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ECONOMIC BENEFIT OF ADOPTING PURDUE IMPROVED CROP STORAGE BAGS FOR MITIGATING POST HARVEST LOSSES OF LEGUMINOUS CROP PRODUCE AMONG RURAL FARMERS IN BENUE AND TARABA STATES NIGERIA

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Abstract
This study was conducted to assess economic benefits of adopting Purdue Improved Crop Storage (PICS) bags among rural farmers in Benue and Taraba States, Nigeria. The population of the study consisted of all leguminous crop farmers, three (300) respondents were selected as sample size using stratified, purposive and simple random sampling techniques. Data collected were from the primary source with the use of structured questionnaire and were analyzed using both descriptive and inferential statistics, particularly frequency, percentages, Factor analysis and Kruskal Wallis. The study reveals that Socioeconomic factors such as level of education (71.0%),farm size (89.3%), marital status (78.3%) had influence on farmers' decision to reject or adopt pics bags technology. It was also found that there was no significant difference (P>0.05) across the three agricultural zones in Benue and Taraba States, in terms of economic benefits of adopting PICS bags. The Kruskal Wallis (H) test conducted shows that H.cal. (-118.1) <x^2tab (11.1) at 0.05 level of probability, It was also found that there were three major categories of constraints to adoption of pics bags, namely innovation related constraints (factor 1) such as complexity of the pics bags (0.489), trialability of the pics bags (0.465) profitability of the pics bags (0.486),, socioeconomic cum cultural constraints (factor 2), such as high cost of pics bag (0.436), Lack of awareness of pics bag (0.592) inadequate extension service (0.544), administrative cum environmental constraints (factor 3) such as policy framework (0.872) climate change (0.444), respectively. Based on the findings of this study , it was concluded that farmers who adopted Pics bags experienced notable reduction in pest infestation, grain deterioration and quantitative losses compared to those using traditional storage methods. It was recommended that more awareness campaigns on Pics bags should be created to farmers.

Keywords: *Economic, Benefits, adoption, Purdue, post harvest losses.*

1.0 Introduction

Agriculture is one of the major sources of the Nigeria's economy. In the course of carrying out agricultural activities in Nigeria and Benue State in particular, farmers have been adopting unacceptable agricultural practices such as traditional methods of agricultural production using hoe and cutlass in weeding instead of using herbicides They also adopted traditional methods of storage, instead of adopting Purdue Improved Crop Storage (PICS) bags for mitigating post-harvest losses of leguminous crop produce among rural farmers in Benue and Taraba States.(Chikoye *et al.,* 2018).

According to Age.(2017), Post-harvest losses can be defined as measurable quantitative and qualitative damages or spoilage in the post-harvest value chain caused by natural or artificial phenomena. These losses affect both the quality and quantity of crop produce, thus reducing their economic value and the total income of the producers. Albeit the per capita agricultural productivity of leguminous crop producers seems to be on the increase in Nigeria these days, almost half of what is produced is lost due to poor handling, processing, preservation, storage, and transportation to the markets where majority of consumers are found (Age, 2017). From Agricultural extension perspective, post-harvest losses can be conceptualized as all the natural and artificial damage that occur to agricultural crop produce after harvest and can be traced from pre-harvest production value chain to post-harvest value chain, culminating at the stage of retail marketing. In modern agriculture, application of science and technology is critical, hence rural farmers are encouraged to adopt Purdue Improved Crop Storage (PICS) bags for mitigating post-harvest losses of leguminous crop produce among rural farmers, by so doing, it could lead to measurable impact in ensuring food security and long term

sustainable food production (Ajayi *et al.,*2021).

The challenges of food shortage would be as a result of pest infestation ,which leads to poor nutrition , poor income, poor State of mind, which also result to high blood pressure of so many farmers. This development is worrisome, loathsome and despicable, considering the teeming population of our country (Nigeria) to be fed with what is domestically produced (Boaua *et al.,*2014). To address this issue, Purdue improved crop storage bags (PICS) technology was developed as a cost effective, triple hermetic storage solution that enables farmers to store grains without the use of insecticides. The PICS bags have been promoted across various States in Northern Nigeria aiming to reduce post-harvest losses and improve food security among rural farmers (Ayertey *et al.,*2020).

2.0 Objectives of the Study

The broad objective of this study was to assess economic benefits of adopting Purdue improved crop storage bags (PICS) for mitigating post- harvest losses of selected leguminous crop produce among rural farmers in Benue and Taraba States, Nigeria.

