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Incidence of Black Coffee Twig Borer in Selected Host Crops, Farmer Awareness and Effectiveness of Eco-Friendly Pest Management Practices

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Abstract: *The Black Coffee Twig Borer (BCTB) (Xylosandrus compactus) is a significant pest affecting coffee and cocoa in Uganda, exacerbated by bio-ecological factors and inadequate field and crop management. Its presence threatens coffee and cocoa production, necessitating comprehensive, sustainable mitigation efforts. This study, conducted in Bundibugyo District, aimed to assess BCTB incidence in selected host crops, evaluate farmer awareness of ecofriendly management practices, and determine the effectiveness of these practices. A non-experimental, cross-sectional research design was used, involving 92 farmers from five randomly selected sub-counties. Data collection included questionnaires and observation checklists. The study revealed that all respondents had been affected by BCTB, with varying incidence rates: 29% reported 0.13–5 cases, while others reported higher incidences, up to 52 and above. Additionally, 81% of farmers were aware of ecofriendly practices, though 28% did not know how BCTB reached their farms. Farmers identified wind, birds, and human activity as contributors to pest spread. Ecofriendly management practices were reported effective by 72% of respondents. The study concluded that BCTB has significantly impacted farmers, reducing soil fertility and coffee quality. It recommended adopting modern, ecofriendly methods for pest and soil management to boost yields and reduce pest incidence. Further, the government, through agricultural agencies, should provide tools, equipment, and sensitization programs to support farmers in managing BCTB, given the importance of coffee and cocoa as major export earners for Uganda.*

Keywords; *Eco-friendly pest management**,** Black Coffee Twig Borer, Coffee Wild Disease, incidence*

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1. Introduction

For many years, smallholder farmers in Bundibugyo district have been growing Coffee and Cocoa. These farmers have faced a lot of challenges while in the production of these crops, among the challenges is the coffee twig borer which attacks their crops and lowers their production, lowers the quality as well as increasing their production costs (Kagezi et al., 2014).

The Black Coffee twig borer, *Xylosandrus compactus* Eichhoff is an ambrosia beetle belonging to the Scolytidae family and tribe *Xyleborini* (Greco and Wright, 2012: Tumuramye et al., 2024). The BCTB is an invasive pest that is probably native to south-east Asia but has spread to most of tropical Africa, Asia, the Pacific islands, Latin America and the US (CABI, 2016). The host of BCTB includes 225 plants worldwide, for example tea, cocoa and several species of ornamentals (CABI, 2016). The black coffee twig borer is native to Asia and is widespread in Japan, Vietnam, Indonesia, Malaya, Sri Lanka,

Madagascar, South India, Seychelles, Mauritius, West Africa, Fiji, Cuba, and Brazil (Kyalo et al., 2024).

A number of outbreaks of BCTB have been reported in Uganda. The first outbreak was in Bundibugyo district in 1993. This coincided with the advent of coffee wilt disease (CWD) in the district that almost wiped-out Robusta coffee (Nanjego et al*.,* 2024). The second outbreak was reported in 2002 in Rukungiri, Kanungu and Bushenyi districts. In September 2007, an outbreak of BCTB was again reported in Nabbaale Sub County in Mukono district. Another outbreak of the pest was reported in December 2008 in Mukono and Kayunga districts. The most recent outbreak was reported in May 2016 in areas of Kasese District like Mahango and Rukoki Sub-Counties have been affected (KRC, 2016). A preliminary study revealed that though BCTB is a relatively new pest of coffee in Uganda, it is enormously spreading to more Robusta coffee growing areas; particularly the central, southern, southwestern, western and mid-eastern regions (International Coffee Organization, 2014). In Uganda, 48 plant species including among others *Mangifera indica*, *Sennaocc identalis*, *Albizia coriaria*, *A. chinensis*, *Artocarpus heterophyllus*, *Eucalyptus* spp., *Grevillea robusta* and *Camellia sinensis* have been identified by the research institution as alternate hosts of BCTB (International coffee organization, 2014).

In Uganda, BCTB prefers Robusta to Arabica coffee, though it can attack both. Female beetle makes a characteristic entry hole into the primary branches and small stems and the plant responds by wilting and then dying within a few weeks (Greco and Wright, 2015). The affected branches do not produce berries. This leads to loss of harvest estimated at 9% of the coffee export volume valued at US$40.1 million annually (Kigezi et al, 2015).

The Black Coffee Twig Borer has further broadened the pest challenge on the crop (Kagezi et al., 2014). BCTB is a serious pest of coffee in Uganda (Egonyu et al., 2009; UCDA, 2012) and elsewhere (Burbano, 2010) but also infests more than 224 other plant species in about 62 families worldwide, including cocoa (Ngoan et al., 1976; Kagezi et al., 2012). This pest thus poses a serious threat to both coffee and cocoa production in Uganda, and therefore, calls for prompt comprehensive mitigation actions.

A number of control options for BCTB with varying effectiveness and sustainability have been recommended. Monocrotophos, an insecticide, is reported to have been used effectively against the pest in India (Egonyu et al, 2009). Chlorpyrifos was reported to kill between 77 and 92% of all stages of BCTB in Florida and China (Yan et al., 2001). Permethrin or bifenthrin, quinalphos or chlorypyrifos plus cypermethrin are also reported to give good control (Bambara, 2003). The most effective but uneconomical cultural control practice is the pruning and burning of infested twigs. This is because continuous pruning reduces the number of berry bearing branches and eventually reduces coffee yields (Egonyu et al, 2009). The study focused on the following questions (i) to what extent does Black Coffee Twig Borer affect selected host crops? (ii) What is the level of awareness of farmers about ecofriendly practices for managing BCTB in selected host crops? (iii) How effective are different ecofriendly practices of managing BCTB in selected host crops?

2. Literature Review

Globally, Coffee is grown in more than 50 countries around the world (Kyalo et al., 2024). It is a major commodity on the global market and provides a source of revenue for many millions of farmers along the value chain (Jeffery and Peter, 2002). Globally, Brazil is the biggest exporter of coffee, providing 25 million bags (each 60 kg), which accounts for more than 30% of world coffee exports (Rutherford and Phiri, 2006). In Africa, Uganda is the second biggest coffee producer and exporter with 3.7 Million bags in 2012/2013 after Ethiopia with 6.4 million bags in 2012/13 (ICO, 2009;Nahanga et al., 2015;Kellet et al., 2024) contributing an estimated 3% of its crop to the world market (ICO, 2014).

In Uganda, two types of coffee are grown, Robusta coffee (80%), mainly in central, eastern and western Uganda and Arabica coffee (20%) mainly in eastern, northern and western Uganda (UNDP, 2012; Kangire, 2013; UCDA, 2015; ICO, 2019). It is estimated that 1.7 Million households grow coffee employing more than 5 Million people along the coffee value chain (ICO, 2019; UCDA, 2019). The crop is intercropped with food crops such as banana, beans and peanuts which are important for household food security; however banana is the most intercropped crop (Bhanu , 2014). Coffee is largely grown under shade trees to ensure sustainable coffee production. The leaves that fall from the shade trees provide manure for the coffee plants (Olango et al., 2024).

This study was underpinned by the theory of integrated pest management. Since the 1960s, integrated pest management theory (IPM) has become the dominant crop protection paradigm, being endorsed globally by scientists, policymakers, and international development agencies (Ehler, 2006). The definitions of IPM are numerous, but all involve the coordinated integration of multiple complementary methods to suppress pests in a safe, cost-effective, and environmentally friendly manner (Piato et al., 2021). These definitions also recognize IPM as a dynamic process in terms of design, implementation, and evaluation (Piato et al., 2021). In the 1960s, the term “pest management” also came into existence and being broader it included other suppressive tactics such as semi-chemicals, host plant resistance and cultural control. But with the passage of time integrated pest control and pest

management became synonymous and both were based on the concept of integrating a range of control tactics to manage pests, with insecticides as one of the tools rather than the only tool. The basic tactics of IPM were proposed and applied to reduce crop losses against the ravages of pests long before the expression was coined (Jones, 1973; Smith et al., 1973). Throughout the early twentieth century, plant protection specialists relied on knowledge of pest biology and cultural practices to produce multitactical control strategies (Kyalo et al., 2024). It was not until the incorporation of all classes of pests in the early 1970s that the modern concept of IPM theory was born (Kogan, 1998; Prokopy and Kogan, 2003). This theory guided the study to evaluate the effectiveness of different ecofriendly practices in managing BCTB in selected host crops.

