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# DETERMINANTS OF FARMER'S PERCEPTION OF PROSTEPHANUS TRUNCATUS (HORN) DAMAGES AND LOSSES ON STORED MAIZE IN TOGO AND BENIN (WEST AFRICA)

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***Abstract***

*Prostephanus truncatus is one of the most damaging post-harvest pests of stored maize in Africa. Research Institutions disseminated Various control strategies during the 1990s in West Africa with significant results. What is farmers' perception of this pest in decades after those control strategies? This study aimed to assess determinants of farmers' perception of current damages and losses caused by Prostephanus truncatus on stored maize in southern of the two countries (Benin and Togo). 300 maize farmers (150 from Togo and 150 from Benin) were randomly selected from 10 villages per country. Descriptive statistics were used in addition to Logit and Tobit regression analysis. The results showed that 38% of farmers (35% in Togo and 41% in Benin) still perceive Prostephanus truncatus as the most damaging pest of stored maize. Logit's results showed that factors influencing farmers' perception of Prostephanus truncatus were group membership, contact with extension agents, and period of maize harvesting. The results from the Tobit regression model showed that factors such as the maize variety, the form of maize storage (with husk), and the storage period influence the extent of damage and loss caused by Prostephanus truncatus. Farmers still perceive Prostephanus truncatus as the main post-harvest pest causing high damage and losses on maize. It is recommended that further dissemination of maize storage technology to reduce postharvest losses.*

***Keywords:***
*damages; losses; maize; Prostephanus truncatus; storage*

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## INTRODUCTION

Prostephanus truncatus (Horn) (Coleoptera: Bostrichidae), called Larger Grain Borer (LGB), was accidentally introduced into Africa in the late 1970s from its area of origin in Central America (Boxall, 2002; Quellhorst et al., 2021). In 1984, LGB was found to be established in Togo (Farrell & Schulten, 2002). Then it gradually spread into neighboring countries such as Benin and Ghana (Aman et al., 2007).

LGB is known to be a serious pest of stored commodities mainly stored maize, dried cassava, and yam chips (Gueye et al., 2008; Quellhorst et al., 2021). Reported losses were particularly high in stored maize. According to CIMMYT (2007), in six months of storage, more than one-third of the maize was destroyed by LGB. In southern Togo, maize losses after an average storage period of six months increased from 11% to more than 35% (Pantenius, 1987). In areas with high incidence of LGB like Tanzania, up to 34% of maize losses have been observed after three months of on-farm storage (Hodges et al., 1983). Although efforts to control Prostephanus truncatus, this pest has expanded to 21 African countries and is still progressing (Gueye et al., 2008; Quellhorst et al., 2021). Reports from Mozambique described maize weight loss of about 61.5% in one Province with P. truncatus being the most important species (Cugala et al., 2007).

Various strategies were used to control LGB (Farrell & Schulten, 2002), initially focusing on fumigants and insecticides as reviewed by Golob (2002). Organophosphorous insecticides were of low efficacy against the LGB (Borgemeister et al., 1997), hence combinations of insecticides were used. Usually, a pyrethroid for the control of P. truncatus and an organophosphate to combat pests such as the maize weevil (Sitophilus zeamays Motschulsky [Col.: Curculionidae]) and the Angoumois grain moth (Sitotroga cerealella [Olivier] [Lep.: Gelechiidae]) (Borgemeister et al., 1997). Pesticide use was very successful in East Africa, but in West Africa, its use was hampered by a lack of distribution networks and a lack of cash by farmers. In some cases, farmers use cotton insecticide for stored maize Meikle et al. (2002) with potential negative health effects. Various natural products and biocontrol agents including inert dust, ash, sand, diatomaceous earth, plant protectants, and the use of microbiological agents, have been tested (Golob, 2002). Classical biological control of LGB with the release of the predator Teretrius nigrescens Lewis (Coleoptera: Histeridae) was implemented in Togo, Benin, and other countries, for targeted control of the pest primarily in the wild and in small-farm maize stores (Hell et al., 2006; Holst & Meikle, 2003).

