Pelita Perkebunan 40(1) 2024, 91–104
DOI: DOI 10.22302/iccri.jur.pelitaperkebunan.v40i1.589
ISSN: 0215-0212 / e-ISSN: 2406-9574

Cocoa Farmers and Agrochemical Safety Compliance: Empirical Insights from Ghana

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Received: 23 January 2024 / Accepted: 18 March 2024

Abstract

The unregulated application of agrochemicals has led to an overabundance of pesticide residues in cocoa beans, posing a potential threat to the cocoa customer base. There is also a pressing issue surrounding the adherence of cocoa farmers to safety protocols in the handling, application, and storage of agrochemicals. This study, therefore, offers empirical insights into the types of agrochemicals used by cocoa farmers, their understanding of safe handling practices, the factors influencing their use of agrochemicals, and the level of compliance with safety standards among cocoa farmers in Ghana. The cross-sectional quantitative survey collected data from 385 cocoa farmers in the Nzema East Municipal through a structured interview schedule. The analysis utilises mean, standard deviation, frequency, percentages, and Tobit regression models. The study found that cocoa farmers exhibit a high level of knowledge in agrochemical handling, positive agrochemical usage practices, and proper agrochemical storage practices. Cocoa farmers employ integrated pest management strategies, using diverse fertilisers, insecticides, fungicides, and herbicides to address crop health and productivity challenges. Tobit regression results showed that the extent of use of agrochemicals was significantly influenced by marital status, household size, farming experience, cooperative membership, and access to spraying machines and personal protective equipment. The research highlights the importance of integrating safety considerations into agricultural policies and practices, emphasising the role of knowledge and awareness in influencing farmers' practices. It suggests the need for targeted interventions and educational programs to enhance agrochemical safety compliance among cocoa farmers.

Keywords: Agrochemical handling, personal protective equipment, safety precautions

INTRODUCTION

Ghana's cocoa industry, recognized as a success in the developing world, ranks second globally in production, yielding around 840,000 tonnes in 2015/2016 (Attipoe *et al*., 2020). This substantial production not only generates significant revenue for the country but also plays a vital role in providing employment opportunities for millions of Ghanaians. The cocoa sector significantly boosts Ghana's revenue, contributing USD 2 billion annually, constituting 14.5% of the GDP in 2018 (GSS, 2019). The cocoa industry supports over four

million jobs in Ghana, holding global significance for consuming nations by providing income and employment across various sectors (Danso-Abbeam & Baiyegunhi, 2017; GSS, 2018). Despite its crucial role, challenges persist, including low soil fertility and pestrelated productivity issues (IITA, 2009).

In Ghana, the severe 'black pod' disease caused by *Phytophthora megakarya* can slash cocoa output by 40–90%, while cocoa capsids or mirids (*Salbegella singularis* or *Distanthiella theobromae*) may cause up to a 75% decline in yields (Nkamleu *et al.*, 2007). To combat pests and diseases, cocoa farmers rely on agrochemicals. Again, as soil fertility declines, the application of fertilisers becomes crucial. Categorised into fumigants, fertilisers, fungicides, herbicides, and insecticides, these agrochemicals effectively address various challenges including insect and pest infestations, as well as reduced soil fertility, leading to increased soil fertility, pest management, and higher crop yields (Nkamleu *et al*., 2007; Oyekale, 2018; Lamichhane *et al*., 2016; Gellings & Parmenter, 2016).

That notwithstanding, the use of pesticides in cocoa cultivation can lead to unintended consequences, causing environmental pollution and residue accumulation in the final product. Pesticides may drift into the air, seep into the soil, or wash away with rainfall, contaminating air, soil, and water bodies. This contamination affects aquatic ecosystems, harming fish and other organisms, as well as non-target plants and animals, disrupting biodiversity. Pesticides absorbed by cocoa trees can remain in cocoa beans after harvest, posing health risks due to residue accumulation. Farmers require proper training on pesticide application techniques and safety measures to minimise misuse and environmental impact. Balancing pest control with environmental and human health is vital for sustainable cocoa production and consumer safety. On average, cocoa farmers apply fungicides and insecticides on four different occasions, and two (2) herbicide applications per year depending on crop type, pest and disease prevalence and severity and weed pressure.