The specific objectives of this study were to:

i. describe the socioeconomic characteristics of the respondents in the study area
ii. identify economic benefits of adopting Purdue improved crop storage bags among rural farmers in the study area; and
iii. identify constraints to adoption of Purdue improved crop storage bags among rural farmers in the study area.

3.0 Methodology

This study was conducted in Benue and Taraba States, Nigeri:a .Benue State derives its name from River Benue, the second largest River in Nigeria .The State was

created in 1976 and is located in the middle belt region, which is a transition zone between the northern and southern part of Nigeria. It lies between longitude $6^0$31'E and 10^0E of the green witch meridian and latitude $6^0$30'N and $8^0$10'N of the equator (Benue State Agricultural and Rural Development Authority BNARDA. (2005). Benue State shares boundaries with other States, namely; Nasarawa to the North, Taraba to the East, Kogi to the West, Enugu to the South- West, and Cross River to the South. It also shares international boundary with the Republic of Cameroon on the South East BNARDA. (2005). Benue State has a land mass of about 33, 955km^2 with 23 Local Government Areas. The State is divided into 3 agricultural zones, namely; Zone A (Katsina Ala, Ukum, Ushongo, Vandeikya, Logo, Kwande and Konshisha Local Government Areas), Zone B (Gboko, Tarka, Buruku, Gwer, Gwer West, Guma and Makurdi Local Government Areas) and Zone C (Ado, Otukpo, Ohimini, Obi, Ogbadigbo, Okpokwu and Oju Local Government Areas).

According to National Population Commission .(2006), Benue State has a population of 4.219.244 million, given the annual growth rate of three percent World Bank .(2024), the estimated population of the State in 2017 was 5.84 million, There are three major ethnic groups in the State, namely, Tiv, Idoma and Igede, other ethnic groups are Etilo, Abakpa, Ofia and Jukun. There are also non-indigenes like the Hausa, Ibo and Yoruba BNARDA. (2005).

The State has favourable agro-climate ecologies for arable crop, tree crop and livestock production and enjoys two distinct seasons, wet and dry seasons. The rainy season begins from April to October, while the dry season starts from November to March. Annual rainfall records varies from 1700mm in the southern to 1250mm in the Northern part with an annual temperature variation of 30^0C and 38^0C According to

BNARDA. (2005) These features create favourable conditions for the cultivation of crops, such as yam, cassava, sweet potato, maize, millet, rice, soyabean, groundnut, cowpea, beans beniseed, fruit crops and vegetable crops. Livestock such as sheep, cattle, goats, pigs and poultry are kept in the State.

Benue State is blessed with abundant mineral resources in the North Central geopolitical zone in Nigeria and has many untapped mineral resources within it's territory, and these mineral resources can be found in various Local Government Areas of the State. According to Benue State agriculture and rural development authority.(2005), limestone can be found in Tsekucha, near Gboko and caolinite at Otukpo are the major mineral deposits that have been commercially exploited by Dangote cement PLC, other untapped resources in Benue State are baryte, feldspar, limestone, gypsum, natural gas, salt, petroleum, clay, coal, calcite, gemstone and magnite BNARDA.(2005).

Taraba State was created out of the former Gongola State on 27 August, 1991 by the military Government of General Ibrahim Badamosi Babangida. The State is an amalgam of three former divisions, Wukari, Mambilla and Muri Divisions. Taraba State is a State in the North-Eastern Nigeria, named after the Taraba River, which traverses the Southern part of the State, and the State capital is Jalingo. Taraba State lies between latitude $6^{0}30'$ and $9^{0}36'$ and Longitude $9^{0}10'50'$ East. It has total land mass of $54.473km^{2}$ ($21,032^{2}m$) and world bank growth of 2024 to estimate the population of 2,294,800 based on 2006 census. The State is bounded in the North by Bauchi, Gombe and Adamawa on the North West by Plateau. The State is further bounded to the East by both Nasarawa and Benue States, while it shares an international boundary with Republic of Cameroon to the South and South East, Taraba State Cathalic Relief Service .(2017).

Taraba State consists of 16 Local Governments Areas, namely Bali, Ibi, Gassol,

Donga, Wukari, Takum, Kurmi, Sarduna, Jalingo, Gashaka, Ussa, Ardo-Kola, Zinng, Yarro, Lau and Karim-Lamido. The major occupation of the people of Taraba State is agriculture. Cash crops produced in the State include coffee, tea, cowpea, beans, groundnut, cotton. Cash crop such as rice, maize, sorghum, millet and yam are also produced in commercial quantities, Taraba State Cathalic Relief Service (2017).