Discussion in the scientific community about the merits of this campaign and its success is not conclusive (Holst & Meikle, 2003). Mutlu (1994) reported reduced LGB infestation rates in villages in southern Togo shortly after the release of T. nigrescens. After eight (8) months of storage, in the first season, losses of 11.6% without T. nigrescens and 8.4% with T. nigrescens, while in the 2nd season, 24.1% without T. nigrescens and 15.9% with T. nigrescens were recorded, furthermore the LGB population was reduced by 73% as compared to stores without T. Nigrescens. After analyses of the socio-economic impacts of this beneficial insect, it was concluded that T. nigrescens efficacy for controlling LGB was higher than the use of chemicals (Mutlu, 1998). T. nigrescens has been reported to be well-established in West Africa, and it was found in most stores infested by P. Truncatus (Lamboni & Hell, 2009; W. G. Meikle et al., 2002; Nansen et al., 2004; Schneider, 1999) and forests (Nansen et al., 2002). Borgemeister and collaborators reported lower trap catches of LGB coupled with reduced infestation levels in maize stores in rural areas in south-western Benin after the introduction of T. Nigrescens (Borgemeister et al., 1997). An early evaluation by Bell and collaborators showed that LGB is still a major problem for rural small producers in some regions of East and West Africa (Affognon et al., 2000).

Years after the first releases and reported establishment, trap catches of P. truncatus in Ghana were reported to be high, and surveys of farmers' stores in southern Benin suggested that a significant proportion of stores were still becoming infested with economically destructive populations of P. Truncatus (W. G. Meikle et al., 2002; Quellhorst et al., 2021). Holst & Meikle (2003) stipulated that classical biological control with T. nigrescens is not likely to be successful, mainly due to the predator's intraspecific density-dependence and its low population growth rate compared with its prey. The authors recommended that further research on P. truncatus integrated pest management considers the farmer an active agent managing the store.

The Purdue Improved Crop Storage (PICS) bags also were tested and disseminated for farmers' use throughout the whole of Africa to protect not only maize but also, sorghum, cowpea, and groundnuts against LGB (Baributsa et al., 2014; Hell et al., 2014; Y. L. E. Loko et al., 2020; Sudini et al., 2015; Williams et al., 2017). PICS bags are a simple and cost-effective way of storing grain and seed without using chemicals to control insect pests, among wich LGB (Baoua et al., 2018). The research question is, therefore, after various pest control methods were disseminated years ago, what is farmers' current perception of damages and losses caused by LGB in stored maize in southern Benin and Togo?

## RESEARCH METHOD

The study was conducted in the southern regions of Benin and Togo in West Africa, where the initial infestation of *Prostephanus truncatus* was reported. The observed temperatures were from 22°C to 36°C with a daily variation of 6°C and relative humidity of 80 ± 5%, except for short periods when it may drop to 10-20%. These environmental conditions represent the optimum for the development of LGB which was reported to be at 30 to 32°C and relative humidity of 80 to 85%.

Data were collected in 10 villages randomly selected in each country. In each village, 15 maize producers were randomly interviewed, giving 300 producers (150 per country). The tools used in data collection were: structured questionnaires, pictures of storage pests, and samples of post-harvest insects according to the method of (Addo et al., 2002).

At the beginning of the storage season, data were collected on the socio-economic and demographic characteristics of respondents, their farm characteristics, storage management, and hygiene prior to storage, storage methods, storage problems, spectra of storage pests, farmers' knowledge and perception of LGB, the extent of damage and losses caused by LGB. In this study, the terms damage and loss are used synonymously because farmers found it difficult to differentiate between these two concepts during the survey.

The study assessed farmers' perception of the current state of post-harvest losses and damages caused by LGB on maize. We assumed that any farmer's perception depends on his prior knowledge and awareness of this pest. A first binary dependent variable evaluated the determinant of farmers' knowledge of LGB as a pest of stored maize (1 = yes or 0 = No); discrete models such as Logit or Probit are suitable for this analysis (Lollivier, 2006). Since it is difficult to establish whether or not the study variables follow the normal distribution, the Logit model was chosen. Logit model associated with an individual "i" the probability "Pi" as presented in the equation.