The unregulated use of illegal agrochemicals and inadequate safety measures expose cocoa producers to severe health risks from agrochemical exposure (Wolf *et al*., 2022). Extra caution during agrochemical application is crucial due to potential adverse health hazards (Worland, 2017). Concerns about agrochemical usage stem from persistent contamination of cocoa beans and water sources (Jayaraj *et al*., 2016). Despite international regulatory efforts (UNEP, 2015), mishandling and misuse of agrochemicals remain global public health concerns, causing approximately 740,000 cases of unintentional acute pesticide poisoning annually, with 7,446 fatalities (Boedeker *et al*., 2022). Cocoa farmers, particularly in Africa, often overlook safety precautions, risking serious health issues like death and disability (Jayaraj *et al*., 2016). Chronic agrochemical exposure increases the risk of various health issues including cancer and birth defects (Alton, 2016; Antwi *et al.*, 2015; Lewis-Mikhael *et al*., 2016; Van Maele-Fabry *et al.*, 2010; Fenga, 2016).

The International Labor Organization (ILO) and the World Health Organization (WHO) recommend the use of personal protective equipment (PPE) by farmers during pesticide application to reduce exposure and associated health risks (Haile *et al.*, 2022). However, cocoa farmers in Ghana have limited utilisation of PPE such as goggles, gloves, and masks (Addai *et al.*, 2022), attributed to factors like high costs, inconvenience, and scarcity of protective measures (Haile *et al.,* 2022). Tarla *et al*. (2015) highlighted inadequate PPE usage among farmers and the risk of water contamination from

agrochemical usage. Bassi *et al*. (2016) noted elevated pesticide doses due to ignorance about associated health hazards among farmers. Bosompem & Mensah (2012) found minimal use of hand gloves, masks, and protective clothing among selected Ghanaian cocoa farmers during agrochemical application. Okoffo *et al*. (2016) identified factors such as farmers' education levels, farming experience, farm size, age, agricultural extension contacts, and the availability of agrochemical shops as determinants of PPE usage.

The uncontrolled application of agrochemicals has led to an abundance of pesticide residues in cocoa beans (Demi & Sicchia, 2021), posing a risk of alienating Ghana's key international cocoa customers. Safety compliance among cocoa farmers in handling, using, and storing these chemicals is a pressing concern. Despite cocoa's economic significance, empirical data on Ghanaian cocoa farmers' agrochemical safety practices are scarce. This research aims to fill this gap by examining the types of agro-chemicals used, farmers' knowledge, factors influencing their use, and current safety compliance. Addressing this gap is crucial for sustainable cocoa cultivation and designing effective interventions for public health, environmental safety, and cocoa productivity (Oyekunle *et al*., 2017).

MATERIALS AND METHODS

The study was carried out in the Nzema East Municipal. The Municipality is situated at the southern extremity of the Western region, spanning longitudes 20^0 05' to 20^0 35' west and latitudes 40^0 40' to 50^0 20' north. Renowned for its geographical coordinates, it stands out as one of the premier destinations for tourists within the region. Encompassing a total land area of 1084.0 km^2, the Municipality shares its boundaries with Jomoro Municipal to the west, Amenfi Central District to the north, and the east with Ahanta West Municipal and Tarkwa Nsuaem Municipal. To the south, the Municipality is bordered by the Gulf of Guinea. As of the 2021 population and housing census, the Municipality hosts a population of 94,621, comprising 48,590 males and 46,031 females (https://ghanadistricts. com/Home/District/208).

The study adopted a cross-sectional survey approach. The research was carried out encompassing the entirety of cocoa farmers in the Nzema East Municipal. According to the Cocoa Health Extension Division (CHED) of the Ghana Cocoa Board (COCOBOD), there are about 10,624 cocoa farmers in the municipality. With a known population, the Yamane (1967) formula was used to estimate the sample size. The formula is given as;

$$n = \frac{N}{1+N(e)^2}$$

Where; n sample size, N = population size (10624), e = Precision level (0.05). Substituting 10624 and 0.05 in the formula,

we have $n = \frac{10624}{1+10624\,(0.05)^2} = 385.486 \approx 385.$

Therefore, 385 cocoa farmers were sampled for this study.

