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Research paper

Analysis of Supply Chain Wastage for Banana at Wholesale Distribution Points in Tamilnadu

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Abstract

India is the second largest producer of overall fruits and vegetables next to China as on 2015. In spite of being a major producer of fruits, various studies were reported that nearly from 20 to 75% of fruits are wasted in India due to various reasons. Fruits wastage was realizing in all stages of its supply chain from farm gate to till it reaches to the consumer. This study concentrates only one supply chain stage i.e. wholesale distribution points in Tamilnadu. This study was conducted based on descriptive research. Scope of this study was confined within Tamilnadu region with 13 specific locations. Data were collected from banana middlemen wholesale traders which include distributors, wholesale agents, commission agents, mandi agents, carry and forward agents, contractors and brokers. Data were collected from 154 wholesale traders through interview as well as survey method by using structured questionnaire. This study revealed that around 6.5% of bananas were getting wasted at wholesale level. This study also identified top three factors which influenced more wastage at wholesale distribution points of banana, they were physical injury, long travel and poor packing method.

Key words: *Banana, Fruits, Middlemen, Supply chain, Tamilnadu, Wastage, Wholesale*

1. Introduction

Fruits and vegetables production in India is continuously growing. India is the second largest producer of overall fruits and vegetables next to China as on 2015. India produced 30.8 million tonnes of bananas in 2012-2013, and Tamil Nadu contributed nearly a third of the total crop, which is the largest producer of banana in India. The state produced over 4.9 million tonnes of bananas in 2009-2010 and more than 8 million tonnes in 2012-2013. As per final estimation of 2013-14 by the Department of Agriculture and Cooperation, India produced 88.977 million MT of fruits from 7.216 million hectares of land. India is producing around 29.725 million MT of banana which contributing around 33% of total fruits production in India[1]. In 2014, India was said to be the country with the number one production in the world by the national horticulture board database. The report said that 9 million tonnes of the 29.7 million tonnes of bananas produced in 2014 in India was from Tamil Nadu [2]. Tamilnadu is a top most banana producer in India with 5.65 million MT of production which contributing around 19% of total banana production in India[1]. In spite of being a major producer of fruits, various studies were reported that nearly from 20 to 75% of fruits are wasted in India due to various reasons [3,4,5]

Industry records show that banana production has doubled in Tamil Nadu over the past four years. Tamil Nadu grows more bananas than any other state, but retail prices of the fruit are steadily on the increase. One of the main factors for this is that large amount of wastage and damage in every consignment during transportation, loading, unloading and handling. For example, at least 50 kg per tonne of smaller varieties of banana rots and is dumped as waste [6]. A considerable increase in agricultural productivity either through sustainable agricultural development or through rapid growth in incomes will be essential to meet the coming challenges of worsening poverty, feeding the growing population and protection of the environment. Effort to increase food production is one aspect of the solution, but equally important is the issue of postharvest loss management that has not received adequate attention in developing countries [8]. Fruits wastage was realizing in all stages of its supply chain from farm gate to till it reaches to the consumer. Indian Ministry of Food Processing Industries (MoFPI) is working with the goal towards minimizing wastage at all stages in the food supply chain through the development of infrastructure for storage, transportation and processing of agro-food produce. As part of this initiative, a research was proposed to identify the total quantity of banana wastage in its supply chain from farm gate to retail outlets in Tamilnadu state and its reasons. As part of this proposed research work, this specific article concentrates only one supply chain stage i.e. wholesale distribution points in Tamilnadu.

2. Research Methodology

This study was conducted based on descriptive research. Scope of this study was confined within Tamilnadu region, because Tamilnadu is a top most banana producer in India with 5.65 million MT of production which contributing around 19% of total banana production in India[1,2]. This study was restricted only among middlemen those who are doing banana trading business between farmer and retailers. Middlemen include distributors, wholesale agents, commission agents, mandi agents, carry and forward agents, contractors and brokers. Farmers and retailers

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were not included in this study. Data were collected from 13 different locations from Tamilnadu state. Location details were given in frequency analysis section. All the data were collected through interview as well as survey method by using structured questionnaire. Questionnaire includes around 22 wastage causing variables. All these variables were identified after the tremendous review of literatures. Questionnaire was circulated around 200 wholesale agents and interview was conducted with 34 wholesalers based on location and time convenience. Out of 200 questionnaires, 154 responses were included in this study and remaining 46 were excluded due to not received back and poor or incomplete responses. All 34 interview responses were also included, hence final sample size was arrived as 188. All the collected data were converted in to table format and exported to SPSS software package.

3. Data Analysis

Master table for collected data was prepared in SPSS package and the same was utilized for data analysis. Frequency analysis was performed to get basic information on demographic details of respondents and banana wastage at wholesale level. Weighted average was used to find out exact quantity of wastage at wholesale stage. Weighted average was calculated by using percentage of response as weights and mean value of given wastage range in the questionnaire as wastage values. Data reliability for all three constructs was checked through cronbach's alpha value. Variables were reduced and key factors were found through factor analysis by using principle component extraction and varimax rotation methods. KMO and Bartlett's test was also performed in factor analysis for testing sampling adequacy and significance respectively. Significance, influence and importance of each variable was analysed by using regression analysis by considering avoidable overall wastage as dependent variable and all other variables as independent variables. Arrived results and respective discussions were given below.

