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AN ECONOMETRIC ESTIMATION OF POST HARVEST LOSSES OF KINNOW IN PAKISTAN

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Abstract
This study was conducted to quantify the post-harvest losses of Kinnow at various stages of supply chain viz. farm, wholesale market and retail levels. A pretested questionnaires was used to collect data from 120 respondents selected randomly from district Sargodha, Pakistan. SPSS was used to for the descriptive statistics and multiple regression model analysis for econometric estimation. The findings revealed that estimated post-harvest losses at farm, wholesale market and retail levels were 72%, 25% and 3% of the total post-harvest losses of Kinnow respectively. Overall post-harvest losses were estimated as 45% of the total production in study area. The econometric estimation revealed that experience, picking time and picking method had significant effect on losses at farm level whereas experience, loading method, storage place showed significant effect on losses at wholesale market level and unsold quantity and type of retailers were the significant determinants of losses at retail level. The study suggests adopting a scientific approach to minimize losses. This is the first empirical study for the estimation of major determinants of post-harvest losses at transportation and retail level as well as farm level.

Keywords: Kinnow, Post-harvest losses, Transportation, Packaging, Estimation, Retail

INTRODUCTION

Citrus is the valued fruit of Pakistan and have number one place among all fruits both for area and production. Pakistan is among the top ten citrus producing countries of the world (Mahmood & Sheikh, 2006). At present, total acreage under citrus has recorded about 199940 hectares and production about 1832000 tones. Punjab has major share of about 96.5 percent in total production of citrus in Pakistan (Government of Pakistan [GOP], 2012).

Regardless of the significant growth of food production worldwide, around half of the population in the least developed countries does not have enough access to food (Food and Agriculture Organization [FAO], 1989). The production and marketing of citrus involves labour directly in the field and packing facilities and indirectly in transport-distribution. It also involves supplies and services such as agricultural inputs, transportation, grading, packaging, etc. (Guzman, 2004). Kinnow production in Pakistan is also exposed to the post-harvest losses during harvesting, handling, transportation, storage and distribution. Due to inadequate handling, transport and storage facilities and lack of technical expertise about 10-15 percent of fruit is wasted from tree to table (Farooq, Ahmad & Khalid, 1978). Major portion of post-harvest losses occur at three levels i.e. orchard, transportation and wholesaler's marketing and retailer's levels. At orchard level, losses are due to harvesting injuries, culled, brushes, insect damage, buttonholes and punchers. All the thrown away or discarded fruits at the orchards are treated as post-harvest loss (Gangwar, Singh & Singh, 2007).

Gangwar et al. (2007) reported that the aggregate post-harvest losses from orchard to consumers in Kinnow in two different and distant markets ranged from 14.84 percent in Delhi market to 21.91 percent in Bangalore market. Mahmood and Sheikh (2006) concluded that problems with Kinnow exports included low quality, lack of storage facilities, non-availability of quality packing, poor transportation facilities, high freights charges, weak role of export promoting agencies and inconsistent government policies. Leghari (2001) reported that in Pakistan, the magnitude of post-harvest losses of vegetables and fruits were about 35 percent. Srivastava (2002) stated that post-harvest losses estimated around 10 percent in food grains and 25-40 percent in fruits and vegetables, which was responsible for waste in terms of food as well as money. Ayandiji, Kehinde, Adeniyi and Omotosho (2009) reported the losses from harvest, market and transportation constituted 14.4 percent of the possible total revenue. Bari (2004) estimated the losses at farm, market and consumption level and reported as 38.6, 35.9 and 25.5 percent of the total losses and total post-harvest losses were 31 percent of the total production. Murthy, Gajanana, Sudha, Saxena and Dakshinamoorthy (2008) reported losses as 28.84 percent in the wholesale channel; comprising 5.53 percent at the field and assembly level, 6.65 percent at the wholesale level and 16.66 percent at the retail level. Basavaraja,

Mahajanshetti and Udagatti (2007) found that about 75 per cent of the total post-harvest losses occurred at the farm level and about 25 percent at the market level.

The review of available literature advocated that most of the studies (Basappa, Deshmanya and Patil(2001); Srivastava (2002); Bari (2004); Basavaraja et al. (2007); Gangwar et al. (2007); Murthy et al.(2007); Ayandiji et al. (2009) only estimate post-harvest losses rather to estimate the determinants of post-harvest losses at aggregate level. Not a single study in Pakistan tried to estimate the determinants of post-harvest losses at various levels of production and marketing. As such empirical estimation of major determinants of post-harvest losses at farm, transportation and wholesale market and retail market level was inevitable. So this study was conducted with the objective of estimating post-harvest losses in kinnow at farm, wholesale market and retail levels.