The sampling process employed a multi-stage approach to identify and select the respondents. In the first stage, Nzema East Municipal was purposefully chosen from the cocoa-growing districts in the Western region. This selection was driven by the necessity to explore safety practices among cocoa farmers in agrochemical usage in cocoa-producing districts that have been inadequately represented in previous studies. In the second stage, three cocoa-growing communities were purposefully selected within the municipality. These communities were chosen purposively because they are the primary cocoa-producing in the munici-

pality. For the third stage, a simple random sampling technique was utilised to select 385 respondents from the three identified cocoa farming communities. The sampled communities and their respective respondent numbers were as follows: Kromanteng (133), Mankessim (142), and Gwira Banso (110). The researchers collected primary data by using a structured interview schedule.

Three field assistants proficient in the local dialects (Nzema & Asante Twi) were selected to assist in data collection. The reliability of the questions was assessed using Cronbach's alpha test yielding a value of 0.70, signifying the questionnaire's reliability. To validate the data collection instrument, each field assistant conducted a pilot test by administering the questionnaire to four cocoa farmers. The pilot test aimed to uncover potential problems or vagueness in the questionnaire, allowing for necessary adjustments before official data collection commenced. The actual data was collected from May to July 2023. Before engaging in data collection, the respondents were briefed on the research topic, and the significance of their participation was explained.

Data collected from the field was checked for accuracy, edited, coded, and entered for analysis using Stata version 17. Descriptive statistics including mean, standard deviations (SD), frequencies and percentages were used to analyse the data. A dichotomous variable (yes = 1, no = 0) was used to measure the type of agrochemicals used by cocoa farmers. It was analysed using frequency and percentages. Cocoa farmers' knowledge regarding agrochemical handling, usage, and storage and their agrochemical safety compliance was measured by employing a 5-point Likert scale from 1 (strongly disagree to 5 strongly agree). These objectives were analysed using mean and SD. The Tobit regression model was used to analyse the factors influencing the extent of the use of agrochemicals. The dependent variable used in this study for the Tobit regression was the extent of use of agrochemicals (number of types of agrochemicals used divided by the total number of types of agrochemicals used for cocoa farming) and the independent variables were sex (Dummy: Male-1, Female-0), age (Continuous: years), education (Continuous: years), marital status (Dummy: Married-1, Single-0), household size (Continuous: number of persons in household), religion (Dummy: Christian-1, Others-0), farming experience (Continuous: years), farm size (Continuous: acre), land acquisition (Dummy: Own land-1, Others-0), labour (Dummy: Family-1, Others-0), coope-rative membership (Dummy: Yes-1, No-0), access to formal credit (Dummy: Yes-1, No-0), access to spraying machine (Dummy: Yes-1, No-0) and access to PPE (Dummy: Yes-1, No-0).

Limitations of this study that it was based on self-reported data, which may be subject to social desirability bias, leading participants to provide responses that align with perceived societal expectations. Furthermore, the study focuses on the farmers' perspectives, without direct validation through on-site observations or external assessments. Lastly, the study assumes that a high level of knowledge and positive practices necessarily translate into effective risk reduction, overlooking potential gaps in implementation. Despite these limitations, our study lays a foundation for understanding cocoa farmers' behaviours and sheds light on key areas for targeted interventions and future research endeavours.

RESULTS AND DISCUSSION

Socioeconomic Characteristics

The results in Table 1 reveal the socioeconomic characteristics (discrete variables)

of cocoa farmers in the study area. The results exhibit a diverse profile within the studied population. In terms of gender, the majority of respondents (74.29%) were males, while 25.7% were female. This is in line with the findings of Tham-Agyekum & Ankuyi (2023). The educational background of the farmers shows that half of the farmers (50.4%) had received formal education. The fact that half of the farmers have received formal education indicates a diverse educational background within the farming community. This diversity could encompass various levels of education, from basic schooling to higher education. Education can significantly influence farming practices. The majority of farmers (72.2%) were married, confirming the typical family-oriented structure frequently connected to agricultural communities. As outlined by Sangber-Dery *et al.* (2023), there is a perception that married farmers are viewed as responsible, possibly because of the support they receive from their spouses in their farming endeavours. In terms of land acquisition, the research showed that 67.27% of farmers either held their property outright or had bought it. This denotes a comparatively high degree of land ownership, which can support the farmers' sense of security and dedication to their farming endeavours. Earlier research (Ankuyi *et al*., 2023; Tham-Agyekum & Ankuyi, 2023) indicates that a significant portion of cocoa farmers cultivate on their lands, aligning with the outcomes of this study. About 68.6% of the cocoa farmers use both hired and family labor on their farms, reflecting a blend of external expertise and internal family contributions. Again, 20.52% and 10.9% of the farmers relied on only hired labor and family labor respectively. Most of the farmers (85.7%) were part of farming cooperatives, underscoring the significance of teamwork