4. Results and Discussions

A. Frequency analysis

Around 12% of data were collected from Chennai region. Chennai sub-urban, Trichy, Theni, Madurai were contributed each around 8% of the total data. Coimbatore, Tirunelveli, Nagarkoil, Dindugul and Hosur markets contributed each around 7% data and all remaining locations such as Salem, Erode and Vellore, Villupuram and Dharmapuri markets contributed each around 5% data. Tamilnadu wholesale markets were dominated by male traders with 82%. Just 12% of the traders alone were in the age group of less than 30 years. Around 95% of the banana middlemen traders were married. Around 70% of the traders had school education and 18% of the traders were possessing graduate degree. Around 59% of the traders were earning less than Rs. 5 lakhs per annum and 34% of the traders were earning Rs. 5 to 10 Lakhs per annum. Rest of the people were earning more than 10 Lakhs per annum. Around 58% of the traders were doing their business from 3 years to 10 years. Around 35% of the respondents were having more than 10 years of experience in this field. This study discloses the information that Tamilnadu wholesale traders were having minimum 15 suppliers. Around 62% of the traders were purchasing their banana consignment once in a day. Around 87% of the traders were not using any packing method for banana transport, instead they directly dump in to the vehicle carrier and transport the bananas to the required locations. Around 53% of the traders were receiving their bananas from more than 200 Kilometres distance.

B. Weighted Average Analysis for the determination of Total Banana Wastage at Wholesale distribution channels

Total banana wastage was calculated based on weighted average method. In this regard, overall banana wastage in terms of frequency and its percentage was determined and values given in Table 1. These values were used to determine total banana wastage at wholesale distribution points. Mean value of wastage range was taken as quantum of wastage and respective response percentage was considered as weight in order to determine total wastage at wholesale stage. For example, A%, B%, C%, D% and E% of the respondents indicated different range of wastage viz., 0 to 5%, 6 to 10%, 11 to 20%, 21 to 30% and 31 to 40% of fruits wastage respectively. The mean value of each range of wastage was calculated and the same was used as weight (They are 2.5%, 7.5%, 15%, 25% and 35%). Then weighted average was calculated by multiplying percentage of respondents by the weights. Then this was divided by total of all mean values. Equation 1 shows the weighted average calculation and it revealed that around 6.5% of bananas were getting wasted at wholesale level.

Table 1 : Overall Banana Wastage At Wholesale Distribution Points

Wastage level	**Frequency**	**Percentage**
Very less (0 to 5%)	94	50.0
Less (6 to 10%)	80	42.6
Average (11 to 20%)	14	7.4
High (21 to 30%)	0	0
Very High (31 to 40%)	0	0
Total	**188**	**100.0**

Total Retail wastage = [(2.5 x 50) + (7.5 x 42.6) + (15 x 7.4) + (25 x 0) + (35 x 0)] / [2.5 + 7.5 + 15 + 25 + 35] = 6.5% ---------- (1)

Since this method was already proven method, the same method was adopted for this study too[8,9,10].

C. Factor Analysis

Factor analysis was used for identifying the vital factors by reducing several variables into few factors based on factor loadings. Sampling adequacy and significance was tested through KMO and Bartlett's test. Table 2 shows that KMO value of all the samples was 0.909 which indicates that sampling adequacy in this study was around 91%. This table also shows the significance value through Bartlett's Test of Sphericity as 0.000 which justified that all the variables taken in this study was found to be significant and suitable for proceeding factor analysis.

Table 2: Kmo And Bartlett's Test Results

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.909
Bartlett's Test of Sphericity	Approx. Chi-Square	3562.058
	df	231.000
	Sig.	0.000

Table 3: Total Variance Explained In Factor Analysis

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	9.832	44.689	44.689	9.832	44.689	44.689	9.734	44.245	44.245
2	3.113	14.152	58.840	3.113	14.152	58.840	3.151	14.323	58.568
3	1.265	5.751	64.591	1.265	5.751	64.591	1.314	5.974	64.542
4	1.077	4.897	69.488	1.077	4.897	69.488	1.088	4.946	69.488

Extraction Method: Principal Component Analysis.

Vital factors of this study were extracted through factor analysis using principle component analysis method. This analysis was given results of 22 components along with Eigen values and loadings. Eigen values one and above was considered for explaining total variance based on extraction sums of squared loadings [11]. Hence Table 3 displayed only with first four components with initial Eigen values one and above, which cumulatively explained around 69% of total variance. Distribution of all the variables under four factors were carried out by using factor loadings of 0.5 and above [11] in rotated component matrix which arrived through verimax rotation method (with 5 iterations). Respective variables in each factor were chosen based on 0.5 and above factor loadings from rotated component matrix. First component had 5 variables such as loading (0.922), load man handling (0.642), damage removal/sorting (0.834), unloading (0.790) and physical injury (0.590). This factor named as handling factors. This factor explained about 44% of variance in wholesale avoidable waste. Second factor consist six other variables with 0.5 and above factor loadings. They were transport problems (0.815), long travel (0.840), temperature issues (0.616), poor packing materials (0.916), poor packing methods (0.818) and poor road conditions (0.766). All these variables were constituted a common factor called transportation wastage which explained another 14% variance in wholesale wastage.

