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Economic Analysis of Post-harvest Losses in Food Grains in India: A Case Study of Karnataka

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Abstract

The post-harvest losses have been estimated at different stages in two major food grains, viz. rice and wheat in India. The time series data from 1982-83 to 2001-02 on area, production and productivity of the selected food grains have been subjected to growth rate analysis. The post-harvest losses have been estimated using the survey data collected from 100 farmers, 20 wholesalers, 20 processors and 20 retailers in each crop in Karnataka for the year 2003-04. Tabular analysis has been used to estimate the post-harvest losses at different stages, and functional analysis has been used to assess the influence of socio-economic factors on post-harvest losses at the farm level.

The increase in rice production in the study district of Shimoga has been mainly from increased area under rice. The increased rice output at the state level is the result of increased productivity and area, while at the national level it is the rise in productivity. The increased wheat output in the country has been due to increased wheat productivity. The post-harvest losses at the farm level have been estimated to be 3.82 kg/ q for rice and 3.28 kg/q for wheat. The losses have been highest during storage in both the crops. The factors that influence the post-harvest losses significantly at the farm level have been identified and some policy implications have been highlighted.

Introduction

Agricultural commodities produced on the farm fields have to undergo a series of operations such as harvesting, threshing, winnowing, bagging, transportation, storage, processing and exchange before they reach the consumer, and there are appreciable losses in crop output at all these stages.

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A recent estimate by the Ministry of Food and Civil Supplies, Government of India, puts the total preventable post-harvest losses of food grains at 10 per cent of the total production or about 20 Mt, which is equivalent to the total food grains produced in Australia annually. In a country where 20 per cent of the population is undernourished, post-harvest losses of 20 Mt annually is a substantial avoidable waste. According to a World Bank study (1999), post-harvest losses of food grains in India are 7-10 per cent of the total production from farm to market level and 4-5 per cent at market and distribution levels. For the system as a whole, such losses have been worked out to be 11-15 Mt of food grains annually, which included 3-4 Mt of wheat and 5-7 million tonnnes of rice. With an average per capita consumption of about 15 kg of food grains per month, these losses would be enough to feed about 70-100 million people, i.e. about 1/3rd of India's poor or the entire population of the states of the Bihar and Haryana together for about one year. Thus, the post-harvest losses have impact at both the micro and macro levels of the economy.

Karnataka is one of the top ten states producing food grains in India. It is blessed with ten agro-climatic zones suitable for growing a variety of food grains round the year. The state has a gross cultivated area of 12.35 Mha. Rice, sorghum, maize, and wheat are the major cereals grown in the state. The total area under cereal crops has increased from 5.4 Mha in 1990-91 to 5.6 Mha in 2000-01. The production of cereal crops has also gone up from 7.1 Mt in 1990-91 to 9.9 Mt in 2000-01. Based on the triennium 1998-99 to 2000-01, average area under food grains has grown in Karnataka; two major food grains, namely rice and wheat have been selected for the study. During the TE 2000-01, rice was grown on 1.48 Mha and wheat on 0.31Mha in the state. These two food grains together accounted for 31.97 per cent of the area under cereal crops in the state.

The study on post-harvest losses in food grains at different stages of their handling would help assess the extent and magnitude of losses and identify the factors responsible for such losses. This in turn would help develop proper measures to reduce these losses. Evolving correct policies for minimizing post-harvest losses would crucially depend on reliable and objective estimates of such losses at different stages. This information is important for scientists, technologists, policymakers, administrators and industrialists. The specific objectives of the present study were:

(i) to estimate the growth pattern of food grains in India,

(ii) to measure the extent of post-harvest losses in food grains at different stages, and

(iii) to study the factors affecting post-harvest losses at farm level.