2.1 Incidence of black coffee twig borer

A study conducted by Kagezi et al. (2012) on 250 farms in 25 districts in the 5 major coffee growing regions of Uganda revealed that the pest is present in all the 5 districts (100%) sampled

in central region viz: - Mukono, Luwero, Mityana, Mubende and Mpigi, and at least 50% of the districts in southwestern viz: - Bundibugyo, Kasese and Rubirizi. However, the beetle was not observed in northwestern (West Nile), northern and part of eastern (Mt. Elgon) regions. *X. compactus* prevalence (percentage of infested farms), incidence (percentage of infested trees) and damage (percentage of infested primary branches) were 58.1, 34.0 and 3.8% respectively in the central region whereas, 22.1, 7.7 and 0.8% respectively in the southwestern region. At district level, the highest prevalence (100%) was observed in Mukono and Luwero then Bundibugyo (62.5%), Mityana (50%), Rubirizi (40%) and Kasese (30%). Similarly, high incidence rates of 92%, 73% and 45% were observed in Mukono, Luwero and Bundibugyo respectively. Likewise, high damage rates of 13.6, 5.2 and 4.8% were observed in Mukono, Luwero and Bundibugyo districts respectively.

Similarly, Kagezi et al. (2014) surveyed 20 households in Bundibugyo, Kibaale and Hoima districts in January 2014. On each field, 10 cocoa trees were examined for BCTB infestation along atransect. The findings of the survey showed that more than half of the cocoa plantations, 13% of trees and 3.8% of primary branches were infested. At district level, Kibaale had the highest proportions of infested fields (100%), trees (30%) and primary branches (8.5%). The survey also revealed that 30% of cocoa farms were infested and 8% of cocoa trees were infested in Bundibugyo whereas in Hoima, 60 % of cocoa farms and 6% of cocoa trees were infested by BCTB (Kagezi et al., 2014).

Egonyu, Kucel, Kangire, Sewaya, and Nkugwa (2009) carried out a survey to determine the identity, spread, incidence and damage caused by black coffee twig borer. The survey was conducted in six and four sub counties in Mukono and Kayunga districts, respectively. The survey results indicated that the black twig borer, which was found on coffee in both districts, infested 38% of the surveyed Robusta coffee farms. The infestation in Mukono was higher than in Kayunga, being 50 and 8%, respectively. The percentage of trees attacked (incidence) in the two districts was 21.2, with 4% of their twigs bored (damaged). Mukono district had a much higher incidence (35%) and damage (5%) compared to Kayunga with 1% for both parameters (Egonyu et al, 2009).

In addition, a study carried out by Wu (2016) showed that 69% of the coffee farms were infested by the black coffee twig borer pest of the 26 districts surveyed, with an average of 40% of the coffee plants being attacked. The national yield loss is estimated to be 9% because of BCTB.

Furthermore, a study conducted by Kagezi at al. (2013) showed that *compactus* had spread to 68% of Robusta coffee (*Coffea canephora*) farms in Uganda, where it infested 40% of coffee trees per farm and killed 9% of twigs (Kagezi et al., 2013).

2.2 Level of Awareness of Farmers about Black Coffee Twig Borer Ecofriendly Management Practices

A survey conducted by Egonyu, Kucel, Kangire, Sewaya, and Nkugwa (2009) in Mukono and Kayunga districts in central Uganda in December 2008 where data on farmers' comments in relation to the BCTB problem were taken revealed that among the farmers interviewed, 51% had no idea of BCTB while the rest had heard about it through the electronic and/or read about it in the print media. Three percent of the farmers reported having applied Malathion, an insecticide, to control BTB, while the rest had done nothing about the problem. Some 3% of the farmers believed that this pest was introduced to their area by pesticide dealers to create a market for their insecticides (Egonyu et al., 2009).

Similarly, a study conducted by Kobusinge, Kagezi, Kasoma et al (2018) to determine Farmers' Knowledge of Pests and Diseases in the Coffee-Banana Agroforestry Systems of Mid-Eastern Uganda showed that the respondents interviewed in the mid-eastern coffee growing region of Uganda possessed knowledge of the insect pests infesting their coffee, mentioning four insect pests, namely, the black coffee twig borer (BCTB), biting ants, stem borers and mites. Of these insect pests, the black coffee twig borer, *Xylosandrus compactus* Eichhoff was the most commonly mentioned insect pest of coffee – by 46% of the

respondents. Farmers' knowledge of BCTB was significantly dependent on sex, but not age or education of the respondent. Results further showed that the respondents had knowledge of managing only BCTB on their coffee with more than 50% of them mentioning that they employ cultural methods to manage the pest (Kobusinge et al, 2018). The authors concluded that all the respondents irrespective of their category had knowledge on the management options of BCTB and this emphasized the importance respondents attach to the pest (Kobusinge et al, 2018).

The annual report of UCDA in 2013 showed variations in source and level BCTB awareness among farmers. The report indicated that 34% of farmers mentioned the print and electronic media as their source of awareness, 24%, farmer to farmer relays, while 17% benefited from extension services (UCDA annual report, 2013).

2.3 Effectiveness of Different Ecofriendly BCTB Management Practices

UCDA (2013) evaluated the community based phytosanitary interventions for management of BCTB, the phytosanitary interventions for BCTB control included de-suckering, pruning and burning of infested coffee plant parts and alternate host plants. Cumulative results clearly showed that the application of phytosanitary recommendations caused decline in BCTB incidences in all the 3 test sub-counties. Reduction in BCTB incidence was more pronounced in Mukono than in Nakaseke district probably due to differences in level of compliance with the recommendations (UCDA annual report, 2013). The report also revealed that attractants among the local potent gin (Kasese-Kasese) appeared to have the same efficiency as commercial ethanol at 75% in trapping BCTB (UCDA annual report, 2013).

According to Mukasa (2010), cultural control methods such as providing good shade, Pruning and burning of beetle-infested plant material is essential and effective in controlling black coffee twig borer. Furthermore, Piato (2021) posits that good tree care promotes vigor and helps in resisting infestation or recovering from black coffee twig borer infestation. In addition, chemical control such as spraying the whole plant with deltamethrin 12g chlorpyrifos 300g/l, or fenitrothion pesticides, mixing pesticides according to the manufacturer's instructions on the label and spraying young coffee plants the first time one year after transplanting, before flowering is also essential and effective in controlling black coffee twig borer. In older coffee plantations, spraying after the desuckering and before flowering and spraying once every 2 weeks, 3 times in total during the season reduces the incidence of black coffee twig borer (Mukasa, 2010).

A report by UCDA in 2015 revealed that modified brocarp-ethanol-based lure traps captured more adult BCTB when they were placed at lower third of the canopy levels of the coffee trees than those placed in the middle and upper sections. These results agreed with earlier studies on the distribution of BCTB damage along the coffee canopy. Therefore, the report recommended that traps should be placed in the lower section of the coffee tree canopy for maximum captures of BCTB (UCDA, 2015). In addition, according to the 2014/2015 annual report of UCDA, two ants namely Plagiolepsis sp. and Pheidolemegacephala were identified by NaCORI scientists as potential predators of BCTB and could therefore be used in BCTB biological control program. Plagiolepsis sp. was observed in 9 out of 11 districts surveyed and had been found to feed on all BCTB stages. Preliminary results showed that this predator can control at least 24% of the BCTB in Uganda (UCDA, 2015). Similarly, the results obtained from a study conducted by Jacques et al (2012) indicated that fragmenting coffee farms at fine scales may help to significantly reduce black coffee twig borer movements between coffee plots.

