Acceptance of European Union (EU) approved pesticides for cocoa production in Nigeria

Kolapo Adetomiwa1*, Akeem Abiade Tijani1, Olowolafe Damilola Ezekiel2 and Muhammed Opeyemi Abdulmumin2

Abstract: In this study, we examined the determinants of acceptance of EU approved pesticides in Nigeria where several conditional logit models of cocoa farmers utility function were estimated using a choice experiment data conducted in Nigeria. We also used the conditional logit model to examine the influence of socioeconomic and economic benefits information variables on acceptance of EU approved pesticides among the cocoa farmers. Results showed that the cocoa farmers valued the EU approved pesticides more than the banned pesticides. The result of the effect of socioeconomic variables on acceptance of EU approved pesticides showed that gender, household income, farm size and access to credit significantly influence the acceptance of EU approved pesticides among the cocoa farmers in Nigeria. Consequently, results showed that providing the cocoa farmers with economic benefits information of using EU approved pesticides could translate to increase in acceptance of EU approved pesticides among the cocoa farmers. Both information variables—economic benefits information received prior to the experiment and economic benefits information received during the experiment—have positive and sizable effects on cocoa farmers’ acceptance of EU approved pesticides. These results suggest that EU approved pesticides dissemination campaigns should always incorporate economic benefits information of using the EU approved pesticides.

ABOUT THE AUTHOR

My research interests focus on the interface between environmental, resource base and agricultural production with a keen interest in agricultural technology adoption to enhancing agricultural productivity without compromising on equally important ecological, ethical, social and welfare goals. My research experience spans across states and institutions in Nigeria having collaborated with different scholars across institutions in Nigeria and beyond. I have worked on several projects in Nigeria detailing few years back. My quest is to understand why smallholder farmers have remained on a small scale of production and degree of commercialization over the years. I have also developed keen interest in understanding farmers’ investment pattern in agrochemical (pesticides) use especially in cocoa production, a decision that will help improve the quality of farm products and help safeguard the environment.

PUBLIC INTEREST STATEMENT

Over the years, cocoa farmers in Nigeria are known to be using pesticides to fight the negative impact of cocoa pests and diseases. However, the common pesticides being used by the farmers have been found to be hazardous to the health of the populace. Efforts have been made to ban those pesticides while introducing a new set of pesticides to the farmers. These new types of pesticides are less toxic and approved for use by the cocoa farmers. Several years after the introduction of the approved pesticides, cocoa bean exported from Nigeria still faces rejection at the international market and this was traced to the high content of hazardous substances found in the cocoa bean. Thus, the need to examine the current acceptance of EU approved pesticides among cocoa farmers in Nigeria. Our result found that providing economic benefit information of using the approved pesticides to the farmers help increases the acceptance of the approved pesticides among the cocoa farmers.
pesticides including higher returns to farmers from the sales of their cocoa beans. Empowering the cocoa farmers through the provision of credit facilities and trainings together with adequate dissemination of economic benefits information of using EU approved pesticides will likely result in acceptance of EU approved pesticides in Nigeria.

**Subjects:** Agriculture & Environmental Sciences; Plant & Animal Ecology; Soil Sciences

**Keywords:** EU approved pesticides; Cocoa farmers; conditional logit; banned pesticides; Nigeria

1. Introduction

Agriculture remains an important sector in the Nigerian economy contributing 24.4% of the GDP and provides employment for about 38% of the working population in Nigeria (Ministry of Budget and National Planning, 2017). The sector provides food for the rapidly growing population and raw material for agro-allied industries. Crop production constitutes the most important sub-sector of agriculture in terms of contribution to Gross Domestic Product and foreign exchange earnings. The contribution ranges between 89.5 and 90.2% from 2010–2016. Apart from the arable crops, cocoa and other permanent tree crops are the major export crops while in terms of foreign exchange contribution, cocoa is ranked first (Olajide et al., 2012). The large expanse of land (more than 65,000 ha) used for cocoa cultivation justifies its economic importance in Nigeria (Sanusi & Oluyole, 2005). As observed by International Cocoa Organization (International Cocoa Organization, 2002) and (2006), Africa, particularly West Africa, is the largest producer of cocoa, accounting for ≤75% of global cocoa production (Shorifzadeh et al., 2018; Etaware, 2021). Ironically, Europe and America jointly account for consumption of over 60% of the world’s cocoa produce (Etaware, 2021). In the early 1970s the foremost cocoa producing countries were Ghana (400,000 tons), Nigeria (250,000 tons), Côte d’Ivoire (200,000 tons) and Brazil (200,000 tons), occupying 1st, 2nd, 3rd and 4th positions, respectively, based on their contributions to the global cocoa market. Presently, Nigeria with a production capacity of 328,263 tons (7%) is ranked 4th behind Côte d’Ivoire, ranked 1st in the world, with 2,034,000 tons (40%), Ghana, ranked 2nd, with 883,652 tons (18%) and Indonesia, ranked 3rd, with 659,776 tons (13%), followed closely by Cameroon, ranked 5th, with 295,028 tons (6%), Brazil, ranked 6th, with 235,809 tons (5%), Ecuador, ranked 7th, with 205,955 tons (4%), and Peru, ranked 8th, with 121,825 tons (3%), while the rest of the world account for ≤4% of global cocoa production (WorldAtlas, 2020; Etaware, 2022). Unfortunately, Nigeria has been unable to sustain its former dominance in the global cocoa market due to several challenges, including stagnant crop size—yields losses and low production, ageing trees and farmlands, pest and disease invasion, irregularity in production patterns, old cocoa trees, old and ageing farmers, lack of new plantations, inconsistent quality of beans and a lack of awareness of good agricultural practices (Oluyole & Taiwo, 2016). However, incidences of diseases and pests have been a significant contributor to the setback of cocoa production and export in Nigeria. The brown cocoa mirid, *Sahlbergella singularis* remains the major insect pest of cocoa capable of reducing yield by a minimum of 30% in a season (Tijani, 2010). The other two sources of cocoa are the swollen shoot virus disease transmitted by mealybugs, and the black pod disease caused by *Phytophthora palmivora* and the more virulent *Phytophthora megakarya* (Anikwe et al., 2009; Tijani, 2010). Cocoa farmers use various practices to keep pest infestations under economic control, including the use of pesticides to inhibit attacks on cocoa plantations (Babasola et al., 2017).

