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FRESH PRODUCE PERISHABILITY: AN EMPIRICAL EXAMINATION AMONG DISTRIBUTORS IN PUDUCHERRY REGION

S. Madhiyarsi* Dr. T. Nambirajan**
**Ph. D Research Scholar, Dept. of Management Studies, School of Management, Pondicherry University, Puducherry,India.*
***Professor, Department of Management Studies, School of Management, Pondicherry University, Puducherry, India.*

Abstract
In this study authors investigate factors affecting fresh produce perishability among distributors in Puducherry region. Key factors which contribute to perishability of fresh produce have been examined. Using survey method sample data were collected from 57 distributors. In this work, authors test hypothesized relationships among variables using correlation and multiple regression analysis. Authors found that damage during harvesting, improper handling while loading and unloading, microbial infection and lack of temperature control are major causes for perishability. Results suggest that fresh produce perishability is an important factor for improving distributors' performance. From this study one can understand contemporary issues faced by fresh produce distributors of Puducherry region.

Keywords: Fresh Produce, Perishability, Regression, Distributors.

1. INTRODUCTION

Perishable Agri-fresh produce refers to any commodity that is produced, harvested and sold in a form that will perish within a reasonable time period.Agri-foods are produced to consume in a limited lifetime. Managing Agri-food perishability has become a big challenge after the post-harvest stage at the distribution level. Emergences of management strategies, science and technology have created ways to minimize the level of perishability through inventory management and cold storage which will optimize performance. Since the perishability vary with the type of produce, travel distance, consumer purchase trend and market size, it is necessary to know which factors highly contribute to perishability of a produce in a particular market. Hence in this study authors try to find out factors which highly affect the fresh produce perishability among distributors in Puducherry region.

2. REVIEW OF LITERATURE

Agri- fresh produce are perishable in nature. Horticulture crops are highly perishable in nature and it is complex to manage their distribution starting from the harvest to end consumption period. Since these crops have short shelf life, more care and importance has to be given during distribution. Various factors affect the perishability and they vary depending on s produce type, location, method of handling etc. It is required to have a separate model for a particular market. Failure to control the level of perishability will lead to loss of success for fresh produce stakeholders in the supply chain in terms of quality, safety, customer satisfaction, profit and ultimately resulting in loss of their business in the market.

Supply chain of Agri-food shows a continuous change from the production stage to the end usage of merchandise. Agri-food industries are different from non-perishable industries because of its perishable nature. Complexity is high in the Agri-food distribution and it requires different management techniques throughout the supply chain. Hence, they require more attention towards planning and decision making with respect to cold storage, quality, safety and hygiene, transportation, packaging and warehousing which improve the shelf life of the product.

High level of perishability affects the nature and characteristics of fresh produce which results in losing its nutrient values, taste, appearance, colour and freshness. Perishability starts from harvesting stage. Growers and distributors will lose their market price for the perishable produce if selling is delayed. Hence perishability acts as a marketing barrier for the supply chain partners such as farmers and distributors. The risk of rejection for export trade happen due to the mishandling of fresh produce(Hewett, Hofma and Weaver 2005).

Perishability of produce is the greatest barrier for the distributor i.e wholesaler, retailer and transporter. Transporters are not bearing major loss occurred due to perishability of the product while comparing with wholesalers and retailers. Hence in this study, authors focused on wholesalers and retailers of fresh produce in Pondicherry region.

Perishability increases during the distribution stage of Agri-fresh produce from farm gate to retail outlet. In this study authors examine how much post-harvest factors affect the fresh produce.

Spoilage of fresh produce is due to its perishable nature. Wee (1993) defined perishability as decay, damage, spoilage,

Evaporation, obsolescence, pilferage, loss of utility or loss of marginal value of a commodity that results in decreasing usefulness from the original one.

Perishability increases due to the following: a) product innovation is frequent, b) products are physically perishable and c) seasonality. These various forms of obsolescence have the same pricing implication, in that the product's value decreases relative to time. This decrease in value produces an incentive to offer price promotions to clear out obsolescent merchandise.

Ahumada & Villalobos (2009) have taken into consideration of perishability nature of the product and designed a supply chain model which results in hygiene products.

