

Comparing Efficiency of Hermetic and Non-Hermetic Storage Technologies among Legume Farmers in Nigeria

By

Bamikole Ayedun^{1*}, Tahirou Abdoulaye¹, M. Bokar², C. Alexander³, J. Ricker-Gilbert³
and D. Baributsa³

¹International Institute for Tropical Agriculture IITA, Ibadan, Nigeria

²Institut National de la Recherche Agronomique du Niger (INRAN), Maradi

³Purdue University, W. Lafayette, IN 47906

29th February,
Livingstone, Zambia

- ✓ Introduction
- ✓ Methodology
- ✓ Results and discussion
 - *How is legume stored at HH level*
 - *Hermetic vs non-hermetic*
 - *Farmers perceptions*
- ✓ Conclusion
- ✓ References



Poorly stored legume grains damage by weevils



Well stored healthy legume grains

- Grain legumes are more difficult to store than cereals and they suffer much greater damage from insects and microorganisms, which can be up to 100% in few month.
- Protection from common storage loss-agents like - insect pests, rodents, moulds & theft is necessary to allow farmers to reduce post-harvest losses.
- In storage, non-airtight storage structures (non-hermetic) and airtight storage structures (hermetic) can be use.
- Boys 2005 stated that use of insecticide/chemical in storage is common & according to Aitchedji (2004), insecticide/chemical poses health challenges; thus the need for safer storage options.

- This study therefore assess efficacies of different storage technologies used for grain legumes. Four storage technologies were compared including Traditional granaries (TG) and Woven bag (WB) that are non-hermetic; and Airtight containers(AC), and PICS bag(PICS) that are hermetic in nature.
- Note that PICS bags are hermetic and chemical free. Sometimes farmers add chemicals in other hermetic storage options.

❖ What are the types of storage technologies available?

❖ How do their efficacy compared (in terms of reducing PHL)?



Metal drum

❖ What factors influence the decision of farmers to store in hermetic containers (PICS bags mainly but also drums)?



Purdue Improved Crop Storage (PICS) bag



Metal silo



Plastic containers

NON-HERMITIC STORAGE options



Traditional Granary

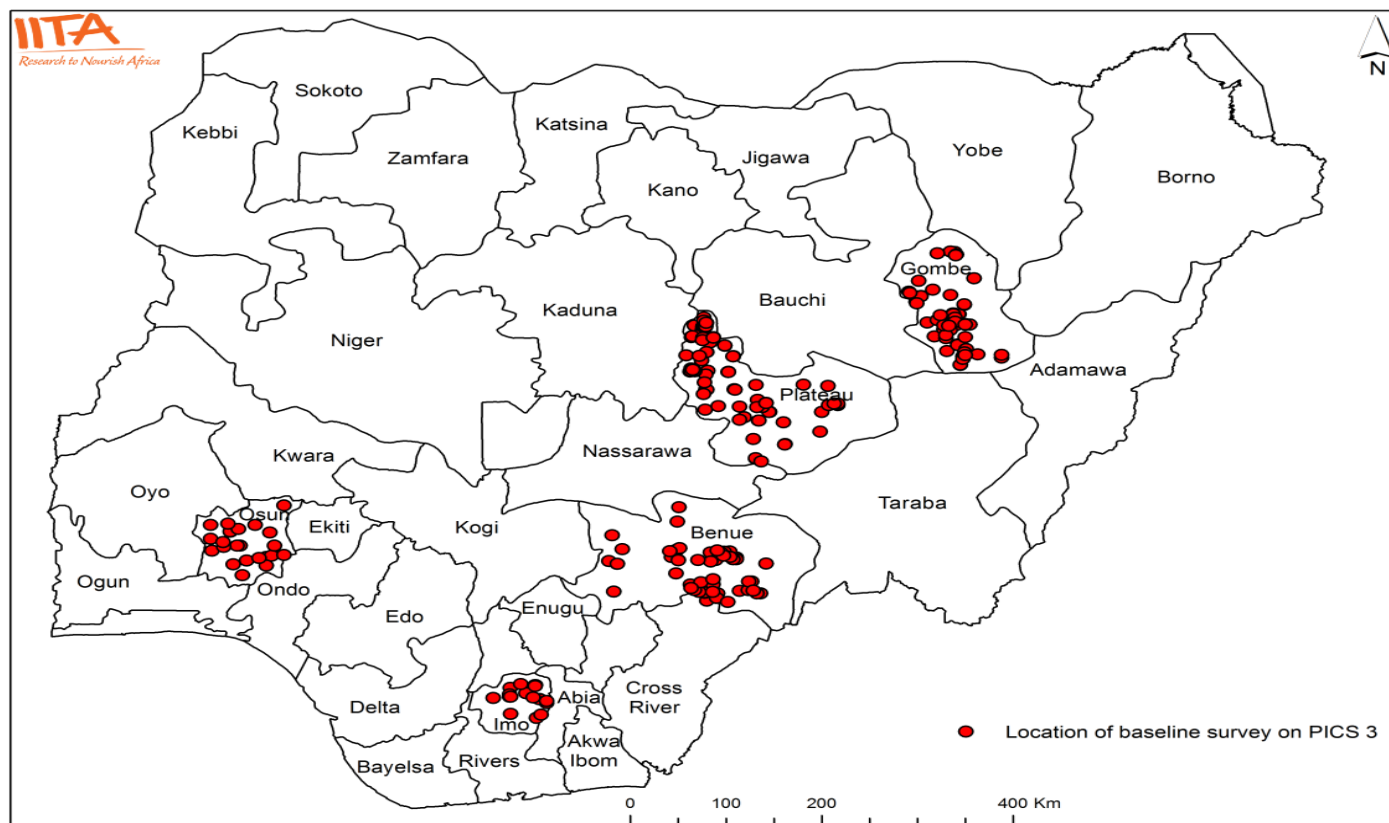


Woven Bag



Traditional Granary

- ✓ 2010 grain farmers were randomly selected from 134 farm villages in 6 of the states in Nigeria – Kano, Gombe, Benue, Imo and Osun
- ✓ From data 1139 farmers were producing legumes (38.2% cowpea farmers, 36.3% soybean farmers and 25.5% other legumes) & 1070 farmers were storing legumes.