Pesticides are a significant component of the modern agricultural technology that has been widely adopted by Nigerian cocoa farmers to control pests, diseases, weed and other plant pathogens, with an effort to reduce or eliminate yield losses and maintain high product quality because of their quick and effective action (Asogwa & Dongo, 2009). According to Oke et al., (2020) cocoa pesticides represent approximately 37% of total annual agrochemical usage in Nigeria.
About 125,000–130,000 metric tons of pesticides are applied in cocoa fields every year in Nigeria (Asogwa & Dongo, 2009; Tijani, 2010). Pesticides are toxic by nature and can be dangerous if not managed properly; therefore, limiting their use through registration is extremely beneficial to developing countries (Mokwunye et al., 2012). The European Union’s regulatory committee has established maximum levels of residue (MRLS) in commercial goods traded on the global market, which include cocoa. In 2008, the European Union resolved to boycott cocoa beans with pesticide levels exceeding the recommended limits (Jones, 2008). Specifically, based on the European Food Safety Authority, the maximum residue limit for cocoa beans is 0.01 mg/kg where cocoa beans from Nigeria range from 0.03 mg/kg and 4.6 mg/kg of dichlorvos pesticide (Akinneye et al., 2018). As a result of these efforts, the Nigeria government has banned the use of about 20 commonly used chemicals in cocoa farming. It has listed the recommended pesticides for use on cocoa farms in Nigeria as presented in Table 1. The pronouncement is a threat to the livelihood of the cocoa farmers as 90% of Nigeria’s processed cocoa and raw cocoa is exported to the European market (Tijani, 2010). As a result of this pronouncement key stakeholders have been compelled to act and mitigate the negative impact it will certainly have on cocoa farmers in Nigeria. Stakeholders have formed a new national cocoa extension programme, which have been responsible for educating farmers on the proper use of recommended pesticides and acceptance of EU approved pesticides. However, according to Ogunya and Tijani (2022), use of EU approved pesticides is expected to increase farmers yield and income since cocoa beans that are certified to meet up with the recommended maximum levels of residue (MRLS) is expected to command higher economic returns to the cocoa farmers. Past studies on compliance and adoption of recommended approved pesticides have shown that cocoa farmers are not entirely receptive to EU approved pesticides in Nigeria (Kehinde & Tijani, 2021; Mokwunye et al., 2014, 2012; Tijani, 2010). While Mokwunye et al. (2012) in their study found that more than 50% of the sampled cocoa farmers were still using banned pesticides in cocoa producing areas of Ogun, Osun and Kwara State of Nigeria, almost a decade later, Kehinde and Tijani (2021) found that about 80 percent of cocoa farming household

| S/N | Trade Name      | Active Ingredient | Commercial form | Pest          |
|-----|-----------------|-------------------|-----------------|---------------|
|     | Insecticides    |                   |                 |               |
| 1   | Esiom 150 S1    | Acetamiprid       | Soluble liquid  | Mirid         |
| 2   | Actara25WG      | Thiamethoxan      | Wettable granule| Mirid         |
| 3   | Proteus170 O-TEQ| Deltamethrin 20 g/1| Oil Dispersion  | Mirid         |
|     | Fungicide       |                   |                 |               |
| 4   | Funguran-OH     | Copper hydroxide  | Wettable powder  | Black pod     |
| 5   | Champ DP        | Copper hydroxide  | Dustable powder  | Black pod     |
| 6   | Ridomil gold 66WP| Cuprous Oxide + metalaxyl-M | Wettable powder  | Black pod     |
| 7   | Nordax 75WP     | Cuprous Oxide     | Wettable powder  | Black pod     |
| 8   | Kocide 101      | Cuprous Oxide     | Wettable powder  | Black pod     |
| 9   | Ultimax plus    | Cuprous Oxide     | Wettable powder  | Black pod     |
|     | Herbicides      |                   |                 |               |
| 10  | Touch down      | Glyphosate        | Soluble concentrate | Weed     |
| 11  | Round up        | Glyphosate        | Soluble concentrate | Weed     |
| 12  | Clear weed      | Glyphosate        | Soluble concentrate | Weed     |
|     | Fumigants       |                   |                 |               |
| 13  | Phostoxin       | A1uminum Phosphides|              | Storage pests |

Source: Cocoa Research Institute of Nigeria, (2015).
had adopted EU approved pesticides in Osun State, Nigeria. Although Kehinde and Tijani (2021) examined how livelihood capital has contributed to adoption of the EU approved pesticides, they however fail to ascertain whether receiving economic benefit information of using EU approved pesticides will increase cocoa farmers’ acceptance of EU approved pesticides. This thus create a gap in knowledge about the effect of prior information and information presented during an experiment on cocoa farmers and thus warrant further investigation because of the potential higher economic benefit impact of acceptance of EU approved pesticides among the cocoa farmers in Nigeria.

Aside from providing cocoa farmers with higher economic benefits information about EU approved pesticides and ensuring that EU approved pesticides possesses similar mixing and spraying attributes to the banned alternative, are there other factors yet to be investigated that can play a crucial role in the success of the acceptance of EU approved pesticides among the cocoa farmers? As a pronouncement with an objective of improving the health status of people across the world especially in developing countries while increasing the income of the cocoa farmers, socio-economic characteristics of cocoa farmers such as their income, amount of land owned, age, education level, household size and access to financial support (access to credit) might play an important role to the success of the acceptance of EU approved pesticides among the cocoa farmers. Therefore, we used experimental data from Nigeria to investigate the effects of EU approved pesticides attributes, socio-economic characteristics of cocoa farmers and economic benefit information on EU approved pesticides acceptance in Nigeria. We disaggregate these effects by states to examine differences in preferences between the two highest cocoa producing States in Nigeria (Ondo and Osun States).

The following research questions are addressed in this paper: What are the determinants of their acceptance for EU approved pesticides? We used a choice experiment to elicit these responses from the cocoa farmers in Ondo and Osun States of Nigeria, and model the responses with conditional logit models. The choice experiment has theoretical and econometric foundations on Lancaster (1966) and McFadden (1973), respectively. It also depicts real-life purchasing decisions. However, due to the hypothetical nature of the choice experiments conducted in this study, we adopted “cheap talk” in the experiment, which was also used by Chowdhury et al. (2011) although they concluded that it does not seem to entirely eliminate the hypothetical bias. The findings of this study will provide policy makers with the importance of awareness and economic benefits campaigns to stimulate the acceptance of EU approved pesticides among cocoa farmers and increase the quantity and quality of cocoa bean exports in Nigeria.

2. Conceptual framework
The conceptual framework of this study is rooted in the works of Lancaster (1966), McFadden (1973), and Ethumnu (2016). Lancaster proposed that demand for a product is spurred by the attributes of that product while McFadden proposed the random utility theory which assumes that an individual’s utility comprises of systematic and stochastic components. In this case where respondents were asked to choose between two different sets of pesticides (EU Approved pesticides and banned pesticides) and a none option, we assume that the utility derived by the ith farmers in choosing option pesticides j is given by

$$U_{ij} = V_{ij} + \epsilon_{ij}$$

where $V_{ij}$ is the systematic component of the utility function determined by the attributes of the pesticides and $\epsilon_{ij}$ is the unobserbale stochastic component. The probability that a farmer chooses alternative j is

$$Prob\{ V_{ij} + \epsilon_{ij} \} \geq Prob\{ V_{ik} + \epsilon_{ik} \}; \text{ for } a11j \neq k$$

Assuming $\epsilon_{ij}$ is independently and identically distributed across the j alternatives and N individuals with an extreme value distribution, the conditional logit results (Louviere et al., 2000; Lusk &
Schroeder, 2004; McFadden, 1973). Based on these assumptions, the probability of choosing alternative \( j \) is

\[
\text{Prob}(j \text{ is chosen}) = \frac{\exp V_j}{\sum \exp V_k}
\]  

(3)

where \( V_j \) is as previously defined and \( j \) is the pesticides options. The objective of this study is to estimate cocoa farmers acceptance of EU approved pesticides and to examine the determinants of farmers acceptance of EU approved pesticides. In order to do this, we need an econometric specification.

Each respondent chooses one option from three alternatives (EU approved pesticides, banned pesticides or 'none'), which they prefer most (derived highest utility from) in each of the three choice set. We assume that these choices are driven by an attribute-based utility function as specified as:

\[
V_{ij} = \beta_1 \text{EU approved pesticides}_j + \beta_2 \text{Banned pesticides}_j + \alpha P_j + \gamma X_i + \theta Z_i
\]  

(4)

where EU approved pesticides\(_j\) takes the value of 1 if alternative \( j \) is an EU approved pesticides, Banned pesticides\(_j\) takes the value of 1 if alternative \( j \) is a Banned pesticides, \( \beta_1 \) and \( \beta_2 \) are alternative-specific constants representing the utility of EU approved pesticides, banned pesticides relative to 'none' option, respectively, \( P_i \) is the price of alternative \( j \), \( X_i \) is a vector of the economic benefit information received by respondent \( i \) and \( \gamma \) is the effect of economic benefits information, \( Z_i \) is a vector of socio-economic characteristics of respondent \( i \) and \( \theta \) is the effect of the characteristics on the deterministic component of the utility. The null hypothesis of the study is that \( \theta \) is zero, while the alternative is that \( \theta \) is non zero; however the direction of the effect is not specified.