In addition, cattle, sheep and goats are reared in large numbers, especially on the Mambilla plateau and along Benue and Taraba valleys. They also undertake livestock production like poultry and rabbit breeding on large scale. Communities living on the bank of River Taraba, River Donga and Ibi engage in fishing all year round. Other occupational activities such as pottery, cloth weaving, dying, mat making and blacksmiths are also carried out in various parts of the State, Taraba State Cathalic Relief Service .(2017).

Taraba is called the nature's gift to the nation as the State is rich and has many ethnic groups including; Jenjo, Ketub, Chamba, Mumuyes, Mambila, Wurkun, Jibu, Fulani, Jukun, Ichen, Tiv, Daka, Yandang, Tigun, Hausa and Ndola. The Northern part is mainly dominated by the Fulani and Mumuye. The Southern part are dominated by Jukun, Chamba, Tiv, Kuteb and Ichen. The Central region is mainly occupied by Fulani, Mumuye, Ndola, Tigun, Jibu, Wurbo, and Daka people, Taraba State Cathalic Relief Service (2017). The climate in Taraba State is marked by dry season between (November - March) and rainy season (April - October). It has an average annual rainfall ranging between 800mm to 1525mm and temperature variation between to 38^0, Taraba State Cathalic Relief Service (2017).

The agrarian nature and rich alluvial track of soil found in most parts of the State makes the State conducive for growing of various food crop. Majority of inhabitants are

farmers, civil servants and traders, some inhabitants engage in farming as a secondary occupation. The basic amenities available are schools, hospitals, electricity, Minerals and communication service among others. Some of the minerals found in Taraba State include: Limestone-used in cement production and construction, Gypsum-Essential for cement manufacturing and soil treatment, Bauxite, Granite-used for construction and decorative stone purposes, Lead/Zinc-used in batteries and metal alloys, Tin, Barite , Marble, Gold, Kaolin.

3.3 Population of the Study

The population of this study consisted of all leguminous crops producers in Benue and Taraba States.

3.4 Sample Size and Sampling Technique

Due to the largeness of the population of the study, a total of 300 respondents was selected as sample size using stratified, purposive and simple random sampling techniques. Firstly, Benue and Taraba States were purposely selected from the North Central, Nigeria due to high production of leguminous crop produce. Secondly, in each of the State, the population of the study was stratified into 3 agro ecological zones. in Benue State, three zones (A, B and C) was selected based on the existing structures due to heterogeneous nature of the States. In Taraba State, the stratified zones include Southern, Central and Northern zones.

Finally, in each of the States, a sampling frame was developed for each of the rural communities in their respective LGAs and using proportional allocation of 1percent (0.01) across board, a total sample size of 300 respondents were selected for the study, thereafter, each stratum was subjected to simple random sampling technique in order to

arrive at the total sample size of 300 respondents

3.5 Data Collection

Data for this study were collected from primary sources with the use of structured questionnaire. This questionnaire consists of (3) three section, namely; A,B and C. Section A dealt with socioeconomic characteristics of the respondents in the study area. Section B focused on economic benefits of using Purdue improved crop storage bags among rural farmers in the study area, while Section C addressed constraints to adoption of Purdue improved crop storage bags among rural farmers in the study area respectively.

3.8 Data Analysis

Data were analyzed using descriptive and inferential statistics. Descriptive statistics such as frequency, percentage were used to analyze specific objectives (i), and Kruskal Wallis (H) test was used to analyze specific objectives (Ii) and (iii), while the null hypotheses (i and ii) were tested using Kruskal Wallis (H) test at 0.05 level of significance.

4.0 Results and Discussion

Table 2 shows that majority (52.0%) of the respondents were males, while (48%) were females. This indicates that men often have greater control over cash, market transactions and formal extension contacts, women often handle household level storage and daily food management. (Mudege *et al.,*2018).

Purdue improved crops storage (PICS) bags depend on who controls purchase, who take decisions, who stores the legumes and who received extension messages. If women are primary managers,of . store grain but lack decision making power or cash up take will be low even if they prefer the bags (Nkere *et al.*,2020).

Also if males were more involved in cultivation of selected leguminous crops,

they will also adopt PICS bags to store their grains to prevent pest infestation against their crop produce. It may also be linked with cultural background of many African communities, where adoption of any innovation decision are commonly regarded as a man's responsibility as the head of the family(Ojo et al.,2021).

Some of the respondents (32.0% were within the age range of 41-50 years. About 25.% of the respondents were within the age range of 31-40 years. This implies that younger farmers within the age range of 30-50 years are often more open to adopt new technologies and quicker to experiment.They may also have the resources to adopt, while very old farmers may be more conservative to adopt innovations (Nkere *et al.,*2020)..