(1) $\text{Pi}=F(\text{li}) = 1/(1+e^{-\text{li}})$

where

(2) $\text{li}=\beta o+\beta_1 x_{12} + \ldots.+\beta_m x_{\text{im}}$

li is a vector representing socio-economic and demographic characteristics of respondents, environment and factors that contribute to his knowledge and awareness of LGB. The associated probability Pi is 1 or 0 depending on the response that the farmer knows as a maize pest or does not know LGB. Individual knowledge depends on certain characteristics; the resulting Logit model can be written as follows:

(3) $\text{Ln}(p/(1-p))=\beta_o+\beta_1\chi_1+\beta_2\chi_2\ldots..+\beta_m\chi_m+\varepsilon i$

With

(4)

$$\text{Ln}(P/(1-P)) = \text{Prob.(LGBKNOWLEDGEi)}=\beta_0+\beta_1\text{GENDER}+ \beta_2\text{INSTRUCTION} + \beta_3\text{EXPERIENCE}+\beta_4\text{GROUP}+\beta_5\text{VARIETY}+ \beta_6\text{FORMSTOR}+\beta_7\text{DURATIONSTOR}+\beta_8\text{INCOME}+\beta_9\text{FAMILYSIZE}+ \beta_{10}\text{MAINACTYVITY}+\beta_{11}\text{EXTENSION} + \beta_{12}\text{FARMSIZE} + \varepsilon_i$$

where Bi are coefficients that need to be estimated, while their sign provides information about the factor's influence on the dependent variables, the variables used in this equation are described (Table 1). Correlations analysis was used to select variables, and co-linear ones were excluded.

The second dependent variable used in this study was the perceived extent of maize damages and losses currently caused by LGB. Producers will only be able to evaluate this variable if they recognize LGB; this causes a truncation or reduction in the sample size. The dependent variable takes the value 0 for the producers who believe that LGB is no longer a storage problem and 1 for those who perceive that LGB exclusively causes any damage observed in their stock. Because of the truncation, a Tobit model is well adapted to the data analysis. We therefore used the Tobit model formulated as follows:

$$Y_i = \begin{cases} X_i\beta_i + \varepsilon \ldots \text{if} \ldots V_i > 0 \\ 0 \ldots \ldots \ldots \text{if} \ldots \text{no} \end{cases} \quad (5)$$

where Yi, is the model's dependent variable, evaluating the farmer's perception of the LGB problem and its intensity

$$V_i = X_i\beta_i + \varepsilon \quad (6)$$

We can write Vi like this:

$$V_i(LGB\text{DAMAGEEXTENT})=\beta_0+\beta_1\text{GENDER}+\beta_2\text{INSTRUCTION} + \beta_3\text{EXPERIENCE}+\beta_4\text{GROUP}+\beta_5\text{VARIETY}+\beta_6\text{FORMSTOR}+ \beta_7\text{DURATIONSTOR}+\beta_8\text{INCOME}+\beta_9\text{FAMILYSIZE}+\beta_{10}\text{PROTECTION} +\beta_{11}\text{EXTENSION} + \beta_{12}\text{FARMSIZE} + \varepsilon_i \quad (7)$$

Vi is a latent variable that estimates damages and losses caused by LGB as perceived by each (i) farmer,

Xi is the farmer's individual characteristic, his store, and the environment in which he operates

β represents the model parameters,

ε is the error term, independent and distributed according to the normal distribution with mean zero and the constant variance $\sigma^2$.

Table 1. Variables used in Logit and Tobit regression models

| Variables | Description | Nature | Modality |
|---|---|---|---|
| LGBKNOWLGB | LGB knowledge as maize pest | binary | 0=No 1=Yes |
| LGBPROBLEM | Perception of the LGB problem | binary | 0=No 1=Yes |
| LGBDAMAGEEXTENT | The extent of LGB maize damage and losses | continuous | - |
| GENDER | Gender of respondent | binary | 0=woman, 1=man |
| AGE | Age of respondent | continuous | - |
| EXPERIENCE | Years of farmer experience | continuous | - |
| INSTRUCTION | Farmer's educational attainment | binary | 0= Not go to CEG; 1= go to CEG |
| FAMILY SIZE | Number of people supported by the household head | continuous | - |
| GROUP | Group membership | binary | 0=no; 1=yes |
| MAIN ACTIVITY | Main Activity | binary | 0=Agriculture; 1=other |