METHODOLOGY

Data Sources

Sargodha district was selected for the study due to its major share in the production of Kinnow i.e. about 47% of the total production in Pakistan (GOP, 2009). Two tehsils Bhalwal and Kot Moman were selected purposively to collect data. Twenty respondents from each tehsil at each level were selected randomly and according to their size of orchard following the criteria adopted by Ahmad (1989). Well-structured and pretested questionnaires including structured and unstructured questions were used to collect data. Personal interview method was employed to interact with respondents. Many difficulties including reluctance of respondents to reveal correct information were encountered but effort was made to collect real and true facts/information.

Analytical Framework

In order to estimate the losses, descriptive statistics (averages and frequency) was used, whereas impact of major determinants of citrus post-harvest losses was estimated by employing double log form of regression analysis. Most of the previous studies used descriptive analysis which mainly include Ayandiji et al. (2009); Gangwar et al. (2007); Murthy et al. (2007) etc. Only a few studies estimated econometric models to evaluate impact of major variables on post-harvest losses in fruits at producer/contractor level i.e. Bari (2004) and Basavaraja et al. (2007). In this study, an effort was made to estimate econometric models for post-harvest losses at three different levels (farm, wholesale market and retail levels). Therefore, the models for three different levels are as under:

Model at Farm level

$\text{Ln } L_1 = \beta_0 + \beta_1 \text{Ln } X_1 + \beta_2 \text{Ln } X_2 + \beta_3 \text{Ln } X_3 + \beta_4 D_1 + \beta_5 D_2 + \varepsilon$

Where

L_1 = post-harvest losses of Kinnow in Kg,

X_1 = Education in years,

X_2 = Experience in years,

X_3 = Orchard size in Acres,

D_1 = Dummy variable for picking time

D_1 = 1 if picking time is Morning,

D_1 = 0 if picking method is Evening,

D_2 = Dummy variables for picking method

D_2 = 1, if picked with scissor,

D_2 = 0, if picked manually,

ε = Disturbance term

β_0 is Constant term (intercept) and β_1, β_2, β_3, β_4, β_5 are the coefficients of estimates in the model.

Model at Wholesale Market level

$\text{Ln } L_2 = \alpha_0 + \alpha_1 \text{Ln } Y_1 + \alpha_2 \text{Ln } Y_2 + \alpha_3 D_3 + \alpha_4 D_4 + \alpha_5 D_5 + \mu$

Where

L_2 = Quantity of post-harvest losses in Kg,

Y_1 = Education in years,

Y_2 = Experience in years,

D_3 = Dummy variables for Infrastructure of transportation

D_3 = 1, if roads were metaled,

D_3 = 0, if roads were non-metaled),

D_4 = Dummy variable for loading method

D_4 = 1, if produce was loaded in boxes,

D_4 = 0, if produce was openly loaded,

D_5 = Dummy variable for storage place

D_5 = 1, if cold storage,

D_5 = 0, if normal storage,

μ = Disturbance term

α_0 is Constant term (intercept) and α_1, α_2, α_3, α_4, α_5, are the coefficients of estimates in the model.

Model at Retail Level

$\text{Ln } L_3 = \gamma_0 + \gamma_1 \text{Ln } Z_1 + \gamma_2 \text{Ln } Z_2 + \gamma_3 D_6 + e$

Where

L_3 = Quantity of post-harvest losses in Kg,

Z_1= Experience in years,

Z_2 = Unsold quantity on daily basis,

D_6 = Dummy variable for type of retailor

D_6 = 1, if respondents was a shopkeeper,

D_6 = 0, if respondent was a hawker,

e = Disturbance term

γ_0 is Constant term (intercept) and γ_1, γ_2, γ_3 are the coefficients of estimates in the model.

EMPIRICAL RESULTS AND DISCUSSION

Post-harvest Losses at various levels

Marketing of Kinnow involves picking, cleaning, standardization, grading, packing, transportation, loading/unloading and retailing. Kinnow post-harvest losses take place at all these stages. Total post-harvest losses of kinnow at farm level, wholesale market level and retail level were about 45 percent of the total production of kinnow in study area as shown in Table 1. The losses were highest at farm level i.e. 32.4 percent of the total produce of kinnow. Murthay et al. (2007) reported the similar post harvest losses (28.84%) in his study carried in Karnatka, India. Aujla (2007), Bari (2004), Srivastave (2002) and Lum (2001) also stated that post harvest losses in fruits and vegetables are about 25-40%. The losses were highest at farm level i.e. 32.4 percent of the total produce of kinnow. Major reasons of these losses were picking (19.6%), packing (3.5%), carrying (2.2%) and during loading and transportation (7.1%). Losses were also high due to low level of management in the orchards. Basavaraja et al. (2007) reported in his study that 75% losses were occurred at field level. Bari (2004) stated that about 39% mangoes were lost during harvesting and other activities at farm level. Mohyuddin (1998) estimated that 17-20% produce were lost during picking and Srivastave (2002) told that 25-40% losses occurred during grading, packaging and labeling. Wholesale market level losses were estimated as 11.2 percent of the total produce of kinnow. The major factors responsible for these losses include unloading and marketing (6.2%) and storage (5%). Murthay et al. (2007) estimated in his study that 58% losses were occurred at wholesale level (during transportation and marketing). Basavaraja (2007), Bari (2004) and Kader (1992) also reported post-harvest losses during transit and wholesale marketing were 20-25%, 35.9% and 10-40% respectively.

