



PROFITABILITY OF COWPEA GRAINS STORED WITH PURDUE IMPROVED COWPEA STORAGE TECHNOLOGY IN BENUE STATE, NIGERIA

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ABSTRACT

Insect infestations impose serious challenge to cowpea storage and negatively affect trade and utilization of cowpea in Nigeria. Purdue improved cowpea storage (PICS) technology provide effective control against these storage pests, thus allowing farmers to tap into better grain prices during the lean season. The study assessed the profitability of cowpea grains stored with Purdue improved cowpea storage technology in Benue State, Nigeria. The objectives of the study include; to determine the effect of PICS technology use on cowpea loss and to estimate the returns to cowpea stored with PICS technology. Two hundred and forty (240) respondents were identified and interviewed using snowballing non-random sampling techniques. The analytical tools used for the study were the gravimetric (count and weight) method and marketing margin analysis. The result of the study revealed that storing with PICS technology reduced weight loss in cowpea by 15.3%, valued at ₦3,450 per bag per season. The use of PICS technology gave a higher marketing margin of ₦11,297.88/bag with farm-to-retail price spread of 45.5% than ₦8,285.83/bag and farm-to-retail price spread of 37.8% in woven bag. It is recommended that; farmers group should be used as a platform to promote and create awareness on the economic benefits of PICS technology use.

Keywords: Count, Cowpea, PICS technology, Profitability, Storage, Weight.

INTRODUCTION

With over 3.41 million tons produces annually (Food and Agricultural Organization Statistics, 2019), cowpea (*Vigna unguiculata*) play a key role in the agriculture and food supply of Nigeria. The seeds are a major source of plant proteins and vitamins for man, feed for animals, and also a source of cash income. The young leaves and immature pods are eaten as vegetables. Over 90% of the population consume this grain as staple food (International Institute of Tropical Agriculture [IITA], 2009). The high share in consumption demand reflects the adoption in meeting food as well as protein-energy requirements both in rural and urban areas. Cowpeas are also a critical economic driver, promoting trade between producing and non-producing areas, with nearly 300,000 metric tons of cowpeas traded (Fulton *et al.*, 2009). Adequate and sustainable supply of this crop will guarantee the nation's economic stability by reducing poverty level, improve health conditions and enhance productivity (Ajayi and Ajanaku, 2007; Kalu and Tomasz, 2010).

A widely recognized constraint in cowpea production, trade and utilization is insect pests' infestation during storage. The most prominent and destructive storage pests of cowpea are bruchids of the genus *Callosobruchus* (*Coleoptera: Chrysomelidae*), which infest cowpea grains both in the field and in storage causing extensive grain weight losses through their feeding (Boxall, 2002; Golob, 2002). Losses in dry weight of cowpea due to bruchid damage have been estimated at about 30-40% of stored cowpea in Nigeria (Tapondjou *et al.*, 2002).



With direct physical (weight) loss, manifesting in seed perforation causing substantial reductions in market value and germination ability of seeds (Santos *et al.*, 1990). Indirect damage includes contamination of their feeding media with faeces, exoskeleton, insect body parts, dead bodies and their own existence in the product is often not commercially desirable.

While the risk and magnitude of losses increases the longer grain is stored, farmers are limited in strategies to cope with storage loss (Kadjo *et al.*, 2013). Most traditional grain storage techniques (such as local rhombus, bags, open field, roof and fire place) commonly used by rural farmers cannot guarantee protection against these storage pests (Gitonga *et al.*, 2013), and have been reported to cause significant grain waste and losses of about 25% of farmers' harvest (Boys, 2005; Moussa, 2006). While the chemical (insecticides) control protocols are frequently unavailable or too expensive for individual and even farmer groups, they are most often subjected to misuse thereby raising economic, technical and safety concerns (Baributsa *et al.*, 2012). As a result, long term storage remains a huge problem for the rural farmers.

Faced with high rates of potential losses, selling at harvest may be an optimal strategy to avoid losses due to pest damage. Thus, farmers are consistently forced to sell immediately after harvest when prices are lowest in order to avoid storage losses (Moussa *et al.*, 2012). According to Kadjo *et al.* (2013), early sales reduce farmers' profit and the potential for producers to take advantage of price increase after harvest. Afolami and Falusi (1999) opined that forced early sales can interact with or induce market failure and reduce farmers' market participation, with adverse consequences for the poor. This is because, farmers' market participation is directly related to their ability to generate marketable surplus (Sharma & Wardhan, 2017). According to Onyango and Silim (2000), without proper storage facilities, high value market will remain largely inaccessible to the smallholder farmers, as this will hinder engaging in temporal arbitrage in the presence of substantial seasonal price fluctuations that increase income (Gilbert *et al.*, 2017; Tesfaye and Tirivayi, 2018).