Table 1. Socioeconomic characteristics of farmers (discrete variables)

Variables	Frequency	Percentage
Sex		
Male	286	74.3
Female	99	25.7
Level of education		
Formal education	194	50.4
No formal education	191	49.6
Marital status		
Married	278	72.2
Unmarried	107	27.8
Land acquisition		
Owned/Purchased	259	67.3
Others	126	32.7
Labor		
Hired	79	20.5
Family	42	10.9
Both	264	68.57
Access to PPE		
Yes	295	76.6
No	90	23.4
Access spraying machine		
Yes	285	74.0
No	100	26.0
Cooperative membership		
Yes	330	85.7
No	55	14.3
Access to formal credit		
Yes	52	13.5
No	333	86.5

Table 2. Socioeconomic characteristics of farmers (continuous variables)

Variable	Mean	Std. dev	Min	Max
Age (Years)	49.01	9.69	25	86
Household size (Number of people)	7.10	2.82	1	21
Farming experience (Years)	19.48	8.27	3	50
Farm size (Acres)	8.79	4.46	2	32

and collective efforts within the agricultural sector. This result is corroborated by the findings of Acheampong *et al*. (2023), who contend that cooperatives can play a substantial role in the cocoa farming community. Most of the farmers (86.5%) did not have access to credit. This points to possible obstacles to obtaining financial resources for agricultural expansion and investment. This discovery is affirmed by the research of Sangber-Dery *et al.* (2023), which revealed that a significant portion of cocoa farmers lack access to credit.

The socioeconomic variables (continuous variables) are shown in Table 2. From the results, the average age of cocoa farmers was 49 years, with the youngest farmer being 25 years and the oldest being 86 years. This suggests that the majority of cocoa farmers in the research area are ageing. The mean household size of the cocoa farmers was seven. This result is expected because agricultural households are often larger than average households in part due to the workforce demands of agricultural operations. Farming experience, measured in years of engagement in the profession, had an average value of 19.48 years. The average farm size was 8.79 acres.

Cocoa Farmers Knowledge

Table 3 provides a snapshot of the knowledge of cocoa farmers regarding agrochemical handling, usage, and storage. Each section focuses on different aspects of their understanding and practices related to agrochemicals.

Agrochemical Handling Practices: The high mean for "I have received comprehensive training on safe agrochemical handling practices" (mean = 4.43, SD = 0.76) indicates that cocoa farmers, on average, strongly agree that they have received comprehensive training on safe agrochemical handling practices. Farmers, on average, agree that they are cautious about potential risks when mixing and applying agrochemicals (mean = 3.85, SD = 0.59). The overall mean of 4.15 suggests a strong agreement with positive agrochemical handling practices. This reflects a generally high level of knowledge in handling agrochemicals among cocoa farmers. The results imply that the cocoa farmers exhibit positive behaviours and attitudes toward handling agrochemicals. This could include adherence to safety protocols, proper use of protective gear, and awareness of potential risks associated with agrochemicals. The acknowledgement of positive agrochemical handling practices reflects an awareness among cocoa farmers that proper handling is crucial not only for farm productivity but also for their health.