Methodology

The study has utilized both time series and cross-sectional data. To study the growth rates in area, production and productivity of food grains, time series data were collected for the period 1982-83 to 2001-02 from the Directorate of Economics and Statistics and the District Agriculture Offices. The cross-sectional data were obtained from the survey of sample cultivators of food grains and various market intermediaries through personal interview with the help of pre-tested and structured schedules for the agricultural year 2003-04 (June to May). The data collected from the farmer respondents included general information about the cultivation of food grains, methods of harvesting, and drying, place of drying, mode of packaging, storage system, mode of transportation and losses during post-harvest operations. A separate schedule was developed and used for eliciting information from market intermediaries who deal in food grains. This included information on quantity purchased, mode of transport, storage, and purchase and quantity marketed.

Sampling

A multi-stage sampling design was adopted for the ultimate selection of foodgrain-growing farmers. The Shimoga district (Karnataka) with a rice area of 156,364 ha (10.54 %), out of the total rice area of 1,483,448 ha in the state topped the list of rice-growing districts. Hence, this district was selected for choosing rice-growing cultivators in the preliminary stage of sampling. For wheat, Dharwad district with an area of 58,411 ha (18.53%) out of the total wheat area of 315,223 ha in the state stood first in the state. Hence, it was considered for selecting wheat-growing cultivators in the first stage of sampling. In the second stage, two talukas were chosen from each of the selected districts and then five villages predominantly growing the selected food grains were chosen from each of the selected talukas. Finally, 10 foodgrains-growing farmers in each village were randomly interviewed. In all, 100 cultivators growing rice in Shimoga district and 100 cultivators growing wheat in the Dharwad districts were selected at the rate of 50 farmers from each taluk. From each of the selected districts, 20 wholesalers, 20 processors and 20 retailers dealing in each of these crops were also interviewed for eliciting information on post-harvest losses.

Analytical Techniques

For computing the growth in area, production and productivity of selected food grains, compound growth equation of the form $Y = ab^T$ was estimated. Averages and percentages were used to compute the post-harvest losses. Information about post-harvest losses was obtained from the farmers during

following operations: (i) harvesting, (ii) threshing, (iii) cleaning/winnowing, and (iv) drying.

The information on following losses was collected from the farmers as well as market intermediaries: (i) storage, and (ii) transit. The total post-harvest losses were estimated as a sum of all these losses.

Functional analysis was carried out to examine the factors affecting post-harvest losses at farm level in food grains, as used by Nag *et al*. (2000) in chickpea. The following multiple linear regression function was specified in the present study:

$$Y = a_0 + a_1X_1 + a_2X_2 + a_3X_3 + \ldots\ldots\ldots\ldots\ldots\ldots + a_{11}X_{11} + e$$

where,

Y = Post-harvest losses of rice/wheat at farm level in quintals per ha
X_1 = Age of the respondents in years
X_2 = Education of the respondents in years
X_3 = Total production of rice/wheat in quintals
X_4 = Area under rice/wheat (ha)
X_5 = Area under irrigation (ha)
X_6 = Area under commercial crops (ha)
X_7 = Storage dummy which takes the value '0' if the storage facility was adequate and value '1' otherwise
X_8 = Weather dummy which takes the value '0' if the weather during harvesting was favourable and value '1', otherwise
X_9 = Transportation dummy which takes the value '0' if transport facility was adequate and value '1' otherwise
X_{10} = Threshing machine dummy which takes the value '0' if availability of threshing machine during harvesting was adequate, '1', otherwise
X_{11} = Labour dummy which takes the value '0' if the labour availability during harvesting was adequate and value '1', otherwise.
e = Random-error

Growth in Area, Production and Productivity of Rice and Wheat

To examine the temporal production pattern of rice and wheat, the growth analysis was conducted with respect to their area, production and productivity in the study districts, state and country. The area under rice in the Shimoga district registered a positive annual growth of 1.69 per cent (Table 1) and the production increased at a moderate rate of 0.87 per cent annually. However, the productivity witnessed a mild declining annual growth of -0.81 per cent. Thus, in the study district, increase in rice production was

Table 1. Growth in area, production and productivity of rice and wheat: 1982-83 to 2001-02