Another seven variables such as ripening (0.949), pests and rodents (0.787), poor inventory/storage conditions (0.879), decay (0.932), pest attacked bananas (0.828), spillage (0.747) and pilferage (0.935) were included in third factor which was named as storage wastage. This factor explained around 6% variance in avoidable wholesale wastage. Fourth factor constituted with three other variables such as unsold items/poor demand (0.747), delay in contract sale (0.818) and delay in delivery (0.549). This factor named as demand based wastage. This factor was explained around another 5% of variance. Out of all 22 variables, "immature bananas" variable was not listed in any factors and hence it was removed from further analysis. All these 21 variables were cumulatively explaining about totally 69% of avoidable banana wastage at wholesale distribution points. Reliability of all these four factors was determined by using Cronbach's alpha value. Reliability of handling factor, transportation factor and storage factor and demand factor was determined as 0.660, 0.794, 0.830 and 0.518 respectively. Since all the values were greater than 0.5, it was declared that all newly identified factors were reliable factors [11].

D. Regression analysis

Table 4 shows that results of model summary and ANOVA results in multiple regression analysis. This analysis was performed by using overall wholesale wastage as dependent variable and all other 22 wastage causing variables as independent variables. R square value of regression analysis was arrived as 0.676. It reveals that 68% of the variance was explained by 21 different variables which included in this analysis. Remaining variance might be explained from other variables which were not included in this study. Since R square value of 0.5 and above was considered to be accepted level for social science studies, arrived value was reasonably accepted. Similarly significance value of ANOVA table shows that 0.000. Since it was less than 0.05, it was concluded that all variables were having significant relationship with dependent variable i.e. overall banana wholesale wastage and hence further analysis could be considered by using these variables.

Table 4: Model Summary Results In Multiple Regression Analysis

Model Summary		**ANOVA**	
R	**R Square**	**F**	**Sig.**
0.822	0.676	16.468	0.000

Core analysis and discussions could be made by using significance, unstandardized and standardized coefficients values of each variable. This result discovers that 7 variables out of 21 variables were turned to be significant as wastage causing variablesat banana wholesale distribution points. They were given in equation 2.

Wholesale banana wastage = -1.251 + 0.311 (Load man handling) + 0.476 (Long travel) + 0.497 (Poor packing methods) + 0.505 (Poor road condition) + 0.966 (Physical injury) + 0.228 (Spillage) + 0.281 (Delay in delivery) ---------- (2)

Unstandardized coefficients were useful to identify relative influence of each significant variable towards overall banana wastage at wholesale points. For example, one unit increase in load man handling issues would cause around 0.311 units of banana wastage in wholesale points. Another one unit increase in long travel would influence 0.476 units of overall wastage of banana at wholesale points. Similarly a unit increase in poor packing methods would generate 0.497 units of wastage at banana wholesale points. A one unit of increase in poor road conditions would originate 0.505 units of banana wastage at wholesale points. Another one unit increase in physical injury would stimulate 0.966 units of overall banana wastage at wholesale points. Similarly a unit increase in spillages would produce 0.228 units of wastage at banana wholesale points. One unit increase in delay in delivery would act as root cause for around 0.281 units of banana wastage atwholesale distribution points.

Standardized coefficients were used to prioritize the wastage causing factors based on their significant impact. Out of all seven significant variables physical injury (0.644) was playing as most significant factor for banana wholesale wastage followed by long travel (0.360), poor packing methods (0.354), poor road conditions (0.313), load man handling (0.210), spillage (0.181), and delay in delivery (0.166). In overall transportation factor plays major role in banana wastage at wholesale distribution points.

5. Conclusion

This study was conducted with the objective of minimizing the food wastage by focusing banana wastage at wholesale distribution points in Tamilnadu state. This study reveals that, around 6.5% of total banana were getting wasted at wholesale points of Tamilnadu. It was comparatively lesser wastage than the retail wastage. Because wholesale agents were the middlemen, hence they transfer entire consignment from one hand to another hand. In this scenario, wastage couldn't be identified, instead damaged or spoiled banana would transfer along with good consignment and it will be identified at last stage of its supply chain i.e. retail stage. This study also identified top three factors which influenced more wastage at wholesale distribution points, they were physical injury, long travel and poor packing method. If one could closely observe these wastage causing factors, they could understand all these three factors were integrated factors, which means that, due to long travelling, poorly packed or unpacked or simply dumped (in vehicle carriers) bananas were injured physically. Hence this study suggested that, using proper packaging techniques such as wooden or plastic boxes or crates with minimum unit load and cushion bottom etc., would bring down the banana wastage. Finally this study strongly recommends that careful handling and minimizing middlemen handling by transporting banana directly from farm gate to retail outlets or just with one middleman either distributor or agent would bring down the wastage at greater level.

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