Perishability is a service component which reflects on produce quality and price, quantity of order, customer purchasing pattern and so on in the trade market.

Perishability is an issue for all players in the Agri-fresh produce supply chain. Especially small scale farmers (Matsane and Oyekale 2014) and distributors face challenge in marketing their produce to consumers. Consumer purchase character differs with the level of perishability of produce with reference to market price and order quantity (Tian, Yang and Li 2008). This study shows that market price as well as product order quantity decreases with increased rate of perishability. Finally high perishability rate results in low profit.

Myae, et al., (2005) stated that long distance results in weak integration between transit market and consumer market which increases the level of perishability. Market infrastructure like transportation, facilities and information will leads to integrate producer and consumer markets. Munir, et al., (1997) have proved in their study that speed of transmission is related to produce perishability in a study conducted in Indonesian Agri-fresh produce market.

3. OBJECTIVE

Main objective of this study is to identify and analyze which factors contribute to high perishability of fresh produce among distributors in Pondicherry region.

4. RESEARCH METHODOLOGY

The study was conducted in Puducherry region. Primary data were obtained by survey method using a questionnaire as a data collection tool. Authors try to find major causes for perishability of fresh produce among distributors considering the fresh produce from postharvest stage in Puducherry region. Simple random sampling was used to collect data from sample size of 57 fresh produce distributors who are responsible for the produce at end stage and also answerable to consumers for causes due to perishability.

Correlation and multiple regression analyses are used for the purpose of study by using SPSS 16.0 statistical package. Correlation was run to test Multicollinearity among independent variables. Multiple regression analysis was used to analyze the effects of factors contributing to perishability of fresh produce among distributors in Puducherry region.

Dependent Variable: Perishability is directly related to shelf life, in that products with a long shelf life have low levels of perishability and products with a short shelf life have high levels of perishability. Perishability limits the time period of a fresh produce in the distribution center. Agri-fresh produce is subject to lose its value from its natural quality in each and every stage of their life period. By nature Agri-fresh produce are more sensitive to time and temperature control.

Independent Variables: From the literature author found factors contributing to fresh produce perishability during distribution from the farm field to retail outlet. Critical factors contributing to perishability are as follow: 1) damaged produce during harvest in the farm field, 2) damage during transit due to poor road conditions, 3) ineffective packaging of fresh produce, 4) microbial infections such as bacteria, fungus, insects and other post-harvest pests and disease etc., 5) non-removal of foreign bodies, 6) lack of proper temperature control, 7) lack of proper cleaning and washing and 8) poor handling of fresh produce.

FORMULATION OF HYPOTHESES

There is a significant positive association between perishability and post-harvest causal factors. Authors framed the following eight alternative hypotheses.

H1: Perishability of fresh produce is positively associated with damage during harvest in the farm field.

H2: Perishability of fresh produce is positively associated with damage during transit due to poor road conditions.
H3: Perishability of fresh produce is positively associated with ineffective packaging.
H4: Perishability of fresh produce is positively associated with microbial infections,
H5: Perishability of fresh produce is positively associated with non-removal of foreign bodies.
H6: Perishability of fresh produce is positively associated with lack of proper temperature control.
H7: Perishability of fresh produce is positively associated with lack of proper cleaning and washing and,
H8: Perishability of fresh produce is positively associated with poor handling of fresh produce.

ESTIMATION OF MULTIPLE REGRESSION EQUAITON

The multiple regression equation used to test the association between perishability and various factors contributing to cause of perishability (independent variables) are presented below:

$$\mathbf{(P) = a + b_1\,HD + b_2\,PD + b_3\,PA + b_4\,MI + b_5\,FB + b_6\,TC + b_7CW + b_8PH + \varepsilon}$$

where
P = Perishability
a = constant (Y-intercept)
HD=Damage during harvesting
PD= Physical damage due to road conditions
PA= Ineffective packaging
MI=Microbial infections (bacteria, fungus, insects etc.)
FB=Non-removal of foreign bodies
TC=Lack of temperature control
CW=Lack of cleaning and washing
MH=Poor handling
b_1, b_2, b_3, b_4, b_5, b_6, $b_7$and b_8 represent slopes of variables in the regression equation and
ε = the error term.

