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# Characterization of Control Methods for Fall Armyworm (*Spodoptera frugiperda* J. E. Smith) in the Maize (*Zea mays* L.) Cropping Systems in Central Benin

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**Abstract**

In Benin, the Fall armyworm (*Spodoptera frugiperda* J.E. Smith) causes severe damage to maize crop and threatens the food security of thousands of small farmers. The objectif of this study was to inventory local knowledge on the management of the Fall armyworm (FAW) by maize farmers in central Benin. A semi-structured questionnaire was used to collect information from 1885 maize farmers in six communes in central Benin. Data were analyzed using descriptive statistics, multivariate analysis and logistic regressions. Results showed that farmers consider FAW attacks as a major constraint to maize production. The common control method used by maize farmers is chemical control (90% of respondents) with synthetic products. Chemical families such as Pyrethroids, Avermectins, Neonicotinoids, Organophosphates are used. The farmers (4%) use organic products such as aqueous extracts of *Azadirachta indica, Jatropha curcas and Carica papaya* to control FAW. Certain farmers do not used any control method for FAW. Socioeconomic characteristics such as area planted, age, experience in maize production, farmer's organization membership, level of education, gender, and income level of the farmer significantly determine ($p < 0.05$) the type of control method used against FAW. These factors should be taken into account by extension programs. Extension services can use farmers in these socio-economic categories as innovators to spread new and more effective control methods against Fall armyworm.

**Keywords:** fall armyworm, insecticides, maize cropping system, farmer's perception, Benin

## 1. Introduction

In Sub-Saharan Africa (SSA), nearly 23.2% of the population is undernourished (FAO, 2018a). This problem affects several Communes in Benin (Zinzindohoué, 2012). Hotspots of severe food insecurity exist in rural areas at the level of smallholder farmers (MAEP, 2017). To meet the food needs of the population, improving the productivity of staple crops is necessary (MAEP, 2017). Moreover, the staple food crop in Benin is maize (Houndété et al., 2021). The country ranks first in terms of consumption of this cereal in West Africa, with an estimated average annual consumption of about 85 kg per capita (Adégbola et al., 2011). Despite its importance, its production is faced with several problems including pest pressure especially the Fall Armyworm (*Spodoptera frugiperda*) (FAO, 2018b). Indeed, the Fall armyworm (FAW) can cause significant yield losses on the maize crop when not properly managed (FAO, 2018b). These losses can be up to more than 50% of the maize yield (Pomalegni et al., 2019). However, farmers' perceptions of these constraints vary from one individual to another, but also from one context to another (Doumde, 2003). For example, Gnanglè et al. (2011) show that local perceptions of the causes and effects of climate change vary according to the socio-cultural categories of the respondents. Maize farmers have developed several techniques to control the FAW (Sikirou et al., 2019). Some growers use unregistered synthetic chemical insecticides that persist in the environment (El Fakhouri et al., 2015). These synthetic chemical pesticides leave residues in crop products and are often a source of food poisoning (Achour et al., 2011).

The perception of maize farmers in relation to the FAW pressure and the capitalization of farmer practices in the face of this constraint therefore constitutes a keystone for sustainable FAW management. This study aimed to determine the significant local knowledge in the control of FAW by maize farmers in central Benin for implementation in agricultural research.

## 2. Materials and Methods

### *2.1 Survey Methodology*

An exploratory survey was conducted on forty maize farmers in the commune of Savalou to determine the sample size. The number of maize farmers surveyed was determined by the formula of Dagnelie (1998):

$$n = \frac{U_{1-\alpha/2}^2 \times P(1 - P)}{d^2} \quad (1)$$

where, n is the size of the sample considered, $P$ is the proportion of people who mentioned FAW attack on maize plants as a constraint to maize production (P = 0.94), $U_{1-\alpha/2}$ is the 95% confidence level (typical value of 1.96); $d$ is the 5% margin of error (typical value of 0.05).

The survey was conducted in the Collines department in the Communes of Savalou, Glazoué, Bantè, and Ouessè and in the Zou department in the Communes of Djidja and Zogbodomey (Figure 1). The majority of respondents were selected from the Collines department based on statistical production data from the map of the geographic distribution of maize cultivation in Benin from 2010 to 2021 agricultural seasons.

A total of 1,885 maize farmers were surveyed, including 169, 384, 268, 376, 350 and 338 people in the communes of Bantè, Djidja, Glazoué, Ouessè, Savalou and Zogbodomey, respectively. The surveyed farmers were randomly selected in each commune.

Based on a semi-structured questionnaire, individual and group interviews were conducted, and data were collected from farmers and resource persons (extension agents and NGOs). In addition to socio-economic characteristics, the questionnaire collected data on maize production constraints in the study area and FAW management methods used by maize farmers.

