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Post-harvest Management of Cowpea: A potential Cash Crop for the Western Coastal Ecosystem of Goa

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ABSTRACT

Cowpea, popularly grown as Alsando (Red Bold Variety) or Chowli (the less bold cream coloredcream-colored variety) is a major pulse crop of the state of Goa cultivated in the rice fallows during rabi season under residual soil moisture conditions. Harvest and post harvestpost-harvest losses of Cowpea were estimated by primary and secondary data collected from 50 Cowpea farmers from five villages each in the two districts, North and South of Goa and 9 storage godowns in the year 2012-13. The results showed that in spite of the crop being highly remunerative, it was cultivated in only 40 % of the paddy area. The average losses on field were 10.84 % for harvest, followed by 6.96% for threshing and 4.34 % for storage as calculated from primary data collected on farm. Secondary data showed that the awareness of losses during harvest and post-harvest unit operations was very less as they reported zero losses. The pulse has a high storage insect pest, pulse borer (Callosobruchus maculatus, Callosobruchus chinensis)incidence and hence was stored only for seed purpose in some cases for a year and generally disposed of by the month of May in the godowns and by September at household level. In spite of having high returns, high local demand and nutraceutical value, the crop is not grown in large area due to labour intensive unit operations and high pest incidence. Sensitizing the farmers on good management practices and development of a drudgery free harvesting device can make this remunerative crop popular in the state.

KEYWORDS

Postharvest losses, harvest, threshing, drying, storage, pulses

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INTRODUCTION

Agriculture is the second important profession in Goa next to tourism with a share of Rs 1889.6 Millions in GSDP (AnonymousAnon, 2020). But with the Covid -19 Pandemic situation the tourism industry has had a severe setback thus driving agriculture to the top spot. The bold red variety of grain Cowpea, locally known as Alsando is a potential high value pulse crop grown in the residual moisture of rice fallows (around 6627 Ha) during Rabi season, December to March (Manjunath et al. 2013, Anonymous 2019). This is just 25.65 % of paddy area during Kharif season in the corresponding year, which was 25841 ha. Cowpea is a drought resistant crop requiring minimal management, of both determinate (Alsando -1) and indeterminate types (Goa (Nadora Badez-1), Dhulape Utorda -3 or Goa Cowpea-3) and every part of the crop is consumed as seed or fodder (for cattle). The average cost of the seed varies from ì Rs. kkharif, this is grown vegetable (Singh and Bhatt, 2013)temperature29 to 35C .It is a good source of protein (Table 1) and a delicacy in the state of Goa (Singh *et al*, 2012).

Table 1: Protein Content of Cowpea versus other sources

Source	Protein g/100 g
Cowpea (alsando)	25-28
Chicken egg	10.62-13.63
Chicken	23-29.8
Fish	6-23
Pork	27.55
lamb	20.91-50.9
Beef	16.9-49.2

Even though Cowpea has high value and demand in the state, the potential of this crop is not realized due to the marginal area under which it is cultivated (Singh *et al*, 2012). The harvesting and threshing of the crop are manual and involves a lot of drudgery which could be one of the reasons for this (Singh *et al*, 2015). The various unit operations involved in the crop from harvest to storage also lead to a lot of losses due to which the profit margins are further eroded. According to a study by AICRP-PHT, ICAR-CIPHET, total loss of pulses in farm operations was 3.4 to 5.0 % at national level and storage

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losses ranged from 0.9 to 2.0 % (Nanda *et al*, 2012) and 6.36 to 8.41% (Jha *et al*, 2015). Jha *et al* (2015) reported higher losses of pulses due to improper threshers, delayed harvesting, and improper storage practices. Hence, a study was conducted at ICAR-CCARI to find the losses from harvest to storage and suggest good management practices for the crop.

MATERIALS AND METHODS

Cowpea (Alsando) was sown in the month of December by broadcasting and after germination it was thinned to rows and harvesting is manually done from early March till April. The crop was sun dried and manually threshed by beating with sticks or rarely mechanically using multi-crop thresher. The storage was generally for consumption from April to September. For seed purpose, it was stored in airtight containers and treated with a mixture of oil and boric acid powder. The losses in field during harvesting, drying, threshing and storage were studied through collecting the data on farm by (i) enquiry and (ii) direct observation from farmers and their field using forms and questionnaires as designed by Vishwakarma et al. (2007), Basavaraja et al. (2007), Nanda *et al* (2012), Jha *et al* (2015) and used by Gupta *et al* (2020).

Sample Collection

To select the farmers for data collection, a multi-stage sampling design was used as followed by Vishwakarma et al. (2007), Nanda *et al* (2012) and Jha *et al* (2015). Famers were selected from Cowpea growing areas of North and South districts of Goa. A total of ten villages, six from the North Goa: Mendkure, Torse, Sangolda, Chodan, Dulape (Tiswadi), Carambolim and four from South Goa district: Rivona, Malkarne, Yerawada(Cotigaon), Dulape (Verna) were chosen by simple random sampling from the list of cowpea cropping villages given by the directorate of agriculture. Five farmers from each village were chosen for data collection and two each for primary data collection. Thus, the sample size for secondary data was 50 and primary data was 20. The methodology for data collection by enquiry and observation, sample plot size, sample size, collection protocol, questionnaires, etc. were as per the protocols developed and reported by Vishwakarma et al. (2007), Basavaraja et al. (2007), Nanda *et al* (2012), and Jha *et al* (2015).

