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# **Pre-and Post Harvest Losses of Pigeon pea in Maharashtra**

**Deepak Shah\***

## **Introduction**

India at present is passing through a complex type of situation due to crop diversification witnessed during 1980s and 1990s and change in the nature of demand for agricultural commodities during 2000s, both in the domestic and foreign markets. The changes witnessed during the last three decades have led to specialized system of commodity production, which, in turn, has resulted in loss of area under traditional crops. The developments witnessed in recent past have also caused widespread prevalence of pests and diseases and consequent use of higher amount of pesticides to raise the productivity of crops. The increased use of pesticides has also resulted in developing insects and disease resistance, which further led to reduction in crop yield. Almost all the foodgrain crops cultivated across states in the country are seen to have been affected by such measures. Despite various policy measures initiated in more recent times, sustainability of foodgrain production system still remain an issue that need to be taken cognizance of as pre-and post harvest losses account for substantial share in crop production. The post harvest losses may occur on account of several reasons. The leakages between production and consumption include loss of grains before harvesting of crop as well as during various post harvest operations viz. threshing, cleaning, winnowing, drying, storage, transportation, packaging, etc. (Shah, 2009). The losses of grain may also occur due to destruction by pests, losses on account of damage caused by mechanical agents such as birds, animals, hailstorms, rains, over drying, shattering in the fields during harvesting, rodents, mites and insects, changes in moisture content, dust and broken grains, reduction in germination power, loss of palatability, heating and caking, etc. (Chakravarti, 1970; Singh, 1974; Birewar, 1984; Swaminathan, 1977). These sources of leakage between production and consumption of foodgrains, therefore, not only include wastage of grains during various post-harvest operations but also at the stage of harvesting (Boxall et. al. 1979). This coupled with substantial loss of grain before harvesting operation lead to reduction in net availability of grain for human consumption.

The state of Maharashtra, which cultivates a significant production volume of pulses in the country mainly in dryland area under rainfed conditions, is seen to have witnessed low yield levels of pulses due to severe abiotic and biotic stresses, aside from loss of crop during various post-harvest operations. The present study, therefore, makes a comprehensive attempt to estimate the dimension of losses occurring during the pre- and post harvest stages of pigeon pea among pulses cultivated in the state of Maharashtra.

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## **Data and Methodology**

The study was carried out in two districts of Maharashtra, which belonged to different agro-climatic regions of the state. Based on higher allocation of area under pigeon pea, the districts of Yavatmal and Latur were selected for primary data collection. The district of Latur falls under assured rainfall zone and belongs to Marathwada region of Maharashtra. It is one of the major pigeon pea producing districts of Maharashtra. The district of Yavatmal falls under moderate rainfall zone and belongs to Vidarbha region of Maharashtra. It is also one of the major pigeon pea producing districts of Maharashtra. From each of the selected sampled districts for pigeon pea crop, one Taluka was selected based on higher area allocation under the reference crop. A further stratification included selection of two villages from each Taluka/ district for canvassing the questionnaire with one nearby the market/ mandi centre and one far off from the market centre subject to the condition that they should be having sufficient area allocation under pigeon pea crop. The villages of Kolora (Near) and Chikhli (Far) were selected from the Taluka of Ner from Yavatmal district. Similarly, the villages of Nagarsoga (Near) and Manglur (Far) were selected from the Taluka of Ausa from Latur district.

In this study, it was decided to select a sample of 30 farmers from each of the selected four sampled villages belonging to two districts of Maharashtra. Therefore, a complete enumeration of the four selected villages drawn from the districts of Yavatmal and Latur was done with view to further categorization of farmers into marginal (less than 1 hectare), small (1 to 2 hectares), medium (2-4 hectares) and large (above 4 hectares). The probability proportion to sample size technique was used for further selection of farmers under each of the land holding size category from the selected villages. The number of farmers from four villages of Yavatmal and Latur districts encompassed 27 in marginal category, 54 in small, 29 in medium and 10 in large category with a sum of 120 farmers drawn from the districts of Yavatmal and Latur.

## **Empirical Findings**

The empirical findings of this paper mainly revolve around evaluating land use and cropping pattern of sampled farmers, incidences of pests and disease attack and crop loss, and extent of losses of crop during harvesting and post harvest operations viz. threshing, winnowing, transportation, handling and storage. The findings also cover suggestions of the households regarding minimization of pre-and post harvest losses.