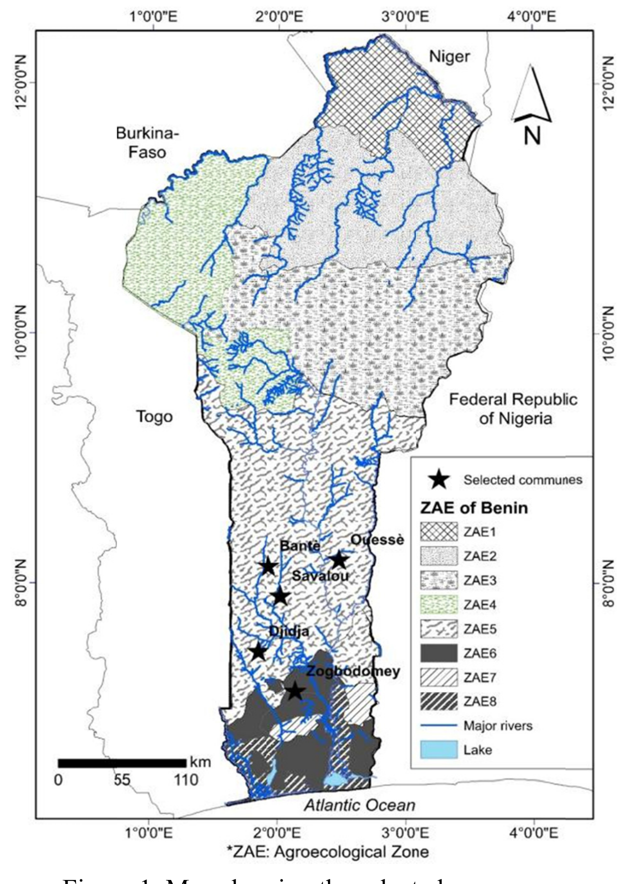


Figure 1. Map showing the selected communes

Source: Topographic Map of Benin (IGN 1992); authors' fieldwork.

### *2.2 Data Analysis and Processing*

Data on the constraints of maize production, farmers' perception of Fall armyworm (FAW) attack, FAW management methods adopted by maize farmers were submitted to frequency analysis in SPSS 20 software. Determinants of farmers' choice of control method for FAW were analyzed using a logistic regression. In the econometric literature, the most commonly used models for analyzing the influence of qualitative and quantitative variables on a dichotomous dependent variable are generally grouped into four types: i) linear probability models; ii) logistic function (LOGIT); iii) normal density functions (PROBIT) and iv) limited dependent variable (Tobit) models (Ngondjeb et al., 2011). For all these models, the objective was the modeling of an alternative (Y = 1 or Y = 0) and thus to estimate the probability associated with the event Y = 1. But Tobit models are used in the case of limited dependent variables. LOGIT models are considered as approximations of PROBIT models for simpler calculations. Therefore, in this study, we chose the Logit model to identify and analyze the factors determining the adoption of Fall Armyworm (FAW) control methods. Due to the fact that the dependent variable under consideration has four independent modalities, multinomial logistic regression was used.

$$P(Yt = j);\ j = 1,\ \dots\ K - 1;\ t = 1,\ \dots\ T \tag{2}$$

The approach consists of giving a reference modality, for example modality *K*, and modeling the probabilities *p_j* (*X*) according to the following equation:

$$\log\frac{p_j(X_t)}{p_k(X_t)} = \beta_{1j}X_{t1} + \dots + \beta_{pj}X_{tp} = X_t'\beta_j;\ \beta_j = (\beta_{1j}, \dots \beta_{pj}) \tag{3}$$

Using this model, it was assumed that the adoption of a control method for FAW depends significantly on the socioeconomic, and institutional characteristics of farmers. Non-adoption of a control method was considered as a baseline variable. Dependent variables included chemical control, botanical control, and cultural control. In this study, the independent variables considered were household socioeconomic variables (Table 1).

The quality of the model was assessed using the likelihood of the model following a Chi-square distribution. The model was considered as significant when the value of the likelihood is greater than that of the Chi-square at the same degree of freedom and at a given threshold (1%, 5% or 10%).

