [21], Discriminant Analysis [22], Kruskal Wallis - H test [23] and Friedman Test [24] to analyze our data using MATLAB [25].

### 2.1Chi Square Analysis

Chi square $\left(\chi^2\right)$ testsare generally used in testing the independence of one or more categories [20]. We use this test against the empirical data collected from the location of our choice. For each problem, we have identified 3 sub factors i.e., **Location** (Urban, Rural), **Form of Organization** (Partnership, Proprietorship (Sole), Private limited company, Public limited company), and **Number of Directors** (below 3, between 3-5 and more than 5).The selected variables are independently analyzed, and the results are presented with appropriate hypothesis and interpretation. We note, in this article, 'S' denotes significance at 5% level (p value<= 0.05) and 'NS' represents non-significance at 5% level (p value>0.05).

### 2.1.1Problems in production
**Hypothesis:** Profile variables have no significant influence on the problems in production related variables.

**Table 1 is computed based on our empirical evidence collected from 36FPIs in Dharmapuri district.**

| S.No | Profile Unit | $\chi^2$value | p-values | Influence |
|------|--------------|---------------|----------|-----------|
| 1 | Location | 4.63 | 0.10 | NS |
| 2 | Form of Organization | 4.34 | 0.36 | NS |
| 3 | Number of Directors | 15.02 | 0.01 | S |

Table 1: $\chi^2$values for the problems in production.

As can be seen from Table 1, the hypothesis is rejected i.e., Significant as the number of directors in a FPI have a significant influence on the problems faced during production while the other factors such as location and form of organization are accepted i.e., Not significant.

**2.1.2 Problems regarding labor**

**Hypothesis:** Profile variables have no significant influence on the problems in labor related variables.

| S.No | Profile Unit | $\chi^2$value | p-values | Influence |
|------|--------------|---------------|----------|-----------|
| 1 | Location | 3.21 | 0.20 | NS |
| 2 | Form of Organization | 1.51 | 0.82 | NS |
| 3 | Number of directors | 6.73 | 0.15 | NS |

Table 2: $\chi^2$values for the problems regarding labors

It is clear from Table 2 that the hypotheses in all these cases are accepted. It is therefore concluded that the profile unit in all cases does not have any influence on the problems in relation to the labors in the Dharmapuri district.

**2.1.3 Problems during export**

**Hypothesis:** Profile variables have no significant influence on the problems during exports.

| S.No | Profile Unit | $\chi^2$value | p-values | Influence |
|------|--------------|---------------|----------|-----------|
| 1 | Location | 9.00 | 0.01 | S |
| 2 | Form of Organization | 4.24 | 0.38 | NS |
| 3 | Number of directors | 23.88 | 0.00 | S |

Table 3: $\chi^2$values for the problems during export.

In this case, we estimated that the hypothesis is rejected for location and number of directors case and for the form of organization it is accepted. It is worth mentioning the fact that companies located are in rural areas,

Private limited with the number of directors less than 3 are highly impacted.

## 2.2Multiple Regression Analysis

The multiple regression analysis $(R^2)$ statistically estimate the relationship between a single (dependent) variable and several independent variables [21].

| S.No | Problems | $R^2$value | p-value | Significance |
|---|---|---|---|---|
| 1 | Problems in production | -1.72 | 0.10 | NS |
| 2 | Problems regarding labors | -0.59 | 0.56 | NS |
| 3 | Problems during export | 1.13 | 0.27 | NS |

Table 4: Results of Multiple Regression Analysis

It is estimated that one dimension has significant influence (p-value < 0.05) on the dependent variable against the various dimensions of impact of problems and prospects of fruit processing industry, see Table 4. The hypotheses in all these cases are also accepted.

## 2.3 Discriminant Analysis

Discriminant analysis classifies the occurrences into non-overlapping groups based on the scores of one or more quantitative predictor variables [22]. In this work, we use a linear discriminant analysis [25] which is given as a linear combination of weighted predictor variables with the least error. Mathematically it is given as:

$$D = L_1.X_1 + L_2.X_2 + \ldots\ldots\ldots\ldots\ldots. + L_k.X_k$$

(1)

In Eq. 1. $X_i$ denotes the predictor variables and $L_i$ represents the discriminant coefficients [25] and $D$gives the value of the discriminant function of the individual elements. It is known that if the value of $D$is greater than the critical value $D^*$, then that individual can be classified as Group A; else, would be classified as Group B. In this work, we use this model on the perception of different levels of problems in FPIs along with variable of profile unit (Location) as described in the previous section.