### **Land Use and Cropping Pattern**

The estimates relating to the magnitude of owned land, net operated area (NOA), irrigated area and sources of irrigation are shown in Table 1. The estimates clearly show that only 40 per cent of the net operated area of sampled farmers was under assured irrigation and the rest was rainfed area. The open well irrigation system dominated on the farms belonging to pigeon pea crop farmers. The average category of pigeon pea crop cultivators showed 71 per cent of their

total irrigated area under open well irrigation, 18 per cent under electric tube-well irrigation, 6 per cent under diesel tube-well irrigation, 4 per cent under canal plus tubewell irrigation and 1 per cent under canal irrigation.

**Table 1: Operational Holdings (acres per household) and sources of irrigation for pigeon pea Farmers**

Farm size	Owned land	NOA	Irrigated area	Sources of irrigation (% of irrigated area)				
				Only canal	Canal + tube-well	Only electric tube-well	Only diesel tube-well	Open well
Marginal	2.12	2.04	0.76	13.41	-	36.59	9.76	40.24
Small	4.24	4.06	1.60	-	11.59	28.41	5.80	54.20
Medium	7.84	7.59	3.29	-	-	10.99	7.33	84.68
Large	18.05	16.10	5.00	-	-	8.00	-	92.00
Total	5.78	5.45	2.10	1.09	3.97	18.43	5.55	70.96

It is to be noted that the cropping pattern of irrigated area differs from the cropping pattern of un-irrigated area. While on one hand, high value commercial field crops are usually grown under irrigated conditions, low value subsistence crops, on the other hand, find place under rainfed conditions. However, there are several important coarse cereal, pulses and oilseed crops like *jowar*, *mung*, *tur*, *soyabean*, etc. that find place in terms of output and area allocation even under dry or rainfed conditions. The information on proportion of GCA allocation under different crops grown under different seasons by the sampled pigeon pea cultivators is provided in Table 2.

**Table 2: Cropping Pattern of Selected Pigeon pea Farmers (% of GCA for the whole year)**

(in per cent)

Category	% of Gross Cropped Area for the whole year												
	Kharif crops						Rabi crops				Perennial crops		
	Pigeonpea	Soybean	Cotton	Jowar	Others	Total	Wheat	Gram	Others	Total	Sugarcane	Others	Total
Marginal	28.36	24.65	3.38	6.38	13.83	76.60	0.71	9.22	12.05	21.98	1.42	-	1.42
Small	19.07	26.01	20.15	6.16	10.03	81.42	5.09	6.06	3.13	14.28	4.30	-	4.30
Medium	16.38	25.57	17.56	9.10	7.46	76.07	9.01	6.92	3.09	19.02	3.46	1.45	4.91
Large	13.54	48.99	12.10	7.49	7.22	89.34	3.17	4.03	1.16	8.36	2.31	-	2.31
Total	17.72	30.88	15.90	7.52	8.84	80.86	5.65	6.20	3.48	15.33	3.29	0.52	3.81

Note: Others under 'Kharif Crops' include mung, udid, sunflower, rice, bajra, sesame. Groundnut, maize and vegetable; under 'Rabi Crops' include jowar and sunflower; under 'Perennial Crops' include banana and Lucerne

The cropping pattern of sampled pigeon pea crop cultivators was seen to be in favour of cultivating pigeon pea, soyabean, cotton, jowar, mung, udid and sunflower in kharif season and wheat, gram and jowar in rabi season. Sugarcane, banana and Lucerne were cultivated as perennial crops by pigeon pea crop cultivators. The average category of pigeon pea crop cultivators showed 81 per cent of gross cropped area under kharif crops, 15 per cent under rabi crops and 4 per cent under perennial crops. Pigeon pea crop, in particular, showed 18 per cent share in gross cropped area of pigeon pea crop cultivators. In general, proportion of GCA under pigeon pea declined with the increase in land holding size of farmers.

#### **Incidences of Pests and Disease Attack and Crop Loss**

The sampled pigeon pea crop cultivators were able to assess the severity of pests and disease attack on their pigeon pea crop, and 8 per cent among them could assess the severity quantitatively, 65 per cent assessed it qualitatively, and the remaining 27 per cent could do both

quantitative and qualitative assessment in this respect. The perceptions of sampled pigeon pea crop cultivators regarding incidence of prevalence of pests and diseases, and also weed attack were recorded, and their perceptions with respect to severity, frequency of attack and loss of production of crop are brought out in Table 3.