Majority (78.3%) of the respondents were married, while (11.3%) were widowed, (1.67%) were single (3.0%) were divorced, widowers were (5.67%). Married households usually have larger household production and consumption needs and more combined labour/capital than single or widowed (Baributsa et al.,2020). Married households may have higher storage needs and greater incentives to invest in storage.

Majority (71.0%) of the respondents had secondary school education, (15.67%) had primary education, (11.3%) had tertiary education, while (1.99%) had postgraduate education This implies that, the respondents are able to contribute effectively to agricultural activities in both States due to the technical knowledge and skills they possessed This finding agrees with (Okoye et al.,2014) and Anonguku .(2014). who stated that it is critical to understand the value and adoption of innovation thereby fast-tracking development.

Analysis of household size indicates that majority (65.67%) of the respondents had 6-10 household members, (22.67%) of the respondents had 1-5 household members, while (8.3%) had more than 10 persons. Household size plays a significant role in

providing family labour for agricultural production. Larger households size produce and consume more and may therefore have greater storage needs, but also greater labour availability for handling storage of produce, (Alhassan et al.,2019). This finding agrees with that of Ayertey et al.(2020) who stated that the greater the storage needs, the greater the needs for adoption of PICS bags for mitigating post-harvest losses of selected leguminous crop produce among rural farmers in Benue and Taraba States.

Majority (69%) of the respondents in both Benue and Taraba States were farmers. About (19%) of the respondents were traders, (8.67%) of the respondents were teachers, while (3.3%) of the respondents were civil servants. This implies that the primary occupation of the respondents was farming. This agrees with Sanusi *et al.(*2020) who stated that more than (70%) of the rural farmers in Benue and Taraba States engage in farming, mostly on a large-scale if to be on large scale, there is demand for greater storage needs which call for adoption of Purdue improved crop storage (PICS) bags to prevent pest infestation against leguminous crop produce among rural farmers in Benue and Taraba States (Mudege et al.,2018).

Majority (65.33%) of the farmers had 6-10 years of farming experience. About (21.0%) of the respondents had 1-5 years of farming experience, while (9.0%) of the respondents had 11-20 years of farming experience. This finding reveals that experienced farmers were ready to adopt improved technologies such as PICS bags for mitigating post harvest losses. Therefore experienced farmers have been reported to increase technical efficiency (Kumar et al.,2017). This finding agrees with Chikoye et al. (2018) who stated that inexperienced farmers may be conservative, while experienced farmers may adopt proven tools to reduce post-harvest losses and be open to new technologies to mitigate post-harvest losses of selected leguminous crops produce among rural farmers in Benue

and Taraba States (Baributsa et al.,2014).

Some of the respondents (45%) earned an annual income ranging from N1,000,000 – N1,800,000 in Benue and Taraba States. About (27.0%) of the respondents earned N1,500,000 – N1,600,000, while (18.3%) of the farmers earned above N1,800,000. The main source of income is said to influence farming decisions, as farming practices depend on capital investment, which is dependent on income (Mathange and Schirly.,2008). This implies that peasant farmers are more likely to experience poverty.

Anonguku .(2014) supported this statement that constraints to sustainable agricultural development arise from the peasant nature of the farming system, characterized by low income, low productivity, low response to technology adoption and low return on investment. Baributsa et al.(2014)

Majority (89.3%) of the respondents cultivated 6-10 hectares of farm-land; about (5.0%) of the respondents cultivated 1-5 hectares of farm-land, while (2%) cultivated 11-20 hectares. This indicates that farmers in both States are willing to engage in agriculture on a large-scale, and therefore can spread the unit cost of PICS over more produce (Alhassan et al.,2019). It also implies that any meaningful agricultural development project introduced will likely be embraced to improve their socioeconomic status. Ajayi et al. (2021) stated that the larger the farm size, the early the adoption of improved technologies to ease the production capacity of rural farmers.

