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Factor contributing post-harvest losses in supply chain management of cauliflower in Gujarat

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Abstract
This study examines factors affecting cauliflower post-harvest losses at farm level in Surat district of Gujarat. Key factors which contribute to post harvest losses of cauliflower have been examined. Using survey method sample data were collected from 120 cauliflower growers from 12 villages. Multiple regression analysis was run to determine the predictors (independent variables) that contribute to fresh produce PHL. The critical concerns for the cause of post-harvest losses at producer level were; damage during harvest, damaged due to diseases, damages due to insect, damage during transportation lack of proper cleaning and washing showed a positive relationship between each independent variable and the dependent variable. In order to reduce the post-harvest losses, farmers have to concentrate on reducing the above major critical concerns. This shows that the these variables were having significant effect on the level of PHL of fresh produce.

Keywords: Cauliflower, regression, factors affecting post harvest losses. PHL

Introduction
In India, the vegetable sector has established its credibility for improving land-use efficiency, generating employment and providing nutritional and food security. Post-harvest losses during handling, transportation, storage and distribution of vegetable commodities are the major problems in the agrarian economy, especially in perishable vegetables. In addition of this low per capita availability and huge monetary losses, the post-harvest losses increase cost also on transport and marketing (Subrahmanyam, 1986) [3]. The growth of Indian vegetable sector during the previous decade was quite impressive. Economic liberalization and globalization have opened up new opportunities to exploit the potential of Indian vegetable sector through exporting premium quality horticultural produce and products.
Due to favourable climatic conditions, a variety of vegetable are grown in the South Gujarat region of Gujarat state. Unfortunately, a considerable proportion of the harvested produce is lost due to improper post-harvest practices followed by farmers and market functionaries in the region. Therefore, both policy makers and scientists are of the view that higher returns may accrue to farmers from proper post-harvest management rather than a boost to crop production in the field. The main reasons for the losses are physiological and biological processes, microbial decay, high perishability and sub-standard post-harvest handling infrastructures. Hence, it is decidedly required to prepare a national as well as state level policy to reduce gigantic post-harvest losses, maintain quality standard and elevate the rate of per capita vegetable consumption in the state as well as in the country. Therefore the present study attempt to estimate the factors contributes to high post-harvest losses of cauliflower among producers in Surat district of Gujarat.

Materials and methods
Primary data were obtained by survey method using a questionnaire as a data collection tool from Surat district of Gujarat. Simple random sampling was used to collect data from sample size of 120 cauliflower growers who are responsible for the produce at end stage and also answerable to consumers for causes due to PHL. Correlation and multiple regression analyses are used for the purpose of study by using Eview 8 statistical package. Correlation was run to test Multicollinearity among independent variables. Multiple regression analysis was used to analyze the effects of factors contributing to PHL of cauliflower among distributors in Surat district of Gujarat.

Identification of Variables
Post Harvest Losses (PHL) is directly related to shelf life, in that products with a long shelf life have low levels of PHL and products with a short shelf life have high levels of PHL.

Total post harvest loss in cauliflower measured in quantity as a dependent variable. This study found that factors contributing to cauliflower PHL during marketing from the farm field to retail level identified as independent variable. 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) Damaged due to insects and other post-harvest pests and disease etc., and 5) Lack of proper cleaning and washing.

Formulation of hypotheses

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

C1: PHL of cauliflower is positively associated with damage during harvest at the field level.
C2: PHL of cauliflower is positively associated with damage due to disease.
C3: PHL of cauliflower positively associated with ineffective packaging.
C4: PHL of cauliflower is positively associated with lack of cleaning and washing.
C5: PHL of cauliflower is positively associated with damaged due to insect.
C6: PHL of cauliflower is positively associated with lack of proper care during transit.

Estimation of multiple regression equation

To analyses this, we were estimated the slope (or slopes, in multiple regressions). The PHL was measured by;

PHL (Y) = f {X1, X2, X3…X6}

Where

X1 = Damage during harvest (HR),
X2 = Damage due to disease (DP),
X3 = Non separation of living organism like insects/pest (DI),
X4 = Lack of cleaning and washing (SR),
X5 = Lack of scientific packaging (PK),
X6 = Lack of care during transportation (TP),

Prior to the applying the regression model, the Pearson's correlation statistic was run to determine the variability across the independent variables. The null and alternative hypotheses were framed to know whether the multiple regression model fit enough to test and explain the variation in PHL of cauliflower by the six independent variables jointly.

Null hypothesis is true when $R^2 = 0$
Alternate hypothesis is true when $R^2 > 0$,

Where

R^2 is the co-efficient of multiple determinations.

Results and Discussion

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. From this table we can see that, dependent variable (PHL) and independent variables (various factors contributing to PHL) are correlated and it was significant at 1 per cent level of significance and highly correlated with Karl Pearson's correlation coefficient between dependent variable i.e. PHL and independent variables *i.e.* HR, DI, DP, SR, TP and PK, which was 0.626, 0.757, 0.768, 0.905, 0.870, and 0.911, respectively. Hence we accept all alternate hypotheses that dependent and independent variables are positively correlated.