1. Use of descriptive statistics - such as mean, standard deviation and frequency distributions
2. Logit model – for analysis of factors influencing decision to use hermetic storage (1= use hermetic with legume and 0 use non-hermetic storage)

$$LM = \ln(P_i / (1 - P_i)) = Z_i = \beta_0 + \beta_1 \sum_k X_{ik} + \varepsilon$$

Where:

P_i = probability that a farmer will store or not store his/her legume grains with hermetic storage technique; $X_{ik} = k = 1, 2, \dots, n$ = independent variables (with i th observation)

ε = error term with zero mean'

P_i is non-linearly related to Z_i

thus the dependent variable ' P ' is 1 if a farmer is storing his legume grains using hermetic storage and is '0' if using non-hermetic storage

β_0 = constant term / intercept;

β_k = coefficients of explanatory variables;

Socioeconomic characteristics of legume grain farmers

Variables	Value (N=1139)
Male%	97.0
Educated%	82.5
Storing legume at harvest%	
Yes	93.9
No	6.1
Mobility%	
Owned bicycle	29.9
Owned motorcycle	71.3
Association Membership%	46.5
Main sources of information on technology	
Family friend	46.1
Extension agent	20.9
Farmers group	29.2
Average Age	45.5(13.5)
Average Household Size	9(6.8)
Average Farm experience	18.3(11.7)
Average Land Area	4.4(4.7)
Average Distance (Nearest market)	5.2(9.8)
Average Year in the community	34.7(18.1)
Average Year of association	10.5(8.0)

✓ Legume farmers are mainly men (97%), Literacy is high (82.3%), Most of them store legumes at harvest (93.9%), 46.5% were member of association,

NB: Figures in the brackets are the SDs

Socioeconomic characteristics of legume grain farmers %

Variables	Hermetic (N=95)	Non Hermetic (N=975)
Male	96.5	97.2
Educated	74.3	84.3
Mobility		
Owned bicycle	34	29
Owned motorcycle	80.2	29
Association Membership	47	46.4
Main sources of information on technology%		
Family friend	52.2	44.8
Extension agent	22.9	20.5
Farmers group	21.8	30.8

- ✓ 9% of legume grain farmers stored their legume in Hermetic storage (HS), while 91% used Non-Hermetic storage (NHS)
- ✓ There were 2 types of HS: PICS (66.3%) and Airtight containers (33.7%)
- ✓ Two types of NHS were also identified: Traditional Granary (8.2%) & Woven Bag (91.8%)

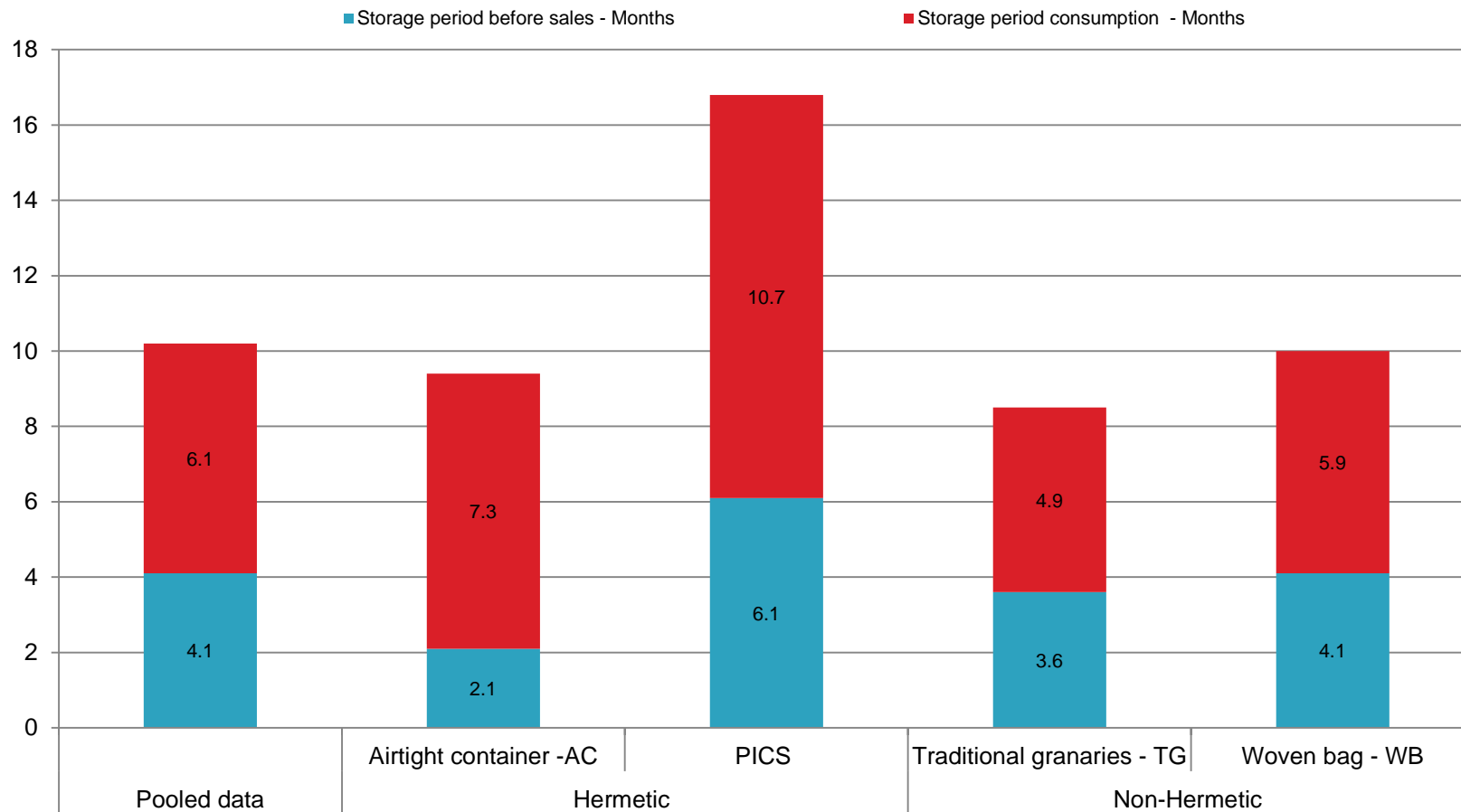
Socioeconomic characteristics of legume grain farmers by storage types