| | | | |
|---|---|---|---|
| INCOME | Proportion of maize in farm income household (%) | continuous | - |
| FARM SIZE | Size of maize fields | continuous | - |
| VARIETY | Maize variety stored | binary | 0= Local 1 = Improved |
| HARVEST PERIOD | Period of maize harvesting | binary | 0=Very dry; 1= Belated harvesting |
| FORMSTOR | Form of maize storage | binary | 0=other 1= Cobs with husk |
| PROTECTION | Method for storage pest management | | 0=Traditional 1=chemical |
| DURATIONSTOR | Duration of maize storage | continuous | |
| DAMAGE EXTENT | The extent of maize damage and losses caused by other pests | continuous | |
| EXTENSION | Contact with extension agents | binary | 0=No; 1=yes |

## RESULTS AND DISCUSSION

### The Socio-Economic Characteristics Of Farmers Interviewed

Table 2: Socioeconomics characteristics of the farmers interviewed

| Variables | Togo N=150 | | Benin N=150 | |
|---|---|---|---|---|
| | Value | Std. Err | Value | Std. Err |
| Age (years) | 44,153 | 0,966 | 40,933 | 1,087 |
| Number of persons nourished by household head | 7,787 | 0,352 | 8,487 | 0,445 |
| Proportion of maize in household income | 37,700 | 1,883 | 54,300 | 2,577 |
| Experience in maize growing (years) | 21,020 | 0,938 | 20,520 | 2,135 |
| Group membership % | 45 | | 35 | |
| Women as household head % | 18 | | 9 | |
| Have formal instruction more than the primary % | 39 | | 12 | |
| Agriculture as main activity % | 76 | | 84 | |

Note: Std. Err. denotes standard error

The socio-economic characteristics of the farmers interviewed about the knowledge and perception of the LGB problem on maize storage are depicted in Table 2. The average ages of farmers surveyed are 44 and 41, respectively, for Togo and Benin. The respondents have agriculture experience of about 20 and 21 years, respectively, for Togo and Benin. In terms of family size, each household have in average 8 members; more than half of the maize production is for their own consumption (54% in Togo and 53% in Benin). The majority of respondents (76% in Togo and 84% in Benin) main activity is agriculture. The proportion of maize in household income is 54% and 38%, respectively, for Benin and Togo. Few respondents have formal instruction, more than 39% in Togo and 12% in Benin.

### Farmers' Knowledge and Perception of LGB

Less than half of the farmers recognized LGB as a pest of maize with 31% in Togo and 40% in Benin (Table 3). Of these, 35% and 41% considered LGB an important stored maize pest, but a higher percentage of 60% for Togo and 48% in Benin thought that *Sitophilus* spp. was the most important stored maize pest. To protect maize against pests, farmers used traditional methods (neem tree leaves), chemical methods or a combination of the two (Table 3). Farmers mentioned that extension agents advised them to use Sofagrain™ (1.5% deltamethrin + 0.5% pirimiphos-methyl) and Atellic Super™ (1.6% pirimiphos-methyl + 0.3% permethrin) as chemicals to protect stored maize, but these products are less available. For Togo and Benin, average damages and losses caused by pests on stored maize were estimated by farmers who recognized LGB to be 16% and 24%, respectively. Significant differences between the two counties were observed (Table 3). According to farmers, LGB would be responsible for 12% and 13% of damages and losses for Togo and Benin, respectively.

Table 3. Farmer's knowledge and perception of LGB by county

| Variable | | Togo N=150 | Benin N=150 |
|---|---|---|---|
| | | Value (Std. Err.) | Value (Std. Err.) |
| Damages and losses attributed to all post-harvest pests *** | | 16.5(2.203) | 25.6 (1.922) |
| The proportion of pest damages and losses attributed to LGB | | 12.1 (2.193) | 13.1 (2.126) |
| Know LGB as a pest of maize % | | 31 | 40 |
| The current most important pest of maize % | | | |
| | *Sitophilus* | 60 | 48 |
| | *P. truncatus* | 35 | 41 |
| | *Tribolium* sp | 5 | 11 |
| Contact with extension agent about maize pests % | | 21 | 27 |
| Learn about methods of pest control % | | | |
| | Himself | 10 | 13 |
| | Radio and television | 1 | 7 |
| | Parents and neighbors | 76 | 59 |
| | NGO | 1 | 7 |
| | Extension agent | 10 | 14 |
| | Others | 1 | 1 |
| Methods of pest control use % | | | |
| | Traditional | 55 | 35 |
| | Chemical only | 35 | 51 |
| | Traditional and chemical | 9 | 15 |