A study conducted by Egonyu et al. (2015) also indicated that the ant Plagiolepis sp. was mentioned by at least one in each of the three groups interviewed and has been proven to be an indigenous predator of *X. compactus* which reduces the incidence of BCTB (Egonyu et al., 2015). Thus, favoring this natural enemy could be an effective way of controlling the pest. Similarly, Limonene, a citrus-based terpene and verbenone an anti-aggregation pheromone act as repellants to *X. compactus* and can reduce the severity of the attack of BCTB (Burbano et al., 2012).

3. Methodology

3.1 Research design

This study used non-experimental research design where the treatment group alone was considered. A cross sectional research design was used on all the three objectives in order to collect data once at a point in time (Sekaran, 2003), in this case the non-experimental research design was used to demonstrate and ascertain effectiveness of different ecofriendly BCTB management practices. This study employed both quantitative and qualitative research approaches. The quantitative research approach was used to quantify findings using ANOVA, T-test analysis and descriptive statistics. The qualitative research approach was used to elicit feelings, opinions, and views of the farmers with regards to the awareness of BCTB and effectiveness of different ecofriendly practices in managing BCTB.

3.2 Area of study

This study was carried out in Bundibugyo district in the five (5) Sub-Counties of Bughendera County where both coffee varieties and cocoa are grown figure 1. The sub-counties were selected using simple random sampling technique and they were; Sindila, Nduguto, Harugale, Bukonzo and Ngamba. In Bundibugyo district, Subsistence agriculture and animal husbandry are the two major economic activities and the district is the largest producer of cocoa in Uganda accounting for unprocessed beans worth UGX: 90 billion annually (Katusabe and Basiime, 2014). Black Coffee Twig Borer was first noticed in Bundibugyo District in 1993, and it has spread throughout the severe economic loses to the farmers (Ssali, 2014).

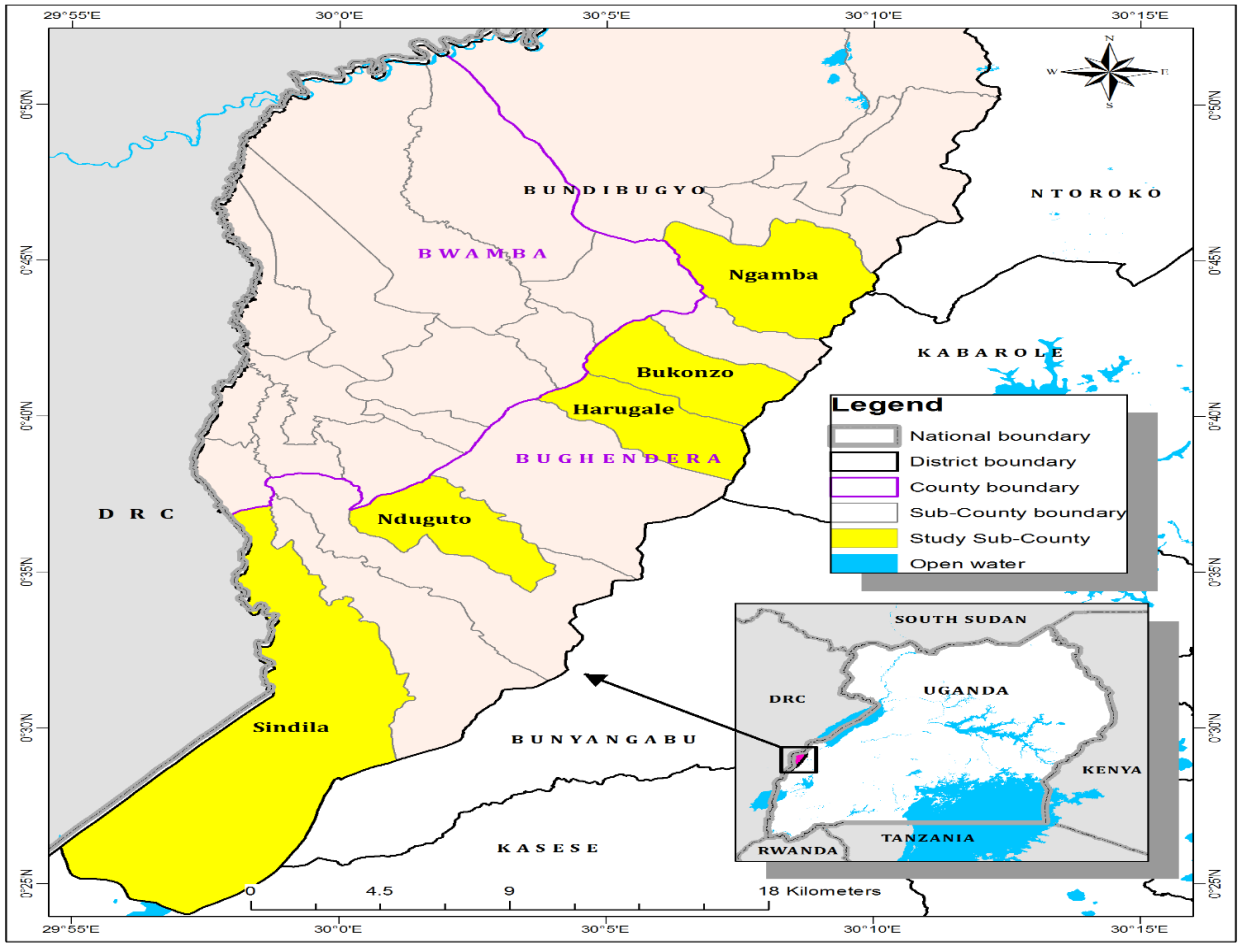

Figure 1: A map showing the study area

3.3 Sample size determination

The sample size for the study was determined using the Krejcie and Morgan (1970) sampling guidelines and thus 92 farmers were selected to participate in the study.

Table 1 Sample size and sample selection

Population category	Target population	Sample size	Sampling Techniques
Farmers	120	92	Simple random sampling

Source: Field Survey, 2019

3.4 Validity

The validity of the instruments was tested using the Content Validity Index (CVI) using expert judgment, taking only variables scoring above 0.7 accepted for research (Amin, 2005).

The Content Validity Index was measured using the formula

$$CVI = \frac{\text{Number of items declared valid}}{\text{Total number of items}}$$

3.5 Data collection instrument

The data collection instruments used were a questionnaire and observation checklist. A questionnaire is a research instrument consisting of a series of questions (or other types of prompts) for the purpose of gathering information from respondents. A close-ended questionnaire on the effect of infested twig removal on BCTB was directly administered to respondents; possessed logically ordered questions which the subjects responded to.

3.5.1 Observation checklist

An observation checklist is a list of things that an observer is going to look at when observing an event (Amin, 2005). This observation checklist was prepared and was structured to record and measure the effectiveness of different ecofriendly practices in managing BCTB in selected host crops.

3.6 Qualitative data analysis

Manual thematic content analysis was employed in analyzing qualitative data and it was presented in a narrative form. The study transcribed information from the interviews conducted and summarized them into meaningful themes pertaining to each of the study objectives. The themes summarized were read and re-read to ensure they make meaning. Qualitative data was presented objective by objective but in a narrative form.

4. Results and Discussion

4.1 Socio Demographic data

According to the study findings, 100% of respondents revealed that they were farmers. This is because due to the fact that the area of study has good arable land suitable for coffee and cocoa growing and it is a rural setting. On perennial crop farming experience, 32% of respondents revealed that they had between 39- 45 years' experience in growing perennial crop, followed by 26% that had between 18-24 years and least followed by 1% who had between 4-10 years. This implies that perennial crops are grown by mature people with the capacity to own their land as can be shown by the years and the age group above and it takes long before maturity which needs care and patience which cannot be done by the youths. On source of farm labour, 72% of respondents revealed that they used self and family labour, 14% used self, 9% me, family and hired workers and self and hired workers with 5%. This implies that most respondents are using family labour as this is cheaper and the size of most farms being on average 1-4 acres at most. The table below show more details of actual figures of each variable that was collected.