It has been estimated that every insect emergence hole present in 100 seeds reduces the price of the grain by 2.3% (Jones *et al.*, 2014; Mishili *et al.*, 2011). Apart from the loss of monetary value (lower unit prices paid), storage loss also tightens food market by removing part of the supply from the market, contributing to farm-gate prices spikes (Rosegrant *et al.*, 2015). Food and Agriculture Organization (FAO, 2011) stated that for every 1% rise in food prices, expenditure on food drops by 0.75% in developing countries. Safe storage of cowpea at the farm level is therefore critical to improve productivity, trade and utilization of cowpea, as this will directly impact poverty alleviation, food security, while improving livelihood and income of smallholder farmers.

Purdue improved cowpea storage (PICS) triple-layer hermetic storage bags has been promoted as improved alternative for insecticide-free, long-term cowpea storage in Nigeria. Evidence has shown that when tied shut, PICS technology ensures effectively airtight low-oxygen (less than 5% by volume) environment are generated through the respiratory action of the seeds and enclosed pests (Murdock *et al.*, 2012). The modified atmosphere (enriched carbon dioxide (CO₂) environment) suppresses the survival of insects and reduce damage caused by their feeding (Baoua *et al.*, 2014; Tubbs *et al.*, 2016). This will provide smallholder farmers with the flexibility to store grain for several months (Swathi and Rajanikanth, 2017), thus allowing them to tap into better grain prices during the lean season. The objectives of the study include; to determine the effect of PICS technology use on cowpea loss and to estimate the returns to cowpea stored with PICS technology in Benue State. Understanding this will provides farmers with information that will facilitate decision making based on sound economic analysis.



MATERIALS AND METHODS

The Study Area

The study was carried out in Benue State, Nigeria. The State is located within the North Central geopolitical zone of Nigeria and lies between longitudes 7° 47' and 10° 0' E and between latitudes 6° 25' and 8° 8' N. The mean annual rainfall in the State is between 1000-1500 mm, with maximum average temperature range of 30 to 35°C. Benue State derives its name from the River Benue; the second longest river in Nigeria (Benue State Government Diary, 2008). The natural vegetation consists broadly of rain forest and wooded savannah (Benue State Agricultural Development Authority, 2005). The state is made up of 23 Local Government Areas (LGAs) which is politically and agriculturally divided into three zones: Northern, Central and Eastern zones (Ajayi and Allagenyi, 2001). The zones are noted for the production of cowpea including maize, millet, rice, sorghum, ginger and groundnut, cassava, yam which are either in the monocropping or intercropping system (Ajeigbe *et al*, 2010; Foli, 2012).

Sampling Procedure

A three-stage sampling technique was used for this study. First stage involved, purposive selection of two zones (northern and eastern) out of the three zones in the state. This is because of their high involvement and relative importance in cowpea production. Because of the few number PICS users, snow-ball non-random sampling techniques was used to identify 12 villages with concentrated numbers of PICS users. Given that PICS technology is mainly commercialized, there was no available frame from which the sample selection can be based upon. Snow balling was also used to select 120 PICS and 120 non-users (i.e., woven users) from each of identified villages, making a total sample size of 240 respondents interviewed for the study.

Data Collection and Experimental Design

Primary data was collected through the use of a structured and pre-tested interview schedule designed to capture information on socio-economic and demographic characteristics, quantity of cowpea stored and marketing dynamics, revenue and cost variable details. On-farm experiment was used to *estimate* the percentage *weight* loss in stored cowpea. Grains were stored in three (3) replicates in PICS bags and woven bags of 100 kg storage capacity for six months (between January and August 2020). Samples were drawn every two months interval from the each of the storage bags visually examined for damage using the 100 grains count and separated into damaged and undamaged grain portions. The number (count) and weight of each portion (damaged and undamaged grains) of the composite sample were then taken.

Analytical Techniques

1. The gravimetric (count and weight) method: The weight loss (WL) at different storage bags was determined using the count and weight method as proposed by Boxall (1986). This is given as:

$$\% \text{ weight loss} = \frac{(UNd - DNu)}{U(Nd + Nu)} * 100 \quad \dots(1)$$

where;

U = weight of undamaged grain,

Nu = number of undamaged grains,

D = weight of damaged grains,

Nd = number of damaged grains.

2. Marketing margin analysis: Marketing margin analysis was used to determine the returns to cowpea storage between users and non-users of PICS hermetic technology. This was determined using the approach adopted by Murthy *et al*. (2007), which estimates marketing



margin as the difference between farm-gate price and the selling price. The net marketing margin is calculated by obtaining the difference between what is received and cost incurred.

This is mathematically presented as:

$$\text{GMM} = \text{SP} - \text{FP} \quad \dots(2)$$

$$\text{NMM} = \text{GMM} - \text{TMC}$$

where;

NMM = Net marketing margin (₦);

GMM = Gross marketing margin (₦);

SP = Sale price (₦);

FP = Farmgate price (₦);

TMC = Total marketing cost (₦);

Total marketing cost consists of both variable and fixed cost incurred during the marketing operation. Variable costs are direct costs incurred during marketing activities such as handling costs, packaging materials, and transportation as well as post-harvest storage loss. The fixed cost consists of the depreciation on all fixed assets which can last for a year or more. This analysis therefore considers the ability of PICS bags to be used for three seasons and PP bag for two seasons. The cost of the storage bags was straight-line depreciated over its useful life. The formula is given by:

$$d = \left\{ \frac{c-s}{n} \right\} \quad \dots(3)$$

where;

d = depreciation (₦)

c = purchase value of an asset or cost (₦)

s = salvage value of asset after its expected years of usage (₦)

n = life span of the asset (years)