3. Research methods

3.1. Area of study and sample selection procedure

The research was conducted in Nigeria’s southwest region, which consists of six geopolitical states: Lagos, Osun, Ogun, Oyo, Ekiti, and Ondo. The research locations are located between longitudes 20°31' and 6°00' E and latitudes 6°21' and 8°37' N, and span an area of approximately 77,818 km\(^2\).

The climate in Southwest Nigeria is tropical, with large differences in mean temperatures (21°C and 34°C) and annual precipitation (150 and 3000 mm) amongst states. The monsoon wind from the Atlantic Ocean is connected with the rainy season, whereas the north-eastern trade wind from the Sahara desert is associated with the dry season. Swamp and deep forest, as well as lowland woods, make up the vegetation in the research areas, which stretch throughout Ogun and Ondo states. The northern limit is made up of forests that stretch all the way to southern Guinea). Cocoa is produced in six states in Southwest Nigeria, Ondo, Osun, Ekiti, Ogun, Oyo and Edo State with (Ondo and Osun) grouped as high producing states, while the medium producing (Ogun, Oyo and Ekiti) States. Ondo States records an output capacity estimated at 92,200 metric tonnes per annum while Osun State produces 74,100 metric tonnes in 2011/2012 (Afolayan, 2020). The map of the study area, Southwest, Nigeria, Ondo and Osun State were represented in Figure 1, 2 and 3 respectively.

This study used a multistage sampling strategy to choose respondents from the study area. A typical-case purposive selection of two largest cocoa producing states (Ondo and Osun) located in the same agroecological area was used in the first step. Using standard case purposive sampling, five local government areas (LGAs) from each state were chosen in the second step, based on the prevalence of smallholder cocoa producers in these areas. In the third stage, five villages from each of the four LGAs were chosen at random. The sample size for the study was established using the sample determination formula at a 95 percent confidence level and a 5 percent margin of error, as stated by Tesfahunegn et al. (2016). Six smallholder cocoa farmers
were chosen from each of the five villages within this framework, totaling 300 respondents who were interviewed for the study. A well-structured questionnaire was used to collect primary data from the respondents. Data on their socioeconomic characteristics, types of pesticides being used, quantities of cocoa produced etc. were all collected. A choice experiment card was embedded in the questionnaire where the cocoa farmers were asked to make their choices while providing them with economic benefit information. Data collected were processed and were analyzed using STATA 14 software. The ethical principles of respect for person, anonymity and confidentiality, beneficence and principle of justice were all observed in the course of the study. For instance, data collection was only done after informed consent had been obtained from the respondents. All respondents, irrespective of their ethnicity and creed, were treated fairly and equally throughout the conduct of the study.

4. Choice experiment
In this study, we used the choice experiment valuation technique to elicit cocoa farmers’ choice of EU approved pesticides in Ondo and Osun States, Nigeria. The choice experiment suits this study because it allows for the estimation of potential demand for a multi-attribute product that is spurred by economic benefits value to be studied, and the socio-economic and information hypotheses to be tested at the same time. The advantages of using the choice experiment relative to other valuation methods includes that we have control over the experiment and the attributes associated with passive uses that cannot be valued in the market place for a relatively new product. Another advantage is that choice experiment closely mimics actual purchasing decisions that both producers and consumers make, and it is based on the random utility theory introduced by McFadden (1973) and theory of consumer behavior introduced by Lancaster (1966), which states that the utility derived from a product is because of the attributes of the product. From some interviews that we conducted and the economic literature, the attributes of EU approved pesticides that warrant investigation in Nigeria includes toxicity, mixability with water, environmentally sustainable, better packaging, economic value, and price. Although it seems ideal to present all these attributes to cocoa farmers in the experiment, considering all the attributes simultaneously renders the choice sets unmanageable because they become too large and confusing. Thus, because of this potential problem, we focus on price and toxicity attributes in this
study, and prepared choice sets based on them. These attributes were varied to create choice scenarios from which respondents made repeated selection among three alternatives that differed by these attributes. Price of the EU approved pesticides was varied at four levels for each of two sets of alternative pesticides. Toxicity was varied at three levels: less toxic, medium toxic and highly toxic. During the conduct of this experiment, we relied on information from pesticides marketers in determining the prices and quantity of pesticides. The prices of the two sets of pesticides (EU approved and Banned) encompass the possible minimum and maximum price that we received from the marketers. From these attributes and their corresponding levels, we constructed choice sets. The respondents were presented with three choice sets to choose from. The first option was EU approved pesticides and the second option was banned pesticides, and the last option was none of the two—a none option. In this set-up, there are two set of pesticides.
varied at four different price levels. This implies that respondents would have to be shown $4^2 = 16$
different choice sets for the EU pesticides experiment. In order to have a basis for comparison we
included a 17th choice set where all the pesticides have the same price.

The availability of a respondent determined if the he or she took part in the experiment. To
reduce hypothetical effect of the purchasing decisions and to increase realism, “cheap talk” was
employed and participants were informed that after making their choices, they would receive a gift — “a
detergent” — that worth about one hundred naira. Each participant was randomly assigned to
one of two treatment groups. One treatment group received economic benefits information about
EU approved pesticides while the other treatment group did not receive economic benefits
information. Participation and assignment was only once and to only one treatment group. Well-
trained enumerators carried out the survey. About three enumerators provided economic benefits
information about EU approved pesticides to cocoa farmers (treatment 1) and the other three
enumerators did not provide economic benefits information (treatment 2). The enumerators first
collected demographic information of the respondents and then elicited their preferences about
the pesticides, providing economic benefits information if required. The experimental sequences of
steps are as follows: 1) Randomization 2) Demographic module 3) Provision of economic benefits
information if applicable, and 4) Choice experiment itself.

The demographic module consists of a series of survey questions that collected information on
respondents socio-economic characteristics such as income, educational level, amount of land
owned, household size and age, which were used as determinants of acceptance of EU approved
pesticides in the empirical estimation. The demographic module was followed by provision of
economic benefits information. Cocoa farmers that were assigned to the information treatment
were provided information on the economic benefits of EU approved pesticides while those that
were assigned to treatment without information were not provided economic benefits information.
The economic benefits message given to the information treatment was designed based on EU
regulatory committee pronouncement of purchasing cocoa bean of countries that complied with
the MRLs at higher prices. All cocoa farmers were asked about whether they had received prior
information on EU approved pesticides and their responses are used as a determinant of acceptance of EU approved pesticides in the empirical estimation. We then give the respondents instructions on how the choice experiment works and provided with scenarios to make their choices.

NB: The pictures in Figure 4 indicate an actual product. It was however used to represent example of EU approved pesticides and banned pesticides to the local cocoa farmers. They are however not the only EU approved and banned pesticides.