4.2 Comparing the incidence of Black Coffee Twig Borer (BCTB) in selected perennial crops

4.2.1 Perennial crops grown

The study sought to know the type of perennial crops grown, the years that they started planting and the land size. According to the study findings, 45% of respondents revealed that they were growing Robusta coffee, 43% Arabica coffee and Cocoa had 12% (Figure 2). This implies that most farmers grew Robusta and Arabica most followed by Cocoa because latter takes long to mature while coffee an average of 2-3 years to begin bearing coffee while Cocoa much as is of high value people steal it and this discourages people and this again could be due to the fact diseases affect Cocoa than coffee and this is supported by Kagezi et al. (2014) surveyed 20 households in Bundibugyo, Kibaale and Hoima districts in January 2014. On each field, 10 cocoa trees were examined for BCTB

infestation along a transect. The findings of the survey showed that more than half of the cocoa plantations, 13% of trees and 4% of primary branches were infested. At district level, Kibaale had the highest proportions of infested fields (100%), trees (30%) and primary branches (9%). The survey also revealed that 30% of cocoa farms were infested and 8% of cocoa trees were infested in Bundibugyo whereas in Hoima, 60 % of cocoa farms and 6% of cocoa trees were infested by BCTB (Kagezi et al., 2014). Kyalo (2024) discusses the related incidence of BCTB in Eastern Busoga and greater Masaka.

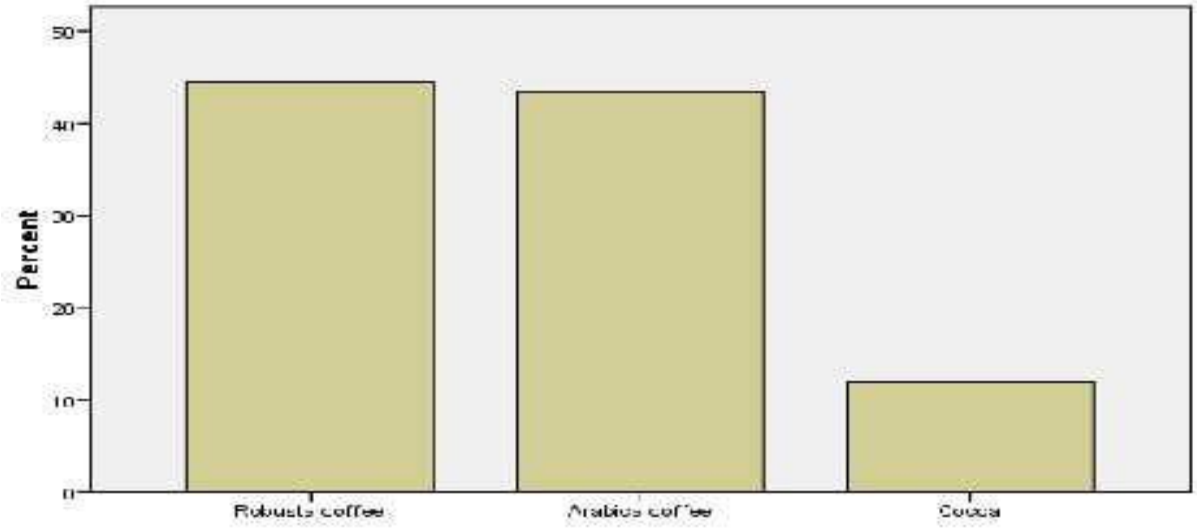

Figure :2 Perennial Crops grown by respondents

4.2.2 Year planted Arabica Coffee, Robusta Coffee and Cocoa were planted

According to the study findings, 42% of respondents revealed that they started growing Robusta between 1979-1989 followed by 30% that started between planting 1988-1998 and with 20% started planting between1999-2009, (Table 2). This implies that most respondents started growing Robusta long time ago. According to the study findings, 42% of respondents started planting Arabica coffee between 1980-1990, this was followed by 27% who started planted between 1969-1979, 22% planted between 1991-2001 and only 9% planted between 2002-2014 (Table 2). This implies that most farmers began planting Arabica coffee long time and because it is expensive than Robusta coffee. Also from the study findings, 86% of respondents revealed that they started cultivating Cocoa between 1995-2005 followed by 14% who had started growing Cocoa between 2006-2016. This implies that most farmers started growing Cocoa late and probably when the prices peaked up.

Table 2: Year of establishment (Robusta, Arabica coffee and cocoa

Crop	Year planted	Frequency	Percent
Robusta	1979-1989	39	42.4
	1988-1998	28	30.4
	1999-2009	18	19.6
	2010-2013	7	7.6
	Total	**92**	**100**
Arabica	1969-1979	25	27.2
	1980-1990	39	42.4
	1991-2001	20	21.7
	2002-2014	8	8.7
	Total	**92**	**100**
cocoa	1995-2005	79	85.9
	2006-2016	13	14.1
	Total	**92**	**100**

Source: Field Survey, 2019

4.2.3 Pests which affect Robusta coffee, Arabica Coffee and cocoa in the respondent's farm

According to the study findings, 34% of respondents revealed that they had mealy bags as the most common pest followed by leaf minors with 24%, Black Coffee Twig Borer with 16%, Coffee berry borer with 8%, stem borer with 8%, coffee root mealy bugs with 4%, scale insects with 4% and Antesia bugs with 2%. Therefore, the implication is that these pests affect Robusta coffee plants and farmers end up getting little coffee. The findings are therefore supported by Egonyu, Kucel, Kangire, Sewaya, and Nkugwa (2009) carried out a survey to determine the identity, spread, incidence and damage caused by black coffee twig borer. The survey was conducted in six and four sub counties in Mukono and Kayunga districts, respectively. The survey results indicated that the black twig borer, which was found on coffee in both districts, infested 38% of the surveyed Robusta coffee farms. The infestation in Mukono was higher than in Kayunga, being 50 and 8%, respectively. The percentage of trees attacked (incidence) in the two districts was 21.2, with 4% of their twigs bored (damaged). Mukono district had a much higher incidence (35%) and damage (5%) compared to Kayunga with 1% for both parameters (Egonyu et al, 2009).

According to the study findings, 34% of respondents revealed that they had mealy bags as the most common pest followed by leaf minors with 19%, Black Coffee Twig Borer with 17%, Coffee berry borer with 4%, stem borer with 9%, coffee root mealy bugs with 7%, scale insects with 1% and Antesia bugs with 10%. Therefore, the implication is that these pests affect Arabica coffee plants and farmers end up getting little coffee. The findings therefore supported by Egonyu, Kucel, Kangire, Sewaya, and Nkugwa (2009) carried out a survey to determine the identity, spread, incidence and damage caused by black coffee twig borer. The survey was conducted in six and four sub counties in Mukono and Kayunga districts, respectively. The survey results indicated that the black twig borer, which was found on coffee in both districts, infested 38% of the surveyed Robusta coffee farms. The infestation in Mukono was higher than in Kayunga, being 50 and 8%, respectively. The percentage of trees attacked (incidence) in the two districts was 21.2, with 4% of their twigs bored (damaged). Mukono district had a much higher incidence (35%) and damage (5%) compared to Kayunga with 1% for both parameters (Egonyu et al, 2009).

According to the study findings, 17% of respondents revealed that they had mealy bags as the most common pest followed by leaf minors with 33%, Black Coffee Twig Borer with 20%, Coffee berry borer with 12%, stem borer with 8%, coffee root mealy bugs with 4%, scale insects with 4% and Antesia bugs with 2%. Therefore, the implication is that these pests affect cocoa plants and farmers end up getting little coffee. The findings therefore supported by Kagezi et al. (2014) surveyed 20 households

in Bundibugyo, Kibaale and Hoima districts in January 2014. On each field, 10 cocoa trees were examined for BCTB infestation along a transect. The findings of the survey showed that more than half of the cocoa plantations, 13% of trees and 4% of primary branches were infested. At district level, Kibaale had the highest proportions of infested fields (100%), trees (30%) and primary branches (9%). Table 6 summarizes both the frequencies and percentages of the pest invasion of the perennial crops. The survey also revealed that 30% of cocoa farms were infested and 8% of cocoa trees were infested in Bundibugyo whereas in Hoima, 60 % of cocoa farms and 6% of cocoa trees were infested by BCTB (Kagezi et al., 2014).