Table 2: Distribution of respondents based on Socioeconomic Characteristics (n=300)

Variables	Benue		Taraba		Pooled	
	Freq	%	Freq	%	Freq	Pooled
Sex						
Male	78	52	78	52.0	156	52.0
Female	72	48	72	48.0	144	48.0
Age (years)						
≤ 30	5	3.33	--	--	5	1.67
31-40	39	26.0	37	24.67	76	25.33
41-50	45	30.0	51	34.0	96	32.0
51-60	32	21.33	30	20.0	62	20.67
≥ 61	29	19.33	32	21.33	61	20.33
Marital Status						
Single	4	2.7	1	7	5	1.67
Married	113	75.3	122	81.3	235	78.33
Widowed	19	12.7	15	10.0	34	11.33
Divorced	5	3.5	4	2.7	9	3.0
Widower	9	6.0	8	5.3	17	5.67
Level of Education						
Primary school	23	15.3	25	16.7	47	15.67
Secondary school	104	69.3	109	72.7	213	71.0
Tertiary	20	13.3	14	9.3	34	11.33
Post-graduate	3	2.0	2	1.3	6	1.99
Household Size (persons)						
1-5	39	26.0	29	19.3	68	22.67
6-10	85	56.0	112	74.7	197	65.67
11-15	16	10.7	9	6.0	25	8.3
16-20	9	6.0	--	--	9	3.0
21-30	1	0.7	--	--	1	0.33
Major occupation						
Farming	102	68.0	105	70.0	207	69.0
Trading	25	16.7	32	21.3	57	19.0
Hunting	7	4.7	3	2.0	10	3.33
Teaching	16	10.7	10	6.7	26	8.67
Farming Experience (years)						
1-5	35	23.4	28	18.7	63	21.00
6-10	86	57.3	109	72.7	196	65.33
11-20	18	12.0	9	6.0	27	9.00
21-30	9	6.0	3	2.0	12	4.00
31 and above	2	1.3	1	0.7	2	0.67
Annual income (Naira)						
100,000 - 1,200,000	17	11.3	4	2.7	21	7.0
1,200,000 - 1,400,000	8	5.3	44	29.3	8	2.67
1,400,000 - 1,600,000	37	24.7	79	52.7	81	27.0
1,600,000 - 1,800,000	57	38.0	23	15.3	135	45.0
Above 1,800,000	31	20.7	--	--	55	18.3
Farm size (Hectares)						
1-5	8	5.3	7	4.7	15	50.0
6-10	125	83.3	143	95.3	268	89.33
11-20	7	4.7	--	--	6	2.00
21-30	6	4.0	--	--	4	1.33
31-40	4	2.7	--	--	--	--

Source: Field Survey, (2025).

4.2 Economic Benefits of Adopting Purdue Improved Crop Storage Bags (PICS)

Table 3 shows that there was no significant difference (P>0.05) across the three agricultural zones in Benue and Taraba States in terms of economic benefits of adopting Purdue Improved Crop Storage bags (PICS) among rural cowpea and groundnut farmers. The Kruskal Wallis analysis conducted shows that H cal. (-118.1) $<X^2$ tab. (11.1) at 0.05 level of probability. It also reveals that

$\sum R_1$=650.0, $\sum R_2$=255.5, $\sum R3$=209.5, $\sum R_4$=708.0, $\sum R_5$=213.0 and $\sum R_6$=61.0.

The above finding implies that the rural cowpea and groundnut farmers in both Benue and Taraba States have been deriving Similar or common economic benefits from adopting Purdue Improved Crop Storage bags (PICS). For instance, Storage longevity in Benue State ($\sum R_1$=62.0) Taraba State ($\sum R_4$=54.5), reduction in food contamination in Benue State ($\sum R_1$59.0) and Taraba State ($\sum R_4$=62.0), reduced insect pest infestation in Benue State ($\sum R_1$=57.0), while in Taraba State, $\sum R_4$= 62.0, increased production in Benue State ($\sum R_1$=57.0), while in Taraba State, $\sum R_4$ was 62.0 and so forth.

This similarity could be due to geographical contiguity between Benue and Taraba States This finding agrees with Ajayi *et al. (*2021) Who stated that one of the most significant importance of Purdue Improved Crop Storage (PICS) bags is the reduction of post-harvest losses. According to Chikoye *et al. (*2018) traditional storage systems such as sacks often result in losses of up to 30%-50% of stored produce, particularly due to pests infestation.

Table 3: Kruskal Wallis Analysis of Economic Benefit of Adopting Purdue Improved Crop Storage (PICS) Bags