5. Results and discussion

5.1. Summary of the descriptive statistics

We surveyed three hundred cocoa farmers for this study and presented the result of the summary descriptive statistics in Table 2. We presented result for the full sample and also disaggregated the result by region and treatment information. For the full sample, 78 percent of the respondents were male with a mean age of 56 years. The average years of formal education was 8 years having a mean household size of 5 people per household. An average of 87,456 naira is being generated annually by the farmers whose average farm size was 5 ha. About 57 percent of the cocoa farmer had access to credit while 68% of them had received information on EU approved pesticides prior to experiment. In addition, we disaggregated the result of the socioeconomic characteristics of the respondents by region and treatment. With respect to region, majority (73 percent and 75 percent) of the cocoa farmers in Ondo and Osun State respectively were male, an indication that cocoa farming is dominated by men in this region. Their average ages and years of formal education were (59 and 54 years) and (9 and 8 years) for Ondo and Osun State respectively. They have an average household size, household income and farm size of 6 and 5 people per household, 92,199 and 86,119, 6 ha each for Ondo and Osun State respectively. About 62 percent and 55 percent of the cocoa farmers from Ondo and State region respectively have access to credit while 72 percent of the cocoa farmers from Osun State had had received information on EU approved pesticides prior to experiment, 66 percent of the farmers from Osun State had had received information on EU approved pesticides prior to experiment. With respect to disaggregation by treatment, majority (74% and 73%) of the cocoa farmers with info and without info respectively were male. The result of the disaggregation shows a general resemblance with that of the disaggregation by gender.

6. Cocoa farmers’ preferences for pesticides

We obtained a total of 4,692 observations from the respondents with 2538 observations from Ondo State and 2388 observations from Osun State. From the 4,692 observations, 1529 represents the choices made by all the respondents, 769 represents the choices made by respondents from Ondo State and 760 represents the choices made by respondents from Osun State. We presented
Table 2. Summary statistics of respondent socioeconomic characteristics

| Definition                                                                 | Full sample | Region       | Treatment               |
|----------------------------------------------------------------------------|-------------|--------------|-------------------------|
|                                                                             |             | Ondo         | Osun                    | With info | Without info |
| Gender (1 = male, 0 = female)                                               | 0.78(0.33)  | 0.73(0.35)   | 0.75(0.32)              | 0.74(0.39) | 0.73(0.33)   |
| Age (years)                                                                | 56.36(14.36)| 59.17(15.27) | 54.29(14.38)            | 58.53(15.34) | 55.18(14.11) |
| Years of formal education                                                  | 8.39(4.32)  | 9.37(5.29)   | 8.21(5.11)              | 8.62(4.27)  | 8.48(4.33)   |
| Household size                                                             | 5.82(1.28)  | 6.28(1.11)   | 5.16(1.36)              | 5.28(1.33)  | 5.19(1.29)   |
| Household income (Naira)(Annual)                                           | 87,456(36,281)| 92,199(38,111)| 86,119(39,345)         | 88,291(32,381)| 89,182(36,199)|
| Farm size (Size of farmland into cocoa production)                        | 5.37(4.18)  | 6.27(3.19)   | 6.31(3.46)              | 5.29(3.28)  | 5.18(3.76)   |
| Access to credit                                                           | 0.57(0.52)  | 0.62(0.51)   | 0.55(0.52)              | 0.58(0.53)  | 0.57(0.55)   |
| Received information on EU approved pesticides prior to experiment (yes = 1, no = 2) | 0.68(0.47)  | 0.72(0.54)   | 0.66(0.61)              | 0.67(0.54)  | 0.64(0.51)   |

Mean value are reported; values in parentheses are standard deviation

In Table 3 the calculated relative preferences of all the respondents from the observations. From the possible 1529 choices of the full sample for the preferred pesticides at different price levels, the EU approved pesticides received 1395 (91%), the banned pesticides received 127 (9%). Our results suggest a huge preference for EU approved pesticides for cocoa production in the study area irrespective of price level used. Furthermore, the region disaggregated sample results shows that EU approved pesticides received 710 (93%) choices for Ondo State, and 685 (90%) choices for Osun State indicating that even subgroup have similar preferences towards EU approved pesticides. We then used the calculated observations to estimate conditional logit models from which we examine the effects of socio-economic characteristics and economic benefits information on their preferences.

We presented the results in Table 4, the estimates of a restricted version of the econometric model using conditional logit for the full sample. Also to compare and discuss variations in estimates between respondents from Ondo and Osun States and treatments, we estimated conditional logit models for both States subsamples which were also presented in Table 4. The explanatory variables (attributes of the pesticides) of the models explain more than 68% of the variation in the dependent variable (pesticides choice made by the respondents) as shown by the relative size of the Pseudo – R² in all the models presented.

For the full sample, the price coefficients is positive and statistically significant, indicating that pesticides with higher prices will be more likely to be chosen by the cocoa farmers. The coefficients of price for the Ondo State subsample is positive and statistically significant meaning that cocoa farmers from Ondo State were more likely to choose pesticides with higher prices. For the Osun State subsample, the price coefficients were positive although statistically insignificant which means that respondents from this State will choose pesticides with higher prices even though the coefficients do not have statistical power. The positive sign of the price coefficients have some economic implications. A positive price coefficients denotes an upward sloping demand curve. There could be a general perception among the cocoa farmers that a higher price represents higher quality, thus suggesting positive price coefficients. This result is in agreement with that of
Table 3. Cocoa farmers' preferences of the pesticides

| Pesticides                  | Full sample | Ondo State | Osun State |
|-----------------------------|-------------|------------|------------|
|                             | Yes         | No         | Yes        | No         | Yes        | No         | Yes        | No         |
|                             | Freq.       | Perc.      | Freq.      | Perc.      | Freq.      | Perc.      | Freq.      | Perc.      |
| EU approved pesticides      | 1395        | 91         | 180        | 1          | 710        | 93         | 105        | 6          |
|                             |             |            |            |            |            |            |            |            |
| Banned pesticides           | 127         | 9          | 1517       | 47         | 54         | 7          | 823        | 46         |
|                             |             |            |            |            |            |            |            |            |
| None                        | 7           | 0          | 1646       | 52         | 5          | 0          | 842        | 48         |
|                             |             |            |            |            |            |            |            |            |
| Total                       | 1529        | 100        | 3163       | 100        | 769        | 100        | 1769       | 100        |

Danso-Abbeam and Baiyegunhi (2018), Antwi-Agyakwa et al. (2015) who all found a significant relationship between prices and pesticides adoption in cocoa production.

We also show the results of the coefficients for the two alternative pesticides in Table 4. The results are similar for the full sample and disaggregated subsample. All the coefficients for the full sample and disaggregated subsample were positive and statistically significant meaning that respondents will choose either EU approved pesticides or banned pesticides relative to “none”. We observed that the size of the coefficients of the EU approved pesticides are more than that of the banned pesticides in the full sample and disagggregate sample indicating that the respondents preferred EU approved pesticides to banned pesticides. This means that the respondents obtained higher indirect utility from the EU approved pesticides relative to banned pesticides. This might be attributed to the fact that a cocoa farmer who uses EU approved pesticides received higher income from the sales of their cocoa bean because their cocoa bean has a higher quality in terms of lower maximum residual levels recommended by the European Union.

7. Determinants of acceptance of EU approved pesticide for cocoa production

We presented the result of the parameter estimates of the coefficients of the conditional logit models in Table 5 where we examined the effect of socioeconomic characteristics and effect of receiving economic benefits information about EU approved pesticides prior or during the experiment on cocoa farmers’ acceptance of EU approved pesticides.