4.2.4 Field observations on BCTB incidence on Robusta

According to the study findings, 29% of respondents revealed that they had 0.13-5 incidences, 13% had 12-18 incidences, 12% had 6-11 incidences, 10% had 19-25 incidences, 9% had 39-45 incidences and 46-51 incidences each, 52 and above incidences with 6.5% and 26-31 incidences with 7%. The implication is that because the incidences are high the annual losses are also high and this is supported by a study carried out by Wu (2016) showed that 69% of the coffee farms were infested by the black coffee twig borer pest of the 26 districts surveyed, with an average of 40% of the coffee plants being attacked. The national yield loss is estimated to be 9% because of BCTB. Furthermore, a study conducted by Kagezi at al. (2013) showed that *compactus* had spread to 68% of Robusta coffee (*Coffea canephora*) farms in Uganda, where it infested 40% of coffee trees per farm and killed 9% of twigs.

4.2.5 Field observations on BCTB incidence in Arabica

According to the study findings, 33% of respondents revealed that they had 27-34 incidences, 26% had 3-10 incidences, 17% had 11-18 incidences, 15% had 19-26 incidences, and 9% had 35-42 incidences (Table 3). The implication is that because the incidences are high the annual losses are also high and this is supported by a study carried out by Wu (2016) which showed that 69% of the coffee farms were infested by the black coffee twig borer pest of the 26 districts surveyed, with an average of 40% of the coffee plants being attacked. The national yield loss is estimated to be 9% because of BCTB. Furthermore, a study conducted by Kagezi at al. (2013) showed that *compactus* had spread to 68% of Robusta coffee (*Coffea canephora*) farms in Uganda, where it infested 40% of coffee trees per farm and killed 8.6% of twigs (Kagezi et al., 2020).

Table 3: BCTB Incidence on Arabica Coffee

Incidence	Frequency	Percent
3-10 incidences	24	26.1
11-18 incidences	16	17.4
19-26 incidences	14	15.2
27-34 incidences	30	32.6
35-42 incidences	8	8.7
Total	**92**	**100.0**

4.2.6 Field observations on BCTB incidence on Cocoa

According to the study findings, 32% of respondents revealed that they had 16-23 incidences, 19% had 8-15 incidences, 14% had 0-7 incidences, 14% had 32-39 incidences, 13% had 24-31 incidences and 40-47 incidences had 8.8% (Table 4). The implication is that because the incidences are high the annual losses are also high and this is supported by Kagezi et al. (2014) surveyed 20 households in Bundibugyo, Kibaale and Hoima districts in January 2014. On each field, 10 cocoa trees were examined for BCTB infestation along a transect. The findings of the survey showed that more than half of the cocoa plantations, 13% of trees and 4% of primary branches were infested. At district level, Kibaale had the highest proportions of infested fields (100%), trees (30%) and primary branches (9%). The survey also revealed that 30% of cocoa farms were infested and 8% of cocoa trees were infested in Bundibugyo whereas in Hoima, 60 % of cocoa farms and 6% of cocoa trees were infested by BCTB (Kagezi et al., 2014).

Table 4: BCTB Incidences on Cocoa

Incidence	Frequency	Percent
0-7 incidence	13	14.1
8-15 incidences	17	18.5
16-23 incidences	29	31.5
24-31 incidences	12	13.0
32-39 incidences	13	14.1
40-47 incidences	8	8.8
Total	**92**	**100.0**

4.3 Awareness of farmers about ecofriendly practices for Black Coffee Twig Borer (BCTB) management

4.3.1 Invasion of BCTB crop farm

According to the study findings, 28% of respondents didn't know how BCTB came to their coffee farm, 20% said that they fly, 15% spreads by husks, 15% by wind, 12% brought by other people and birds with 10%. This implies that most farmers are ignorant of how BCTB came to their coffee farms and hence don't know how to protect themselves against the pest. This finding is supported by the survey carried out by Egonyu, Kucel, Kangire, Sewaya, and Nkugwa (2009) in Mukono and Kayunga districts in central Uganda in December 2008 where data on farmers' comments in relation to the BCTB problem were taken revealed that among the farmers interviewed, 51% had no idea of BCTB while the rest had heard about it through the electronic and/or read about it in the print media. Three percent of the farmers reported having applied Malathion, an insecticide, to control BTB, while the rest had done nothing about the problem. Some 3% of the farmers believed that this pest was introduced to their area by pesticide dealers to create a market for their insecticides (Egonyu et al., 2009; Tumuramye et al., 2024).

The findings similarly supported by Hultman (2016) to investigate if the knowledge level and opinion about BCTB and shade for coffee, vary between farmers, officers and researchers revealed that the opinions and knowledge between the three groups of people (farmers, officers and researchers) differed in some questions. One question that resulted in various answers, especially among the officers and researchers, was if shaded or sun-exposed coffee is most affected by the BCTB. Most of the farmers said it is shaded coffee that is most affected by BCTB. However, there were different opinions among farmers, officers and researchers about possible host trees of BCTB (Hultman, 2016).

4.3.2 Ecofriendly management practices farmers apply in management of BCTB in Robusta coffee, Arabica Coffee and Cocoa

According to the study findings, 28% of respondents revealed that manure application is the most used ecofriendly management practice respondents apply on their crop farm to manage the BCTB in Robusta, followed by mulching with 16%, pruning with 9%, agroforestry with 8%, planting healthy seedlings/seeds with 4% and trapping with 4%, removal of affected branches with 5%, and general phytosanitation with 4% and many more (Table 5). This implies that farmers are trying to manage the pest using ecofriendly management practices and these findings agree with UCDA (2013) which evaluated the community based phytosanitary interventions for management of BCTB, the phytosanitary interventions for BCTB control included de-suckering, pruning and burning of infested coffee plant parts and alternate host plants. Cumulative results clearly showed that the application of phytosanitary recommendations caused decline in BCTB incidences in all the 3 test sub-counties. Reduction in BCTB incidence was more pronounced in Mukono than in Nakaseke district probably due to differences in level of compliance with the recommendations (UCDA annual report, 2013). The report also revealed that attractants among the local potent gin (Kasese-Kasese) appeared to have the same efficiency as commercial ethanol at 75% in trapping BCTB (UCDA annual report, 2013).

According to Mukasa (2010); Kyalo (2024) cultural control methods such as providing good shade, Pruning and burning of beetle-infested plant material is essential and effective in controlling black coffee twig borer. Furthermore, Mukasa (2010) posits that good tree care

promotes vigor and help in resisting infestation or recovering from black coffee twig borer infestation. In addition, chemical control such as spraying the whole plant with deltamethrin 12g chlorpyrifos 300g/l, or fenitrothion pesticides, mixing pesticides according to the manufacturer's instructions on the label and spraying young coffee plants the first time one year after transplanting, before flowering is also essential and effective in controlling black coffee twig borer. In older coffee plantations, spraying after the desuckering and before flowering and spraying once every 2 weeks, 3 times in total during the season reduces the incidence of black coffee twig borer (Mukasa, 2010). Armengot (2020) says agroforestry systems in cocoa are more efficient to reducing disease incidence on farm.

According to the study findings, 17% of respondents revealed that recommended spacing is the most used ecofriendly management practices respondents apply on their crop farm to manage the BCTB in Arabica, followed by mulching with 15%, manure application with 13%, pruning with 9%, Agro forestry with 7%, Removal of affected branches with 6%, Both Removal of affected twigs, planting healthy seedlings/seeds, Intercropping and trapping with 4% each, Both Regular weeding and general phytosanitation with 3% each, Both Irrigation, Planting pest free seedlings and Spraying organic concoctions with 2% each, and Both Terracing, Regular Inspection and Proper shade management with 1% each (Table 8). This implies that farmers are trying to manage the pest using ecofriendly management practices and this finding agrees with UCDA (2013) evaluated the community based phytosanitary interventions for management of BCTB, the phytosanitary interventions for BCTB control included de-suckering, pruning and burning of infested coffee plant parts and alternate host plants. Bwambale et al., (2021) says planned agroforestry systems can as well address the challenge of pest on farm. Cumulative results clearly showed that the application of phytosanitary recommendations caused decline in BCTB incidences in all the 3 test sub-counties. Reduction in BCTB incidence was more pronounced in Mukono than in Nakaseke district probably due to differences in level of compliance with the recommendations (UCDA annual report, 2013). The report also revealed that attractants among the local potent gin (Kasese-Kasese) appeared to have the same efficiency as commercial ethanol at 75% in trapping BCTB (UCDA annual report, 2013).

