Chapter 12
Reducing Commodity-Driven Biodiversity Loss: The Case of Pesticide Use and Impacts on Socio-Ecological Production Landscapes (SEPLs) in Ghana

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Abstract Ghana's Western North and Central Regions are biodiversity-rich landscapes. Cocoa is a major commodity produced in these two regions, accounting for over 50% of Ghana's cocoa output. As part of the efforts to further improve productivity and ecological health of the landscape, the Government of Ghana initiated the Cocoa Disease and Pests Control Programme primarily to control cocoa pests and diseases, including the use of pesticides. In recent times, however, there has been an upsurge in the use of highly hazardous pesticides (HHPs) that have far-reaching consequences on human and ecological health of the cocoa production landscape. To gain a better understanding of pesticide-use patterns on cocoa farms and address HHP-driven biodiversity loss, Conservation Alliance International (CA) conducted a study within the landscape. The study was based on both qualitative and quantitative research approaches to understand pesticide use and resulting impacts on human and ecological health. In all, 306 cocoa farmers were surveyed. Analysis of the data revealed that about 81% of the cocoa farmers use pesticides to address pests and diseases, causing visible impacts on humans and the environment, including skin irritation, eye irritation, and death of pollinators. Pesticide use was exacerbated by the adverse economic impacts of the COVID-19 pandemic. Policymakers are therefore advised to take steps to phase out HHPs, promote integrated pest management, and tackle the spread of COVID-19 infections.

Keywords Pesticides · Cocoa · Communities · Environment · Health · Landscape · Biodiversity

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1 Introduction

Cocoa production is a major economic activity in Ghana. Many studies have confirmed that the cocoa sector is the mainstay of the economy, employing about 45.0% of the workforce (Vigneri & Kolavalli, 2018; Gakpo, 2012). It provides 30% of Ghana's total export earnings making it the second largest source of export earnings after mineral exports (World Bank Group, 2018). Since 1990, the Government of Ghana has implemented several policies aimed at reforming the cocoa sector in order to increase the national cocoa output. Notably, in 1999, the government developed a national cocoa development strategy to increase cocoa production from 300,000 metric tons (MT) to 700,000 MT by 2010 (Amoah, 2013). In 2001, the government through its agency, the Ghana Cocoa Board (COCOBOD), designed another programme named the Cocoa Disease and Pests Control (CODAPEC) programme, primarily to assist in the control of cocoa pests and diseases (Essegbey & Ofori-Gyamfi, 2012). The CODAPEC programme provides free spraying of approved pesticides over one acre of cocoa farm per farm to address incidences of diseases and pests in an effort to curb the declining cocoa output (Anang et al., 2013; Boadu, 2014). The programme does not cover the additional acres of farms that are of more than one acre in size. Hence, cocoa farmers are expected to purchase additional approved pesticides to cover the rest of their farms.

Additionally, the programme provided opportunities for enhancing the ecological health of the production landscape by promoting agroforestry systems, integrated pest management (IPM), and conservation of faunal IUCN Red List species (Adjinah & Opoku, 2010). It also made provisions for enhancing the technical capacity of key staff of the Ghana Health Service (GHS), Forest Services Division (FSD), Wildlife Division (WD), and the Environmental Protection Agency (EPA), as well as Protected Area Managers, to monitor the impacts of pesticide application on the health of humans and protected areas. It therefore provided the requisite motivation for conservation practitioners to collaborate with the programme proponents and relevant agencies, including the Ministry of Food and Agriculture (MoFA), to address cases of pesticide poisoning among humans and ecosystems through alternatives, including IPM. IPM is an environmentally sensitive approach to pest and disease management that relies on a combination of common cultural practices (Singh & Prasad, 2016). IPM programmes have a proven track record of significantly reducing the risks of pesticides while improving the health of the ecosystem. Cultural practices such as pruning trees and maintaining a close canopy, among others, are practical ways to prevent pest attacks and also give agronomic benefits to the cocoa trees.

By 2012, the CODAPEC programme had significantly increased national cocoa output from 600,000 MT to a record 1,000,000 MT. This record was 35.7% higher than the full-year record of 740,000 MT, obtained in the 2005/2006 season (ISSER, 2011). Much of the increase in cocoa output was attributed to increased pesticide application on cocoa farms (Afrane & Ntiamoah, 2011). While the increase in output is most welcomed, several studies have suggested that cocoa farmers have become overly dependent on pesticides in addressing disease and pest control, posing enormous risk to humans and the environment within the cocoa production landscape (Conservation Alliance (CA), 2019, 2020; Pesticide Action Network (PAN) UK, 2018). Biodiversity loss within the agricultural portion of the production landscape is mostly driven by pesticide use. Other factors degrading biodiversity in the protected portions of the landscape include illegal logging, agricultural encroachment, and poaching.