Table 1. Variables used in the polytonic logistic model

| Variables | Description | Expected signs |
|---|---|---|
| Sex | Sex of respondent (male; female) | +/- |
| Age | Age of farmer [Young (< 30 years); Adult (30-60 years); Old (> 60 years) | +/- |
| Formal education | Level of formal education (Non-instructed; Primary; Secondary; University) | +/- |
| OP | Membership in a farmer organization (no; yes) | +/- |
| Dep | Respondent's department (Collines; Zou) | +/- |
| Experience | Number of years of experience in maize cultivation [Very experienced (> 10 years); Experienced (5-10 years); Little experienced (2-5 years); Very little experienced (1-2 years)] | +/- |
| Damage | Intensity of FAW damage [Very high; High; Low; Not perceived | +/- |
| Income | Income level of the respondent (High; Medium; Low) | +/- |

## 3. Results

### *3.1 Socio-economic Characteristics of Respondents*

Descriptive statistics on the socio-economic characteristics of the farmers are presented in Table 2. Surveyed farmers are predominantly male (89.8%) and married (99.41%). The most represented age group was adults (30-60 years-old). The number of years of experience of respondents in maize cultivation varies from 1 to 30 years, and those who are very experienced (> 10 years of experience) are the most represented (69%). Only 6% of respondents do not belong to any farmer organization. With regard to the level of education, a large proportion of farmers do not have access to formal schooling. Most of the farmers surveyed had a low level of income.

Table 2. Characteristics of respondents

| Characteristics | Modalities | Number | Frequency (%) |
|---|---|---|---|
| **Sex** | Male | 1696 | 89.80 |
| | Female | 193 | 10.20 |
| **Marital status** | Single | 11 | 1.00 |
| | Married | 1880 | 99.00 |
| **Age** | Young (< 30 years-old) | 151 | 8.00 |
| | Adult (30-60 years-old) | 1648 | 87.20 |
| | Old (> 60 years-old) | 90 | 4.80 |
| **Departments** | Collines | 1164 | 61.60 |
| | Zou | 725 | 38.40 |
| **Experience in maize cultivation** | Very experienced (> 10 years) | 1303 | 69.00 |
| | Experienced (5-10 years) | 372 | 19.70 |
| | Not very experienced (2-5 years) | 190 | 10.10 |
| | Very little experience (1-2 years) | 24 | 1.30 |
| **Farmer's organization membership** | Yes | 1776 | 94.00 |
| | No | 113 | 6.00 |
| **Formal education** | Non-instructed | 1588 | 84.10 |
| | Primary level | 165 | 8.70 |
| | Secondary level | 60 | 3.20 |
| | University level | 76 | 4.00 |
| **Income level** | High | 130 | 7 |
| | Medium | 525 | 28 |
| | Low | 1234 | 65 |

### *3.2 Constraints in Maize Production*

Pests attacks are a major problem in all the Communes surveyed (Figure 2). Farmers are facing the FAW damages in Ouessè (99.46%), Savalou (94%), and Bantè (78.69%) than Djidja (62.11%) and Glazoué (42.53%).

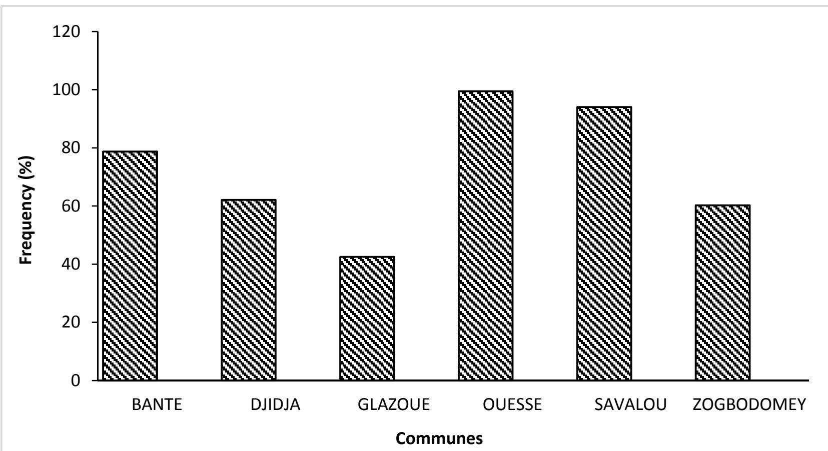


Figure 2. Farmers facing pest attacks by surveyed Commune

### *3.3 Farmers' Perception of the Fall Armyworm (FAW) Attack*

#### 3.3.1 Identification of the FAW by the Farmers Surveyed

The identification of FAW is easier in some Communes than others. Farmers in the Communes of Bantè (100%), Zogbodomey (98.77%), Ouessè (98.40%), Savalou (97.71%), and Djidja (86.85%) easily identify FAW from other species. In the Commune of Glazoué, this pest is not easily identified by farmers (only 41.79%) (Figure 3).

Recognition criteria vary from one individual to another. They recognize FAW by leaf tearing, leaves skeletonization, windows on the leaf's lamina, regular holes on the leaves; central shoot nibbled by grown-up larva; faecal pellets or frass in the whorl with mature larvae.