According to Mukasa (2010), cultural control methods such as providing good shade, Pruning and burning of beetle-infested plant material are essential and effective in controlling black coffee twig borer. Furthermore, Mukasa (2010) posits that good tree care promotes vigor and help in resisting infestation or recovering from black coffee twig borer infestation. In addition, chemical control such as spraying the whole plant with deltamethrin 12g chlorpyrifos 300g/l, or fenitrothion pesticides, mixing pesticides according to the manufacturer's instructions on the label and spraying young coffee plants the first time one year after transplanting, before flowering is also essential and effective in controlling black coffee twig borer. In older coffee plantations, spraying after the desuckering and before flowering and spraying once every 2 weeks, 3 times in total during the season reduces the incidence of black coffee twig borer (Mukasa, 2010).

According to the study findings, pruning with 17% of respondents revealed that pruning is the most used ecofriendly management practice respondents apply on their crop farm to manage the BCTB in cocoa, followed by manure application with 12%, Mulching and Agro forestry with 11% each, planting healthy seedlings/seeds with 9%, Recommended spacing with 8%, removal of affected branches with 5%, Both Trapping, General Phytosanitation and Intercropping with 4% each, Both Regular weeding, Spraying organic concoctions, Irrigation, Removal of affected twigs, Planting pest free seedlings with 2.2% each and many more. This implies that farmers are trying to manage the pest using different ecofriendly management practices in cocoa production based on farmer capacity and this is supported by Mukasa (2010), cultural control methods such as providing good shade, Pruning and burning of beetle-infested plant material is essential and effective in controlling black coffee twig borer.

Furthermore, Mukasa (2010) posits that good tree care promotes vigor and help in resisting infestation or recovering from black coffee twig borer infestation. In addition, chemical control such as spraying the whole plant with deltamethrin 12g chlorpyrifos 300g/l, or fenitrothion pesticides, mixing pesticides according to the manufacturer's instructions on the label and spraying young coffee plants the first time one year after transplanting, before flowering is also essential and effective in controlling black coffee twig borer. In older coffee plantations, spraying after the desuckering and before flowering and spraying once every 2 weeks, 3 times in total during the season reduces the incidence of black coffee twig borer (Mukasa, 2010).

Table 5: Ecofriendly practices used by farmers to manage the BCTB on their farms

Practice	Frequency			Percent		
	Robusta	Arabica	Cocoa	Robusta	Arabica	Cocoa
Manure application	26	12	11	28.3	13	13
Mulching	15	14	10	16.3	15.2	15.2
Recommended spacing	2	16	7	2.2	17.4	17.4
Removal of affected branches	5	5	5	5.4	5.5	5.5
Irrigation Spraying organic concoctions/Botanicals	2	2	2	2.2	2.2	2.2
Intercropping	4	4	4	4.3	4.3	4.3
Regular weeding	2	3	2	2.2	3.3	3.3
Planting healthy seedlings/seeds	4	4	8	4.3	4.3	4.3
Agroforestry	7	6	10	7.6	6.5	6.5
Pruning	8	8	16	8.7	8.7	8.7
Removal of affected twigs	2	4	2	2.2	4.3	4.3
General Phytosanitation	4	3	4	4.3	3.3	3.3
Terracing	1	1	1	1.1	1.1	1.1
Regular inspection	1	1	1	1.1	1.1	1.1
Proper shade management	1	1	1	1.1	1.1	1.1
Trapping	4	4	4	4.3	4.3	4.3
Planting pest free seedlings/seeds	2	2	2	2.2	2.2	2.2
Total	**92**	**92**	**92**	**100**	**100**	**100**

4.3.3 Pesticide application in Robusta Plantation

According to the study findings, 41% of respondents revealed that they applied the ecofriendly management practices half a year this was followed by 24% who applied annually, those who applied monthly and quarterly were both 12% each and seasonally was 11% (Table 6). This implies that farmers apply these ecofriendly practices always to fight BCTB pest and they have been effective. This is supported by Dahlqvist (2016) to find out the view of the Black Coffee Twig Borer (*Xylosandrus compactus*) Eichhoff among farmers, advisers and experts in the area surrounding Masaka (Kalungu and Bukomansimbi districts), in Central Uganda revealed that the most common and effective control method used by the farmers was coffee tree management; primarily by removing and burning affected twigs but also by removing sprouts on the coffee trees and by weeding (removing potential host plants). Tree management, by pruning shade trees, was also used due to its effectiveness as stated by the farmers and felling of shade trees was a method used by the farmers to control X. compactus (Dahlqvist, 2016; Koutouleas, 2022).

According to the study findings, 41% of respondents revealed that they applied ecofriendly management practices half a year followed by 24% who applied monthly, annually were 21%, and quarterly was 13% and seasonally were 1% (Table 6). This implies that farmers apply these ecofriendly practices always to fight BCTB pest in Arabica coffee growing and they have been effective and this is supported by Dahlqvist (2016) to find out the view of the Black Coffee Twig Borer (*Xylosandrus compactus*) Eichhoff among farmers, advisers and experts in the area surrounding Masaka (Kalungu and Bukomansimbi districts), in Central Uganda revealed that the most common and effective control method used by the farmers was coffee tree management; primarily by removing and burning affected twigs but also by removing sprouts on the coffee trees and by weeding (removing

potential host plants). Tree management, by pruning shade trees, was also used due to its effectiveness as stated by the farmers and felling of shade trees was a method used by the farmers to control *X. compactus* (Dahlqvist, 2016).

According to the study findings, 45% of respondents revealed that they applied the ecofriendly management practices annually followed by 20% applied seasonally, half a year with 20%, quarterly with 15% and monthly was 1%. This implies that farmers apply these ecofriendly practices always to fight BCTB pest and they have been effective and this is supported by Egonyu et al. (2015) also indicated that the ant *Plagiolepis sp*. was mentioned by at least one in each of the three groups interviewed and has been proven to be an indigenous predator of *X. compactus* which reduces the incidence of BCTB (Egonyu et al., 2015). Thus, favoring this natural enemy could be an effective way of controlling the pest. Similarly, Limonene a citrus- based terpene and verbenone an anti-aggregation pheromone act as repellants to *X. compactus* and can reduce the severity of the attack of BCTB (Burbano et al., 2012).

Table 6: Application frequencies for ecofriendly management practices in Robusta coffee, Arabica coffee and cocoa

Period	Frequency			Percent		
	Robusta	Arabica	Cocoa	Robusta	Arabica	Cocoa
Monthly	11	22	1	12	23.9	1.1
Quarterly	11	12	14	12	13	15.2
Half a Year	38	38	18	41.3	41.3	19.6
Annually	22	19	41	23.9	20.7	44.6
Seasonally	10	1	18	10.8	1.1	19.5
Total	**92**	**92**	**92**	**100**	**100**	**100**

4.3.4 Effectiveness of different ecofriendly Black Coffee Twig Borer (BCTB) Management practices

According to the study findings, 22% of respondents revealed that removal of alternate hosts is the most effective ecofriendly management practices respondents apply on their crop farm to manage the BCTB in Robusta, followed by agro forestry with 14.1%, planting at recommended spacing with 14%, removal affected twigs with 13%, planting pest free seedlings/seeds with 11%, pruning with 9% and many more (Table 7). This implies that farmers are trying to manage the pest using ecofriendly management practices and these findings agree with UCDA (2013) evaluated the community based phytosanitary interventions for management of BCTB, the phytosanitary interventions for BCTB control included de-suckering, pruning and burning of infested coffee plant parts and alternate host plants. Cumulative results clearly showed that the application of phytosanitary recommendations caused decline in BCTB incidences in all the 3 test sub-counties. Reduction in BCTB incidence was more pronounced in Mukono than in Nakaseke district probably due to differences in level of compliance with the recommendations (UCDA annual report, 2013). The report also revealed that attractants among the local potent gin (Kasese-Kasese) appeared to have the same efficiency as commercial ethanol at 75% in trapping BCTB (UCDA annual report, 2013).