Damalas and Eleftherohorinos (2011) indicated that pesticides are widely used in agricultural production to prevent losses due to pests and improve yields. Unfortunately, pesticides reduce the populations of insects, spiders, and birds that naturally control pests and pollinate the crops, through either direct effects or indirect effects (such as lowering the number of flowering weeds visited by insects) (Gill & Garg, 2014). These hazards have been exacerbated by flooding of the markets with highly hazardous pesticides (HHPs) and by abuses—including the use of mixtures of different pesticides, use in higher concentrations than recommended, and application at higher frequencies than required—by most farmers. More worryingly, the applications are carried out without strict adherence to precautionary measures including wearing of appropriate personal protective equipment (PPE). Additionally, current government regulations and control measures in regard to the use of unapproved pesticides including HHPs—such as fines—are not enough of a deterrent and are poorly enforced. This is exacerbated by the lack of a clear policy direction on timelines from the Government of Ghana with respect to phasing out HHPs within the agricultural production landscapes.

The use of pesticides provides a number of benefits, including control of vector-borne diseases (Conservation Alliance (CA), 2020). However, the use of these toxic materials on the production landscape has potential hazards that are of great human and ecological health significance (Conservation Alliance (CA), 2019). Concern has risen in recent years that the current pesticide regulatory system, which is intended to minimise health risk to the general population, may not adequately protect the health of cocoa farmers and the environment (Pesticide Action Network (PAN) UK, 2018). Additionally, the increasing demand for more cocoa for export has resulted in the increased use of pesticides (Conservation Alliance (CA), 2020).

Aimed at cutting down the use of pesticides, Conservation Alliance International (CA), an NGO, carried out a public awareness and education programme on the adverse effects of pesticide abuse within the landscape through radio broadcasts and community public address systems. Awareness on the associated risks of dependency on pesticides could motivate cocoa farmers to press for alternatives. As part of the awareness program, a study was conducted by CA to understand pesticide use and impacts on human health and the environment since pesticide use poses a major challenge in managing the production landscape. Another challenge for managing the production landscape has been weak institutional coordination among stakeholders due to overlapping mandates. There is an opportunity to address this challenge through the local government authority, which is developing a strategic plan to address biodiversity loss and promote sustainable development through a jurisdictional landscape approach that encompasses activities of actors under one central coordination unit to enhance the success of project interventions.

The main goal of this study was to gain better understanding of the use of pesticides for disease and pest management and their impacts on human health and biodiversity within two agricultural production landscapes in Ghana. Specifically, the study sought to:

1. Determine farmers' level of dependency on pesticides in managing diseases and pests on farms.
2. Estimate the extent of use of unapproved pesticides on cocoa farms.
3. Assess farmers' perceptions of the impacts of pesticides on the health of humans and the environment.
4. Evaluate the effects and benefits of alternatives (IPM and organic pesticides) on protected areas and the environment.
5. Document any COVID-19 and gender-related experiences relevant to the biodiversity-health-sustainability nexus.

2 Methodology

2.1 Study Area

The study was conducted within two major agricultural production landscapes in Ghana. These are the Bia Conservation Area (BCA) and Kakum Conservation Area (KCA) in the Western North and Central Regions of Ghana, respectively. The BCA includes the Bia, Enchi, Juaboso, and Sefwi Wiawso districts. The KCA includes the Assin North, Assin South, Lower Denkyira, and Upper Denkyira districts (Fig. 12.1 and Table 12.1). The two landscapes cover a total area of 34, 987 km^2 and fall within the Upper Guinean forest hotspot, one of the most biodiversity-rich hotspots of Ghana. The landscapes also contain 75% of primary forest and lie in the equatorial climatic zone, which is characterised by moderate temperatures. The landscapes lie in the moist deciduous forest ecosystem part of Ghana, with an average rainfall of 1600 mm per annum. They are characterised by a number of isolated forest patches that contain exceptionally diverse ecological communities, distinctive biodiversity, and a mosaic of forest types that provides refuge to numerous endemic species (Conservation Alliance (CA), 2018). The cultivation of cocoa and oil palm constitutes the main commodity-driven deforestation within the landscape. Agriculture is the main economic activity within both landscapes, dominated by tree and food crops. Cocoa is a major tree crop accounting for more than 55% of Ghana's tree crop exports (Kolavalli & Vigneri, 2011; Denkyirah et al., 2016). The BCA and KCA accounted for more than half (56%) of cocoa production in Ghana in 2019 (COCOBOD, 2020). The favourable edaphic conditions and the rich ecosystem largely account for the high production of cocoa.