**Table 3: Incidence of major pests and disease (percentage of households) – Pigeon pea**

Name of the pest/disease/weed	Rank of severity*			Frequency of attack**			Production loss***				
	1	2	3	1	2	3	1	2	3	4	5
<b>Major Pests – Local variety</b>											
Pod Borer	80.00	20.00	-	93.33	6.67	-	66.67	6.67	6.67	13.33	6.67
Plume Moth	-	-	-	-	-	-	-	-	-	-	-
Stem Fly	-	-	-	-	-	-	-	-	-	-	-
Tur Pod Fly	80.00	20.00	-	60.00	20.00	20.00	80.00	20.00	-	-	-
Aphids	100.00	-	-	100.00	-	-	100.00	-	-	-	-
<b>Major Pests - HYV variety</b>											
Pod Borer	60.87	35.87	3.26	81.52	18.48	-	27.17	25.00	35.87	10.87	1.09
Plume Moth	-	100.00	-	50.00	50.00	-	50.00	50.00	-	-	-
Stem Fly	-	100.00	-	37.50	50.00	12.50	62.50	37.50	-	-	-
Tur Pod Fly	64.00	36.00	-	84.00	12.00	4.00	76.00	24.00	-	-	-
Aphids	61.90	19.05	19.05	57.14	38.10	4.76	66.67	19.05	9.52	4.76	-
<b>Major Diseases – Local variety</b>											
Leaf Spot	33.33	66.67	-	100.00	-	-	66.67	-	-	-	33.33
Dry root rot	85.71	14.29	-	42.86	57.14	-	28.57	71.43	-	-	-
Fusarium Wilt	100.00	-	-	100.00	-	-	-	100.00	-	-	-
Powdery mildew	-	-	-	-	-	-	-	-	-	-	-
Sterility mosaic Disease	-	-	-	-	-	-	-	-	-	-	-
Yellow mosaic	100.00	-	-	-	100.00	-	-	-	-	-	100.00
<b>Major Diseases – HYV variety</b>											
Leaf Spot	28.85	65.38	5.77	46.15	48.08	5.77	65.38	28.85	5.77	-	-
Dry root rot	60.78	31.37	7.84	80.39	19.61	0.00	23.53	74.51	1.96	-	-
Fusarium Wilt	80.00	20.00	-	60.00	33.33	6.67	40.00	60.00	0.00	-	-
Powdery mildew	-	-	-	-	-	-	-	-	-	-	-
Sterility mosaic Disease	50.00	50.00	-	50.00	50.00	-	-	100.00	-	-	-
Yellow mosaic	33.33	66.67	-	50.00	50.00	-	66.67	33.33	-	-	-
<b>Major Weeds – Local variety</b>											
Spreading dayflower	12.50	87.50	-	87.50	12.50	-	25.00	50.00	25.00	-	-
Large crabgrass	41.67	58.33	-	91.67	8.33	-	50.00	25.00	25.00	-	-
Crowfoot grass	33.33	66.67	-	100.00	-	-	55.56	33.33	11.11	-	-
<b>Major Weeds – HYV variety</b>											
Spreading dayflower	25.00	61.36	13.64	81.82	18.18	-	65.91	29.55	4.55	-	-
Large crabgrass	28.77	60.27	10.96	76.71	23.29	-	63.01	35.62	1.37	-	-
Crowfoot grass	33.33	64.10	2.56	89.74	10.26	-	35.90	61.54	2.56	-	-
Indian heliotrope	18.60	72.09	9.30	93.02	6.98	-	39.53	53.49	6.98	-	-