S. No.	Particulars	Rice			Wheat		
		Shimoga district	Karnataka state	India	Shimoga district	Karnataka state	India
1	Area	1.69	1.34	0.62	-1.42	-1.23	1.67
2	Production	0.87	2.88	1.90	0.61	0.83	3.81
3	Productivity	-0.81	1.51	1.27	2.24	2.08	2.11

mainly from increased area under rice. At the state level, the area, production and productivity showed a positive annual growth of 1.34 per cent, 2.88 per cent and 1.51 per cent, respectively. At the all-India level, the area, production and productivity showed a positive annual growth of 0.62 per cent, 1.90 per cent and 1.27 per cent, respectively. This implied that the increased rice output in the state had resulted from the increased productivity and area under its cultivation, while at the national level, it was the productivity that had led to growth in the production. The increased demand for rice coupled with better rice prices in the recent years might have encouraged the farmers to allocate more area to rice.

The area under wheat in the study district had registered a moderate declining annual growth of –1.42 per cent, while the production showed a mild increasing growth of 0.61 per cent annually. The productivity witnessed an increasing growth of 2.24 per cent every year. At the state level, similar trends were observed with respect to area (-1.23%), production (0.83%) and productivity (2.08%). At the national level, the compound growth rates for area (1.67%), production (3.81%) and productivity (2.11%) were positive. The increase in production of wheat in the study district, at the state level and at the national level might be due to the encouraging productivity growth of wheat on account of use of high-yielding varieties by farmers in the study area and adoption of improved cultivation practices.

Estimated Post-harvest Losses in Rice and Wheat

The survey data revealed that average size of farm holding was 5.00 ha for rice growers, and 6.24 ha for wheat growers. The sample farmers were found growing rice over an area of 2.50 ha and wheat over 2.25 ha. These sample farmers obtained an average yield of 43.96 q/ha of rice and 13.70 q/ha of wheat. A majority of rice-growers (44.00%) and wheat-growers (52.00%) belonged to middle age group of 35-50 years. The proportion of illiterate farmers in the sample was 19.67 per cent for rice cultivators and 21.67 per cent for wheat cultivators.

Estimation of Post-harvest Losses

Farm Level Losses

The estimated post-harvest losses per quintal of food grains produced or handled at different stages are presented in Table 2. These were estimated to be 3.82 kg/q in rice and 3.28kg/q in wheat at the farm level. These losses were maximum due to faulty storage (1.20 kg/q in rice and 0.95 kg/q in wheat) in both the crops. Important factors leading to storage losses were (i) non-availability of separate godowns for storage, (ii) poor storage structures, (iii) presence of rodents, insects and dampness, and (iv) improper drainage at storage places. The grain losses during the threshing activity were estimated to be 0.52 kg/q in rice and 0.44 kg/q in wheat. The threshing losses were mainly in the form of broken grains, which were slightly higher, when the produce was threshed by machine as compared to manual

Table 2. Estimated post-harvest losses at different stages in rice and wheat : 2003-04

Stages	Rice		Wheat	
	Loss (kg/q)	Loss (%)	Loss (kg/q)	Loss (%)
I Farm level losses				
• Harvesting	0.40	7.70	0.36	8.33
• Threshing	0.52	10.02	0.44	10.19
• Cleaning/Winnowing	0.20	3.85	0.14	3.24
• Drying	0.80	15.41	0.66	15.28
• Storage	1.20	23.11	0.95	21.99
• Transportation	0.50	9.63	0.51	11.81
• Packaging	0.20	3.85	0.22	5.09
Total losses at farm level	3.82	73.57	3.28	75.93
II Wholesale level losses				
• Storage	0.12	2.31	0.08	1.85
• Transit	0.17	3.27	0.12	2.78
Total losses at wholesale level	0.29	5.59	0.20	4.63
III Processor level losses				
• Storage	0.01	0.17	0.01	0.19
• Transit	0.01	0.15	0.01	0.14
• Grain scattering	0.01	0.10	0.01	0.14
Total losses at processor level	0.03	0.42	0.03	0.46
IV Retailer level losses				
• Storage	0.53	10.21	0.41	9.49
• Transit	0.32	6.16	0.25	5.79
• Handling	0.21	4.04	0.16	3.70
Total losses at retailer level	1.06	20.42	0.82	18.98
Total post-harvest losses	5.19	100.00	4.32	100.00

threshing. The threshing losses were still higher when power threshers were used. However a majority of the producers preferred power threshers due to their cost and time advantage

The losses due to drying operation in grains were estimated to be 0.80 kg/q in rice and 0.66 kg/q in wheat. These were mainly due to use of traditional methods of drying by the farmers. The grain losses as a result of faulty transportation were estimated to be 0.50kg/q in rice and 0.51 kg/q in wheat. A majority of the producers used bullock carts and tractors to transport the produce to different market places. The losses were noticed during loading and unloading of produce during transportation.