The farmers' share measured as a percentage of selling price was then derived mathematically as:

$$\text{Farmers' share} = \frac{\text{SP} - \text{FP}}{\text{SP}} \times 100 \quad \dots(4)$$

where;

SP = Sales price at the retail market

FP = Farm-gate price at the producer end

RESULTS AND DISCUSSION

At the onset of the trial, cowpea in both PICS and polypropylene bag were slightly damaged by bruchids, and had an average weight loss of 0.25%. At two to four months of storage, grain damage was much lower in the PICS hermetic bags than in the polypropylene bags. After six months of storage, the weight loss increases significantly to 17.36% (Table 1) for grain stored in polypropylene bags representing quantity loss of 15.6 kg per 90 kg grain. While weight loss in PICS bag was 2.03%, which amount to quantity loss of 1.83 kg per 90 kg grain. The abated loss through the use of PICS bags was 15.33%, which equals 13.8kg grain saved and valued at ₦3,450, assuming farmers store for six months only.



Table 1: Extent of Weight Loss (%) of cowpea stored with PICS and PP bag

Category	Average weight loss (%)				Loss (kg/bag) *
	Initial loss	2 months	4 Months	6 months	
Pp (Woven) bags	0.25	2.84	8.45	17.36	15.6
PICS bag	0.25	0.76	1.83	2.03	1.83
Abated loss (bag/season)				15.33	13.8
Abated gain (N/bag/season) - N250 per kg					3,450

Note: $* \frac{WL \times 90}{100}$

Source: Field survey 2020

Table 2 shows the marketing margins, cost, and farmers' share in cowpea marketed in the study area. From the result, the average farm-gate price per bag (or per 100 kilograms) of cowpea was ₦13,514.17 and ₦13,622.05, while the retail price was ₦24,812.05 and ₦21,908.33 for the users and non-users of PICS technology, respectively. The result of the gross marketing margin shows that without considering the associated costs incurred in marketing, the users had gross margin of ₦11,297.88 per bag (or per 100 kilograms) while the non-users had gross margin of ₦8,285.83. Indicating that the users receive a higher return from cowpea sale than the non-users. This could be due to better price arbitration resulting from quality grain and longer storage with PICS bag.

Considering the marketing cost, it was evident that store rent and labour constitutes the largest cost component for the users, while post-harvest storage loss and labour constitute the highest cost for the non-users. The total marketing cost incurred by the users and the non-users was ₦4,136.45, and ₦7,273.63, respectively. Thus, the net marketing margin earned by the users per bag (or per 100 kilograms) of cowpea marketed was ₦7,161.43, which was higher than the non-user's value of ₦1,012.2. This implies that more is spend by non-users of PICS technology on marketing services such as cost of transportation, storage, rent, and market levy compared to the amount received for value addition in cowpea retails marketing.



Table 2: Estimated Marketing Margin per bag of Cowpea

Variables	Users Value (₦/bag)	Non-users Value (₦/bag)
Selling Price: SP	24,812.05	21,908.33
Farm-gate price: FP	13,514.17	13,622.5
Gross marketing margin	11,297.88	8,285.83
Marketing cost items:		
Labour	1,311.02	1,169.89
Insecticide	0	300.02
Transportation	661.81	642.35
Storage (weight) loss	457.5	3,900.0
Market charges	135.0	110.0
Storage bag	193.3	115.0
Store rent	1,377.82	1,036.37
Total marketing cost	4,136.45	7,273.63
Net marketing margin	7,161.43	1,012.2
Margin as % of selling price	45.5	37.8

Note: GMM = SP-FP; NMM = GMM – TMC

Source: Field survey 2020

Furthermore, from Table 2, the farmers share as a percentage of selling price shows that, the users received higher share of 45.5%, compare to 37.8% share for the non-users of PICS technology. This implies PICS users earn a higher share from what the consumer pays than the non-users storing with polypropylene bag. This therefore indicated that a 100% retail price paid by the final consumer will result in farm-to-retail price spread of about 46% for the users and 38% for the non-users. In other words, an average cowpea marketed in the study area earns a farm-to-retail spread of ₦0.46 to the users and ₦0.38 to the non-users, for every ₦1 retail price paid by the final consumer in the marketing process. While the remaining 54.5% and 62.2% of the consumers' expenditure on cowpea will go to other marketers in the marketing system.

CONCLUSION AND RECOMMENDATIONS

The research findings revealed that, PICS technology help farmers avoid (abate) grain weight loss of 15.3% (13.8kg) valued at ₦3, 450 per bag per season. Indicating that PICS is more effective in reducing storage loss caused by insect infestation, and better-quality grain than with polypropylene bags. Also, the use of hermetic bags presents higher return and price share to users per season. Indicating that the use of PICS technology has a better economic effect than the storing with Polypropylene (woven) bag. The study recommend that farmers adapt the use of PICS in the storage of beans.

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