Note: \* very important=1; important=2; not important=3

\*\* every season=1; once in two seasons=2; once in three seasons=3

\*\*\* <5%=1; 5-10%=2; 10-25%=3; 25-50%=4; >50%=5

An analysis with respect to perceptions of sampled pigeon pea crop cultivators regarding incidence of major pests and disease revealed that Pod Borer in the case of local variety and Pod Borer as well as Tur Pod Fly and Aphids for HYV variety were the major pests affecting their pigeon pea crop. These pests were found to attack pigeon pea crop almost once in every season. Majority of the sampled pigeon pea crop cultivators reported about 5 per cent loss of pigeon pea crop production on account of these pests attack. As for the disease, Leaf spot, Dry root rot, Fusarium wilt, and Yellow mosaic were the major diseases affecting both local and HYV variety

of pigeon pea crop. The severity of attack of these diseases was once in every season or once in two seasons. Majority of the pigeon pea crop cultivators reported about 5-10 per cent loss of pigeon pea crop production on account of these diseases. The major weeds affecting the pigeon pea crop were Spreading dayflower, large crabgrass, and Crowfoot grass in case of both local and HYV variety. Another important weed affecting the HYV variety of pigeon pea crop was Indian heliotrope. Majority of sampled pigeon pea crop cultivators found these as important weeds. These weeds were found to attack pigeon pea crop once in every season. About 5-10 per cent of pigeon pea crop production was reported to be lost due to the emergence or attack of these weeds. The magnitude of pigeon pea crop production loss due to various pests, diseases and weeds infestation for various categories of sampled farmers is presented in Table 4.

**Table 4: The magnitude of crop loss due to pests, disease and weed infestation- Pigeon pea**

Description	Marginal		Small		Medium		Large		Total	
	Local	HYV	Local	HYV	Local	HYV	Local	HYV	Local	HYV
Actual production with attack (quintal/acre)	4.22	4.60	4.30	4.76	4.40	4.74	4.40	4.62	4.30	4.71
Normal production without attack (quintal/acre)	4.61	5.09	4.67	5.36	4.80	5.40	4.80	5.32	4.68	5.34
Loss of output (quintal/acre)	0.39	0.49	0.37	0.61	0.40	0.66	0.40	0.70	0.38	0.63
Percentage loss over actual production	9.24	10.65	8.60	12.82	9.09	13.92	9.09	15.15	8.84	13.38
Percentage loss over normal production	8.46	9.63	7.92	11.38	8.33	12.22	8.33	13.16	8.12	11.80

The magnitude of pigeon pea crop production loss due to various pests, disease and weed infestation for average category of farmers was estimated at 8.84 per cent of actual production and 8.12 per cent of normal production in case of local variety, and 13.38 per cent of actual production and 11.80 per cent of normal production for HYV variety of tur crop.

The pigeon pea crop farmers aired a number of suggestions to minimize pre-harvest losses, which mainly revolved around extension of proper guidance on pests and disease control measures, adequate and timely use of insecticides, pesticides and weedicides, timely availability of pesticides and reduction in prices, an element of subsidy on insecticides, pesticides and weedicides in order to use adequate doses, protection from wild animals, soil testing on farm, adequate care during growth of crop, timely and early harvesting of crop, etc.

Pre-harvest loss is one end of the spectrum, the other end being post harvest losses during various operations viz. threshing, winnowing, transportation, handling and storage, aside from loss of crop during harvesting operation.

#### **Production Loss during harvest**

The sampled pigeon pea crop cultivators were found to harvest their crops during early, mid and late stages. The estimates relating to the extent of harvesting of selected crops during early, mid and late stages, proportion of area harvested during these stages, severity of loss, and the magnitude of loss during these stages are provided in Table 5.

**Table 5: Quantity lost at different stages of harvest – Pigeon pea Crop**

Stages of harvest and variety		Early		Mid		Late	
		Local	HYV	Local	HYV	Local	HYV
Area harvested per hh (acres)		1.75	1.08	1.34	1.22	1.00	0.90
Percentage area harvested (early, mid and late)		18.18	53.07	76.62	39.30	5.20	7.63
Area manually harvested (percentage)		18.18	53.07	76.62	39.30	5.20	7.63
Area mechanically harvested (percentage)		-	-	-	-	-	-
Rank of loss (percentage of households)	High	33.33	66.67	66.67	-	-	33.33
	Medium	25.00	30.00	50.00	66.67	25.00	3.33
	Low	-	64.38	100.00	24.66	-	10.96
Quantity lost during harvest	Kg per acre of harvest	2.29	6.51	4.31	8.31	8.00	14.00
	Kg per quintal of harvest	0.39	1.36	1.10	1.76	1.78	3.25

A critical analysis carried out in terms of per acre quantity of pigeon pea crop loss revealed a rise in loss of pigeon pea crop from early to mid and mid to late stage of harvesting, which increased from 2.29 kg in early to 8.00 kg in late stage for local variety, and from 6.51 kg in early to 14.00 kg in late stage for HYV variety. Similarly, the per quintal quantity of loss of pigeon pea crop increased from 0.39 kg in early to 1.78 kg in late stage for local variety, and 1.36 kg in early to 3.25 kg in late stage for HYV variety. The area harvested per household varied from 1.00 acre in late to 1.75 acres in early stage for local variety and from 0.90 in late to 1.22 acres in mid stage for HYV variety. The proportion of total area harvested was more than 90 per cent during early and mid stages put together for both local and HYV variety of tur crop.