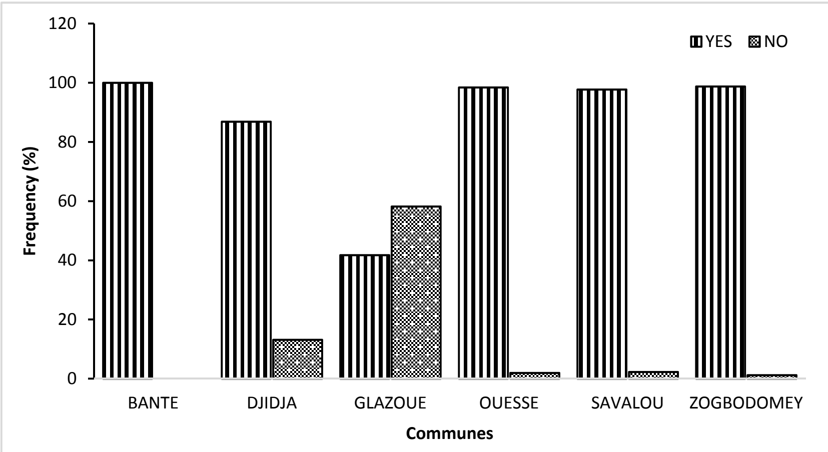


Figure 3. Distinction of FAW by farmers

### 3.3.2 Farmers' Perception of FAW Abundance Maize

In this survey, 58.23% of the growers reported that the FAW is abundant in maize fields (Figure 4). They informe that FAW damages are pronounced on maize leaves than other organs. In the Communes of Savalou, Ouessè, and Zogbodomey, the abundance of FAW in the fields was reported by 94.85%, 87%, and 75.07% of the farmers, respectively (Figure 5). Informants in the communes of Djidja (60.56%) and Bantè (62.13%) suppose that FAW is not very abundant. In the Commune of Glazoué, 58.20% of respondents reported that this pest is rare in the fields, compared to 26.41% who reported that FAW is very abundant (Figure 5).

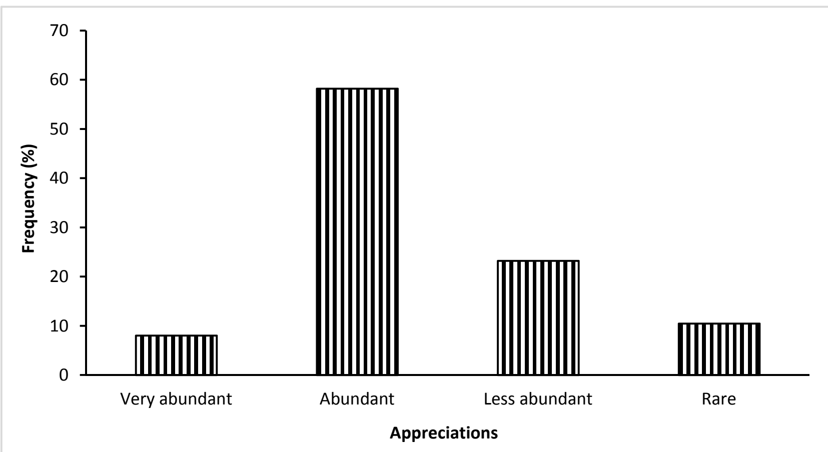


Figure 4. Perception of surveyed farmers on the abundance of FAW in the fields

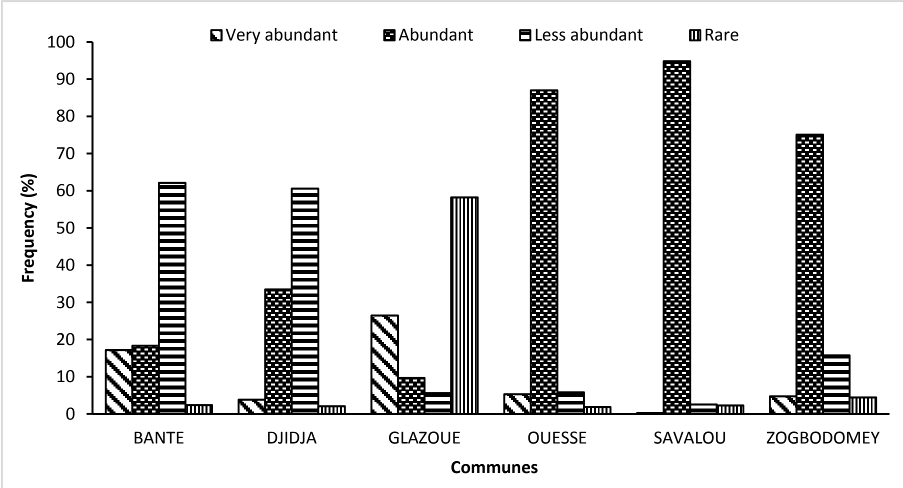


Figure 5. Perception of farmers surveyed by Commune on the abundance of FAW in the fields