All the socioeconomic characteristics except household size positively influence cocoa farmers acceptance of EU approved pesticides for the full sample as shown in column 1 of Table 5. For the

Table 4. Parameter estimate of the conditional logit of the utility function

| Variables                               | Full sample | Ondo State | Osun State |
|-----------------------------------------|-------------|------------|------------|
| Price of pesticides                     | 0.0012***   | 0.0018***  | 0.0002     |
|                                         | (0.0004)    | (0.0005)   | (0.00004)  |
| EU approved pesticides relative to “none” | 0.0024***   | 0.0070***  | 0.0020***  |
|                                         | (0.0007)    | (0.0020)   | (0.0006)   |
| Banned pesticides relative to “none”    | 0.0004***   | 0.0016*    | 0.00013*** |
|                                         | (0.0002)    | (0.0009)   | (0.0004)   |
| Observations                            | 4,692       | 2,538      | 2388       |
| Choices                                 | 1529        | 769        | 760        |
| Pseudo R²                               | 0.742       | 0.692      | 0.733      |
| log likelihood                          | −1735       | −729       | −856       |

***, **, * significant at 1%, 5% and 10% respectively; standard error in parentheses
subsamples of column 2, all socioeconomic characteristics except gender positively influence acceptance of EU approved pesticides in Ondo State. For the subsamples in column 3, all the socioeconomic characteristics positively influence acceptance of EU approved pesticides in Osun State as presented in Table 5. The coefficient of gender is positive for both the full sample and Osun State region (subsample) although only statistically significant for Osun State. It is negative and insignificant for Ondo State subsample. This indicates that male gender is more likely to accept EU approved pesticides in Osun State and vice versa in Ondo State. It has been noted in literature that men have more access to resources and training in Nigeria thus, the male cocoa farmers might have had access to the EU approved pesticides in Osun State. This agrees with Denkyirah et al. (2016), Fosu-Mensah et al. (2022) that gender of cocoa farmers plays an important role in the adoption of recommended pesticides use in cocoa production. The coefficient of age was positive and insignificant for the full sample, Ondo and Osun subsamples. This implies that age increases the acceptance of EU approved pesticides among the cocoa farmers. As farmers aged, they tend to accumulate experience and quality information which may assist them in making decision that will influence their acceptance of EU approved pesticides. This result is in agreement with the study of Denkyirah et al. (2016), Danso-Abbeam and Baiyegunhi (2018), Antwi-Agyakwa et al. (2015) that age of the cocoa farmers influences the decision to adopt chemical pesticides in cocoa production. The coefficient of education was positive although not statistically significant for the full sample, Ondo and Osun subsamples. This indicates that

| Variables                  | Region Full sample (1) | Region Ondo (2) | Region Osun (3) | Region Full sample (4) | Region Ondo (5) | Region Osun (6) |
|----------------------------|------------------------|-----------------|-----------------|------------------------|-----------------|-----------------|
| Price                      | 0.2987*** (0.0906)     | 0.1894*** (0.0684) | -2.5221*** (0.1585) | 0.6904*** (0.2560) | 0.4705*** (0.1089) | 0.4489*** (0.1561) |
| EU approved pesticides     | 2.5714*** (0.1580)     | 2.2385*** (0.0809) | 5.6205*** (0.0863) | 5.3218*** (0.1018) | -2.9339*** (0.7456) | 1.1754*** (0.2942) |
| Banned pesticides          | 1.8995*** (0.5862)     | -1.2451*** (0.4518) | 4.1277*** (1.6821) | 4.7080*** (0.4333) | 1.2936*** (0.1578) | 0.6407** (0.2685) |
| Gender                     | 0.2647 (0.2099)        | -0.0009 (0.0007)  | 0.0725*** (0.0134) | 0.0001 (0.0006)    | -0.0006 (0.0008)  | -0.0001 (0.0004) |
| Age                        | 0.0025 (0.1729)        | 0.0001 (0.0001)   | 0.0005 (0.0004)   | 0.0005 (0.0003)    | -0.0001 (0.0006)  | 0.0001 (0.0005)  |
| Education                  | 0.0005 (0.0004)        | 0.0002 (0.0002)   | 0.0005 (0.0006)   | 0.0003 (0.0003)    | 0.0003 (0.0004)   | 0.0002 (0.0005)  |
| Household income           | 0.0001 (0.0005)        | 0.0035* (0.0021)  | 0.0002 (0.0002)   | -0.0002 (0.0003)   | -0.0008 (0.0005)  | 0.0007 (0.0005)  |
| Farm size                  | 0.0015*** (0.0006)     | 0.0004 (0.0006)   | 0.0001 (0.0006)   | 0.0003 (0.0002)    | -0.0003 (0.0007)  | 0.0001 (0.0006)  |
| Household size             | -0.0004 (0.0005)       | 0.0007 (0.0009)   | 0.0114 (0.0203)   | 0.0001 (0.0001)    | -0.0009 (0.0017)  | 0.0003 (0.0006)  |
| Access to credit           | 0.0124 (0.0184)        | 0.0029* (0.0017)  | 0.0264 (0.0266)   | -0.0006 (0.0008)   | 0.0006 (0.0005)   | -0.0002 (0.0011) |
| Prior information          | 0.0003*** (0.0001)     | 0.0038*** (0.0013) | 0.0062*** (0.0020) | 0.0031** (0.0017) | 0.0026*** (0.0006) | 0.0074*** (0.0035) |
| During information         | 0.0003 (0.0001)        | 0.0002 (0.0001)   | 0.0006 (0.0005)   | 0.0001 (0.0006)    | 0.0002 (0.0005)   | 0.0001 (0.0006)  |
| Observations               | 4,692                  | 2,538            | 2388             | 4,692                 | 2,538           | 2388            |
| Choices                    | 1529                   | 769              | 760              | 1529                  | 769             | 760             |
| Pseudo R²                  | 0.629                  | 0.721            | 0.711            | 0.627                 | 0.724           | 0.661           |
| log likelihood             | -1472                  | -9281            | -1922            | -1728                 | -1836           | -1563           |

***, **, * significant at 1%, 5% and 10% respectively; standard error in parenthesis
education increase the likelihood of accepting EU approved pesticides among the cocoa farmers. Farmers who are educated get training where they access current information about their farm production and thus assist them in making important decision that will help them increase their income such as accepting EU approved pesticides for cocoa production. This agrees with; Adejumo et al. (2014), Adeogun and Agbongiarhuoyi (2009), and Afrane and Ntiamoah (2011) who all ascertained that education received prior to dissemination of useful pesticides significantly affects their adoption.

Household income was positive and only significant for the Ondo subsample. This means that as household income increases, the likelihood of acceptance of EU approved pesticides also increase. Thus, when income increases, the farmers will be able to purchase the EU approved pesticides because it is more expensive than the banned pesticides. This agrees with Aminu et al. (2019) that income of cocoa farmers affects pesticides use in cocoa production in Nigeria. Danso-Abbeam et al. (2014) also found that income of the cocoa farmers affects their investment decision in agrochemical for cocoa production in Ghana.

Farm size was positive and statistically significant for full sample, positive but insignificant for the Ondo and Osun subsamples. This implies that the larger the farm size, the higher the likelihood of acceptance of EU approved pesticides by the cocoa farmers. Cocoa farmers who have large hectares of cocoa farmland will be tempted to accept EU approved pesticides because of the fear of rejection of their cocoa bean if it is found with higher maximum residue levels of harmful chemicals. This is in agreement with Danso-Abbeam et al. (2014) that farm size of cocoa plantation influences the decision of the cocoa farmers to invest in agrochemicals to be used in cocoa production. Access to credit was positive for the full sample and Osun subsample although insignificant while it is positive and statistically significant for the Ondo subsample. This implies that having access to financial support will increases the acceptance rate of EU approved pesticides in Nigeria. Farmers who have access to credit including trade credit will most likely accept EU approved pesticides since it is more expensive than the banned pesticides and having financial support inform of loan or trade credit will afford them the financial power to purchase the EU approved pesticides. This result agrees with Sebopetji and Belete (2009), Sharifzadeh et al. (2018) that accessing financial supports help smallholder farmers to invest in farm inputs such as pesticides for cocoa production.