Variables	Hermitic	Non Hermitic	Mean Difference	Significant Level	T-Value
Age	49.5±14.7	45.1±13.42	4.39	0.0016	3.17
Household Size	9.9±5.20	8.9±6.89	1.01	0.0072	1.82
Farm experience	23.85±11.63	17.77±11.55	6.08	0.00000013	5.08
Land Area	4.54±4.54	4.32±4.74	0.2	0.66	0.44
Distance (Nearest market)	7.05±9.09	5.05±9.08	1.97	0.049	1.97
Year in the community	43.76±15.67	33.88±18.09	9.88	9.56E-08	6.04
Years of using the technology	5.37±2.79	8.26±2.49	-2.900	6.28E-18	-10.17
Year of association	17.38±8.67	10.16±7.8	7.22	0.0011	3.73

✓Hermetic usage farmers were more aged, more experienced in farming, more mobile, sell grain in far distanced markets, and have been in 'association' for longer period compared to Non-Hermitic ones.

✓The differences in characteristics could affect econometric results between the 2 sets of farmers.

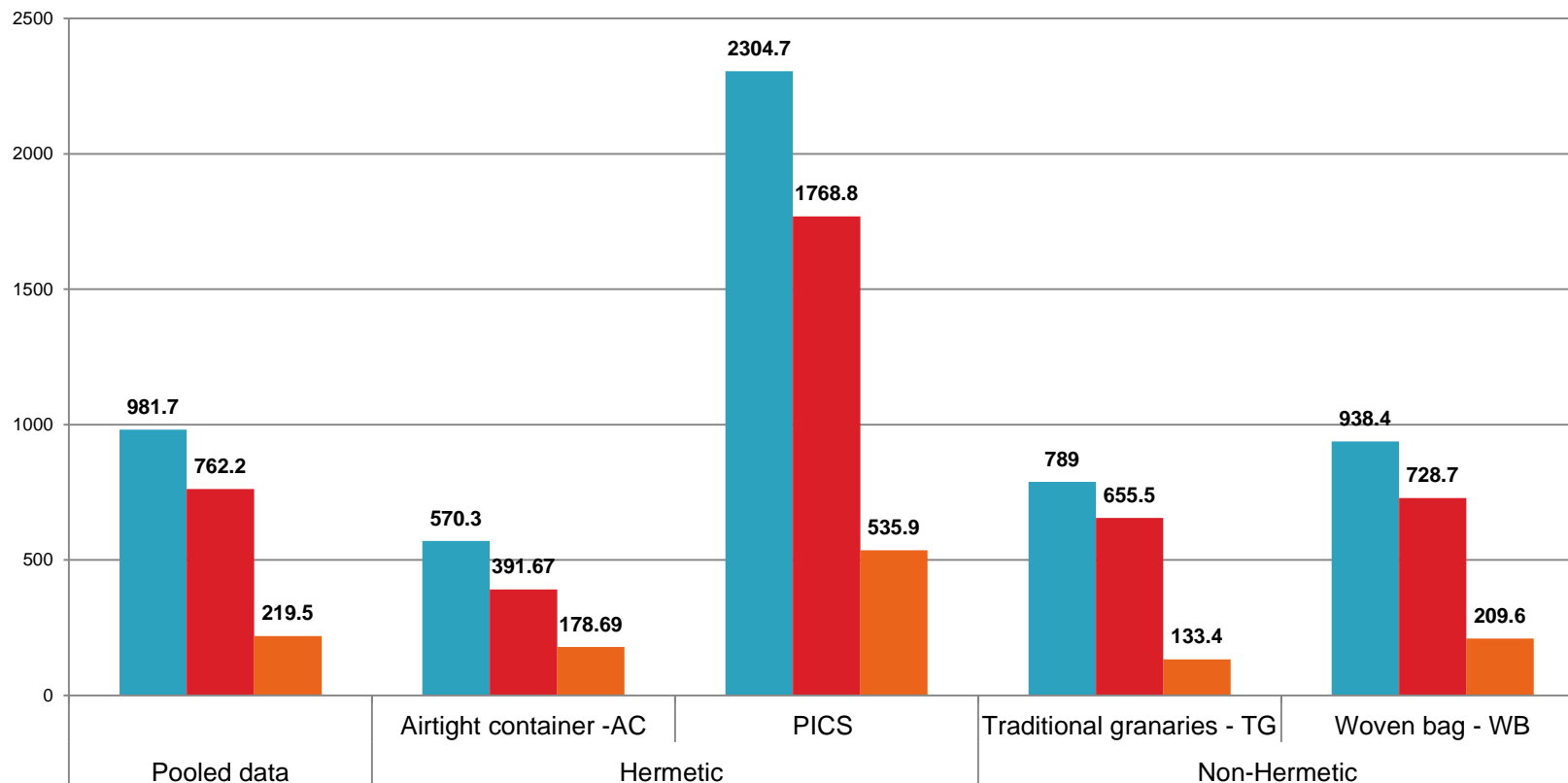
How long do farmers store?