### 3.3.3 Parts Attacked by Fall Armyworm on Maize Plants According to Farmers

Figure 6 shows the parts of the maize plant attacked by FAW according to the farmers. They mostly (57.07%) reported that the leaves are the most attacked. The stalk, inflorescence, cobs and cobs of maize were the other parts attacked by the FAW according to the farmers. However, flower, spathe, and cobs were lowly cited (less than 10%). According to farmers, the armyworm causes damage to up to 100% of the production (Figure 7). Indeed, more than 70% of the respondents indicated that FAW causes high (50% crop loss) to very high (75-100% crop loss) damage.

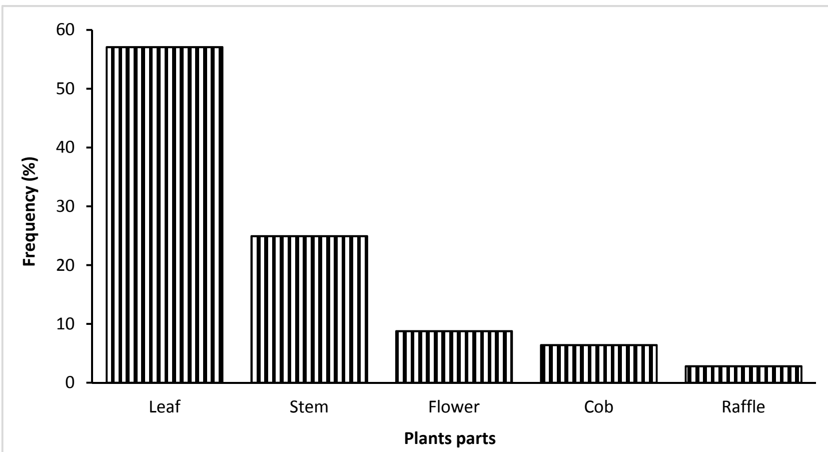


Figure 6. Maize organs attacked by the Fall armyworm

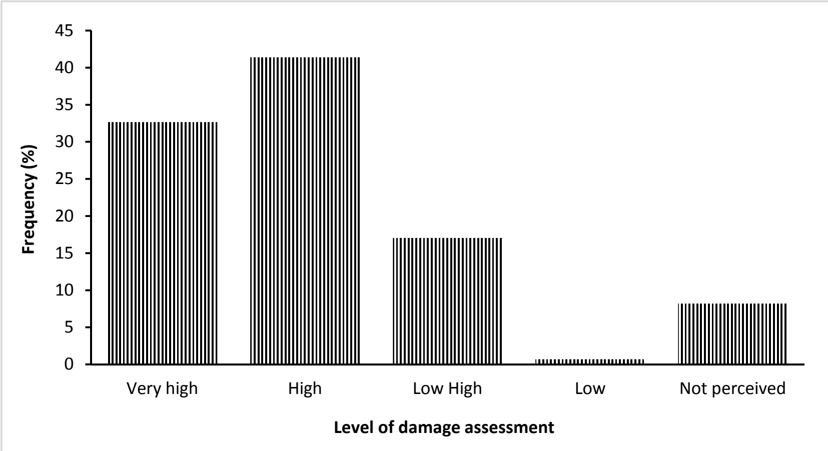


Figure 7. Farmers' assessment of the damage caused by the FAW

3.3.4 Fall Armyworm Control by Farmers

In order to limit the damage caused by the Fall armyworm (FAW), farmers use several control methods. Among the control methods used by the farmers, we have: chemical control (90%), biological control (4.45%) and cultural control (1.30%) (Figure 8). About 4% of the surveyed farmers do not use any control method against FAW.