Consequently, providing cocoa farmers with economic benefits information of using EU approved cocoa pesticides appears to be very important as shown from the regression results in column 4, 5 and 6 in Table 5. The coefficient of the dummy variable about receiving economic benefits information prior to the experiment is positive, highly statistically significant and large for the full sample and Ondo and Osun subsamples. This might be attributed to the fact that stakeholders in Nigeria had previously formed a new national cocoa extension programme, which was responsible for educating farmers on the proper use of recommended pesticides and acceptance of EU approved pesticides. Thus, this result is expected given the role that this national cocoa extension programme would have played in accepting the recommended EU approved pesticides in Nigeria. We can thus inferred from the results that accompanying economic benefits information with the dissemination of information on approved pesticides could leads to successful acceptance of the recommended EU approved pesticides. That information may play an important role in pushing for the acceptance of approved pesticides in Nigeria is suggested by the magnitude of the estimated information coefficients across the full sample and subsamples, which is likely to completely mitigate negative effects from other factors.

We also included the dummy variable for receiving economic benefits information of accepting EU approved pesticides in the conditional logit model that were presented in the regression columns of 4, 5 and 6 in Table 5. We used it as the treatment variable. As expected, the coefficients of receiving economic benefits information during experiment are positive and statistically significant. This suggests that intensification campaign may result in general acceptance of recommended EU approved pesticides for cocoa production across Nigeria and other cocoa
producing countries in Africa and the world at large. Thus, if the issue of trust with informants is
taken care of in the rural cocoa producing areas, providing economic benefits information is likely
to result in the acceptance of EU approved pesticides across Nigeria.

8. Joint effect of interaction variables on acceptance of EU approved pesticides

In this study, we further examine the effect of economic benefits information and socioeconomic
characteristics together on cocoa farmers choice of pesticides. We estimate the conditional logit
model with interaction variables that was generated from multiplying economic benefits informa-
tion and socio-economic variables. We first interacted socio-economic characteristics with receiv-
ing prior information and later interacted the socio-economic characteristics with receiving
information during experiment. We reported the results of the regression model interacting prior
information with socioeconomic variables in column 4, 5 and 6 in Table 6 while in Table 7, we
reported the regression results of the interaction between receiving economic benefits information
during the experiment and socioeconomic variables in column 4, 5 and 6. The coefficients of the
interaction between gender and receiving information prior to the experiment was positive for the
full sample, Ondo and Osun subsamples although only Ondo subsample was statistically signifi-
cant. This implies that incorporating information with all the gender will increase the likelihood
of acceptance of EU approved pesticides. This agrees with Danso-Abbeam and Lloyd (2017) who
found that gender plays an important role in the adoption of agrochemicals management prac-
tices in cocoa production. Diirio et al. (2015) also found that gender affect the adoption of input
technologies among smallholder farmers. The coefficients of the interaction variable between farm
size and prior information was positive and statistically significant for full sample while negative
and positive for Ondo and Osun subsample respectively and also insignificant. This implies that an
increase in farm size will increase the the acceptance of EU approved pesticides in the full sample
and Osun state. This agrees with Adeogun and Aibongiarhuoyi (2009), Afrane and Ntiamoah
(2011) who all found a significant association between farm size and agrochemical use in cocoa
production. It will however, lead to less acceptance of EU approved pesticides in Ondo State even
though not expected. As expected, the coefficients of the interaction of education and prior
information were positive and significant for the full sample, Ondo and Osun subsample. This
suggests that receiving prior information, an increase in years of education will increase the rate
of acceptance of EU approved pesticides among the cocoa farmers. Cocoa farmers who are educated
might have had access to quality information about the recommended EU approved pesticides and
this might have influenced their decision to accepting the EU approved pesticides. Similarly, the
interaction variable for household income and receiving prior information about the economic
benefits of using EU approved pesticides was positive and significant for the full sample, Ondo and
osun subsamples. This result suggests that receiving prior information together with increase
household income increases the likelihood of acceptance of EU approved pesticides. This implies
that incorporating the information effect with income effect would increase the rate of acceptance
of EU approved pesticides. An increase in the income of the respondents if they received prior
information to the experiment will increase their willingness to pay for the EU approved pesticides.
The coefficients of the interaction between access to credit and prior information were positive and
insignificant for the full sample, Ondo and Osun State subsamples. This result suggests that having
access to credit will increase the likelihood of acceptance of EU approved pesticides among the
cocoa farmers. Farmers who have access to financial support inform of loan or trade credit and
have prior information about the recommended pesticides could lead to acceptance of the EU
approved pesticides among the cocoa farmers.

The regression results of the interactions of receiving information during the experiment
together with socioeconomic variables were presented in column 4, 5 and 6 in Table 7. We
found similar results with the previous sets of interaction in gender, farm size education and
access to credit. The coefficient of gender was positive and significant for the Osun subsample
while insignificant for the full sample and Ondo subsample. This implies that male gender receiving
information during the experiment will increase the acceptance of EU approved pesticides. Age
was positive and statistically significant with receiving information during experiment. Thus an
Table 6. Determinants of EU approved pesticides acceptance (2)

| Variables                  | Region   | Region   | Region   | Region   | Region   |
|----------------------------|----------|----------|----------|----------|----------|
|                            | Full sample (1) | Ondo (2) | Osun (3) | Full sample (4) | Ondo (5) | Osun (6) |
| **Price**                  | 0.0065*** (0.0033) | 0.0080*** (0.0041) | 0.0533*** (0.0121) | −0.0010*** (0.0002) | −0.0012*** (0.0002) | −0.0009*** (0.0002) |
| **EU approved pesticides** | 1.009*** (0.0004) | 0.0020*** (0.0006) | 0.0665*** (0.0009) | 0.0003** (0.0001) | 0.0004*** (0.0002) | 0.0004** (0.0002) |
| **Banned pesticides**      | 0.0014* (0.0008) | 0.0018** (0.0007) | 0.0053*** (0.0015) | 0.0003* (0.0002) | 0.0003* (0.0001) | −0.0015*** (0.0005) |
| **Gender**                 | −0.0019 (0.0014) | −0.0019 (0.0014) | −0.0017 (0.0014) | −0.0004 (0.0004) | 0.0001 (0.0003) | 0.0005 (0.0016) |
| **Age**                    | −0.0001 (0.0005) | −0.0001 (0.0005) | −0.0004 (0.0004) | 0.0002 (0.0006) | 0.0003 (0.0005) | −0.0014 (0.0024) |
| **Education**              | −0.0005 (0.0008) | 0.0001 (0.0003) | 0.0048 (0.0045) | 0.0008 (0.0009) | 0.0007 (0.0007) | −0.0047 (0.0035) |
| **Household income**       | −0.0001 (0.0005) | −0.0001 (0.0005) | −0.0004 (0.0004) | −0.0001 (0.0002) | −0.0001 (0.0002) | 0.0003 (0.0007) |
| **Farm size**              | 0.0001 (0.0003) | 0.0005 (0.0016) | 0.0006 (0.0007) | −0.0006 (0.0019) | 0.0006 (0.0013) | −0.0016 (0.0066) |
| **Household size**         | 0.0004 (0.0007) | 0.0002 (0.0006) | 0.0003 (0.0005) | 0.0003 (0.0002) | −0.0001 (0.0002) | −0.0001 (0.0002) |
| **Access to credit**       | −0.0014 (0.0024) | 0.0005 (0.0016) | 0.0006 (0.0007) | 0.0006 (0.0019) | 0.001 (0.0002) | −0.0006 (0.0019) |
| **Prior information**      | 0.0627*** (0.0096) | 0.0185* (0.0094) | 0.0357*** (0.0125) | −0.0098*** (0.0014) | −0.0069*** (0.0018) | −0.1022*** (0.0211) |
| **During information**     | 0.0020*** (0.0006) | 0.0022*** (0.0006) | 0.0015*** (0.0005) | −0.0059*** (0.0013) | 0.0314*** (0.0043) | 2.3671*** (0.4263) |
| **Gender** Prior info      | 0.0448 (0.0045) | 0.0314*** (0.0043) | 0.0005 (0.0016) | 0.2635** (0.1131) | −0.0004 (0.0004) | 0.0001 (0.0003) |
| **Farm size** Prior info   | 0.0004 (0.0007) | 0.0002 (0.0006) | 0.0003 (0.0005) | 0.0004 (0.0003) | 0.0005 (0.0005) |
| **Education** Prior info   | 0.2998*** (0.0922) | 0.0003 (0.0005) | 0.0014 (0.0024) | 0.0001 (0.0002) | 0.0006 (0.0013) |
| **Income** Prior info      | −0.0001 (0.0002) | −0.0001 (0.0002) | −0.0001 (0.0002) | 0.0001 (0.0002) | 0.0006 (0.0013) |
| **Access to credit Prior info** | 0.0001 (0.0002) | 0.0001 (0.0002) | 0.0001 (0.0002) | 0.0001 (0.0002) | 0.0003 (0.0007) |
| **Observations**           | 4,692     | 2,538     | 2388     | 4,692     | 2,538     | 2388     |
| **Choices**                | 1529     | 769       | 760      | 1529     | 769       | 760      |
| **Pseudo R²**              | 0.783    | 0.745     | 0.735    | 0.718    | 0.741     | 0.627    |
| **Log likelihood**         | −1728    | −781.3    | −632.1   | −662     | −163.3    | −825.4   |