The establishment of small-size cold storage units in the production centers would help to reduce the storage losses (Begum, Hossain and Papanagiotou, 2012). Retail level losses were about 1.4 percent of the total produce of kinnow in the marketing channel. The reasons of losses were retail marketing (0.67%), unsold quantity on daily basis (0.69%) and type of retailer that is shopkeeper or hawker. These results are also similar to Gajananaet al. (2008) and Food and Fertilizer Technology Centre (1993).

Table 1: Percentage shares of farm, market and retail level losses in total produce and total losses of kinnow

Levels	Percentage share in total produce of kinnow	Percentage share in total losses of kinnow
Farm Level Losses	32.4	72
Wholesale Market Level Losses	11.2	24.9
Retail Level Losses	1.4	3.1
Total	45	100

Factors affecting Post-harvest Losses at various levels

At Farm Level

The results presented in Table 2 revealed that the overall fitness of the model is shown by the value of R square that is 40.6% i.e. about 40 percent of the total variations in the dependent variable was explained by the estimated explanatory variables. Coefficients show that all the variables have inverse relationship with losses except orchard size that has positive sign. The coefficient of experience revealed that for every one year increase in experience, there would be 22 percent reduction in post-harvest losses, keeping other factors constant. Education has negative relationship with post-harvest losses, keeping other factors constant but education was significant at a high level of significance i.e. 0.137. In case of orchard size, for every one acre increase in orchard size caused about 21 percent increase in post-harvest losses due to some management problems (picking, grading and packing) and climatic conditions (rainfall and temperature). When fruit was picked at morning, the losses were 0.276 times less than the losses occurred when fruit was picked at evening. If the fruit was picked with scissor, the losses are 0.477 times less than the losses with manual picking. Therefore, the picking time and picking method had significant effect on post-harvest losses of Kinnow at farm level. Picking with scissor and at morning caused less post-harvest losses than manual picking. Bari(2004), Gangwar et al.(2007); Murthay et al. (2007); Ragni and Berardinelli(2002), Mohyuddin (1998);

Leghari (2001) and Sarivastave (2002) also reported in their studies that picking time and picking method are very important regarding post-harvest losses of fruits.

Table 2: Results of the Multiple Regression Analysis at Farm Level

Variables	Coefficients	Std. Error	t-value	Sig.	Overall Fitness
(Constant)	3.839	0.590	6.507	0.000	R^2 = 0.406,
Ln X_1 (Education in Years)	-0.211	0.138	-1.526	0.137	
Ln X_2 (Experience in Years)	-0.222	0.108	-2.057	0.048	Adjusted R^2 = 0.315,
Ln X_3 (Orchard size in Acres)	0.214	0.074	2.878	0.007	
D_1 (Dummy for Picking Time)	-0.276	0.143	-1.936	0.061	F-value = 4.5 at 5% degree of freedom
D_2 (Dummy for Picking Method)	-0.477	0.218	-2.187	0.036	

Wholesale Market Level

The signs of the coefficients revealed that model was appropriate and value of R^2 shows that about 68% of the losses were caused by the variables. F value of the model as shown in Table 3 was about 14.48 at a significance level of 0.000.Education and infrastructure of transportation had not significantly effecting post-harvest losses of kinnow at wholesale market level. Experience, loading method and storage place had a significant effect. The coefficient of experience revealed that one percent increase in experience results in 27% reduction in post-harvest losses. The coefficient of education revealed that for every one percent increase in education level there would be 15 percent reduction in post-harvest losses but the level of significance of education is 0.191, which was very high. The coefficients of transport infrastructure, method of loading and storage place revealed that for every one percent increase in these variables there would be 59%, 55% and 56% reduction in post-harvest losses respectively. Use of metallic road for transportation of fruit causes losses 0.593 times less losses used for non-metallic road. Chances of losses during open loading are more because of pressing, injury etc. Liu (1990); Kader (1992); Bachmann and Earles (2000); Basappa et al. (2001); Bari (2004); Udas, Rai, Gurung, Thapa and Khatiwada (2005); Aujla, Abbas, Mahmood and Saadullah (2007); Chohan and Ahmad (2008) and Ayandiji et al. (2009) stated that means of transportation like vehicle, road infrastructure etc. plays major role in the post-harvest losses. As stacking of boxes had 0.555 times less losses than open loading. Cold storage, have fewer losses than normal storage. Cold storage had 0.562 times less losses than the normal storage. Previous studies like Adeoye, Odeleye, Babalola and Afolayan (2009); Basavarajaet al. (2007); Bari (2004); Leghari (2001); Kader (1992) and Asian Development Bank [ADB] (1990) also identified that better cold storage facilities decreases the post-harvest losses. So, the statistics