### 2.3.1 Problems in production

**Null Hypothesis:** The Discriminant analysis is not valid.

| Test function | Wilks' Lambda | $\chi^2$ value | DoF | p-value |
|---|---|---|---|---|
| 1 | 0.18 | 27.75 | 12 | 0.01 |

Table 5: Wilks's lambda statistics for problems in production. DoF refers to degrees of Freedom.

It is evident from Table 5 that Wilk's lambda is very low (0.18) and significance (0.01) is also less than 0.05. We therefore reject the null hypothesis which implies that the discriminant analysis is valid.

### 2.3.2. Problems faced in exporting

**Null Hypothesis:** The Discriminant analysis is not valid.

| Test of Function(s) | Wilks' Lambda | $\chi^2$ value | DoF | p-value |
|---|---|---|---|---|
| 1 | 0.17 | 30.91 | 9 | 0.00 |

Table 6: Wilks's lambda statistics for problems faced in exporting.

Wilk's lambda is very low (0.17) and significance (0.00) is less than 0.05, so we reject the Null hypothesis, implying that the discriminant analysis is valid.

### 2.4. Friedman Test

The k-related samples test is, in general, referred to as the Friedman's test (FT). Here, a comparison is made on k-parallel variables [24]. In this study, FT is used to examine whether there is any significant influence on selection of location.

**Hypothesis:** The ranks for the selection of location are the same.

| S.No | Ranking Factors | Mean Rank | DoF | $\chi^2$ value | p - value |
|---|---|---|---|---|---|
| 1 | Easy availability of raw materials | 1.22 | | | |
| 2 | Availability of quality labour | 3.69 | | | |
| 3 | Transportation | 2.31 | 4 | 82.36 | 0.00 |
| 4 | Other infrastructure | 3.81 | | | |
| 5 | Proximity to market centre | 3.97 | | | |

Table 7: Ranks for selection of location

**Hypothesis:** The ranks for the selection of product are the same.

| S.No | Ranking Factors | Mean Rank | DoF | $\chi^2$ value | p - value |
|---|---|---|---|---|---|

| 1 | Availability of raw materials at a reasonable price | 1.38 | 4 | 59.15 | 0.00 |
|---|---|---|---|---|---|
| 2 | Demand in market | 3.72 | | | |
| 3 | Availability of labour | 3.90 | | | |
| 4 | Availability of credit facilities | 3.25 | | | |
| 5 | Export potential | 2.75 | | | |

Table 8: Ranks for selection of product

As it can be seen from Table 7 and 8 that the significance (0.00) is less than the (0.05) therefore these hypotheses can be rejected. In addition to this, the mean ranks of the five factors are also not the same.

**3. Discussions& Conclusion**

➤ Processing one or two fruits and its processed products are the ultimate goal of every country. For example, orange juice from Brazil, apple juice from Europe/China, lemon juice from Argentina, and mango from India to name a few. Therefore, in India, it is recommended that based on fruits availability small clusters must be made, for example Mosambi from Ananthpur, Oranges from Nagpur/Punjab, and Mango from Salem/Chittoor. From those areas, government may organize small organizations among farmers to establish the food processing unit sand provides necessary logistical supports. From a sustainable perspective, farmers must be advised to maintain a healthy practice in handling water, maintain nutrition and to grow new varieties based on climate. The effects of pesticides should also be properly educated.

➤ More recently, industries are witnessing increased applications of novel engineering technologies such as Artificial Intelligence (AI) based industry 4.0 to achieve increased productivity. The recent development into the field of nanotechnology is also assisting FPIs to maintain the quality of fruits and vegetables. In addition to this, a few countries are already using robots in harvesting ripened fruits/vegetables from the clusters. Such technologies must be indigenously developed and promoted for the use case in industries, in India.