***, **, * significant at 1%, 5% and 10% respectively; standard error in parenthesis; Standard error in parenthesis

increase in age for those who received information during the experiment will increase the acceptance of EU approved pesticides in the study area. This result agrees with Denkyirah et al. (2016), Fosu-Mensah et al. (2022) who all found that age of cocoa farmers affects investment decision in agrochemicals needed in cocoa production. The coefficients of access to credit interaction variable were positive and insignificant for the full sample, Ondo and Osun subsamples. This result implies that cocoa farmers that have access to credit and received information during the experiment could lead to acceptance of EU approved pesticides for cocoa production among the farmers. We however observed that only interaction variables of income and household size with receiving information during experiment could lead to less acceptance of EU approved pesticides because of their negative sign even though that of income is not expected. The effects of receiving prior information and information during experiment were positive and statistically significant thus suggesting that the activities of national cocoa extension programme and cocoa research institute of Nigeria (CRIN) that promote EU approved pesticides in cocoa producing areas of Nigeria are yielding expected results and may lead to market demand for EU approved pesticides in the long
Table 7. Determinants of EU approved pesticides acceptance (3)

| Region          | Variables       | Full sample (1)     | Ondo (2)           | Osun (3)          | Full sample (4)    | Ondo (5)        | Osun (6)        |
|-----------------|-----------------|---------------------|--------------------|-------------------|-------------------|----------------|----------------|
|                 |                 | (0.00030622)**     | (0.00032629)       | 0.017291          | (0.00450421)**    | (0.0114609)**  | (0.0047857)**  |
| Price           | EU approved     | 1.0017583**        | 0.0026357          | 0.0041253         | -1.000253         | -1.0038109     | -1.0100117     |
| pesticides      |                 | (0.0016374)**      | (0.0036437)**      | (0.0020785)**     | (0.0074875)**     | (0.0032672)**  | (0.0012372)**  |
| Banned pesticides | 0.0012867      | 0.0013558          | 0.0043749          | 0.0029943         | -0.00100117       | -0.0071339     | -0.0035566     |
|                 |                 | (0.0005327)**      | (0.0006754)**      | (0.0016487)**     | (0.0010727)**     | (0.0032672)**  | (0.0032672)**  |
| Gender          |                 | -0.0000708         | 0.0007735          | 0.0005528         | -0.0065546        | 0.0789621      | -0.8496466     |
|                 |                 | (0.0001146)        | (0.0002033)        | (0.0002526)**     | (0.000125)        | (0.0898966)    | (0.5718311)    |
| Age             |                 | -0.0000901         | -0.0008030         | 0.000603          | 0.0000667         | 0.0356067      | -0.802365      |
|                 |                 | (0.0001024)        | (0.000185)         | (0.001257)        | (0.0003825)       | (0.0501557)    | (0.1476237)    |
| Education       |                 | 0.000727           | 0.017291           | 0.0037743         | -0.0289314        | 0.0204316      | 0.1119943      |
|                 |                 | (0.0032629)        | (0.0054042)**      | (0.00019984)      | (0.011609)**      | (0.0349179)    | (0.0957983)    |
| Household income|                 | -0.0007726         | -0.000763          | -0.0024134        | -0.005460         | 0.0044956      | -0.0014108     |
|                 |                 | (0.0007963)        | (0.000764)         | (0.0019984)       | (0.010355)        | (0.0094016)    | (0.0013405)    |
| Farm size       |                 | -0.0000808         | -0.0001417         | -0.0005347        | -0.0004173        | 0.0003659      | 0.0789621      |
|                 |                 | (0.0001884)        | (0.0001613)        | (0.0004309)       | (0.0004545)       | (0.0008651)    | (0.0889966)    |
| Household size  |                 | 0.0003091          | 0.0002129          | 0.00066           | -0.0004173        | 0.0007647      | -0.8496466     |
|                 |                 | (0.0002017)        | (0.0001827)        | (0.0004695)       | (0.0004665)       | (0.0009571)    | (0.5718311)    |
| Access to credit|                 | -0.0014108         | -0.4303103         | -1.2890746        | 0.0490749         | 1.2690498      | 0.8705659      |
|                 |                 | (0.0013405)        | (0.63450567)       | (0.51133475)      | (0.55193617)      | (1.0616152)    | (0.63551682)   |
| Prior information|                | -0.0002007         | 0.18339331         | 1.4090169         | 0.7033907         | 1.2275187      | 0.802365       |
|                 |                 | (0.0009132)**      | (0.0972118)*       | (0.4193792)**     | (0.0483975)*      | (0.0938944)**  | (0.1476237)**  |
| "During" info  |                 | 0.1868908          | 0.098171           | 0.5843075         | 0.4683099         | 1.596359       | 0.5635231      |
|                 |                 | (0.1021664)*       | (0.0386332)*       | (0.1174973)**     | (0.0582561)**     | (0.4496845)**  | (0.1897654)**  |
| Gender "During info |         | 0.0000978          | 0.0001498          | 0.00002154        | 0.00010489        | 0.00011058     | 0.00000158     |
|                 |                 | (0.000000151)      | (0.0001827)        | (0.0001403)       | (0.0000403)       | (0.0001311)    | (0.0000349)    |
| Farm size "During info |   | 0.0000651          | 0.0000561          | 0.00002045        | 0.00001409        | 0.00001572     | 0.00000029     |
| Education "During info |    | 0.0001409         | 0.0001147          | 0.0001385         | 0.0001147         | 0.0001476      | 0.00002049     |
| Income "During info |            | -0.0032855         | -0.0039786         | -0.0038651        | -0.0007796        | -0.0023475     | -0.00002049    |
| Age "During info |               | 0.0007065          | 0.0008454          | 0.00012432        | 0.0001476         | 0.00000298     | 0.00002049     |
| Household size "During info |     | -0.0007796         | -0.0017505         | -0.0012394        | 0.0009794         | 0.00004841     | 0.00003881     |
| Access to credit "During info |   | 0.0014176          | 0.0011146          | 0.0009838         | 0.0004841         | 0.00003881     | 0.00003881     |
| Observations    |                 | 4.692              | 2.538              | 2388              | 4.692             | 2.538          | 2388           |
| Choices          |                 | 1529               | 769                | 760               | 1529             | 769            | 760            |
| Pseudo R²       |                 | 0.711              | 0.637              | 0.628             | 0.728            | 0.662          | 0.643          |
| Log likelihood  |                 | -729.2             | -1036.3            | -7251             | -1342.5          | -1.365         | -815.9         |