Agrochemical Usage: There is strong agreement that farmers actively seek guidance on the latest agrochemical usage techniques and best practices (mean = 4.50, SD = 0.72). This shows that the farmers are aware of the potential environmental impact of incorrect agrochemical usage, showing a responsible attitude toward sustainable farming practices. Farmers express a strong agreement that they can accurately calculate the right dosage of agrochemicals (mean = 4.09, SD = 0.67). This indicates that they can accurately calculate the right dosage of agrochemicals for specific cocoa farming needs, indicating a strong understanding of application requirements. The overall mean of 4.27

Table 3. Knowledge of cocoa farmers on agrochemical handling, usage and storage

Statements	Mean	Std. Dev
Agrochemical handling practices		
I have received comprehensive training on safe agrochemical handling practices	4.43	0.76
I consistently wear appropriate protective gear when handling agrochemicals	4.42	0.74
I believe that proper agrochemical handling is crucial for both farm productivity and my health	3.88	0.65
I am cautious about potential risks when mixing and applying agrochemicals	3.85	0.59
Overall mean	4.15	0.69
Agrochemical usage		
I seek guidance and information on the latest agrochemical usage techniques and best practices	4.50	0.72
I understand the importance of timing and application methods when using agrochemicals on cocoa crops	4.29	0.89
I am aware of the potential environmental impact of incorrect agrochemical usage	4.20	0.87
I can accurately calculate the right dosage of agrochemicals for specific cocoa farming needs	4.09	0.67
Overall mean	4.27	0.79
Agrochemical storage		
I store agrochemicals in a designated area that is secure and away from living spaces	4.43	0.76
I know the proper way to dispose of empty agrochemical containers to prevent pollution	4.42	0.74
I am willing to share my knowledge of safe agrochemical storage practices with fellow farmers	3.88	0.65
I regularly inspect agrochemical storage facilities for leaks or damage	3.85	0.59
Overall mean	4.15	0.69

Note : 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree.

indicates a strong agreement with positive agrochemical usage practices. The results imply that cocoa farmers demonstrate a collective alignment with positive practices related to agrochemical usage. This could include accurate dosage calculations, awareness of environmental impact, seeking guidance, and understanding the importance of timing and application methods. Positive agrochemical usage practices are not only beneficial for farm productivity but also for environmental sustainability. Farmers who are aware of and adhere to such practices are more likely to strike a balance between optimising crop yields and minimising adverse effects on the environment.

Agrochemical Storage: Farmers strongly agree that they store agrochemicals in a designated area that is secure and away from living spaces (mean = 4.43, SD = 0.76). There is an agreement that farmers regularly inspect agrochemical storage facilities for leaks or damage (mean = 3.85, SD = 0.59). The overall mean of 4.15 indicates a strong overall agreement with positive agrochemical storage practices. This agreement suggests that farmers share a common understanding and commitment to the safe and responsible storage of agrochemicals. This could include storing agrochemicals in secure, designated areas away from living spaces, regular inspections for leaks or damage, proper disposal of containers, and a willingness to share knowledge with fellow farmers. Positive agrochemical storage practices are critical for safeguarding the health and well-being of farmers, as well as preventing environmental pollution. Overall, cocoa farmers demonstrate strong knowledge and adherence to agrochemical handling, usage, and storage practices. This analysis provides valuable insights into the knowledge and practices of cocoa farmers, offering a basis for targeted interventions or educational programs to further enhance agrochemical safety compliance. The results are consistent with Tijani's (2006) assertion that cocoa farmers properly store pesticides. In contrast, Okoffo *et al*. (2016) found conflicting evidence, suggesting that cocoa farmers may not handle pesticides appropriately.

Table 4. Precautionary measures observed by cocoa farmers in handling and spraying with agrochemicals

Statement	Mean	Std. dev.
I actively seek training programs or workshops on the safe handling and application of agrochemicals	4.37	0.89
I communicate with nearby farmers and community members to minimise accidental exposure during agrochemical application	4.34	0.92
I am mindful of weather conditions, such as wind speed, to prevent agrochemical drift into unintended areas	4.34	0.84
I wear appropriate PPE when handling agrochemicals	4.34	0.81
I follow the recommended dosage and application methods specified on agrochemical labels	4.20	0.84
I use calibrated equipment to ensure accurate agrochemical application and avoid excessive spraying	4.17	0.85
I make it a priority to stay informed about the proper use of agrochemicals by regularly reading and understanding label instructions	4.11	0.77
I handle agrochemical mixing outdoors or in well-ventilated areas to minimise exposure to fumes	4.03	0.79
I engage in knowledge-sharing with fellow farmers to raise awareness of safe agrochemical practices	4.01	0.83
I consistently adhere to the instructions and safety guidelines on agrochemical labels during handling and application	3.94	0.76
I avoid spraying near water bodies, beehives, or sensitive areas to protect the environment and non-target organisms	3.88	0.69
I carefully read and understand the instructions, warnings, and safety precautions provided on agrochemical labels	3.88	0.73
I follow recommended practices for mixing, storage, and disposal of agrochemicals to ensure safety and prevent environmental contamination	3.78	0.99
I dispose of empty containers and unused agrochemicals according to local regulations or label instructions	3.70	0.95
I store agrochemicals in a secure and locked area, away from children, animals, and food products	3.51	1.18
Overall mean	3.75	0.86

Note : 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree.