The preliminary data was collected from farmers selected for the study during December, 2012 to January, 2012. On-farm data on losses during harvesting, threshing and winnowing was collected between March to April 2013 through observation. Storage and secondary data collection were done between May to September 2013.

Data analysis

On farm post-harvest losses were estimated for farmers as per the following formula and average of the same was reported.

Harvest loss (%):

$$\frac{No.of\ grain\ collected\ fromselected\ plot\ , kg}{Final\ dry\ weight\ of\ production\ from\ plot, kg} \times 100$$

Threshing and winnowing losses %=

$$\frac{Weight\ of\ grains\ in\ discarded\ 100\ g\ of\ empty\ pods,\ \ kg}{weight\ of\ dry\ cowpea\ grains\ obtained\ similar\ number\ of\ pods, kg} \times 100$$

Storage losses, %=

$$\frac{Weight\ of\ infested\ cowpea\ grains\ per\ 100\ g\ of\ sample\ collected\ from\ farm,\ \ kg}{100} \times 100$$

The data was taken from cowpea stored on farm and state storage godowns (12 nos.) at 3 months interval for storage losses. It was brought to lab and examined under Stereo Zoom Leica Microscope (Leica S8 APO, 8:1 Zoom, 75 mm working distance) and averaged across all samples.

Moisture Content

Moisture content of Cowpea was estimated by taking samples of cowpea in three replications, and using standard hot air oven (Galaxy instruments, Panaji, Goa; Range: 50-300^{o}C) drying at 105^{o}C for 72 h. Sample weight was determined using an analytical balance (Atco T210AB0021/W, range: 0.001- 200g, least count: 0.001 g).

RESULTS AND DISCUSSION

Land holding pattern and production practices of the sampled farmers

Basic data of the sample farmers showed that 68% of farmers had less than 1 acre of land and 34% of farmers had less than 5 acres of land. The cropping practices showed that except in 3 villages (average percent of cowpea area: 90.99±11.51%of the ten surveyedarea (average: 34.71±38.04 %) was used for Cowpea cultivation. upland (morod)Kher),and no source of irrigation water. The basic data is summarized in Table 2.

The crop is sown manually by broadcasting or dribbling. After germination thinning of the crop is done with a spacing of row to row and plant to pant spacing of 3'X3'. The local cowpea is red colored bean, known as *alsando* and is an indeterminate crop. Harvest is done manually (Fig.1) at intervals of 8 days. Hybrid cowpea, which is a white bean crop, (locally known as *Chowli*) is a determinate crop which is

Table 2: BasicData of cowpea farmers and their post-harvest management practices

Villages	Average total cropped area, m^2	Average area under Paddy, m^2	Average area under Cowpea, m^2	Percent of Paddy area under cowpea	Variety	Method & Month of sowing	Method of Harvest	Harvest M.C.(% WB)	No of picking	Method of Threshing& Winnowing	Average no. of seeds per pod	Weight of final stored seeds, 100 no., g	Yield, t/ha	No of months stored
Dulape, Tiswadi	72500	9200	383.9	4.17	Local accession	Broadcast/ November	Manual	34.67	6	Manual	10	27.5	1.14	4
Chodan	3840	11240	2880	25.62	Local accession	Broadcast/ November	Manual	14.09	7.5	Manual	12	20.8	0.34	0
Carambolim	440	540	540	100	Local accession	Broadcast/ December	Manual	23.33	4.5	Manual	9	27.9	0.53	4
Torse	20400	9960	680	6.82	Local accession	Broadcast/ December	Manual	27	2.5	Manual	8.5	27	0.38	4
Mendkure	27500	24000	2410	10.01	Local accession	Broadcast/ December	Manual	19	4.5	Manual	11	25	3.48	7
Dhulape, Verna	5700	5700	5600	98.25	Local accession	Broadcast/ December	Manual	18.5	4.5	Manual	8.5	33	0.98	4
Malkarne	7900	2500	160	6.4	Local accession	Broadcast/ November	Manual	24	3.5	Manual	8	31	0.67	4
Sangolda	5575	6690	5000	74.74	Local accession	Broadcast/ December	Manual	11.83	3	Manual	8.5	18	0.22	4
Yedawada, Cotigaon	10600	10600	54	0.51	Local accession	Broadcast/ November	Manual	25.75	2.5	Manual	6	21.5	3.25	4
Rivona	2800	2800	575	20.54	Local accession	Dribbling/ November	Manual	14.83	3	Manual	6.5	20	3.035	4

harvested once after all the beans mature (harvest moisture: 11.83-34.67%). The unit operations in processing of the crop are given in fig. 2.