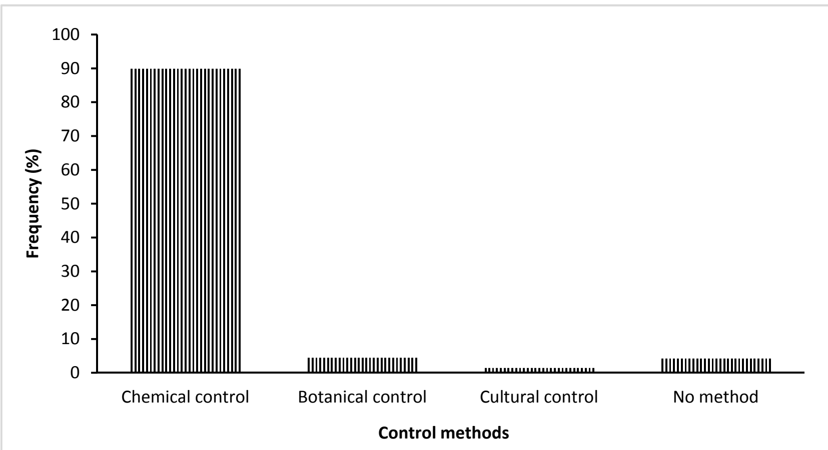


Figure 8. Control methods for FAW

Table 3 shows the products used in chemical control of FAW in the surveyed communes. Most of the products used are insecticides belonging to various chemical families. These are Pyrethroids, Avermectins, Neonicotinoids and Organophosphates. Acetamiprid, Emamectin benzoate, Lambda-cyhalothrin, Cypermethrin and Chlorpyriphos-ethyl are the active ingredients used. The chemicals are in liquid or powder form and act by contact, inhalation and/or absorption.

Table 3. List of chemicals used by farmers

| Trade names | Active ingredients | Rate per ha | Formulation | Types | Chemical families | Mode of action |
|---|---|---|---|---|---|---|
| **Napeco Metafos EC** | Acetamiprid 32 g/L + Emamectin benzoate 24 g/L | 1 Liter /ha | Liquid | Insecticide | Pyrethroids and Avermectins | Contact and ingestion |
| **PACHA 25 EC** | Acetamiprid 10 g/L + Lambda-cyhalothrin 15 g/L | 1 Liter/ha | Liquid | Insecticide and acaricide | Neonicotinoids and pyrethroids | Contact and ingestion |
| **EMACOT 050 WG** | Emamectin benzoate 50 g/L | 1 kg/ha | Powder | Insecticide | Avermectins | Ingestion |
| **EMACOT A 112 EC** | Emamectin benzoate 48 g/L + Acétamiprid 64 g/L | 0.5 Liter/ha | Liquid | Insecticide | Avermectins et Pyrethrinoïds | Contact and ingestion |
| | Cypermethrin 72 g/L + Chlorpyriphos-ethyl 600 g/L | 0.5 Liter/ha | Liquid | Insecticide | Pyrethrinoïds et Organophosphates | Contact, inhalation and ingestion |

The organic products used by the respondents in the botanical control of FAW are presented in Table 4. They are either aqueous extracts of parts or whole plants or oils extracted from the grains. The plants used are *Azadirachta indica*, *Jatropha curcas*, *Carica papaya* and *Vernonia* sp.

Table 4. Products used in the botanical control of FAW

| Organic products used | Dose per ha | Organs |
|---|---|---|
| Neem oil (*Azadirachta indica*) | 2 liters/ha | Grains |
| Aqueous extract of neem leaves (*Azadirachta indica*) | - | Leaves |
| Jatropha oil (*Jatropha curcas*) | 2 liters/ha | Grains |
| Aqueous extract of Papaya leaves (*Carica papaya*) | - | Leaves |
| Aqueous extract of *Vernonia* sp. leaves | - | Leaves |

### 3.3.5 Factors Influencing Different Control Methods by Farmers

Type 3 tests (Table 5) show that most of the explanatory variables are significant for the model. Indeed, some explanatory variables such as field superficy, age, experience in maize production, membership in a farmer's organization, level of formal education and income level of the farmer significantly determine the type of control method used against FAW.

Table 6 summarizes the results of the polytomous logistic regression. The area planted determines negatively the use of botanical control and positively the use of chemical and cultural control of FAW. Indeed, the odd-ratio shows that when the sown area increases by one unit, the probability that a farmer uses botanical control to control FAW is reduced by a factor of 0.56 while the probability of the chemical and cultural method increases by 1.414 and 1.94 respectively. The age class of farmers significantly influences the use of botanical and chemical control. Young and adult farmers preferred the use of botanical control less than old farmers. An opposite response was observed for chemical control where they have a preference for its use. Botanical control was preferred by experienced (Wald Chi-sq = 4.31; p-value = 0.005) and very experienced (Wald Chi-sq = 3.37; p-value = 0.032) farmers compared to the old. The farmer's experience in maize production did not significantly influence his decision to use the chemical or cultural method against FAW. The results showed that farmers used the chemical method when perceived damage was high or very high and preferred the botanical or cultural method when perceived damage was low and low. Membership in a farmer organization favors the adoption of at least one of the three control methods. However, as the odd-ratio values show, they prefer to use the chemical method. The regression coefficients are positive and significant for farmers with high school and university education for the adoption of the botanical method and the cultural method compared to uneducated farmers. This means that the latter prefer to use the botanical method and the cultural method to control FAW.