✓ Legume grain can also be stored for longer period in PICS bag for both consumption storage (10.7 months) and for sales in the future (6.1 months). AC also gave good promising for future storage than TG & WB

Legume grains stored - average kg

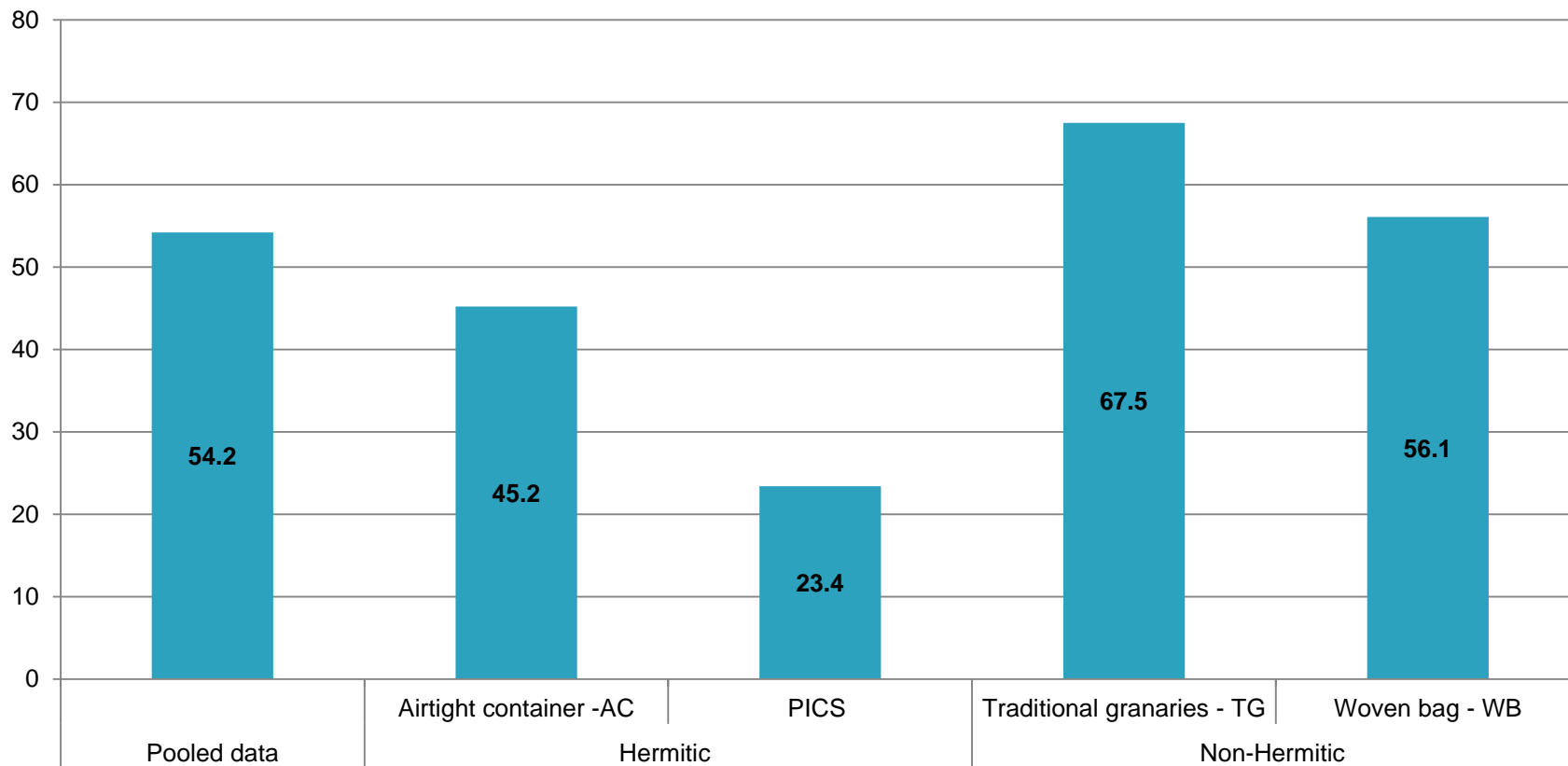
■ Total stored ,kg - TSTORED ■ Qty stored for sale, kg -SSTORED ■ Qty stored for Consumption, kg - CSTORED



On the average, more grain was stored with PICS bag than other storage means followed by Woven Bag

By estimation, 77.6% was stored for sales & 22.4% for consumption. This is another reason for making improved storage system available as many farmers store their grains after harvest for sales in the future