States:	Benue						Taraba					
	SA		AG		SD		SA		AG		SD	
Variables	**Freq**	**R1**	**Freq**	**R2**	**Freq**	**R3**	**Freq**	**R1**	**Freq**	**R2**	**Freq**	**R3**
Improved food security	130	59.0	20	14.5	10	5.0	80	47.5	45	33.0	5	4.5
Improved grain quality	110	49.5	30	23.0	00	5.0	11	54.5	6	7.0	4	2.0
Improved standard of living for farmers	90	44.0	40	30.0	20	14.5	100	47.5	40	30.0	10	5.0
Income & Profitability of PICS	85	41.5	25	18.5	40	30.0	130	52.0	20	14.5	--	--
Reduction in post harvest	130	50.0	20	14.5	--	--	150	62.0	--	--	--	--
Increased income for rural farmers	95	16.0	30	23.5	25	18.5	145	57.0	5	4.5	--	--
Reduced rural farmers challenge	50	34.5	60	36.5	40	30.0	75	35.0	35	26.5	48	--
Reduced insect pest infestation	145	52.0	5	4.5	--	--	150	62.0	--	--	--	--
Long term economic impact	85	40.5	30	23.0	25	18.5	110	49.5	30	23.0	50	5.0
Reduced food contamination	148	59.0	2	1.0	--	--	150	62.0	--	--	--	--
Chemical free consumption	25	18.5	35	36.5	90	44.0	30	23.0	40	30.0	--	39.5
Increase in legume production	145	57.0	5	4.5	--	--	150	62.0	--	--	--	--
Storage longevity	150	62.0	--	--	--	--	140	54.5	10	5.0	--	--
Trust & confidence in PICS bags	50	34.5	--	--	90	44.0	60	36.5	80	39.5	00	5.0

H.cal = $\sum R_1 = 650.0,\ \sum R_2 = 255.5,\ \sum R_3 = 209.5,\ \sum R_4 = 708.0,\ \sum R_5 = 213.0, \sum R_6 = 61.0$

Source: Field Survey, (2025)

4.3 Constraints to Adoption of Purdue Improved Crop Storage (PICS) Bag in Benue and Taraba States

Table 4 shows that there were three major categories of constraints to adoption of Purdue Improved Crop Storage (PICS) bags among rural farmers in Benue and Taraba States, namely; Innovation related constraints (Factor 1), Socioeconomic cum cultural constraints (Factor 2) and Administrative cum environmental constraints (Factor 3).

In Factor 1, the significant innovation related constraints to adoption of Purdue Improved Crop Storage (PICS) bags among rural cowpea and groundnut farmers in Benue and Taraba States were complexity of the PICS bags (0.489), relative cost

advantage (0.300), compatability of PICS bags (0.321), triability (0.465), observability (0.404), profitability (0.456) and laborious activities (0.503). In Factor 2, the significant socioeconomic cum cultural constraints to adoption of Purdue Improved Crop Storage (PICS) bags among rural cowpea and groundnut farmers in Benue and Taraba States were high cost of Purdue Improved Crop Storage (PICS) bags (0.462), lack of awareness (0.592), lack of market information (0.332), inadequate extension services (0.544), poverty level of farmers (0.418), ethnocentrism (0.302), lack of credit facilities (0.336) and level of education (0.723).

In Factor 3, the significant administrative cum environmental constraints to adoption of Purdue Improved Crop Storage (PICS) bags in Benue and Taraba States were lack of policy framework (0.872) and climate change (0.444). The above findings have several implications as far as adoption of innovation is concerned. Firstly, the innovation related constraints such as complexity, compatibility, relative cost advantage and profitability can either make or mar adoption of Purdue Improved Crop Storage (PICS) bags among rural cowpea and groundnut farmers in Benue and Taraba States. For instance, if Purdue improved crop storage (PICS) bags are physically available but not economically affordable, it may adversely affect adoption among rural cowpea and groundnut farmers in Benue and Taraba States. The present cost of one Purdue improved crop storage (PICS) bag in the market is between #2000- #2500

Secondly, if rural farmers are not aware of the advent and usage of Purdue improved crop storage, bags, they cannot adopt them. Besides, lack of marketing information, inadequate extension services, low level of education service and lack of credit facilities can adversely affect adoption among farmers in Benue and Taraba States.

Thirdly lack of policy framework on the usage Pics bags among rural farmers

This finding agrees with Nkere *et al.(*2020) who stated that government policy such as subsidized or incentive for Purdue Improved Crop Storage (PICS) bags can facilitate adoption, effective implementation and alignment with national agricultural strategies are critical.