Table 5. Likelihood test results for the polytomous logistic regression.

| Criterion | Intercept Only | | Intercept and Covariates |
|---|---|---|---|
| **AIC** | 1081.02 | | 772.35 |
| **SC** | 1096.68 | | 1038.65 |
| **-2 Log L** | 1073.02 | | 636.352 |
| ***Testing Global Null Hypothesis: BETA = 0*** | | | |
| **Test** | **Chi-Square** | **DF** | **Pr > ChiSq** |
| **Likelihood Ratio** | 417.98 | 56 | < 0.0001 |
| **Score** | 356.69 | 56 | < 0.0001 |
| **Wald** | 143.10 | 56 | < 0.0001 |
| **Like-R²** | | | |
| **R-Square** | 0.6759 | | |
| **McFadden** | 0.718 | | |
| ***Deviance and Pearson Goodness-of-Fit Statistics*** | | | |
| **Test** | **Chi-Square** | **DF** | **Pr > ChiSq** |
| **Pearson** | 2311.377 | 1284 | < .0001 |
| **Deviance** | 456.196 | 1284 | 1.000 |

Table 6. Parameters of the polytomous logistic model to evaluate the determinants of the control method used to control fall armyworm

| Effect | Model Fitting Criteria | Likelihood Ratio Tests | | |
|---|---|---|---|---|
| | -2 Log Likelihood of Reduced Model | **ChiSq** | **DF** | **Pr > ChiSq** |
| **Intercept** | 456.196 | 0.000 | 0 | |
| **Field superficy** | 476.087 | 19.892 | 3 | <0.0001 |
| **Sex** | 457.329 | 1.133 | 3 | 0.7690 |
| **Age** | 469.628 | 13.432 | 6 | 0.0377 |
| **Department of origin** | 459.638 | 3.442 | 3 | 0.3280 |
| **Experience** | 481.855 | 25.659 | 9 | 0.002 |
| **Perception of FAW** | 3.868 | 3.4+42 | 12 | 0.3430 |
| **Membership in a Farmers' Organization** | 667.591 | 211.395 | 3 | <0.0001 |
| **Education** | 828.403 | 372.208 | 9 | <0.0001 |
| **Income** | 1597.303 | 1141.108 | 6 | <0.0001 |

## 4. Discussion

The results showed that maize farmers consider Fall armyworm (FAW) as a major constraint to production. According to the respondents, FAW can cause considerable damage and even total crop loss. This confirms the findings of Tepa-Yotto et al. (2021) who stated that FAW is the most damaging insect currently affecting maize crops in Africa and Asia. Fall armyworm (FAW) can cause yield losses ranging from 15% to 75% (Hruska & Gould, 1997). In addition, its larvae are very voracious and attack more than 80 crops of different species, although with a preference for maize (Prasanna et al., 2018). The control method most used by maize farmers is chemical control and conducted with chemical families containing active ingredients such as Acetamiprid, Emamectin benzoate, Lambda-cyhalothrin, Cypermethrin and Chlorpyriphos-ethyl. These active ingredients that are dangerous for the ecosystem and humans (Chimweta et al., 2020; Kansiime et al., 2019; Davis et al., 2018). Although chemical molecules are used to control armyworm, some authors (Martin et al., 2005; Abou-Yousef et al., 2010; Houndété et al., 2010) have reported the resistance of FAW to most of the chemical insecticides used in in Benin. Aware of the resistance of FAW to most chemical molecules, the farmers surveyed are increasing the quantity of insecticides and the frequency of application. This is illustrated by the results by the number of phytosanitary treatments and the quantity of phytosanitary products that are higher than the recommendation of the plant protection services in Benin. This practice implies an additional cost for small farmers and an environmental and health problem due to the release of a large quantity of insecticide residues (Aubertot et al., 2005). In addition, the molcules used are not specific to the FAW and kill almost all entomofauna including useful species and create a profound disruption in the ecosystem (Son et al., 2017).

The results of the present study show that a small proportion of the farmers surveyed use organic products such as leaves and/or seeds of *A. indica*, *J. curcas*, *C. papaya* and *Vernonia* sp for FAW control. Several authors have shown the effectiveness of these products and the advisability of using them to ensure the quality of harvested products and the maintenance of ecosystem balances. In Benin, Tepa-Yotto et al. (2022) showed that aqueous extracts based on *Vernonia* sp., *J. curcas*, *H. suaveolens* and *A. indica* significantly reduced larval density and damage to maize plants. Tamgno and Ngamo (2018) reported that ash has an abrasive effect that smothers, rubs out armyworm larvae. Bullangpoti et al. (2012) showed that vernonia and jatropha have a larvicidal and antifeedant effect that effectively controls armyworm. The advantage of using these insecticidal plants is that they are biorational and biodegradable, do not present hazards to human health and do not create any damage in the environment (Ramos-López et al., 2010; Yarou et al., 2017; Sisay et al., 2019).