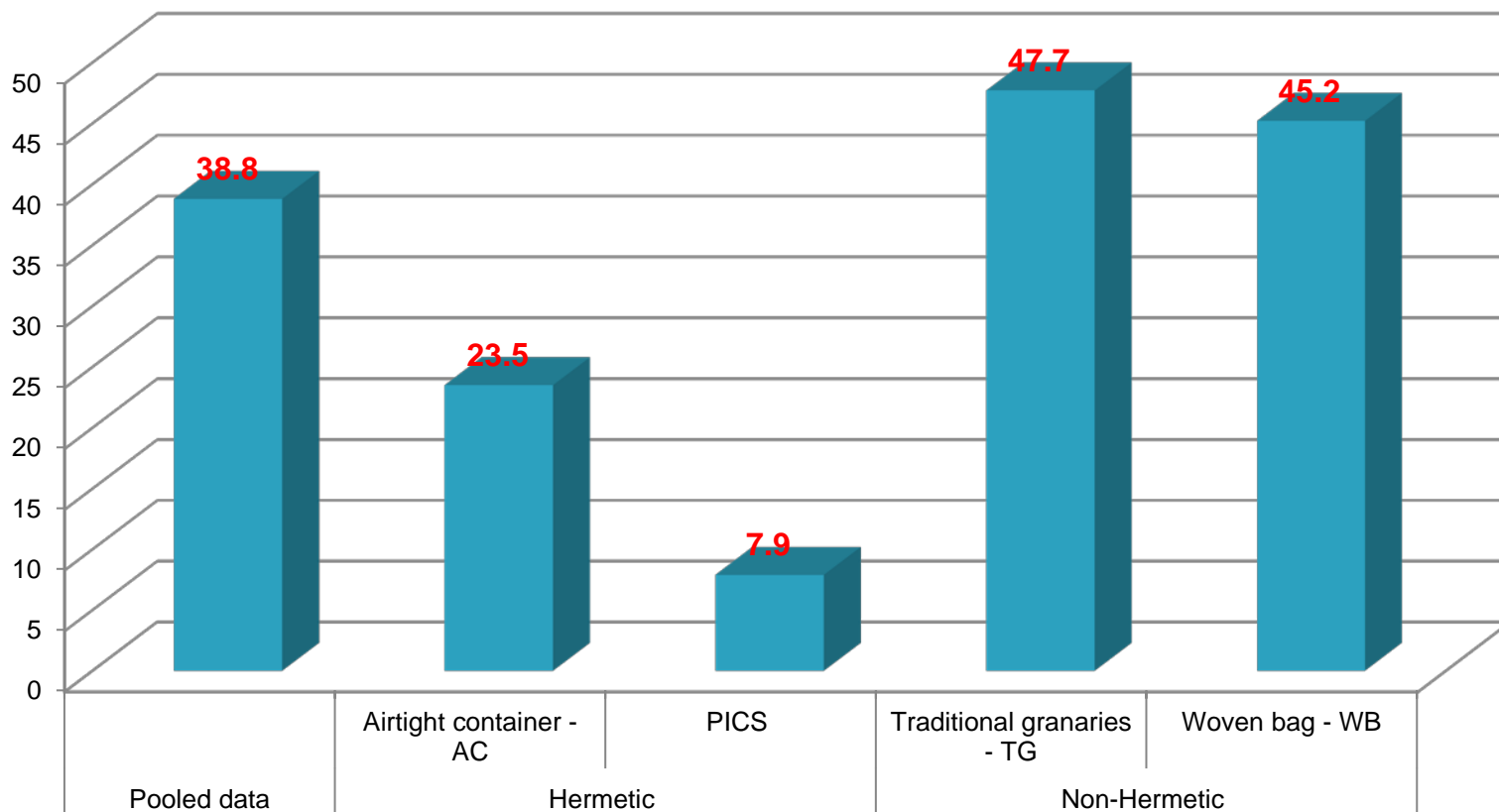
Respondents distribution based on insect as a source of loss %



More than half of the stored grain(54.2%) was lost through insect attack; Storage method most susceptible to insect attack was TG (67.5%), followed by WB.

Based on this fact, it's advisable to discourage the use of TG & WB in storing grain for sales/consumption in the future.

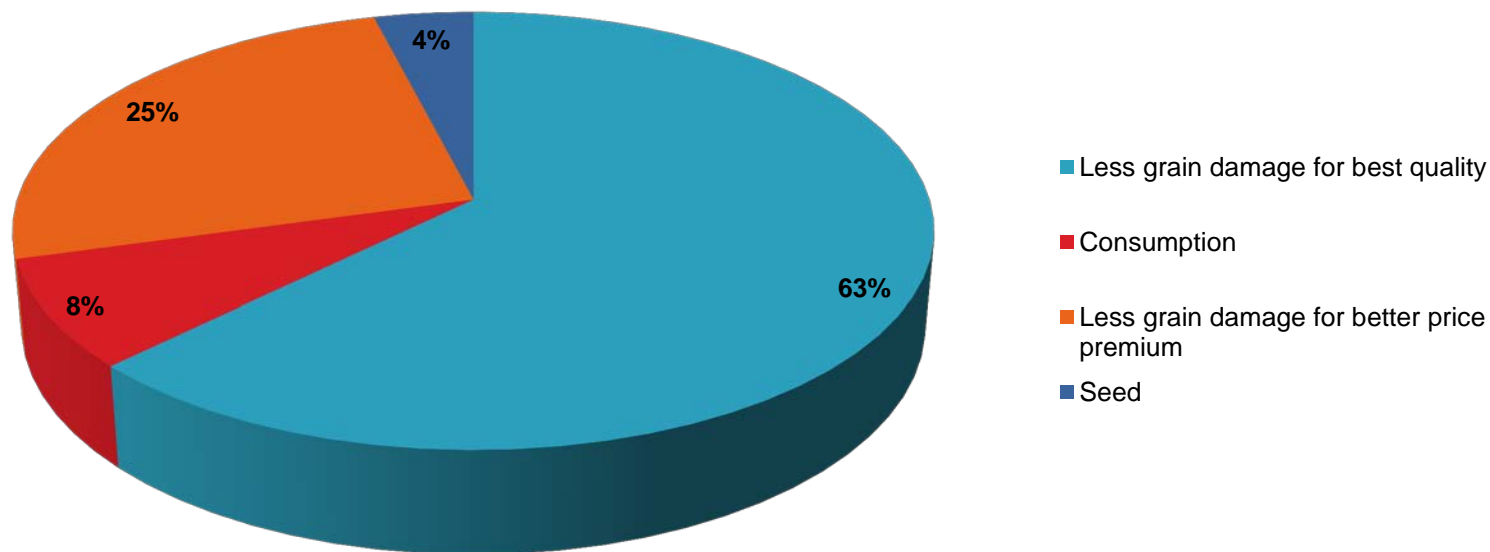
Farmers adding protectant to stored legumes%