The null and alternative hypothesis are framed to know whether the multiple regression model infit enough to test and explain the variation in perishability of fresh produce by the eight independent variables jointly.
Null hypothesis is true while $R^2 = 0$
Alternate hypothesis is true while $R^2 > 0$,where
R^2 is the co-efficient of multiple determination.

5. RESULTS AND DISCUSSIONS

CORRELATION ANALYSIS AND MULTICOLLINEARITY TEST

Correlation analysis was run in order to understand the relationship between dependent and independent variables. The results are shown in Table 1.

Table 1 Pearson's correlation test results with respect to causal factors and Perishability

	P	**HD**	**PD**	**PA**	**MI**	**FB**	**TC**	**CW**	**PH**
P	1								
HD	.692	1							
PD	.613	.594	1						
PA	.568	**.643**	.584	1					
MI	.631	.503	.498	.557	1				
FB	.594	.472	.504	.555	.478	1			
TC	.705	.536	.391	.301	.414	.360	1		
CW	.571	.437	.412	.484	.613	.461	.425	1	
PH	.667	.422	.511	.385	.529	.297	.587	.480	1

From the Pearson correlation analysis, dependent variable (perishability) and independent variables (various factors contributing to perishability) are significant at 0.01 level and also highly correlated with Pearson correlation values 0.692, 0.613, 0.568, 0.631, 0.594, 0.705, 0.571 and 0.667. Hence we accept all alternate hypotheses that dependent and independent variables are positively correlated.

Multicollinearity exists when there is a strong correlation between predictor variables in a regression model (Field 2009). The highest simple correlation between independent variables is 0.643, between damage due to harvest and packaging. According to Hair, et al., (2011) the simple correlation not exceeding 0.90 between independent variables should not be considered harmful. Hence, the above results indicate that there is no collinearity between the independent variables.

Table 2ANOVA test results showing contribution of casual factors on perishability

Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	40.581	8	5.073	20.324	**0.000[a]**
	Residual	11.980	48	.250		
	Total	52.561	56			
a. **Predictors:**Damage during harvesting, Physical damage due to road conditions, Ineffective packaging, Microbial infections (bacteria, fungus, insects etc.), Non removal of foreign bodies, Lack of proper temperature control, Lack of proper cleaning and washing, Poor handling during loading and unloading.						
b. **Dependent Variable**: Perishability						

Table 2 shows the ANOVA result. From the significant value authors inferred that there is a significant contribution of predicators (independent variables) on perishability (dependent variable) which is denoted by F value of 20.324 and explained by the probability value of 0.000. This indicates that independent variables are jointly significant to explain dependent variable (Perishability).

Table 3 Multiple regression analysis results for factors contributing to perishability

Coefficients				
Model	**Unstandardized Coefficients**		**Standardized Coefficients**	**t value**	**Sig. value**
	B	**Std. Error**	**Beta**		
(Constant)	.278	.248		1.122	.267
Harvest Damage	.170	.082	.221	2.080	**.043**
Poor road conditions	.055	.078	.070	.708	.482
Ineffective packaging	.011	.085	.014	.133	.894
Microbial infections (bacteria, fungus, insects etc.)	.162	.073	.201	2.219	**.031**
Non-removal of foreign bodies	.090	.077	.117	1.174	.246
Lack of temperature control	.207	.070	.283	2.951	**.005**
Lack of cleaning and washing	.036	.070	.048	.515	.609
Poor handling	.192	.085	.222	2.262	**.028**
Dependent Variable: Perishability					

From Hypothesis 1 it is predicted that high damage during harvesting cause high perishability, Hypothesis 4 predicts that high infection due to microorganisms like bacteria, fungus and insects cause high perishability, Hypothesis 6 predicts that lack of proper temperature control causes high perishability for fresh produce and Hypothesis 8 predicts that poor handling of fresh produce during loading and unloading causes high perishability at distributors level. All the above four hypotheses are supported with high coefficient and significant p values. Hence independent variables such as lack of proper temperature control, poor handling of fresh produce during transit, microbial infections due to bacteria, fungus and post-harvest pests and physical damage during harvesting are significant with p values 0.005, 0.028, 0.031and 0.043 respectively. The co-efficient shows a positive relationship between each independent variable and the dependent variable with the respective unstandardized coefficient values0.207, 0.192, 0.170 and0.162.