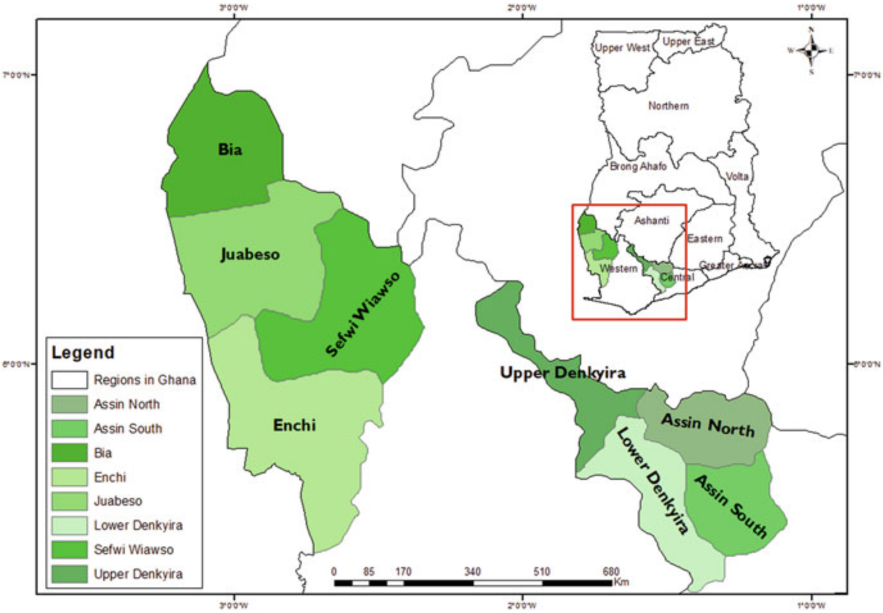

Fig. 12.1 Map showing the study landscapes: BCA (left) and KCA (right) (source: Conservation Alliance (CA), 2020)

Table 12.1 Basic information of the study area (source: Conservation Alliance (CA), 2020)

Country	Ghana
Province	Central and Western North Regions
Districts	Bia, Enchi, Juaboso, Sefwi Wiawso, Assin North, Assin South, Lower Denkyira, Upper Denkyira
Municipality	n.a.
Size of geographical area (hectare)	3,498,700
Number of direct beneficiaries (persons)	1500
Number of indirect beneficiaries (persons)	5000
Dominant ethnicity(ies), if appropriate	*Akans*
Size of the case study/project area (hectare)	780,400
Geographic coordinates (latitude, longitude)	6°45′35.1″N, 3°04′44.3″W

2.2 Study Population and Sampling Method

The total number of registered cocoa farmers is about 1500 in the Western North and Central regions (900 and 600 members, respectively) (Table 12.1). Among registered members, 70% are men and 30% women. A simple random sampling technique was adopted in selecting members of the Cocoa Conservation Association (CCA) for the study. A sample size of 306 was derived from the random selection of respondents of which 184 were from Western North Region and 122 from the Central Region based on the respective population size (Kirk, 2011; Etikan & Bala, 2017). The sample sizes were further divided to get an equal representation of the gender groupings. For the BCA, 129 male and 55 female farmers were sampled. Similarly, 85 male and 37 female cocoa farmers were sampled in the Central Region within the KCA. Images of interviewed respondents are shown in Fig. 12.2.

2.3 Data Collection

Both quantitative (survey) and qualitative research approaches were used. Farmer surveys, community consultations, focus group discussions, district-wide

Fig. 12.2 Researcher interviewing input seller (**a**), CCA members (**b**), and individual farmers (**c** and **d**) (Source: Conservation Alliance (CA), 2020. Photo credit: All images taken by CA Communications Team)

stakeholder consultations, and key informant interviews constituted the main strategies to generate data. Both primary and secondary data constituted a useful set of data that defined the state of pesticide usage and impacts among cocoa farmers within the landscape.

Surveys were conducted with farmers of the sample to generate primary data. Secondary data was secured from various sources including public records, institutional documents, management plans, policy statements, official publications, and other research works. The questionnaires for the survey were administered in the various districts in September 2020. Reviews of government documents on the CODAPEC programme, including operational manuals and monitoring reports, constituted another important form of data collection.

A series of key interviews were also conducted with the FSD, WD, EPA, and Protected Area Managers to assess the effects of alternatives to pesticide use on the health of protected areas. With respect to the effects of unapproved pesticides on human health, the study team conducted a risk assessment based on farmers' experiences in relation to the likelihood of occurrence and consequences of use of the unapproved pesticides.