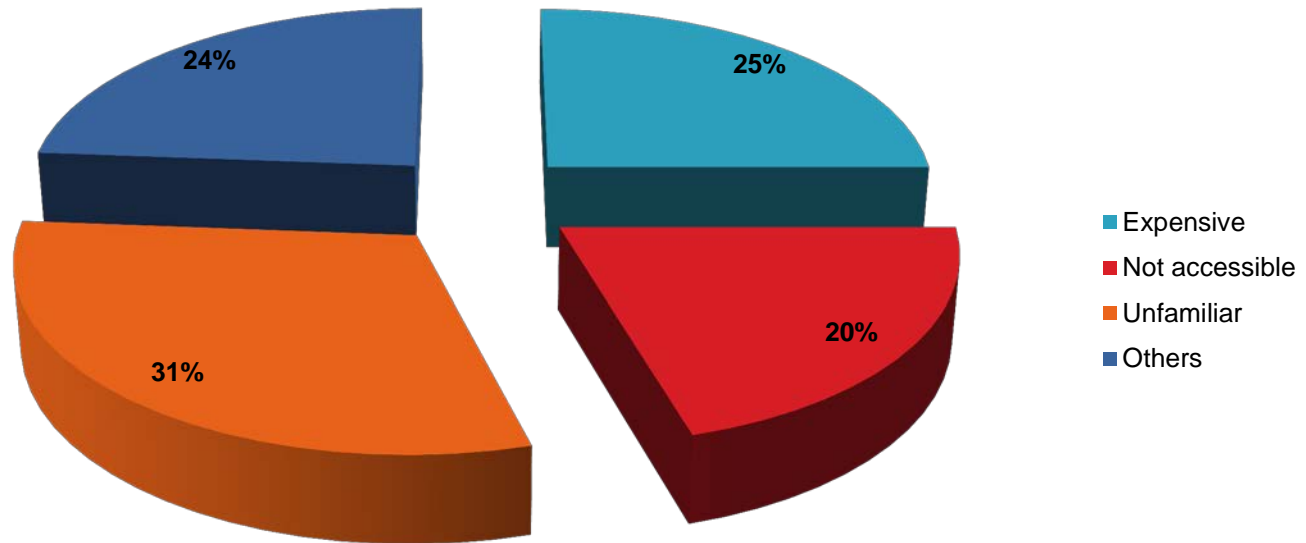
✓To make TG & WB better storage methods, more of storage chemical is needed, thus, TG used protectant (47.7%), followed by WB (45.2%)

✓PICS bag used the least (7.9%) protectant for storing grain. According to Mudrock, 2003, if use according to procedure there is no need to add protectant during storage.

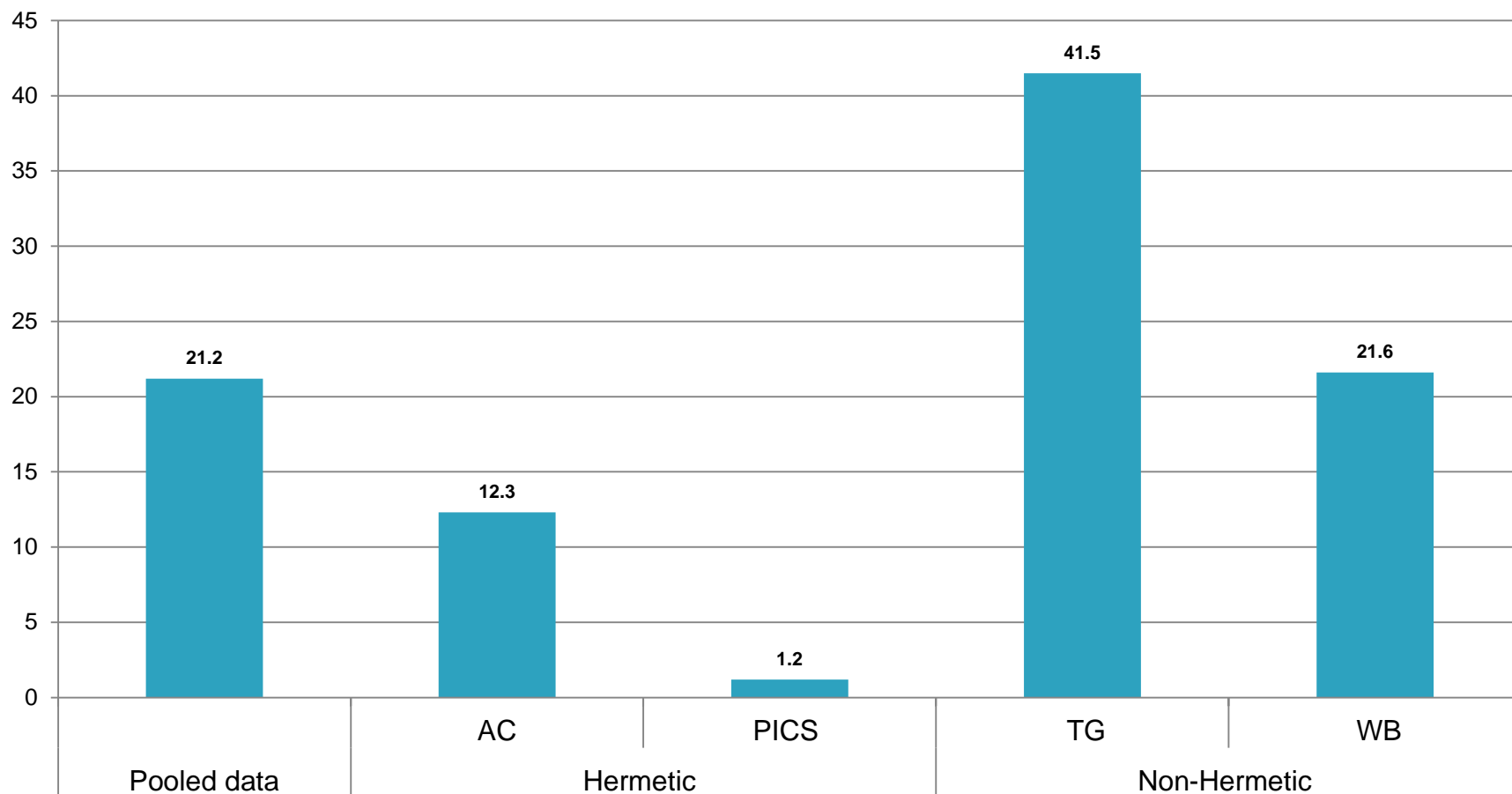
Respondents' most important benefit for using hermetic storage