Note: Std. Err. denotes standard error ***$P<0.01$

Our findings show that in both countries, more than half of respondents do not know LGB, and generally, farmers had difficulties recognizing most maize storage pests. The results from this study show that farmers cannot identify particular insects and, as such, cannot efficiently target those insects. In a similar study in Ghana, Addo et al. (2002) reported that 15% of respondents did not know LGB as a maize pest. These authors also added that farmers hardly mentioned its name explicitly. In our study area in Togo, the name "Kpokpoe" is used for all "pests of maize stock" compared to the name "Sokpozi" used for all "pests of maize stock" in Benin. Few farmers distinguished LGB by its local name, "Tagan" in Togo and "Zomon" in Benin. In a study conducted on farmers' knowledge, perceptions, and management practices for termite pests of maize in Southern Benin, L. Loko et al. (2019) showed that farmers' use of size and color were the main criteria used by farmers to classify and identify maize pests. The Logit model helped identify factors that helped gain knowledge about LGB, and these factors should be exploited to facilitate the dissemination of knowledge concerning storage pests in general and LGB specifically.

**The Determinants of Farmer's Perception and Knowledge of LGB As a Pest of Maize Storage**

Three models run were significant at 0.01% with ($R^2$) 79.79%, 55.60%, and 60.22% of the independent variables explaining the dependent variables for Benin, Togo, and the combined data, respectively (Table 4). Five of the 12 explanatory variables introduced into the models significantly affected the farmer's knowledge of LGB. These variables were respondent's gender (GENDER), number of years of experience in maize production (EXPERIENCE), group membership (GROUP), main activity farming (MAIN ACTIVITY), and contact with extension agents (EXTENSION), but these five variables were not significant for all the three models (Table 4).

Table 4. Logit regression estimated results

| Variables | Togo | | Benin | | Togo-Benin | |
|---|---|---|---|---|---|---|
| | Coef. | Std. Err. | Coef. | Std. Err. | Coef. | Std. Err. |
| GENDER | -.0199731** | .0096859 | .0015272 | .0100842 | -.0114674** | .0056866 |
| INSTRUCTION | .1631522 | .4624144 | -.0676594 | .60348 | -.095445 | .3216257 |
| EXPERIENCE | .474552** | .1938325 | .1184171 | .1773483 | .1914254* | .1149988 |
| GROUP | 1.547351*** | .4779669 | .8384977** | .4186133 | .9023668*** | .2742354 |
| VARIETY | .461017 | .4988348 | -.0008824 | .0079897 | -.1266982 | .2817361 |
| FORMSTOR | -.1407393 | .4616035 | .2398888 | .464328 | -.2582601 | .2859787 |
| DURATIONSTOR | .1912912 | .2273558 | .0755344 | .2384177 | .2295095 | .1463529 |
| INCOME | .6097759 | .5992931 | -.4930685 | .6661447 | -.1652296 | .4033385 |
| FAMILY SIZE | -.4012103 | .306758 | -.3171437 | .2404796 | -.2626157 | .1697982 |
| MAIN ACTIVITY | 3.209128*** | .8331962 | -1.987668*** | .6136549 | .2540409 | .2531694 |
| EXTENSION | .602322 | .7827044 | 2.464463** | 1.11205 | 1.818917*** | .5255733 |
| FARM SIZE | .0300679 | .4986841 | .1985135 | .4498189 | .3561433 | .2917178 |
| Constant | -5.464756 | 1.828303 | 2.79476 | 1.584581 | -1.144802 | .9299664 |
| Number of obs | 150 | | 150 | | 300 | |
| LR chi2(12) | 61.74 | | 43.02 | | 45.53 | |
| Prob > chi2 | 0.0000 | | 0.0000 | | 0.0000 | |
| ($R^2$) | 79.79 | | 55.60 | | 60.22 | |