#### **Production Loss during Threshing and Winnowing**

It is to be noted that while some of the pigeon pea crop cultivators used manual threshing, the others used either mechanical or both the methods of threshing. Similarly, the pigeon pea crop cultivators either winnowed pigeon pea crop manually or mechanically. The estimates relating to the quantity of pigeon pea crop lost during threshing and winnowing are furnished in Table 6.

The estimates showed that in general the loss of pigeon pea crop was medium to low in manual and mechanical method of threshing. Further, majority of pigeon pea crop cultivators followed manual method of winnowing. The per acre loss of pigeon pea crop was 2.18 kg for local variety and 1.38 kg for HYV variety in manual threshing, 0.05 kg for local variety and 0.83 kg for HYV variety in mechanical threshing, and 1.51 kg for local variety and 3.86 kg for HYV variety while following both methods of threshing. The per quintal loss of pigeon pea crop was estimated at 0.51 kg for local variety and 0.29 kg for HYV variety in manual threshing, 0.01 kg for local variety and 0.18 kg for HYV variety in mechanical threshing, and 0.35 kg for local variety and 0.82 kg for HYV variety while following both methods of threshing. Similarly, the per acre loss pigeon pea crop was estimated at 3.14 kg for local variety and 1.41 kg for HYV variety in manual winnowing and 0.57 kg for local variety and 1.18 kg for HYV variety in mechanical winnowing. The per quintal loss of pigeon pea crop was worked out at 0.73 kg for local variety and 0.30 kg for HYV variety in manual winnowing and 0.13 kg for local variety and 0.25 kg for HYV variety in mechanical winnowing.

**Table 6: Quantity lost during threshing and winnowing – Pigeon pea Crop**

Stages of harvest and variety		Local	HYV
<b>Area/quantity manually &amp; mechanically threshed (% of hh)</b>		100.00	100.00
- Manual		64.29	30.19
- Mechanical		7.14	12.26
- Both		28.57	57.55
Rank of loss <b>Manually</b> (Percentage of hh)	High	22.22	6.25
	Medium	33.33	46.88
	Low	44.44	46.88
Rank of loss <b>Mechanically</b> (Percentage of hh)	High	-	-
	Medium	-	46.15
	Low	100.00	53.85
Rank of loss <b>Both</b> (Percentage of hh)	High	-	-
	Medium	25.00	19.67
	Low	75.00	80.33
Quantity lost during <b>manual threshing</b>	Average loss (Kg per acre)	2.18	1.38
	Average loss (Kg per qt)	0.51	0.29
Quantity lost during <b>mechanical threshing</b>	Average loss (Kg per acre)	0.05	0.83
	Average loss (Kg per qt)	0.01	0.18
Quantity lost during <b>both threshing</b>	Average loss (Kg per acre)	1.51	3.86
	Average loss (Kg per qt)	0.35	0.82
<b>Area/quantity manually &amp; mechanically winnowed (% of hh)</b>			
- Manual		80.00	55.56
- Mechanical		20.00	44.44
Rank of loss <b>Manually</b> (Percentage of hh)	High	12.50	4.00
	Medium	62.50	44.00
	Low	25.00	52.00
Rank of loss <b>Mechanically</b> (Percentage of hh)	High	50.00	5.00
	Medium	-	45.00
	Low	50.00	50.00
Quantity lost during <b>manual winnowing</b>	Average loss (Kg per acre)	3.14	1.41
	Average loss (Kg per qt)	0.73	0.30
Quantity lost during <b>mechanical winnowing</b>	Average loss (Kg per acre)	0.57	1.18
	Average loss (Kg per qt)	0.13	0.25

The estimates presented in Table 6 clearly underscore the fact that threshing and winnowing put together using various methods resulted loss of pigeon pea crop to the tune of 1.73 kg per quintal for local variety and 1.84 kg per quintal for HYV variety, showing marginally higher loss of crop for HYV variety as against local variety.