We observed that socio-economic characteristics such as field superficy, age, experience in maize production, farmer's organization membership, level of education and income level of the farmer significantly determine the type of control method used against army worm. Farmers with high acreage prefer chemical control to any other control method. This may be explained by the fact that biopesticides are not well known in Benin, are even more expensive, and do not have special incentives. The positive influence of age was demonstrated by Mango et al. (2017). According to the results of the present study, young people and adults have a particular preference for chemical control compared to old people who prefer botanical control. This is justified by the fact that young people and adults are those who sow a large area and mostly assume that chemical control is the most effective. Our results show that literacy and education are key pillars that increase farmers' predisposition to accept and adopt agricultural technologies such as fall armyworm control methods. Such conclusions were made by Brett (2004). Furthermore, the preferential adoption of biological and cultural control by the literate and those with advanced levels of education reflects the fact that these practices require an appreciation of the technology that access to education has provided them. In other words, people with an advanced level of education could inform themselves through the internet and social networks about the health and environmental consequences of chemical pesticide use and the benefits of biopesticides. Moreover, they are quick to accept and adopt new technologies compared to uneducated or non-literate farmers who are more conservative and reluctant to take the risk of adopting a technology that seems new to them (Akplo et al., 2020). It was found that the extent of damage determines the type of method chosen by farmers, and the chemical method is preferentially used when perceived damage is high or very high. Membership in a farmer organization favors the adoption of at least one of the three control methods. This observation justifies the fact that within farmers' organizations, farmers exchange their own experiences and are well informed on different agricultural innovations (Nyangena & Juma, 2014). In other words, farmers' organizations constitute a kind of social network in which farmers make contact with new technologies and have their first experiences with these technologies (Akplo et al., 2020).

The FAW is an invasive insect pest that continues to spread across Africa, affecting millions of smallholder maize farmers. In response to this situation, two elements are essential: innovative research and farmer training. Since the advent of this insect in West Africa, research initiatives have been undertaken both nationally and internationally to understand its biology and better control it. However, one is tempted to doubt the effectiveness of the proposed control approaches and to question their impact on the quality of the products and their effect on the environment. Synthetic pesticides have adverse effects through the presence of pesticide residues in products, the development of pesticide resistance by pests and the appearance of secondary pests (Al-Zaidi et al., 2011). They are often a source of intoxication (Thabet et al., 2009). Conventional pesticides that are used to effectively control similar insects are less effective on FAW. It is therefore important to explore the combination of several control methods with a particular emphasis on cultural control and the use of biopesticides produced. For example, the practice of intercropping is an ancient practice used in traditional agricultural systems in Africa (Kafara, 2007), one of the advantages of which is to break the life cycle of pests, including insects. In addition, the use of biofertilizers is a practice of providing nutrients that have a long-term positive effect on soil properties and crop yield (Mukendi et al., 2017). In contrast to conventional pesticides, biopesticides have tremendous advantages including biodiversity preservation, target specificity, and biodegradability (Kumar et al., 2015). According to Kumar et al, (2015), the use of biopesticides can play a major role in protecting plants from pests in a sustainable manner. However, the use of biopesticides remains low with only 2.5% of the overall pesticide market (Kaki, 2014). On the other hand, Korangi et al. (2021) showed that compared to developed countries, the development of biopesticide markets in Africa remains very low. Further research is needed on botanical extracts of neem leaves and/or oil, papaya leaves, tobacco, etc., to determine the effective dose and method of application to control FAW.

As mentioned above, the second essential element in controlling armyworm is farmer training. To disseminate the control tools to a larger number of small farmers, it will be necessary to build on existing structures and exploit opportunities currently available. Trials should be conducted both at research stations and at action-research sites in partnership with farmers, for example through Farmer Field Schools or other farmer-led extension initiatives. This strategy will allow for rapid and widespread adoption of the technologies.

## 5. Conclusion

The objective of this study was to inventory local knowledge on the management of the FAW by maize farmers in central Benin. The results showed that maize farmers consider the FAW as a major constraint to the development of maize cultivation. They mostly use chemical methods to control FAW to the detriment of organic methods which are sustainable. Also, it was found that socio-economic characteristics can influence the choice of a FAW control method. Therefore, the results of this research suggest that (a) the extension of agricultural technologies including FAW control methods should take these factors into account and (b) policy makers should encourage technical guidance, literacy and training of farmers.

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