Fig. 2: Unit operations inharvest and post-harvest management of Cowpea

The beans are sun-dried (Figure 3) and threshed manually by beating with sticks (Figure 4) or treading by feet. One of the farmers used a multi-crop thresher. The common methods of storage were in woven plastic bags, airtight plastic/ metal cans with coating of mixture of boric powder @1g/ 2kg of cowpea and cooking oil @1g/ 2.5 kg of

Fig. 3: Sundrying of harvested cowpea pods

Fig. 4: Threshing of cowpea pods

cowpea or non-chemical protection such as Triphal, Neem leaves. During the study season, the yield of cowpea varied from 0.34–3.48 t/ ha among sampled farmers (Manohara *et al*, 2020) and reported yield of 1.44 t/ ha for local cowpea germplasm grown on research farm. The 100 grain weight of the dried cowpeas varied from 18-33g (due to variability in the local germplasm (Manihara et al., 2020 have reported varying 100 seed weights of <16-22.9 g in Goa, while Kamara et al.also reported 15-21g in West African Savannas)

Losses on field by observation

Winnowing and storage losses wefigure fig. 5 harvest losses were the maximum ranging from 3.79 to 34.34% (average-10.83±8.25%)10-34.92 %(average-6.96±8.80%) and storage losses from 3.72 to 5.6%(average-4.35±0.88%).godowns surveyed, none had any infested beans (Table 2). Nanda *et al*. (2012)reported losses during farm operations in Pulses as 2.2 -9.1% and storage losses as 0.9-2.0et al(2015)4.69 ±0.45 % to 7.23±0.38 % and 1.18±0.10 to 1.67±0.13 % respectively(2005)reported farm level losses from 2.20 to 3.74% in pulses. The major losses in were due to the multiple pickings in the crop at intervals of 8 days, which led to shatter losses on the field. Manual threshing and winnowing was the major reason for losses. It could be eliminated by stored beans are highly susceptible to pest infestation. Pulse beetle Callosobruchus spp were the major storage insect pests found in cowpea. Three species of pulse beetle viz., Callosobruchus maculatesC. chinensis and analis were found damaging the stored cowpea. Primary source of infestation was in the field. When infested seeds were harvested and stored causes the secondary infestation. The secondary infestations were more damaging and resulted in destruction of seed lot Also, inert dusts such as clays, sand, paddy husk ash, volcanic ash, wood ash, dolomite and diatomaceous earth could be added to the grains before storage. Common bio-control practices like addition of Neem leaf powder, Nochi leaf powder, turmeric powder, Sweet Flag (Vasambu) Rhizome powder @10g/kg have been found to be effective against storage pests. Also, finely crushed Triphalor even Boric acid powder@ 3-4g/kg could be used in storage to protect the Bruchids.

Table 3: Storage godowns for cowpea in Goa

Name of godown	Taluka	Previous stock	Total Stored	No. Of month of storage	Weather grains infested (Y/N)
Goa Bagayatdar,Porvorim	Bardez	No	500 kg	Jan-feb	No
Goa Bagayatdar,Pernem	Pernem	175 kg	225 kg	April	No
Goa Bagayatdar,Chawadi,	Cancona	No	1000 kg	January-June	no
Goa Bagayatdar,Shiroda	Shiroda	No	1070 kg	March-april	no
Goa Bagayatdar,Senqualim	bicholim	No	1850 kg	March-april	No
Goa Bagayatdar,Valpoi	Sattari	No	1869 kg	April-May	No
Goa Bagayatdar, Ponda	Ponda	No	800 kg	January-May	No
Goa Bagayatdar, Marcel	Ponda	No	700 kg	April-May	No
Goa Bagayatdar, Arlem	Salcette	No	26000kg	January-March	No

Fig. 5: Percent Post-harvest losses as estimatedby data taken on farmers' field

Losses on field by enquiry

The data collected by enquiry from farmers showed that the farmers felt there were almost negligible losses on farm. They estimated the average losses during harvest threshing, winnowing, drying, transportation and storage as- 0.82±2.5 ,2.5, 0.51±1.4, 0.24±0.7, 0.42±1.3, 0, 0.85±1.8 %,his was due to the lack of awareness about post-harvest losses among farmers. The farmers felt maximum loss was in field before harvesting due to rodents and birds (13±14.2%).

CONCLUSIONS

The harvest and post-harvest losses for cowpea cultivation was done during the year 2012-13 in Goa. It was found that only 34.71±38.04 % of the Paddy fallows were used for Cowpea cultivation. Farm level harvest and post-harvest losses amounted to more than 20% of the total on-farm production. Multiple picking of the crop increases drudgery of the operation and increases harvest losses. Open sun drying, manual threshing and winnowing were traditionally practiced and needed to be replaced with solar drying with threshing and winnowing mechanically to reduce the losses during these unit operations. Proper crop management and bio-control techniques were combined for storage pests with improved storage techniques like hermetic storage could reduce the storage losses. Sensitization of farmers, along with introduction of uniformly maturing varieties suitable for local palate could help Goa and coastal farmers benefit from this high value crop and also improve the nutritional security of the coastal regions.

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