### **Production Loss during Transportation and Handling**

The pigeon pea crop cultivators were seen to transport their produce from field to home and from home to market. The magnitude of loss of crop during transportation and handling using various modes of transportation is worked out from the total production of the crop and subsequently added up to ascertain the extent of total loss of the crop. The major transportation modes were head load, bullock cart, trolley and tempo. The estimates relating to the magnitude of crop loss during transportation and handling using various modes of transportation are brought out in Table 7.

The average per household quantity of pigeon pea transported from field to home was worked out at 5.32 quintals. The per quintal transportation cost from field to home was estimated at Rs.5.17. The loss of pigeon pea crop was reported to be low by majority of the households. The per quintal loss in relation to total production of pigeon pea crop during transportation from field



to home was estimated at 0.24 kg, which encompassed major loss of crop during its transportation through bullock cart. The per quintal handling loss in relation to total production of pigeon pea crop during transportation from field to home was estimated at 0.22 kg, which also included major handling loss of crop when transported through bullock cart.

**Table 7: Quantity lost during transportation and handling – Pigeon pea Crop**

Mode of transportation		Head load	Bullock cart	Trolley	Tempo	Total
<b>Field to Home</b>						
Average quantity transported (qtls per hh)		5.43	5.35	4.50	5.00	5.32
Average distance covered (kms)		0.45	2.13	1.33	2.42	1.97
Transportation cost (Rs per quintal)		4.69	5.15	5.56	6.33	5.17
Rank of loss (percentage of hh)	High	-	-	-	-	-
	Medium	-	4.00	-	-	3.33
	Low	100.00	96.00	100.00	100.00	96.67
Quantity lost during transport	Average loss (Kg per qtl of amount transported)	0.01	0.22	0.003	0.005	0.24
Quantity lost during handling	Average loss (Kg per qtl of amount handled)	0.004	0.19	0.003	0.02	0.22
<b>Home to Market</b>						
Average quantity transported (qtls per hh)		-	3.58	3.25	4.44	4.34
Average distance covered (kms)		-	34.67	22.00	20.00	20.50
Transportation cost (Rs per quintal)		-	5.35	6.54	8.79	8.61
Rank of loss (percentage of hh)	High	-	-	-	0.92	0.83
	Medium	-	66.67	25.00	20.18	21.67
	Low	-	33.33	75.00	78.90	77.50
Quantity lost during transport	Average loss (Kg per qtl of amount transported)	-	0.002	0.02	0.28	0.30
Quantity lost during handling	Average loss (Kg per qtl of amount handled)	-	0.01	0.05	0.45	0.51

During the stage of transportation of pigeon pea crop from home to market, the average per household quantity transported was estimated at 4.34 quintals. The average distance covered in transportation from home to market was 20.50 km with a transportation cost of Rs.8.61 per quintal. The loss of pigeon pea crop was reported to be medium to high during its transportation from home to market. The per quintal loss in relation to total production of pigeon pea crop during transportation from home to market was estimated at 0.30 kg, which included major loss of crop during its transportation through tempo. The per quintal handling loss in relation to total production of pigeon pea crop during transportation from home to market was estimated at 0.51 kg, which also included major handling loss of crop when transported through tempo. Thus, handling loss of tur crop was relatively higher than transportation loss, especially during transportation of crop from home to market.

### **Production Loss during Storage**

Generally, farmers store their crop either in Kutcha/ Pucca house or in scientific godown/warehouse. The sampled pigeon pea cultivators were found to store their crop either in Kutcha house or in Pucca house, and they did not use any scientific method of storage. The mode of storage was gunny/plastic bags, Kothi/bin, open space, etc. The estimates relating to amount of total production of pigeon pea stored using various modes of storage, average number of days stored, ranking of loss, loss of crop due to various reasons, etc. are shown in Table 8.