Mukasa (2010), says cultural control methods such as providing good shade, Pruning and burning of beetle-infested plant material is essential and effective in controlling black coffee twig borer. Furthermore, he confirms that good tree care promotes vigor and help in resisting infestation or recovering from black coffee twig borer infestation. In addition, chemical control such as spraying the whole plant with deltamethrin 12g chlorpyrifos 300g/l, or fenitrothion pesticides, mixing pesticides according to the manufacturer's instructions on the label and spraying young coffee plants the first time one year after transplanting, before flowering is also essential and effective in controlling black coffee twig borer. In older coffee plantations, spraying after the desuckering and before flowering and spraying once every 2 weeks, 3 times in total during the season reduces the incidence of black coffee twig borer (Koutouleas et al., 2022)

According to the study findings, 13% of respondents revealed that removal of alternate hosts is the most effective, removal of affected twigs with 13%, General Phytosanitation with 13%, agro forestry with 12%, planting at recommended spacing with 11%, planting pest free seedlings/seeds with 9%, planting resistant varieties

with 7% and regular inspection with 7%, and others (Table 12). This implies that farmers are trying to manage the pest using ecofriendly management practices and this finding agrees with UCDA (2013) evaluated the community based phytosanitary interventions for management of BCTB, the phytosanitary interventions for BCTB control included de-suckering, pruning and burning of infested coffee plant parts and alternate host plants. Cumulative results clearly showed that the application of phytosanitary recommendations caused decline in BCTB incidences in all the 3 test sub-counties. Reduction in BCTB incidence was more pronounced in Mukono than in Nakaseke district probably due to differences in level of compliance with the recommendations (UCDA annual report, 2013). The report also revealed that attractants among the local potent gin (Kasese-Kasese) appeared to have the same efficiency as commercial ethanol at 75% in trapping BCTB (UCDA annual report, 2013)

According to Mukasa (2010), cultural control methods such as providing good shade, Pruning and burning of beetle-infested plant material is essential and effective in controlling black coffee twig borer. Furthermore, Mukasa (2010) posits that good tree care promotes vigor and help in resisting infestation or recovering from black coffee twig borer infestation. In addition, chemical control such as spraying the whole plant with deltamethrin 12g chlorpyrifos 300g/l, or fenitrothion pesticides, mixing pesticides according to the manufacturer's instructions on the label and spraying young coffee plants the first time one year after transplanting, before flowering is also essential and effective in controlling black coffee twig borer. In older coffee plantations, spraying after the desuckering and before flowering and spraying once every 2 weeks, 3 times in total during the season reduces the incidence of black coffee twig borer (Mukasa, 2010).

According to the study findings, spraying organic concoctions/Botanicals with 22% of respondents was revealed as the most effective ecofriendly management practices respondents apply on their crop farm to manage the BCTB in cocoa, followed by 17% planting recommended spacing, removal of alternate hosts with 14%, mulching with 9%, General Phytosanitation with 9% and pruning with 8% and many more. This implies that farmers are trying to manage the pest by applying ecofriendly management practices in cocoa gardens and this is supported by Mukasa (2010), cultural control methods such as providing good shade, Pruning and burning of beetle-infested plant material is essential and effective in controlling black coffee twig borer. Furthermore, Mukasa (2010) posits that good tree care promotes vigor and help in resisting infestation or recovering from black coffee twig borer infestation. In addition, chemical control such as spraying the whole plant with deltamethrin 12g chlorpyrifos 300g/l, or fenitrothion pesticides, mixing pesticides according to the manufacturer's instructions on the label and spraying young coffee plants the first time one year after transplanting, before flowering is also essential and effective in controlling black coffee twig borer. In older coffee plantations, spraying after the desuckering and before flowering and spraying once every 2 weeks, 3 times in total during the season reduces the incidence of black coffee twig borer (Mukasa, 2010).

Table 7: Most effective ecofriendly BCTB management practice on Robusta coffee, Arabica coffee and cocoa farms

Practice	Frequency			Percent		
	Robusta, Arabica, Cocoa			Robusta, Arabica, Cocoa		
Agro forestry	13	11	1	14.1	12	1.1
Planting at recommended spacing	13	10	16	14.1	10.9	17.3
Pruning	8	5	7	8.7	5.4	7.6
Spraying organic concoctions/Botanicals	1	1	20	1.1	1.1	21.7
Removal of affected twigs	12	12	9	13	13	9.8
General Phytosanitation	4	12	8	4.3	13	8.7
Manure application	3	3	1	3.3	3.3	1.1
Mulching	2	2	8	2.2	2.2	8.7
Terracing	1	1	1	1.1	1.1	1.1
Irrigation	1	1	1	1.1	1.1	1.1
Regular inspection	1	6	1	1.1	6.5	1.1
Proper shade management	1	1	1	1.1	1.1	1.1
Trapping	1	1	1	1.1	1.1	1.1
Planting resistant varieties	1	6	1	1.1	6.5	1.1
Removal of alternate hosts	20	12	13	21.7	13	14.1
Planting free seedlings/seeds	10	8	3	10.9	8.7	3.3
Total	**92**	**92**	**92**	**100**	**100**	**100**

4.3.5 Black Coffee Twig Borer management practices in the past two seasons in Robusta

According to the study findings, 25% of respondents revealed that planting at recommended spacing is the BCTB management practices respondents apply on their crop farm to manage the BCTB in Robusta in the last two seasons, followed by agroforestry with 17%, mulching with 13%, removal of affected twigs with 12%, removal of alternate hosts with 9%, pruning with 9% and many more. This implies that farmers are trying to manage the pest using ecofriendly management practices and this finding agrees with UCDA (2013) evaluated the community based phytosanitary interventions for management of BCTB, the phytosanitary interventions for BCTB control included de-suckering, pruning and burning of infested coffee plant parts and alternate host plants. Cumulative results clearly showed that application of phytosanitary recommendations caused decline in BCTB incidences in all the 3 test sub-counties. Reduction in BCTB incidence was more pronounced in Mukono than in Nakaseke district probably due to differences in level of compliance with the recommendations (UCDA annual report, 2013). The report also revealed that attractants among the local potent gin (Kasese-Kasese) appeared to have the same efficiency as commercial ethanol at 75% in trapping BCTB (UCDA annual report, 2013).

According to Mukasa (2010), cultural control methods such as providing good shade, Pruning and burning of beetle-infested plant material is essential and effective in controlling black coffee twig borer. Furthermore, Mukasa (2010) posits that good tree care promotes vigor and help in resisting infestation or recovering from black coffee twig borer infestation. In addition, chemical control such as spraying the whole plant with deltamethrin 12g chlorpyrifos 300g/l, or fenitrothion pesticides, mixing pesticides according to the manufacturer's instructions on

the label and spraying young coffee plants the first time one year after transplanting, before flowering is also essential and effective in controlling black coffee twig borer. In older coffee plantations, spraying after the desuckering and before flowering and spraying once every 2 weeks, 3 times in total during the season reduces the incidence of black coffee twig borer (Mukasa, 2010).

According to the study findings, 15% of the respondents revealed that spraying organic concoctions/Botanicals as the most used method in the last two seasons, removal of affected twigs with 13%, General Phytosanitation with 12%, Removal of alternate hosts with 11%, Planting pest free seedlings/seeds with 11% and regular inspection with 10%. This implies that farmers are trying to manage the pest in most seasons using ecofriendly management practices and this finding agrees with UCDA (2013) evaluated the community based phytosanitary interventions for management of BCTB, the phytosanitary interventions for BCTB control included de-suckering, pruning and burning of infested coffee plant parts and alternative host plants. Cumulative results clearly showed that the application of phytosanitary recommendations caused decline in BCTB incidences in all the 3 test sub-counties. Reduction in BCTB incidence was more pronounced in Mukono than in Nakaseke district probably due to differences in level of compliance with the recommendations (UCDA annual report, 2013).