According to Rogers (2013), the rate of adoption of an innovation like the Purdue Improved Crop Storage (PICS) bags among rural farmers particularly in Benue and Taraba States has attracted significant academic and policy interest, generally in Northern Nigeria, where post-harvest losses of leguminous crop are prevalent

Table 4: Factor Analysis of Constraints to Adoption of Purdue Improved Crop Storage (Pics) Bags in Benue and Taraba States

Variables	Factor 1	Factor 2	Factor 3
High cost of PICS bags (HCOPS)	0.073	0.426**	0.027
Lack of awareness (LOA)	0.041	0.592**	0.118
Lack of market information (LOMI)	0.795-02	0.332**	0.031
Inadequate extension services (IES)	0.244	0.544**	0.107
Poverty level of farmers (PLF)	0.042	0.418**	0.136
Ethnocentrism (EM)	0.411E-12	0.302**	0.164
Lack of policy framework (LOPF)	0.134	0.336-02**	0.872***
Lack of credit facilities (LOCF)	0.872E-02	0.336**	0.134
Level of education (LOE)	0.027	0.723**	0.286
Complexity of PICS bags (COPB)	0.489*	0.187	0.120
Relative cost advantage (RCA)	0.300*	0.063	0.86E-3
Compatibility of PICS bags (COPB)	0.321*	0.564E-2	0.032
Triability of PICS bags (TOPB)	0.465*	0.265	-0.54
Observability of PICS bags (OOPB)	0.404*	0.052	0.011
Profitability of PICS bags (POPB)	0.456*	0.42	0.262
Laborious Activities (LA)	0.502*	0.002	0.187
Climate change (CC)	0.017*	0.013	0.444***

Method: Varimax with Kaisesrs Normalization
*Factor 1: Innovation related constraints.
**Factor 2: Socioeconomic cum cultural related constraints.
***Factor 3: Administrative cum environmental constraints.

Source: Field Suvey, (2025)

5.0 Conclusion and Recommendations

5.1 Conclusion

Based on the findings of this study, it can be concluded that this technology has played a significant role in mitigating post harvest losses of selected leguminous crop produce such as cowpea, Groundnut and soyabean. The study shows that farmers who adopted pics bags experienced notable reduction in pest infestation, grain deterioration, and quantitative losses compared to those using traditional storage method. The finding underscores the importance of sustained awareness campaigns, effective extension support. Strengthening these measures will not only improve adoption rate but also contribute to food security, and income stability.

5.2 Recommendation

Based on the findings of this study, the following recommendations were made:

(I) Government agencies, research institutions and Non-governmental organizations should intensify awareness campaigns and practical demonstrations on the benefits and proper use of PICS bags. Extension agents should be trained and adequately equipped to disseminate information and provide technical guidance to farmers at the grassroots level.

(ii) As the cost of PICS bags remains a major barrier to adoption, stakeholders, including Government and private distributors, should explore subsidy schemes, cooperative purchasing systems, and local retail networks to make the bags more affordable and readily available in rural communities.

(iii) Encouraging local production of PICS bags within Nigeria can reduce costs associated with importation and improve availability. Partnerships between

manufacturers, aggro-dealers, and farmers' cooperatives can strengthen distribution channels and ensure timely supply during harvest seasons.

(iv). Regular training workshops should be organized for farmers to enhance their knowledge of post-harvest handling, proper grain drying, and correct usage of PICS bags to ensure maximum efficiency and durability of the storage technology.

(v). Government should integrate the promotion of improved storage technologies into agricultural development policies and programs. Collaboration among agricultural research institutes, extension services, and donor organizations can accelerate technology dissemination and adoption.

References

Afolabi, M. M. (2008). Women as pillars of the economy in Nigeria: A study of economic activities of rural women in six Local Government Areas in Ondo State. Proceedings of the international association for feminist economics summer conferences, June 19 - July 21, Italy, 1-14.

Age, A. I. (2017). Sustainable Agriculture and Rural Development: Panacea for national security threats and absolute poverty in Nigeria. First published by Kency Printing Press, Makurdi. 102-120.

Ajayi, C.A., Fasae, O.O.,and Okoli, A. (2021). Adoption of management of post harvest of cowpea in Nigeria. *International Journal of Agricultural Sustainability , ISSN 1562-3599.*

Alhassan, R., Mohammed, A., Abdulaziz, A. and Affarhood, I. (2019). Factors influencing the adoption of Purdue improved crop storage (PICS) bags among smallholder farmers in northern Ghana. J*ournal of Stored Product Research , 8(2), 673-676.*

Anonguku I. (2014) Comparative assesment of rural and agricultural project in Benue and Nassarawa states of Nigeria. A Ph.D thesis submitted to Department of gricultural Extension and Communication. Federal university of agriculture, Makurdi pp102-103.

Asogwa, U.G., Taru, B., Cynthia, N.,and Ikplamaeze, G.C. (2021). Cowpea grains stored with profitability of cowpea storage technology in Benue State, Nigeria, 165-164.