Hypothesis 2 asserts that high damage due to bad road condition leads to high perishability of fresh produce. The coefficient shows a positive relationship between the variables. Still the relationship is not statistically significant with the p value 0.482. Likewise the hypothesis 3, 5 and 7 are having insignificant values such as 0.894, 0.246 and 0.609 respectively with low coefficients. These hypotheses are not supported since the relationships have insignificant values.

Table 4 Model summary results

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Sig. F Change	Durbin-Watson
1	.879[a]	.772	.734	.500	.000	1.936
a. **Predictors**: Damage during harvesting, Physical damage due to road conditions, Ineffective packaging, Microbial infections (bacteria, fungus, insects etc.), Non removal of foreign bodies, Lack of proper temperature control, Lack of proper cleaning and washing, Poor handling during loading and unloading						
b. **Dependent Variable**: Perishability						

Adjusted R-square value in the model summary table indicates that 73.4 % of the variation in the fresh produce perishability can be attributed to these eight variables. From table 4 it is inferred that R square value is greater than zero so we reject null hypothesis. And also the Durbin-Watson value is 1.936 which is close to the value two. It shows that our estimated multiple regression models are not suffering from serial correlation i.e. in this study, residuals are not correlated. This indicates that the estimated multiple regression models is good and we can use this model for prediction.

Multiple regression analysis was run to determine the predictors (independent variables) that contribute to fresh produce perishability. The results are shown in Table 3. From the regression analysis, the association between dependent variable and independent variables are measured.

By usingunstandardized beta coefficient values multiple regression equation is estimated as follow:

$$\hat{y} = 0.278 + 0.170 *x1+ 0.055 *x2+ 0.011* x3 + 0.162* x5 + 0.090* x4 +0.207*x6 + 0.036 *x7 + 0.192* x8$$

Using the above multiple regression equation perishability at distributor's level in Puducherry region was estimated as 3.103 (Perishability ($\hat{y}$) =3.103). In order to reduce the perishability, distributors have to concentrate on reducing the four major critical concerns. The critical concerns for the cause of perishability at distributor level are the following: (1) harvest damage, (2) microbial infection, (3) lack of proper temperature control and (4) poor handling. This shows that the above four variables are having significant effect on the level of perishability of fresh produce. Damage due to road condition, non-removal of foreign bodies, ineffective package and lack of cleaning and washing are having insignificant effect on the level of perishability with higher p values.

6. FINDINGS AND CONCLUSIONS

In this study, authors investigated eight factors contributing to perishability of fresh produce among distributors in Puducherry region. From correlation analysis authors identified a significant relationship between the independent variables (damage due to harvest, physical damage due to road conditions, in effective packaging, microbial infections (bacteria, fungus, insects etc.), non-removal of foreign bodies, lack of temperature control, lack of cleaning and washing, poor handling during loading and unloading) and dependent variable (perishability). Hence, by reducing the contribution of critical factors distributors can reduce high perishability of fresh produce. This results in improving distributor's performance in terms of profit and also provides quality produce to consumers in the market.

From the regression analysis, it is found that damage during harvesting, microbial infections (bacteria, fungus, insects etc.), lack of temperature control and poor handling during loading and unloading are having significant association with perishability of fresh produce.

Perishability is a natural process which is unavoidable and also essential in a certain level for metabolic activities of fresh produce. But factors such as post-harvest pest and diseases, physical damage due to ineffective packaging, harvesting and handling can be controllable by creating awareness among employees.

Damage during harvesting, ineffective packaging and poor handling are caused due to lack of awareness are people involved in such activities. These problems can be reduced by providing knowledge and skills by training employees in order to ensure proper handling and storage of fresh produce.

By focusing on the above mentioned four critical concerns distributors can reduce perishability across distribution network which in turn improves the quality of fresh produce, shelf life of fresh produce and profit. This helps to reduce the Agri-fresh produce spoilage and wastage due to high perishability of fresh produce in the distribution stage.

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