**References**

1. MS Sidhu (2005) Fruit and Vegetable Processing Industry in India: An Appraisal of the Post-Reform Period – Economic and Political Weekly – Punjab Agricultural University; Volume 40 (28): Pages 3056-3061.

2.  Joanna Majerska and Anna Michalska and Adam Figiel (2019) – A Review of new directions in managing fruit and vegetable processing by-products: Trends in Food Science and Technology Volume 88, June 2019, Pages 207-219.

3.  G. Joshi, (2011). an analysis of marketing surplus and price spread of brinjal in Western Utter Pradesh. Asian J. of Mngt. Res, 2(1), 141-145.

4.  Annual report on 2014-2015 Indian Institute of Horticultural Research (IIHR), Bangalore.

5.  MOFPI Report (1999): 'Food Processing - Fact sheet', MOFPI reports, 1999; p. 01 – 03.

6.  MOFPI Annual Report: (2000-01): 'Fruits and vegetable exporters, Fruits and vegetable suppliers, India'; Department of Food Processing, Ministry of Agriculture, New Delhi, 2001.

7.  The Agricultural and Processed Food Products Export Development Authority (APEDA) - Copyright © 2015, New Delhi.

8.  Rangit Singh, Fruits, National Book Trust, New Delhi, India,

9.  T. Krishnakumar - Making India's fruit processing industry globally competitive- 02 May 2018.

10. India's Fruit & Vegetable Processing Market 2018-2019 & 2023: Data on Food Processing Sector Trends (Dairy, Fruits & Vegetables, Grains & Cereals, Fisheries, Meat & Poultry, Consumer Food) - ResearchAndMarkets.com, November 25, 2019.

11. Aanad J.C. (1978) "Fruit and Vegetables Processing industry Problem and Prospects". Indian Farmers Digest. Aug., Vol. XI, No. 8, pp. 19-23.

12. Yeo, Lay Hwee. "Impact of Covid-19 pandemic on Asia-Europe relations." Asia Europe Journal 18.2 (2020): 235-238.

13. Dachner, Alison M., et al. "The future of employee development." Human Resource Management Review 31.2 (2021): 100732.

14. Azizi, Mohammad Reza, et al. "Innovative human resource management strategies during the COVID-19 pandemic: A systematic narrative review approach." Heliyon 7.6 (2021): e07233.

15. Biron, Michal, et al. "Structuring for innovative responses to human resource challenges: A skunk works approach." Human Resource Management Review 31.2 (2021): 100768.

16. Ceballos, Francisco, Samyuktha Kannan, and Berber Kramer. "Impacts of a national lockdown on smallholder farmers' income and food security: Empirical evidence from two states in India." World Development 136 (2020): 105069.

17. JodyHarris, et al. "Food system disruption: initial livelihood and dietary effects of COVID-19 on vegetable producers in India." Food Security 12.4 (2020): 841-851.

18. Howe, David C., et al. "Paradigm shifts caused by the COVID-19 pandemic." Organizational dynamics 50.4 (2021): 100804.

19. Hobbs, Jill E. "Food supply chains during the COVID-19 pandemic." Canadian Journal of Agricultural Economics/Revue canadienned' agroeconomie 68.2 (2020): 171-176.

20. McHugh, Mary L. "The chi-square test of independence." Biochemia medica 23.2 (2013): 143-149.

21. Mason, Charlotte H., and William D. Perreault Jr. "Collinearity, power, and interpretation of multiple regression analysis." Journal of marketing research 28.3 (1991): 268-280.

22. Morrison, Donald G. "On the interpretation of discriminant analysis." Journal of marketing research 6.2 (1969): 156-163.

23. Vargha, András, and Harold D. Delaney. "The Kruskal-Wallis test and stochastic homogeneity." Journal of Educational and behavioral Statistics 23.2 (1998): 170-192.

24. Zimmerman, Donald W., and Bruno D. Zumbo. "Relative power of the Wilcoxon test, the Friedman test, and repeated-measures ANOVA on ranks." The Journal of Experimental Education 62.1 (1993): 75-86.

25. MATLAB. 9.9.0.1570001 (R2020b). Natick, Massachusetts: Math Works Inc (2020).