Grain losses during harvesting were estimated to be 0.40kg/q in rice and 0.36 kg/q in wheat. These losses were mainly due to shedding of grains. The amount of losses depended on the crop stage and time of harvesting. The losses during cleaning/winnowing operation were estimated to be 0.20 kg/q in rice and 0.14 kg/q in wheat. The packing losses were estimated to be 0.20 kg/q in rice and 0.22 kg/q in wheat. Atibudhi (1997) has revealed the total post-harvest losses at farm level in onion as 13.75 per cent of the total output.

The average post-harvest losses per farm were estimated at 4.20 quintals for rice and 1.01 quintals for wheat. The average losses per ha worked out to be 1.68 quintals for rice and 0.45 quintals for wheat. Nag *et al*. (2000) have reported that post-harvest losses in chickpea were 6.97 per cent of production.

Market Level Losses

The total post-harvest losses at wholesaler level were 0.29 kg/q in rice and 0.20 kg/q in wheat. The storage losses in rice and wheat at the wholesaler level were 0.12 kg/q, and 0.08 kg/q, respectively. The other component of post-harvest losses at this stage was transit losses of 0.17 kg/q in rice and 0.12 kg/q in wheat. The transit losses were more because of the use of unsuitable transport containers, negligent driving and rough roads.

The quantity of food grains handled by each processor worked out to be 68178 quintals of rice and 85775 quintals of wheat. The post-harvest losses at the processor level were negligible (0.03 kg/q) at less than one per cent of the quantity handled in both the food grains. On an average, each retailer handled 280 quintals of rice and 120 quintals of wheat in a year. The post-harvest losses at the retail level were 1.06 kg/q in rice and 0.82 kg/q in wheat. The transit loss was 0.32 kg/q in rice and 0.25 kg/q in wheat. The losses due to spoilage and multiple-handling of produce during retailing were 0.21 kg/q in rice and 0.16 kg/q in wheat. The post-harvest losses at the retailer level due to storage were 0.53 kg/q in rice and 0.41 kg/q in wheat.

Total Post-harvest Losses in Food Grains

The total post-harvest losses worked out to be 5.19 kg/q in rice and 4.32 kg/q in wheat. The losses were maximum at the farm level (3.82 kg/q in rice and 3.28 kg/q in wheat) accounting for 73.57 per cent and 75.93 per cent of the total post-harvest losses, respectively. The market level losses were 5.59 per cent in rice and 4.63 per cent in wheat of total post-harvest losses. The losses at processor level were less than 0.50 per cent of the total losses. The losses at retail level were 20.42 per cent in rice and 18.98 per cent in wheat. The post-harvest losses were relatively more at retail than at wholesale level. Hence, proper storage arrangements at retail level are needed.

Factors Affecting Post-harvest Losses at Farm Level

To study the influence of different socio-economic features of farmers on post-harvest losses at the farm level, a multiple linear regression analysis was carried out. The estimated regression coefficients are presented in Table 3. The variations in 11 independent variables included in the regression model explained nearly 72 per cent variations in the total post-harvest losses in rice and 76 per cent in the case of wheat. The F-ratio was significant in both the cases, indicating thereby the good fit of the regression models. Except for the variables of age and education of the farmers, a positive association was hypothesized between dependent variable and other independent variables. The regression coefficients of all the variables, except age, education, transport dummy and threshing machine dummy were positive, as postulated in the model for rice. A negative influence of age and education on the dependent variable was noticed. Thus, the coefficients of nine variables out of eleven included in the model were in conformity with the postulated hypotheses. The post-harvest losses were positively and significantly conditioned by total production of rice, area under rice, area under irrigation, area under commercial crops and weather dummy. These losses in rice increased with increase in output, adverse weather conditions, and the areas under commercial crops and irrigation. The post-harvest losses were negatively associated with age and education of the farmers.