Safety Compliance Measures Observed by Cocoa Farmers

Table 4 presents information on the precautionary measures observed by cocoa farmers in handling and spraying agrochemicals. The high mean for "I actively seek training programs or workshops on safe handling and application of agrochemicals" (mean = 4.37, SD = 0.89) indicates that cocoa farmers actively seek training programs or workshops on the safe handling and application of agrochemicals. This suggests a proactive approach to acquiring knowledge and skills related to agrochemical use. The high mean for the statement "I wear appropriate PPE when handling agrochemicals" (mean = 4.34, SD = 0.81) indicates that farmers prioritise personal safety by wearing appropriate PPE when handling agrochemicals. This is crucial for minimising health risks associated with chemical exposure. In contrast to the results presented by Atreya *et al*. (2022), which indicated that the utilisation of gloves and goggles is not frequently observed among farmers, our findings reveal a different pattern. The mean for "I carefully read and understand the instructions, warnings, and safety precautions provided on agrochemical labels" (mean = 3.88, SD = 0.73) suggests that farmers agree with carefully reading and understanding the instructions, warnings, and safety precautions provided on agrochemical labels. This discovery contradicts the results of Oyekale's (2018) study, wherein farmers were found to be non-compliant with the instructions outlined on agrochemical labels. The mean for "I store agrochemicals in a secure and locked

area, away from children, animals, and food products" (mean = 3.51, SD = 1.18) indicates that farmers agree with storing agrochemicals in a secure and locked area, away from children, animals, and food products. The overall mean of 3.75 suggests a generally positive stance on precautionary measures. The overall positive mean score indicates that responsible agrochemical handling is not merely an individual concern but also a collective responsibility within the cocoa farming community. The findings set a foundation for building on existing good practices and fostering a culture of safety, responsibility, and sustainability within the cocoa farming community. Responsible agrochemical handling practices are essential for the long-term sustainability of cocoa farming. The positive stance suggests that farmers recognize the importance of preserving their environment, ensuring safety, and maintaining the effectiveness of agrochemicals.

Use of Agrochemicals

Table 5 presents a breakdown of cocoa farmers' utilisation of various agrochemicals. From the results, all surveyed cocoa farmers reported using chemical fertilisers. This indicates a consistent reliance on chemical fertilisers for enhancing soil fertility and promoting cocoa plant growth. The widespread use of chemical fertilisers suggests that cocoa farmers recognize the importance of soil fertility and tree nutrition. This adoption can potentially lead to increased cocoa yields and improved crop quality, which is essential for their economic well-being. This result goes against the findings of Olutegbe & Sanni (2021), who observed that only 6% of cocoa farmers adhered to fertiliser application recommendations. A significant majority (92.7%) of the cocoa farmers use insecticides. This high percentage underscores the prevalence of pest-related challenges in cocoa farming. The usage of insecticides reflects an acknowledgement of the need to protect cocoa crops from damaging pests. The substantial use of fungicides by 86.5% of cocoa farmers indicates a recognition of the importance of disease management in cocoa cultivation. In line with this study, Ankuyi *et al.* (2023) reported that a significant proportion of cocoa farmers employed fungicides and insecticides in their farming practices. Fumigants are utilised by 43.9% of cocoa farmers. While the percentage is lower compared to fertilisers, insecticides, and fungicides, the use of fumigants suggests a substantial portion of farmers recognize the significance of soil disinfection and pest control through fumigation. More than half of the surveyed cocoa farmers, 52.2%, use herbicides. This indicates a prevalent need for weed management in cocoa plantations. Following the research conducted by Hoque *et al.* (2022), it was observed that farmers employ a range of agrochemicals such as fertilisers, pesticides, fungicides, weedicides, and similar substances.