**Table 8: Quantity lost during storage - Pigeon pea**

Place of storage		Kutch house	Pucca house
Mode of storage (percentage of amount stored)	Open	2.11	2.82
	Gunny/plastic bag	20.13	69.14
	Kothi/bin kuchha, Pucca	0.16	5.01
	Steel drums	-	0.63
Amount stored (Qtls per hh)		4.21	5.76
Percentage of hh who dried before storing		55.88	54.65
Average number of days stored (per hh)		100.12	92.69
Rank of loss in storage	High	-	2.33
	Medium	29.41	17.44
	Low	70.59	80.23
Quantity lost during storage (kgs per quintal of storage)	Due to weight loss	0.22	0.53
	Due to rodents	0.17	0.27
	Due to fungus	0.01	0.14
Storage cost Rs. per quintal		2.22	4.06

The estimates showed that 69 per cent of the production of pigeon pea was stored in Pucca house and 20 per cent in Kutch house using gunny bags, 3 per cent in Pucca house and 2 per cent in Kutch house using open space, and 5 per cent in Pucca house using bin, and 1 per cent in steel drum. The per quintal loss of pigeon pea was estimated at 0.75 kg due to weight loss, 0.44 kg on account of rodents, and 0.15 kg due to fungus. Thus, the loss of pigeon pea during storage was worked out at 1.34 kg per quintal, mainly due to weight loss, rodents and fungus.

#### Post-Harvest Loss

The estimates relating to total post-harvest loss of crop on account of harvesting, threshing, winnowing, transportation, handling and storage for various categories of pigeon pea cultivators are brought out in Table 9. The total post harvest losses of crop on per acre basis for various categories of pigeon pea cultivators are also shown in Table 9.

**Table 9: Total post harvest losses per quintal by farm size – Pigeon pea**

Particulars	Marginal	Small	Medium	Large	Total
Quantity lost in harvest (kg per qtl)	2.02	2.04	1.26	0.78	1.56
Quantity lost in threshing (kg per qtl)	1.67	1.62	0.85	0.82	1.24
Quantity lost in winnowing (kg per qtl)	1.35	0.83	0.25	0.14	0.59
Quantity lost in transport (kg per qtl)	0.89	0.62	0.45	0.28	0.54
Quantity lost in handling (kg per qtl)	1.47	0.95	0.40	0.29	0.73
Quantity lost in storage (kg per qtl)	1.97	1.78	0.86	0.85	1.34
Total post harvest loss (kg per qtl)	9.37	7.84	4.07	3.16	6.00
Total post harvest loss (kg per acre)*	41.88	36.77	19.21	14.54	27.90

Note: Post harvest loss per acre is calculated by multiplying losses in kg per quintal by the productivity per acre.

An analysis into total post harvest loss revealed wide variation in loss of pigeon pea crop across various categories of sampled farmers. The per quintal total loss of pigeon pea crop was estimated at 6.00 kg, which encompassed 1.56 kg in harvesting, 1.24 kg in threshing, 0.59 kg in winnowing, 0.54 kg in transportation, 0.73 kg in handling, and 1.34 kg in storage. The total post harvest loss of pigeon pea crop decreased with the increase in land holding size of farmers, and it varied from 3.16 kg for large category to as much as 9.37 kg for the marginal category of farmers. The per acre post harvest loss of pigeon pea was estimated at 27.90 kg, which also declined with the increase in land holding size of farmers.

## Conclusions

The study showed about 14-18 per cent of the total production of pigeon pea as lost on account of pre-harvest, harvest and post-harvest operations. Such high magnitude of loss of crop production is certainly a matter of great concern. Therefore, efforts need to be initiated to curb such losses by adopting appropriate measures. It is expected that measures and programme initiatives such as adoption of improved pre- and post-harvest technology and water and pest control practices will not only increase the productivity of individual crops and their quality but these are also likely to substantially minimize the post-harvest losses, increase the total crop area cover and generate adequate quality surplus for their conversion into value-added food products. In fact, the scientific methods of harvesting, threshing, winnowing, transportation and storage operations will certainly lead to minimization of total post-harvest losses. It is important for the government agencies to impart training and demonstration to the farmers about adoption of scientific methods of various post-harvest operations. The quick diversion of produce in the market after harvest will also minimize post-harvest losses to a greater extent. However, early market clearance may also lead to low prices on offer. Therefore, there is need to develop such mechanism in which farmers do not suffer when they look for early and timely sale of produce. In such cases, exploitation of farmers from private traders should be prevented. Further, timely harvesting of crop may ensure minimization of losses at harvesting stage. In brief, in order to reduce, post-harvest losses, it is important to develop technologies and techniques that are more appropriate to the needs of small scale as well as large farmers.

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