Respondent' reasons for not using hermetic storage



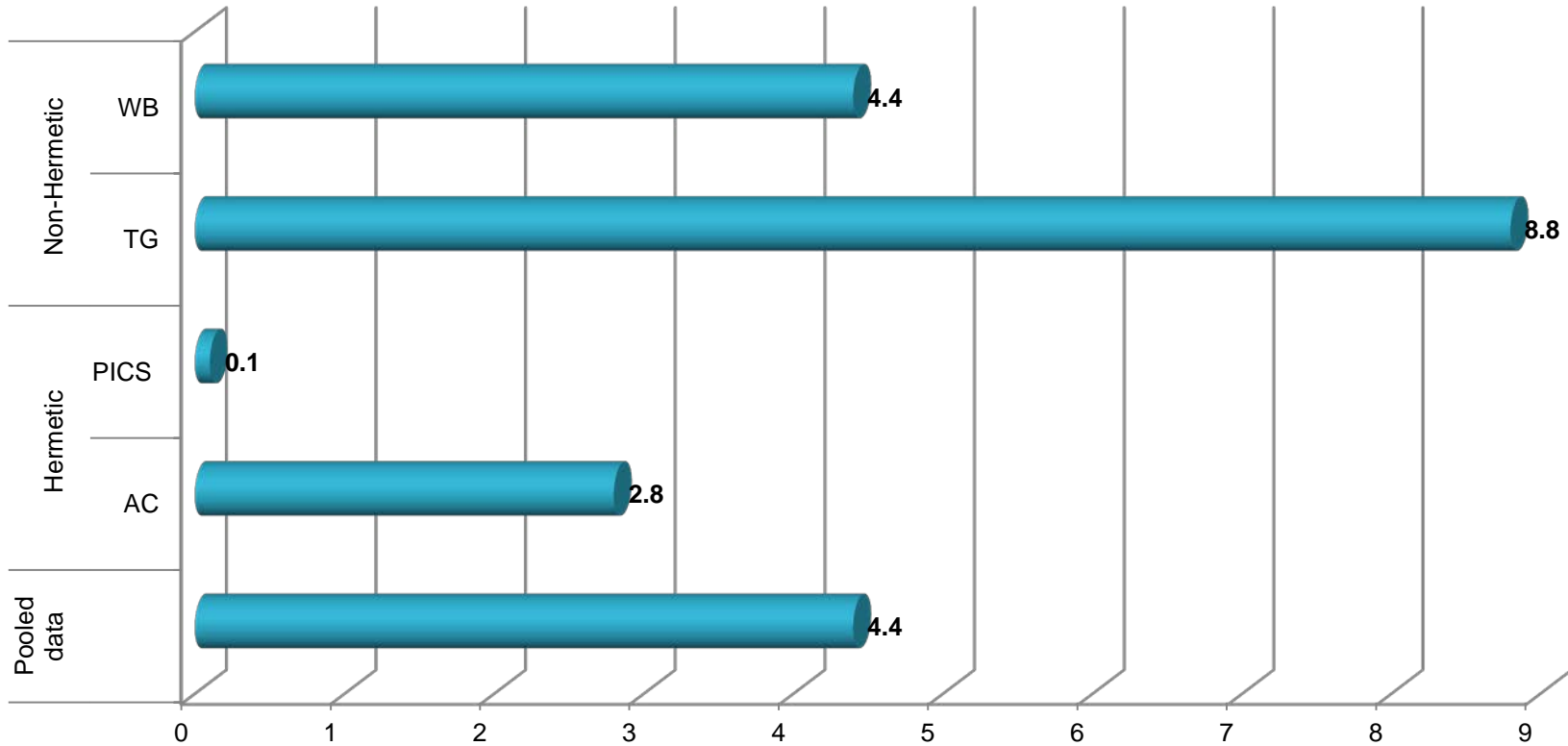
Average grain lost in storage, kg - GLOST



Average legume grain in kg lost was also least with PICS & AC

% Post Harvest Loss- PHL

■ Post Harvest Loss (Grain lost in storage/Total grain stored *100) - PHL



Proportion of amount lost in storage to total stored (PHL) was least with PICS bag(0.1%) and highest with TG.