indicates that we should have good transportation infrastructure, modern technology for storage and improved handling techniques. The results of this model are also very near to previous studies like Murthay et al. (2007); Msogoya and Kimaro (2011); Sharma and Singh (2011).

Table 3: Results of the Multiple Regression Analysis at Wholesale Market Level

Variables	Coefficients	Std. Error	t-value	Sig.	Overall Fitness
(Constant)	4.808	0.461	10.437	0.000	R^2 = 0.68, Adjusted R^2 = 0.63, F-value = 14.48 at 5% degree of freedom
Ln Y_1 (Education in Years)	-0.154	0.115	-1.335	0.191	
Ln Y_2 (Experience in Years)	-0.272	0.140	-1.944	0.060	
D_3 (Dummy for Infrastructure of transportation)	-0.593	0.390	-1.521	0.137	
D_4 (Dummy for Loading Method)	-0.555	0.273	-2.031	0.050	
D_5 (Dummy for Storage Place)	-0.562	0.293	-1.916	0.064	

At Retail Level

The R^2 revealed that 62% of the losses at retail level were caused by these factors as depicted by Table 4. The overall F value of the model was 18.74 and this shows that model was appropriate. Experience of retailer had coefficient value of -0.08, which mean that one percent increase in experience cause 0.08 percent decrease in post-harvest losses but this value is not significant as significant level is 0.46. Therefore, experience is no significant at retailer level. Retailer's business is run on daily basis i.e. they purchased and then sale out fruits daily. Therefore, the unsold quantity on daily basis causes great post-harvest losses to retailers. Results shows that when there is one percent increase in unsold quantity causes 0.26 percent increase in post-harvest losses. In addition, this coefficient has significant at 6 percent level of significant. Liu (1990), FFTC (1993) and Bari (2004) also indicate that unsold quantity was lost daily and also retailers don't have enough resources to store their unsold commodity. Retailer type is also an important factor causing post-harvest losses. There are two types of retailers one are small shopkeepers and second are hawkers. Post-harvest losses were high in case of hawker than shopkeepers. When the retailer type is shopkeeper, the losses are 1.32 times less than that of hawker retailer type.

Losses at retailer level are obvious because he is unaware about the daily sales and he buys fruit according to their experience and bears losses in shape of unsold quantity. Retailers should have their own shop to get good returns. Here is the proposed marketing channel for Kinnow which is simple and effective.

Table 4: Results of the Multiple Regression Analysis at Retail Level

Variables	Coefficients	Std. Error	t-value	Sig.	Overall Fitness
(Constant)	0.453	0.317	1.429	0.162	R^2 = 0.62,
Ln Z_1 (Experience in Years)	-0.080	0.108	-0.738	0.466	Adjusted R^2 = 0.59,
Ln Z_2 (Unsold quantity in Kgs)	0.259	0.135	1.921	0.063	
D_6 (Dummy variable for type of retailer)	-1.320	0.266	-4.959	0.000	F-value = 18.74

CONCLUSION

Total post-harvest losses of kinnow at farm, wholesale market and retail level were 45 percent of the total produce. Losses at farm level were maximum i.e. 32.4 percent of the total produce and 72 percent in total losses in kinnow. At farm level, experience of the respondents, picking time and picking method were statistically significant while education had non-significant impact on post-harvest losses. Orchard size had significant but had positive sign of coefficient showing inverse relationship with losses. At wholesale market level, experience, loading method and storage place had significant impact on losses while education and infrastructure of transport had non-significant impact. At retail level, unsold quantity and type of retailer had significant and experience was non-significant. The limitation of the study is that it was carried out in one tehsil and should be done in all Kinnow districts of Pakistan. Also a detailed analysis is required on wholesale market and retail levels. These huge losses are due to improper and poor harvesting and handling techniques, marketing inefficiencies, lack of infrastructure and delayed marketing of kinnow. This study suggests by adopting some scientific approaches like modern harvesting methods, improved storage and handling facilities, healthy extension services and producer's cooperatives to undertake all the activities of production, harvesting and marketing of kinnow to minimize post-harvest losses and to fetch maximum gains.

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