***, **, * significant at 1%, 5% and 10% respectively; standard error in parenthesis; Standard error in parenthesis

run. However, empowering the cocoa farmers through credit facilities and trainings without adequate dissemination of economic benefits information of using EU approved pesticides may not likely results in acceptance of EU approved pesticides in the study area and all other cocoa producing areas in Nigeria at large.
9. Conclusion and policy recommendations

In this study, we examined the determinants of acceptance of EU approved pesticides in Nigeria where several conditional logit models cocoa farmers utility function were estimated using a choice experiment data conducted in Nigeria. We also used the conditional logit model to examine the influence of socioeconomic and economic benefits information variables on acceptance of EU approved pesticides among the cocoa farmers. Results showed that the cocoa farmers valued the EU approved pesticides more than the banned pesticides. The result of the effect of socioeconomic variables on acceptance of EU approved pesticides showed that gender, household income, farm size and access to credit significantly influence the acceptance of EU approved pesticides among the cocoa farmers in Nigeria. Consequently, results showed that providing the cocoa farmers with economic benefits information of using EU approved pesticides could translate to increase in acceptance of EU approved pesticides among the cocoa farmers. Both information variables—economic benefits information received prior to the experiment and economic benefits information received during the experiment—have positive and sizable effects on cocoa farmers acceptance of EU approved pesticides. These results suggest that EU approved pesticides dissemination campaigns should always incorporate economic benefits information of using EU approved pesticides including higher returns to farmers from the sales of the cocoa beans.

In general these results suggest that the tendency of fully accepting EU approved pesticides in Nigeria is high provided that it helps to reduce the maximum residuals levels of chemicals in the cocoa bean which has been largely responsible for the rejection of exported cocoa bean from Nigeria. Empowering the cocoa farmers through the provision of credit facilities and trainings together with adequate dissemination of economic benefits information of using EU approved pesticides will likely results in acceptance of EU approved pesticides in Nigeria.

Acknowledgement
The effort of Anibije George was appreciated during the time of data collection. We also appreciate the farmers who participated willingly during the course of interview.

Funding
This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Author details
Kolapo Adetomiwa
E-mail: kolaopedetomiwa@gmail.com
Akeem Abiade Tijani
Olowolafe Damilola Ezekiel
Muhammed Opeyemi Abdulmumin
Department of Agricultural Economics, Obafemi Awolowo University, Ile-Ife, Nigeria.
Department of Plant Science and Biotechnology, Ekiti State University, Ado-Ekiti, Nigeria.
Department of Agricultural Economics, University of Ibadan, Ibadan, Nigeria.

Disclosure statement
No potential conflict of interest was reported by the author(s).

Data availability statement
Data will be made available on reasonable request.

Author’s contribution
Conceptualization, Adetomiwa Kolapo; Data curation, Damilola Olowolafe and Opeyemi Muhammed; Formal analysis, Adetomiwa Kolapo; Investigation, Akeem Tijani, Damilola Olowolafe and Opeyemi Muhammed; Methodology, Akeem Tijani; Supervision, Akeem Tijani; Writing – original draft, Adetomiwa Kolapo; Writing – review & editing, Adetomiwa Kolapo.

Citation information
Cite this article as: Acceptance of European Union (EU) approved pesticides for cocoa production in Nigeria, Kolapo Adetomiwa, Akeem Abiade Tijani, Olowolafe Damilola Ezekiel & Muhammed Opeyemi Abdulmumin, Cogent Food & Agriculture (2022), 8: 2098590.

References
Adejumo, O. A., Ojoko, E. A., & Yusuf, S. A. (2014). Factors influencing choice of pesticides used by grain farmers in Southwest Nigeria. Journal of Biology, Agriculture and Healthcare, 4(28), 31–38.
Adeogun, S. O., & Agbongiarhuoyi, E. A. (2009). Assessment of cocoa farmers’ chemical usage pattern in pest and disease management in Ondo State. International Journal of Innovation and Development Strategy Bangladesh, 3, 27–34.
Afolayan, O. S. (2020). Cocoa production pattern in Nigeria: The missing link in regional agro-economic development. In Analele Universităţii din Oradea, Seria Geografie, 30 (1) (pp. 88–96).
Afrane, G., & Ntimoa, A. (2011). Use of pesticides in the cocoa industry and their impact on the environment and the food chain. In M. Stytscheva (Ed.), Pesticides in the modern world risks and benefits (pp. 51–68). Books on Demand. https://doi.org/10.5772/17921
Akinneye, J. O., Adeleye, O. A., Adesina, F. P., & Akinneyemi, M. I. (2018). Assessment of pesticide residue on cocoa beans in Ondo State, Nigeria. Brazilian Journal of Biological Sciences, 51(10), 577–588.
Aminu, F. O., Ayinde, I. A., Sanusi, R. A., & Olaya, A. O. (2019). Determinants of pesticide use in cocoa production in Nigeria. Canadian Journal of Agriculture
Olajide, O. B., Akinlabi, & Tijani, A. (2012). Agricultural resource and economic growth in Nigeria. *European Scientific Journal, 8*(22), 103–115. https://eujournal.org/index.php/lsesj/article/view/422

Oluyole, K. A., & Taiwo, O. (2019). Socio-economic variables and food security status of cocoa farming households in Ondo State, Nigeria. *Asian Journal of Agricultural Extension, Economics and Sociology, 9*(1), 1–7.

Sanusi, R. A., & Oluyole, K. A. (2005). A review of the cocoa sub-sector of the Nigerian economy (1930-2003). *Bull. Science Association of Nigeria, 26*, 146–153.

Sebopetji, T. O., & Belete, A. (2009). An application of probit analysis to factors affecting small-scale farmers decision to take credit: A case study of the Greater Letaba Local Municipality in South Africa. *African Journal of Agricultural Research, 4*(8), 718–723.

Sharifzadeh, M. S., Abdollahzadeh, G., Damalas, C. A., & Rezaei, R. (2018). Farmers’ criteria for pesticide selection and use in the pest control process. *Agriculture, 8*(2), 24. https://doi.org/10.3390/ agriculture8020024

Tesfahunegn, G. B., Mekonen, K., & Tekle, A. (2016). Farmers’ perception on causes, indicators and determinants of climate change in northern Ethiopia: Implication for developing adaptation strategies. *Applied Geography, 73*, 1–12.

Tijani, A. A. 2010. Factors influencing pesticide use among cocoa farmers in Ondo State, Nigeria. *paper presented at second RUFORUM biennial meeting 20-24 September 2010, Entebbe, Uganda. WorldAtlas (2020). The Top 10 Cocoa Producing Countries. p. 12. Available online at: https://www.worldatlas.com (accessed June 12, 2021)