It's advisable to store with PICS bags or AC (2.8%) to safeguard & minimize loss in storage

Factor influencing decision to store grain legumes by farmers using hermetic storage method

Variables	Coefficient	z	P>z	dy/dx
REGION (south=0, North =1)	-1.097576	-1.37	0.1710	-0.033119
DISTANCE fm mkt	0.0095862	0.66	0.5070	0.0001698
EDU_DUMMU (educated=1, non educated=0)	-0.174918	-0.47	0.6410	-0.003271
FEXPERIENCE	0.0670478	4.38	0.0000	0.001188
FARM_SIZE	-0.111522	-2.25	0.0240	-0.001976
LEGUME_TYPE(cowpea=1, otherwise=0)	1.168139	3.25	0.0010	0.0250502
AWARENESS(aware of hermetic storage=1, not aware=0)	1.467437	4.13	0.0000	0.0335293
YEARSOFUSINGTECH (years of using storage method)	-0.503656	-7.99	0.0000	-0.008924
PROTECTANT (use of insecticide=1, otherwise=0)	-1.294449	-3.53	0.0000	-0.022001
LOSSES_THROUGH_INSECT (Yes=1, No=0)	-1.227992	-3.4	0.0010	-0.024731
QTY STORED FOR CONSUMPTION	0.000581	1.62	0.1000	0.0000103
EXPECTED_STORAGE_PERIOD-CONSUMPTION (months)	0.1478821	3.41	0.0010	0.0026202
QTY_STORED_FOR_SALES	0.0002399	1.58	0.1150	4.25E-06
EXPECTED_STORAGE_PERIOD-SALES (months)	-0.087021	-1.74	0.0810	-0.001542
CONSTANT	-0.261511	-0.26	0.7930	
Log likelihood	-151.34591			
LR Chi ²	304.91			
Prob>Chi ²	0.0000			
Pseudo R ²	0.5018			

✓ Overall model fit was good based on the log likelihood (-151.34591), and probability of Chi-square (304.1)

✓ Result shows that awareness of hermetic storage (AWARENESS), type of legume grain stored (LEGUME_TYPE), losses through insect (LOSSES_THROUGH_INSECT) and use of protectant among other, influenced the probability of using HS.

.It means that awareness creation led to 3.4% increased in the probability of using HS; storing of cowpea led to 2.5% increased in the probability of using HS; an increased in the use of HS reduced losses through insect by 2.5%; also an increase in the use of HS reduced the usage of protectant by 2.2%.

- ❖ Farmers take actions to reduce PHL, either by selling early to avoid losses, applying protectants or use other storage options.
- ❖ The result shows that PICS bag gives opportunity for the longest storage period of 6 months for sales and 10.4 month for consumption; it also give the minimum lost of grain during storage and the least PHL, thus enabling farmers to get maximum income from their stored grains if sold & ensuring longer food security & healthy grains for consumption purpose.
- ❖ Losses through insect was least for PICS and by using PICS bag for storage, the use of insecticide/pesticide may not be necessary as the only 7.9% of farmers used insecticide with PICS bag. The difference was statistically attested by ANOVA and LSD tests.

- ❖ Determinants of choice to store or not to store grains using HS shows that awareness creation on HS, storage of cowpea (legume type) will encourage farmers to store their grains using HS. Also, use of HS reduces the use of protectant and losses through insect pest among others.
- ❖ Hermetic storage will help to facilitate sustainable farm income and food security in healthy form which is one of the goals of this conference.
- ❖ The result concluded that the use of TG & WB necessitated the use of insecticide (protectants), while the use of PICS and AC require little or no protectants, since past literature posited that the use of protectant poses health hazard for consumers of legume grains, Hermetic storage should then be disseminated promoted and made available to farmers at affordable prices

- Aitchedji, C. (2004). Adoption of Cowpea Storage Technology in the main Cowpea growing Area of Benin (West Africa). Preliminary Report.
- Bokar Moussa, Tahirou Abdoulaye, Ousmane Coulibaly, Dieudonné Baributsa, J. Lowenberg-DeBoer, 2014. Adoption of on-farm hermetic storage for cowpea in West and Central Africa in 2012. *Journal of Stored Products Research*, 58(2014), Pp 77-86
- Boys (2005) Boys, K. (2005). Adoption of Economic Impact Implications of Storage Technology and Improved Cowpea Varieties in the North Central Peanut basin of Senegal. Master's Thesis, Department of Agricultural Economics, Purdue University.
- Dieudonné Baributsa, Tahirou Abdoulaye, Jess Lowenberg-DeBoer, Clémentine Dabiré, Bokar Moussa, Ousmane Coulibaly, Ibrahim Baoua., 2014. Market building for post-harvest technology through large-scale extension efforts., *Journal of Stored Products Research*, 58 (2014) Pp 59-66.
- Murdock et al.,(2003) Murdock, L.L., Seck, R.E., Ntoukam, G., Kitch, L. and Shade, R.E. (2003). Presentation of Cowpea Grain in Sub-sahara Africa Bean-Cowpea CRSP Contribution. *Field Crops Research*. 82:169-178.

Thank you