The diverse use of insecticides, fungicides, and herbicides suggests that cocoa farmers are likely engaged in integrated pest management (IPM) strategies. This holistic approach aims to address multiple aspects

Table 5. Cocoa farmers' use of agrochemicals

Agrochemicals	Frequency	Percentage
Chemical fertilisers	385	100.0
Insecticides	357	92.7
Fungicides	333	86.5
Fumigants	169	43.9
Herbicides	201	52.2

Note : Field survey, 2023.

of crop health and productivity. The high usage of agrochemicals reflects the challenges cocoa farmers face in maintaining a healthy and productive crop. It also highlights opportunities for educating farmers on sustainable and responsible agrochemical use to mitigate potential negative impacts.

Factors Influencing Use of Agrochemicals

The Torbit regression model in Table 6 shows the factors influencing cocoa farmers' extent of use of agrochemicals. The model allows us to understand how different independent variables collectively impact the dependent variable. The pseudo-R^2, which shows how the variables used in the regression model jointly explain the changes in the dependent variable is 0.591. This indicates that 59.1% of the variations in the dependent variable are jointly explained by the independent variables considered in the model. This explains how the chosen independent variables are meaningful and relevant in explaining the variations in knowledge.

Table 6 reveals that marital status has a negative and statistically significant influence on farmers' extent of use of agrochemicals at 5%, suggesting that farmers who are married have lower extent of use of agrochemicals. Thus, farmers who are married tend to use agrochemicals to a lesser extent compared to their unmarried counterparts. Married farmers may have additional financial responsibilities related to family and household expenditures. As a result, they might allocate fewer resources to agrochemicals compared to unmarried farmers who may have fewer financial commitments. This finding can guide the development of targeted interventions and policies that align with the preferences and priorities of married farmers, contributing to more sustainable and context-specific agricultural practices. Household size is also negative and statistically significant at 1%. This indicates that farmers with larger household sizes have a lower extent of use of agrochemicals. Thus, as the size of the household increases, the use of agrochemicals tends to decrease. Larger households may face resource constraints, and farmers within such households might allocate resources differently. This could lead to a trade-off where the financial resources available for agrochemicals are spread thin across the needs of a larger household. This finding adds a layer of complexity to the understanding of agrochemical adoption and emphasises the importance of considering household dynamics in agricultural research and policy-making.

Farming experience is positive and statistically significant at 1%, suggesting that farmers who have been cultivating cocoa for many years have a higher extent of use of agrochemicals. Thus, as farmers accumulate more years of experience in cocoa cultivation, there is a tendency for them to use agrochemicals to a greater extent. Farmers with more years of experience are likely to have accumulated knowledge and expertise in cocoa farming. They may have learned about the benefits of agrochemicals in improving crop yield and may feel more confident in their use. The finding highlights the role of accumulated knowledge in shaping farming practices. The discovery validates the outcomes reported by Hoque *et al*. (2022) and Rahman & Haque (2013). Cooperative membership is positive and statistically significant at 10%, suggesting that farmers who are members of cooperative organisations have a higher extent of use of agrochemicals. This indicates that farmers who are members of cooperative organisations tend to use agrochemicals more extensively. Cooperative members might benefit from resource pooling within the cooperative, making it easier to collectively purchase and access agrochemicals. This could result in

a higher extent of agrochemical use compared to individual farmers. The finding highlights the importance of understanding the dynamics within cooperative structures and tailoring support programs to promote sustainable and efficient farming practices among cooperative members. The discovery aligns with the findings of Tsufac *et al*. (2020), who observed that membership in farmer organisations has an impact on the utilisation of agrochemicals.

Access to spraying machines is positive and statistically significant at 1%, suggesting that farmers who own spraying machines are more likely to have a higher extent of use of agrochemicals. This suggests that the presence of a spraying machine is associated with an increased adoption of agrochemicals. Owning a spraying machine can be considered a financial investment. Farmers who make such an investment may be more committed to optimising its use, including the application of agrochemicals, to maximise returns on their investment. While the study highlights a positive association, it's crucial to balance increased agrochemical use with sustainability concerns. Farmers with access to spraying machines should be encouraged to adopt practices that minimise environmental impact and prioritise long-term soil health.