In the case of wheat, contrary to the anticipation, the coefficients of the proportion of area under wheat, area under irrigation, threshing machine dummy and labour dummy exerted a negative influence on the dependent variable. Thus, in four out of eleven variables, the coefficients did not support the hypothesized relation between dependent and independent variables. However, none of these contradicting coefficients was significant. The

Table 3. Factors affecting post-harvest losses in rice and wheat at farm level

Explanatory variables	Rice		Wheat	
	All	Step-down	All	Step-down
Intercept	4.3794	3.7000	1.3997	1.2021
	(0.418)	(0.327)	(0.884)	(0.720)
Age of the respondent (X_1)	-0.1062	-	-0.0130	-
	(0.064)		(0.018)	
Education of the respondent (X_2)	-0.1277**	-0.1311**	-0.0652**	-0.0663**
	(0.043)	(0.035)	(0.017)	(0.014)
Total production of the crop (X_3)	0.0187**	0.0218**	0.0006	-
	(0.006)	(0.006)	(0.008)	
Area under the crop (X_4)	0.0042*	-	-0.0021	-
	(0.002)		(0.008)	
Area under irrigation (X_5)	0.0040**	0.0504**	-0.0016	-
	(0.001)	(0.005)	(0.008)	
Area under commercial crops (X_6)	0.0056**	1.3386**	3.42E-05	-
	(0.003)	(0.245)	(0.0004)	
Storage dummy (X_7)	0.0551	-	0.1107**	0.1146**
	(0.157)		(0.031)	(0.026)
Weather dummy (X_8)	0.0940*	0.1885**	0.0178	0.1885**
	(0.0309)	(0.081)	(0.028)	(0.081)
Transportation dummy (X_9)	-0.1365	-	0.0003	-
	(0.267)		(0.029)	
Threshing machine dummy (X_{10})	-0.2420		-0.0085	-
	(0.115)		(0.024)	
Labour dummy (X_{11})	0.1506	0.2659**	-0.0085	-
	(0.086)	(0.080)	(0.024)	
R^2	0.72**	0.62**	0.76**	0.70**
F-value	9.07	18.30	12.57	14.58
$\bar{R}^2$	0.46	0.34	0.52	0.47

Note : Figures within the parentheses are standard errors of coefficients
** Level of significance $p<0.01$
* Level of significance $p<0.05$

coefficients of age and education of the respondents were negative, as anticipated. The step-down regression analysis showed that the post-harvest losses in wheat were associated significantly and positively with weather and storage dummies and negatively with education. These could be reduced thorough proper storage methods.

Conclusions and Policy Implications

The study has estimated post-harvest losses in two major food grains, viz. rice and wheat. It has been found that about 75 per cent of the total post-harvest losses occurr at the farm level and about 25 per cent at the market level. The post-harvest losses at farm level have been observed as 1.68 q/ha in rice and 0.45 q/ha wheat. On per farm basis, these have been estimated to be 4.20 quintals in rice and 1.01 quintals in wheat. The storage losses at different stages have added up to about 35.80 per cent of the total post-harvest losses in rice and 33.52 per cent in wheat, while harvesting and threshing operations together have accounted for about 17 per cent of total losses in both the crops. Transit losses at different levels have been important component of post-harvest losses, contributing to about 20 per cent of the total losses. The functional analysis has revealed that education level of farmers and bad weather conditions influence the post-harvest losses significantly at farm level in both the food grains, while inadequate availability of labour and faulty storage method influence the post-harvest losses positively and significantly in rice and wheat, respectively. Educating and training the farmers on post-harvest operations would greatly help in reducing the post-harvest losses in food grains. The establishment of small-size cold storage units in the production centres would help reduce the storage losses. In this direction, the zero energy cool chambers technology developed by the Indian Council of Agricultural Research needs to be popularized.

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