Ayertey, N.J., Offori-attah, S., Anthony ,M., Bosomoen, G. (2020) .Adoption of Purdue improved cowpea storage (PICS) technology in Ghana; what factors explains farmers usage intensity? world development perspective 83: 353-363.

Baoua, I.B, Margam, V., Amadou, I., and Murdock, L.L. (2014). performance of triple-layer hermetic storage bags for post harvest preservation of cowpea grain in Niger *"Journal of Storage Products Research 5; 9-14.*

Baributsa, D.,and Njoroge ,A.W. (2020). The use and profitability of hermetic technologies for grain storage among Smallholder farmers in Eastern Kenya. J*ournal of Stored Products Research , 87, 101-610.*

Baributsa,D., Lowenberg DeBoer, J., Murdock, L., Moussa B. (2014). Adoption of hermetic Storage for groundnut and cowpea in West Africa and Central Africa. *Journal of stored product research.58;35-42.*

Benue State Agricultural and Rural Development Authority, (BNARDA) (2005). BNARDA yield survey report 2005.

Chikoye, S., Agbolla, A., Adieke, K. (2018). Evaluation of Purdue improved cowpea storage (PICS) bags in West Africa: impact on post-harvest reduction "*journal of post harvest Technology, 6(3), 14-21*

Food and Agricultural Organizations (FAO) (2019). Reducing post harvest losses in sub-saharan Africa: the role of hermetic storage technologies FAO report.

Fulton, J., Murdock,L. L., Moussa, B., Stanish, L., Everhart-Valentin, K. and Lowenberg-DeeBoer, J. (2009). Applying research with extension;22 years of strengthening cowpea storage in Africa .Proceeding of the 25th annual meeting , association of international agricultural extension education (AIAEE) Kristina, R., Robert, S., Alexa,L., (Eds) Inter-continental San juan Resort, Puert Rico pp.509-510

Kumar, D.and Kalita, P. (2017). Reducing post harvest losses during storage of grain crops to strengthen food security in developing countries. *Foods , 6(1), 8. doi:10.3390/foods6010008.*

Mahamane, M., Ibrahim, B., Barua .and Dieudonne, B. (2021).Adoption and profitability of the Purdue improved crop storage technology for grains storage the South-Central Regions of Niger 3-4.

Mathangi and Tschirly (2008) off farm work and farm production discussions: evidence fro maize production house in rural kenge tegemo working paper series No 33/2008 p25-45.

Mudege, N.N., Mbiri, D., Mdege, N. (2018) .Factors influencing adoption of Purdue improved crop storage bags (PICS) by small-holder farmers in Kenya. Food Security DOI: 104160/97892906051l9 53(1)37-48.

National populations Commission (NPC), (2006). population census of the Federal Republic of Nigeria Census report. National population commission Abuja 2006.

Ngigi, M.(2009). Climate change adoption strategies water resources management option for smallholder farming system in sub-saharan Africa . The World Bank 33 (2) 255-298.

Nkere C., Joachim, N., Onyeyirichi O., Onye Ka, T.J. (2020). Influencing of Purdue improved crop storage (PICS) bags among cowpea farmers in Northern Ghana. *Journal of post harvest Technology Vol 396-397.*

Okoye B.C, Okorjo E.C and Assumugba G.N (2014) Outlook of production economics of rice under resource constraints in Ebonyi State Agbele, O.O, Idris N.B Rahiman S.A, Ali M.M, Orgaa M.I, and Assumugba (Eds) proceeding of the 38th Annual conference of agriculture Lafia, Nassarawa state 17th - 21st Oct. pp337-342.

Okwoche V.A, Asongwa B.C, and Hon F.A (2015) Assessment of extension education needs of crop farmers in Zone B area of Benue state Nigeria, *American International Journal of Social Science, 4(2) pp243-245.*

Ojo, A.O., Ojo, M.A., Adebayo, C.O. and Coker, A.A. (2021). Social network effects on the adoption of Purdue improved cowpea storage (PICS) bags technology among rural farmers in Nigeria. *African Journal of Agricultural and Resource Economics , 16(1), 1-15.*

Peterman, A., Behrman, J.A., and Quisumbing, A.R. (2014). A review of empirical evidence on gender differences in non land agricultural inputs technology and service in developing countries 37 (4) 481-492.

Rogers, E.M .(2013). diffusion of innovation theory and educational technology. *The Turkish online journal of technology. 85(3) :177-181.*

Sanusi R., Bello A. and Usman A. (2020) Rate of adoption and effectiveness of PICS bags in mittigating post harvest losses in Bauchi state, Nigeria *Journal of post harvest technology 8(3) 11*