Note: Std. Err. denotes standard error *P< 0.10, **P <0.05 and ***P<0.01

The first-factor determinant that influences the level of awareness of LGB is the respondent's gender, suggesting that women have a higher level of knowledge about LGB than men. Indeed, women are more concerned with post-harvest operations such as sorting and winnowing (Affognon et al., 2000). During the execution of these tasks, women can observe the various stored maize pests. During our survey, we noticed that women could quickly recognize LGB. Mugisha-Kamatenesi et al. (2008) also reported that women, particularly those living in the rural areas of third-world countries, play a major role in post-harvest operations. They observed that women were very knowledgeable about post-harvest pests.

The second factor influencing farmers' awareness of LGB is their experience with maize production. According to Merleau-Ponty P., (1975) experience plays an important role in the level of knowledge of a person. In our study this variable was positively linked with the dependent variable. When a farmer is more experienced, he is more likely to know LGB as a pest of stored maize. Moreover, during the survey, we encountered farmers who remembered years when the damages and losses of this pest were very important. This is essentially true in Togo, where important efforts to control LGB have been implemented since the 1990s, as described by Schneider (1999).

Belonging to a farmers' group positively influenced farmers' knowledge of LGB. This variable was significant in all countries. This shows the important role of farmers' groups in sharing information and knowledge about the control of storage pests. Similarly, Adegbola & Gardebroek, (2007) reported that maize producers who were cooperative or farmers' association members were more likely to be aware of improved storage technologies. As reported by Sinzogan et al., (2004) farmers' groups also frequently receive the visits of extension agents, increasing their probability of access to information. Contact with extension agents is another variable significantly and positively linked to knowledge of LGB. This is similar to the observation of Adegbola & Gardebroek (2007). These agents aim to train and advise farmers on agricultural technologies (Feder & Savastano, 2006; Velay et al., 2001). Some training modules also focused on improving storage systems and pest control. As a result, farmers that these extension agents often visit can easily distinguish LGB from other stored maize pests. Feder & Savastano (2006) underlined the importance of extension and information programs in spreading new knowledge across a large population. Similarly, Sinzogan et al. (2004) For a study on cotton, farmers who have contact with extension agents knew more about insects and could identify them as compared to those who are not paid a visit by extension agents, making their application of pest control more efficient.

**Factors Affecting Farmers' Perceptions on The Extent of Damage and Losses Caused by LGB on Stored Maize**

Maize variety (Variety), storage form (Formstor), storage duration (Durationstor), and demographics (Family size) were identified to significantly influence farmers' perceptions of damage and losses caused by LGB with the combined data from the two countries (Table 5). Considering data from Togo only, farmers' perception of the extent of the LGB problem is also linked to factors such as gender (Gender), experience, and contact with extension agents, whereas in Benin, only Durationstor and Family size affected farmers' perception. All three models are significant at 0.01%, with ($R^2$) 65.26%, 53.94%, and 78.75% of the total variability predicted by the Togo, Benin, and Togo-Benin models, respectively (Table 5).

Farmers' perception of the damages and losses caused by LGB on maize revealed that farmers who grew improved maize varieties were perceived to incur higher damages and losses than those who cultivated local varieties. Probably, this effectively translated into higher damage levels on improved maize since several researchers reported that maize variety plays an important role in reducing the extent of damage and losses caused by stored maize pests (Demissie et al., 2008; Kossou et al., 1993; W. G. Meikle et al., 1998). Varietal characteristics, such as grain hardness, amount and tightness of husk cover, etc., have been linked to the population density of storage pests and grain losses (W. G. Meikle et al., 1998).