The discovery is corroborated by Danso-Abbeam & Baiyegunhi (2017). Access to PPE is negative and statistically significant at 10%, suggesting that farmers who do not have PPEs tend to use agrochemicals to a lesser extent. This implies that the presence of PPE is associated with a higher extent of agrochemical use. Farmers without access to PPEs may be more cautious about using agrochemicals due to safety concerns. The absence of PPE might make them hesitant to handle chemicals, influencing their decision to use agrochemicals to a lesser extent. The finding highlights the interplay between safety measures and agricultural practices. It emphasises the importance of integrating safety considerations into agricultural policies and practices to protect the health and well-being of farmers.

Based on the findings, we recommend the implementation of comprehensive and continuous training programs for cocoa farmers, focusing on safe agrochemical handling practices. It is crucial to collaborate with agricultural extension services and industry experts to ensure the efficacy of these training initiatives. Collaboration with local suppliers is necessary to make quality PPE readily avail-able to farmers at affordable prices. Outreach programs should be conducted

Table 6. Tobit regression for factors influencing cocoa farmers' extent of use of agrochemicals

Variables	Coef.	Std. Er.
Sex	-0.008	0.049
Age	-0.002	0.004
Education	0.005	0.005
Marital status	-0.069**	0.033
Household size	-0.028***	0.009
Religion	-0.013	0.048
Farming experience	0.012***	0.004
Farm size	-0.002	0.006
Land acquisition	0.035	0.04
Labour	-0.063	0.032
Cooperative membership	0.065*	0.066
Access to formal credit	-0.007	0.065
Spraying machine	0.192***	0.066
PPE	-0.109*	0.061
Constant	4.329***	0.179
Var (e)	0.167	0.012

Notes : Mean dependent var: 4.025; Pseudo r-squared: 0.591; Likelihood Ratio $X^2(14)$: 40.375; Log likelihood: -201.028; SD dependent var: 0.431; Number of obs.: 385; Prob > chi^2: 0.000; *** *p<.01,* ** *p<.05,* * *p<.1.*

to reinforce positive agrochemical storage practices among cocoa farmers. To stay abreast of evolving challenges in agrochemical usage, continuous research and monitoring efforts are recommended. Regular updates resulting from these efforts will enable policymakers to adapt interventions based on emerging trends and the evolving needs within the cocoa farming community. Furthermore, acknowledging the widespread use of agrochemicals among cocoa farmers, we propose introducing educational programs on IPM practices to reduce reliance on chemical inputs. Lastly, exploring incentives for farmers adopting sustainable practices, such as organic farming methods and agroecological approaches, is crucial for promoting environmentally friendly and resilient cocoa farming.

CONCLUSIONS

This study delves into the knowledge, practices, and safety compliance of cocoa farmers concerning agrochemical handling, usage, and storage. The findings reveal a commendable level of understanding and preparedness among cocoa farmers, particularly in handling agrochemicals. Positive practices are observed in agrochemical usage and storage, reflecting a strong consensus among respondents. The precautionary measures adopted by cocoa farmers in handling and spraying agrochemicals emphasise their commitment to safety. Notably, farmers actively seek training programs, wear appropriate PPE, and show diligence in reading and understanding agrochemical labels. The overall positive stance on precautionary measures indicates a responsible approach to agrochemical handling and spraying practices. Examining the utilisation of agrochemicals, the study accentuates the prevalence of chemical fertilisers, insecticides, fungicides, fumigants, and herbicides among cocoa farmers. This widespread adoption reflects an acknowledgement of the importance of soil fertility, pest control, disease management, and weed control for optimal cocoa cultivation. Moreover, the factors influencing the extent of agrochemical use among cocoa farmers reveal intriguing insights. Marital status, household size, farming experience, cooperative membership, access to spraying machines, and the availability of PPE all play significant roles in shaping farmers' practices. This research provides a comprehensive understanding of cocoa farmers' knowledge and practices related to agrochemicals, highlighting areas of strength and areas that may require targeted interventions. Secondly, the identification of factors influencing agrochemical use can inform policy-making and tailor educational programs to enhance safety compliance among cocoa farmers. Finally, the study underlines the importance of integrating safety considerations into agricultural policies and practices, emphasising the pivotal role of knowledge and awareness in influencing farmers' practices. Overall, the findings contribute to the broader goal of promoting sustainable and safe agrochemical practices in cocoa farming.

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