Table 2 shows the ANOVA result of the fitted model. From the significant value of the model inferred that there is a significant contribution of predicators (independent variables) on PHL (dependent variable) which is denoted by F value i.e. 192.442. F value is significant at 1 per cent level of significance. This indicates that independent variables have jointly significant effect to explain dependent variable (PHL).

From Hypothesis 1 it is predicted that high damage during harvesting cause high PHL, Hypothesis 4 predicts that high infection due to microorganisms like bacteria, fungus and insects cause high PHL, Hypothesis 6 predicts that poor handling of fresh produce of cauliflower during loading, unloading and transit causes high PHL. All the above three hypotheses are supported with high coefficient and significant p values. Hence, independent variables such as damaged during harvesting (HR), damaged due to disease (DP), damages due to insect (DI) and damage during transportation (TP) and lack of proper cleaning and washing (SR) are significant with p values. The co-efficient showed a positive relationship between each independent variable and the dependent variable with the respective unstandardized coefficient values 0.960, 1.061, 1.354, 3.660 and 1.004, respectively.

Table 1: Pearson's correlation coefficients among the selected variables.

Pearson's Correlations								
Factors		**PHL**	**HR**	**DI**	**DP**	**SR**	**TP**	**PK**
PH	Post-harvest loss	1.000	0.626**	0.757**	0.768**	0.905**	0.870**	0.911**
HR	Damaged during harvest		1.000	0.411**	0.634**	0.488**	0.365**	0.521**
DI	Damaged due to diseases			1.000	0.737**	0.730**	0.705**	0.738**
DP	Damaged due to pest				1.000	0.698**	0.634**	0.719**
SR	Lack of cleaning and washing					1.000	0.941**	0.992**
TP	Lack of effective care during transport						1.000	0.936**
PK	Lack of effective packing							1.000
** Correlation is significant at the 0.01 level (2-tailed).								

Table 2: ANOVA test results showing contribution of casual factors on PHL

Model		**Sum of squares**	**Df**	**Mean square**	**F value**	**Probability**
1	Regression	50523287.880	5	10104658	192.442	0.000[a]
	Residual	5985846.241	114	52507.423		
	Total	56509134.121	119			
a. Predictors: Damaged during harvesting (HR), Damaged due to diseases (DP), Damage due to insect (DI), Lack of proper cleaning and washing (SR), Damage during transportation (TP).						

Hypothesis 2, 3 and 4 asserts that high damage due to bad road condition leads to high PHL of fresh produce. The coefficient shows a positive relationship between the variables. These hypotheses are not supported since the relationships have insignificant values.

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

By using unstandardized beta coefficient values of multiple regression equation was estimated as follow:

PHL= 39.3 + 0.960 HR + 1.061 DI + 1.354 DP + 3.66 SR + 1.004 TP

Using the above multiple regression equation PHL at field level in Surat district of Gujarat was estimated. In order to reduce the PHL, farmers have to concentrate on reducing the four major critical concerns. The critical concerns for the cause of PHL at producer level were; damage during harvest, damaged due to pest and disease, lack of proper cleaning and washing and poor handling. This shows that the above four variables were having significant effect on the level of PHL of fresh produce. The results of the study substantiate with Acharyulu and Madhavedi, 2011 [1]; Madhiyarsi and Nambirajan, 2015 [2].

Table 3: Multiple regression analysis for factors contributing to PHL

Coefficients[a]						
Model		Unstandardized Coefficients		T	Probability	VIF Value
		Beta	Std. Error			
1	(Constant)	39.30	39.30	1.00	0.320	
	HR	0.960	0.165	5.84	0.000	1.900
	DI	1.061	0.455	2.33	0.021	2.830
	DP	1.354	0.841	1.61	0.110	3.260
	SR	3.660	1.300	2.82	0.006	11.68
	TP	1.004	0.265	3.79	0.000	9.910
a. Dependent Variable: PHL						

Table 4: Model summary results

Model Summary[b]					
Model	R	R Square	Adjusted R square	Std. Error of the Estimate	Durbin-Watson
1	0.946	0.894	0.889	229.145	1.412
a. Predictors: (Constant), Damaged during harvesting (HR), Damaged due to diseases (DP), Damage due to insect (DI), Lack of proper cleaning and washing (SR), Damage during transportation (TP),					
b. Dependent variable: PHL					

The model summary (table 4) indicates what predictions are relevant for the R and R^2. The word constant in parenthesis refers to intercept. The coefficient of multiple determinations is 0.894. Adjusted R-square value in the model summary indicates that 89.4 per cent of the variation in the fresh produce PHL can be attributed to these five variables. From Table 4 it is inferred that R square value is greater than zero so we reject null hypothesis. The Durbin-Watson value is 1.412 represents that there is autocorrelation among the independent variables.

Conclusion and recommendations

Correlation analysis identified that 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.), lack of cleaning and washing, poor handling during loading and unloading) and dependent variable (PHL). Hence, by reducing the contribution of critical factors farmers can reduce high PHL of cauliflower. This results in improving farmer's performance in terms of profit and also provides quality produce to the consumers in the market. The present status of packaging of vegetable crops in Surat district of Gujarat is not suitable. Farmers are still using plastic bags for packing of cauliflower which causes loss during transportation. Strengthening and scaling up of the packaging sector is urgently needed. Manufacture of good quality and affordable packaging materials for perishables are need of the time.

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