The second significant factor is "the form in which maize is stored". In our study, the negative sign that follows this variable indicates that farmers who stored their maize as grains perceive less damage than those who stored it on the cob. As reported by CIMMYT (CIMMYT, 2007), LGB caused more damage and losses on maize stored on the cob. Storage form and storage structures are closely linked. Farmers who store maize as grains use barrels or cans, while those storing maize on the cob with the husk use traditional or improved cribs. Cans and barrels are hermetic storage systems, and the effectiveness of these systems in reducing pest damage is well-known (Moussa et al., 2009). According to Nansen et al. (2004), wood used to construct traditional storage structures can host LGB and be a source of infestation from one season to another. This could explain why farmers who stored their maize as a cob in traditional stores perceived higher damage levels.

Table 5. Tobit regressions estimated results

| Variables | Togo | | Benin | | Togo-Benin | |
|---|---|---|---|---|---|---|
| | Coef. | Std. Err. | Coef. | Std. Err. | Coef. | Std. Err. |
| GENDER | -.1262185* | .0708752 | -.0261976 | .095172 | -0.043 | 0.058 |
| INSTRUCTION | .0048899 | .0536473 | -.065238 | .1072519 | 0.005 | 0.047 |
| EXPERIENCE | .103726* | .0542578 | -.0242974 | .0649487 | -0.005 | 0.039 |
| GROUP | .0441389 | .05794 | .0783495 | .0694434 | 0.063 | 0.040 |
| VARIETY | .1316186* | .0688038 | -.0048942 | .0801809 | 0.073* | 0.040 |

| | | | | | | |
|---|---|---|---|---|---|---|
| FARM SIZE | -.0098685 | .0405819 | -.072994 | .0481016 | -0.044 | 0.028 |
| FORMSTOR | -.2235046*** | .0562807 | -.0049941 | .0859709 | -0.097** | 0.048 |
| DURATIONSTOR | .0381945 | .0271349 | .1231137*** | .0439247 | 0.062** | 0.024 |
| INCOME | .0008964 | .0011017 | .001184 | .0014386 | 0.001 | 0.001 |
| FAMILY SIZE | -.0827722** | .0383934 | .0056828** | .002482 | 0.007*** | 0.002 |
| PROTECTION | -.0004598 | .0279131 | .0054856 | .0323394 | -0.002 | 0.019 |
| EXTENSION | -.22221** | .0890843 | -.077544 | .0815119 | -0.057 | 0.058 |
| Constant | .1645044 | .2020483 | -.3118792 | .2426333 | -0.178 | 0.141 |
| Se | .1301117 | 189473 | .1972744 | .0283123 | 0.167 | 0.017 |
| Number of obs | 44 | | 57 | | 101 | |
| LR chi2(12) | 37.09 | | 28.39 | | 60.930 | |
| Prob > chi2 | 0.0002 | | 0.0049 | | 0.000 | |
| $R^2$ | 65.26 | | 53.94 | | 78.75 | |

Note: Std. Err. denotes standard error *P< 0.10, **P <0.05 and ***P<0.01

Storage duration (Durationstor) is the third factor that significantly affected farmers' perception of the extent of damage and losses caused by LGB. Storage losses increase with storage duration. Sofa grain and Atelic Super can be used to control maize pests for three months, but farmers often do not have access to these insecticides, and when they do, they misuse them, resulting in health and environmental issues Golob (2002). Some alternatively use cotton chemicals, unsuitable for pest control, to protect maize.

The last variable that significantly influences farmers' perception of the extent of LGB damage and losses is the number of people the household head nourishes. The positive sign of this variable shows that the higher the number of people nourished by the household head, the higher the perceived damages and losses. For Feder & Savastano (2006), larger households imply lower land per person (holding land area constant), thus less wealth per capita. Therefore, even if the losses are small, it means higher for larger household heads.

## CONCLUSION

This study focused on understanding farmers' perception of LGB and its problem. It has shown that Farmers still perceive *P. truncatus* to be causing high levels of damage and losses to maize in both countries (Benin and Togo). Farmers that mostly perceived LGB problems are (1) women, (2) belong to farmer's groups, or (3) have contact extension agents. It's important that both farmers and extension agents continue their collaborative work to mitigate LGB and other post-harvest insects' effects on stored maize. Moreover, any long-term LGB protection options will require a high degree of information sharing between farmers and scientists and between farmers since this is one of the best information dissemination channels. It is recommended further dissemination of maize storage technologies to reduce postharvest losses.

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