The report also revealed that attractants among the local potent gin (Kasese-Kasese) appeared to have the same efficiency as commercial ethanol at 75% in trapping BCTB (UCDA annual report, 2013). According to Mukasa (2010), cultural control methods such as providing good shade, Pruning and burning of beetle-infested plant material is essential and effective in controlling black coffee twig borer. Furthermore, Mukasa (2010) posits that good tree care promotes vigor and help in resisting infestation or recovering from black coffee twig borer infestation. In addition, chemical control such as spraying the whole plant with deltamethrin 12g chlorpyrifos 300g/l, or fenitrothion pesticides, mixing pesticides according to the manufacturer's instructions on the label and spraying young coffee plants the first time one year after transplanting, before flowering is also essential and effective in controlling black coffee twig borer. In older coffee plantations, spraying after the desuckering and before flowering and spraying once every 2 weeks, 3 times in total during the season reduces the incidence of black coffee twig borer (Mukasa, 2010).

According to the study findings, Manure application with 34% of respondents revealed as the most used ecofriendly management practices respondents apply on their crop farm to manage the BCTB in cocoa in the last two seasons, followed by 13% Removal of affected twigs, removal of alternate hosts with 11%, terracing with 9%, planting resistant varieties with 8% and many more. This implies that farmers are trying to manage the pest in most season using ecofriendly management practices and this is supported by Mukasa (2010), cultural control methods such as providing good shade, Pruning and burning of beetle-infested plant material is essential and effective in controlling black coffee twig borer. Furthermore, Mukasa (2010) posits that good tree care promotes vigor and help in resisting infestation or recovering from black coffee twig borer infestation. In addition, chemical control such as spraying the whole plant with deltamethrin 12g chlorpyrifos 300g/l, or fenitrothion pesticides, mixing pesticides according to the manufacturer's instructions on the label and spraying young coffee plants the first time one year after transplanting, before flowering is also essential and effective in controlling black coffee twig borer. In older coffee plantations, spraying after the desuckering and before flowering and spraying once every 2 weeks, 3 times in total during the season reduces the incidence of black coffee twig borer (Mukasa, 2010).

4.3.6 Selected effective ecofriendly management practice of BCTB in Robusta, Arabica and Cocoa

According to the study findings, 45% strongly agreed that BCTB ecofriendly management practices such as removal of affected twigs, manure application and many more while 32% agreed. This implies that BCTB ecofriendly management practices like manure application, removal of affected twigs, mulching, terracing and irrigation among others have helped farmers in fighting the pest (Table 8). This is supported by Dahlqvist (2016) to find out the view of the Black Coffee Twig Borer (*Xylosandrus compactus*) Eichhoff among farmers, advisers and experts in the area surrounding Masaka (Kalungu and Bukomansimbi districts), in Central Uganda revealed that the most common and effective control method used by the farmers was coffee tree management; primarily by removing and burning affected twigs but also by removing sprouts on the coffee trees and by weeding (removing potential host plants). Tree management, by pruning shade trees, was also used due to its effectiveness as stated by the farmers and felling of shade trees was a method used by the farmers to control *X. compactus* (Dahlqvist, 2016).

According to the study findings, 48% strongly agreed that BCTB ecofriendly management practices such as removal of affected twigs, manure application and many more while 44% agreed. This implies that BCTB ecofriendly management practices like manure application, removal of affected twigs, mulching, terracing and irrigation among others has helped farmers in fighting the pest (Table 13). This is supported by Dahlqvist (2016) to find out the view of the Black Coffee Twig Borer (*Xylosandrus compactus*) Eichhoff among farmers, advisers and experts in the area

surrounding Masaka (Kalungu and Bukomansimbi districts), in Central Uganda revealed that the most common and effective control method used by the farmers was coffee tree management; primarily by removing and burning affected twigs but also by removing sprouts on the coffee trees and by weeding (removing potential host plants). Tree management, by pruning shade trees, was also used due to its effectiveness as stated by the farmers and felling of shade trees was a method used by the farmers to control *X. compactus* (Dahlqvist, 2016).

According to the study findings, 32% strongly agreed that BCTB ecofriendly management practices such as removal of affected twigs, manure application and many more while 21% agreed (Table 8). This implies that BCTB ecofriendly management practices like manure application, removal of affected twigs, mulching, terracing and irrigation among others has helped farmers in fighting the BCTB pest. This is supported by Dahlqvist (2016) to find out the view of the Black Coffee Twig Borer (*Xylosandrus compactus*) Eichhoff among farmers, advisers and experts in the area surrounding Masaka (Kalungu and Bukomansimbi districts), in Central Uganda revealed that the most common and effective control method used by the farmers was coffee tree management; primarily by removing and burning affected twigs but also by removing sprouts on the coffee trees and by weeding (removing potential host plants). Tree management, by pruning shade trees, was also used due to its effectiveness as stated by the farmers and felling of shade trees was a method used by the farmers to control *X. compactus* (Dahlqvist, 2016).

Table 8: Effectiveness of BCTB Ecofriendly management practices crops

Response	Frequency			Percent		
	Robusta	**Arabica**	**Cocoa**	**Robusta**	**Arabica**	**Cocoa**
Strongly Agree	41	44	29	44.6	47.8	31.5
Agree	29	40	19	31.5	43.5	20.7
Not sure	13	4	19	14.1	4.3	20.7
Disagree	3	1	19	3.3	1.1	20.7
Strongly Disagree	6	3	6	6.5	3.3	6.5
Total	**92**	**92**	**92**	**100**	**100**	**100**

5. Conclusion and Recommendations

5.1 Conclusion

The study highlights Robusta coffee, Arabica coffee, and Cocoa as the main crops grown by respondents. Robusta and Arabica coffee were mostly planted between 1979-1990, while Cocoa cultivation started later, between 1995-2005. Farmers' choices reflect considerations of maturation periods, economic returns, and vulnerability to pests and diseases. Cocoa faces challenges like theft and disease susceptibility, discouraging its cultivation compared to coffee, which matures faster. Common production constraints include soil infertility, pests, diseases, high labor costs, poor planting materials, and adverse climate conditions. Pests such as the Black Coffee Twig Borer (BCTB) significantly reduce crop yields, with Arabica coffee being the most affected, followed by Robusta and Cocoa.

Farmers' awareness of BCTB spread was limited, with many attributing its presence to external factors. Ecofriendly practices like pruning, mulching, manure application, and agroforestry were commonly used to combat BCTB. The removal of alternate hosts emerged as the most effective method, complemented by agroforestry and proper spacing. Despite these efforts, BCTB's persistence underscores the need for integrated pest management, combining traditional and modern approaches. The study emphasizes the economic and food security risks posed by pests and diseases. It calls for improved farmer training, access to quality seedlings, and institutional support to enhance sustainable agriculture and strengthen farmers' resilience.

5.2 Recommendations

Farmers should adopt modern methods of growing these perennial crops and apply ecofriendly management practices for both soil fertility and pest management to increase their yields and reduce pest incidence. Furthermore, they should continuously prune their crops as the only alternative right now to fight the BCTB pest. The government should recruit more extension workers in the provision of advisory services to help in fighting the BCTB pest. The extension workers would help in identifying and train farmers to manage the pest early enough.

The government should make more sensitization to the people about the outbreak of the BCTB, its dangers and its management, so that farmers adopt these ecofriendly pest management practices and can stop using rudimentary methods of managing the pest. The government of Uganda through the Ministry of Agriculture Animal Industry and Fisheries (UCDA, NARO and NAADS) should also help in provision of tools and equipment used during the application of the ecofriendly management practices and control of the BCTB pest as coffee and cocoa are major exchange earners to the country.

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