2.4 Data Analysis

The questionnaires for the survey of farmers were pretested using a selected group of respondents outside the target population to ensure the reliability and validity of the questions and responses. All data were coded, and analysis was carried out using Statistical Package for Social Sciences (SPSS) and Microsoft Excel. The data obtained reflected the views, opinions, and attitudes of the respondents and further enhanced the reliability, validity, credibility, and accuracy of the results. The data obtained are summarised in tables for simplicity of analysis. The analysis was done using descriptive analysis where issues of similarity and dissimilarities of responses were compared. The descriptive statistical tools facilitated the quantitative comparative analysis of the responses.

3 Results

3.1 Demographic Characteristics of Respondents

The key demographic characteristics that were generated during the study included the age, years of experience, level of education, and marital status of respondents. Almost 70% of the respondents were male, arising from the dominance of males in the sector (Table 12.2). Additionally, over 77% of the respondents were over 41 years of age and almost 80% of the respondents had more than 10 years of work experience. Education plays a significant role in the acquisition and use of new

Table 12.2 Demographic characteristics of farmers (source: Conservation Alliance (CA), 2020)

Variable	Category	Number of Respondents	Percent (%)
Gender	Male	214	69.9
	Female	92	30.1
Age (Years)	<30	5	1.5
	30-40	65	21.3
	41-50	90	29.3
	51-60	81	26.5
	61-70	47	15.3
	>70	18	6.0
Marital Status	Married	256	83.6
	Divorced	17	5.7
	Single	33	10.7
Education	Non-Formal	130	42.5
	Basic	96	31.3
	Secondary	73	24.0
	Tertiary	7	2.2
Years of Experience	1 – 5	15	5.0
	6 – 10	47	15.3
	> 10	244	79.7

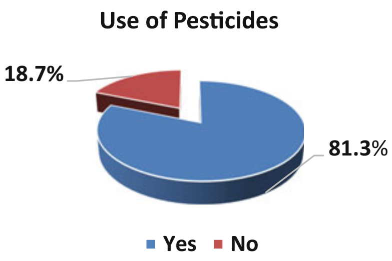

Fig. 12.3 Use of pesticides (source: Conservation Alliance (CA), 2020)

technology. With more than 40% of respondents having no formal education, the risk of unapproved pesticide use is high.

3.2 *Farmers' Level of Dependency on Pesticides*

The use of pesticides is widespread among cocoa farmers due primarily to the high level of disease and pests and the ready supply of free inputs. The study revealed that about 81.3% of farmers are solely dependent on pesticides and consider them as the most important method for managing diseases and pests (Figs. 12.3 and 12.4). About 18.7% of the respondents are reliant on IPM, including cultural methods to control diseases and pests on farms, and depend less on pesticides.

Fig. 12.4 Farmer spraying (source: Conservation Alliance (CA), 2020. Photo: CA Communications Team)

3.3 Use of Unapproved Pesticides

The study revealed that at least 30% of the sampled farmers have continuously applied unapproved pesticides on their farms. *Akate Suro* (Diazinon) and *Consider* (Imidacloprid) were the most widely used because they are readily available on the market and their price is affordable (Table 12.3). *Carbamult* (Promecarb) and *So Bi Hwe* (a suspected cocktail of several active ingredients), on the other hand, were considered to be the most effective in controlling diseases and pests. The rest of the farmers have consistently benefited from the government's free supply of approved pesticides.

The risk matrix (Table 12.4) revealed that *Sumitox* (chlorpyrifos), *Akate Suro* (diazinon), *So Bi Hwe* (suspected cocktail), and *Lambda Super* (lambda-cyhalothrin) had the most devastating impacts on human health. The study recorded 23 reported cases of pesticide poisoning among cocoa farmers within the study areas within the past 5 years. The BCA, which accounts for almost half (45%) of cocoa output in Ghana, coincidentally also recorded about 78% of the reported cases, and the KCA (11% of cocoa output) accounted for about 22% of reported cases of human health impacts (Table 12.5).

Table 12.3 Unapproved pesticides used on cocoa by farmers (source: Conservation Alliance (CA), 2020)

Pesticide	Active ingredient	Importing companies	Exporting countries
Carbamult	Promecarb	Smuggled	Cote d'Ivoire
Sumitox	Chlorpyrifos	Kumark Ghana Limited	India
Consider	Imidacloprid	Thomas Fosu Enterprise	China
Akate Suro	Diazinon	Mybarnes Limited	Israel
Lambda Super	Lambda-Cyhalothrin	Kumark Ghana Limited	China
So Bi Hwe	Mixture of two or more of the above active ingredients	Smuggled	Cote d'Ivoire

Table 12.4 Human health risk matrix of unapproved pesticides (source: Conservation Alliance (CA), 2020)

Likelihood	Health Consequences					
	Skin Irritation	**Eye Irritation**	**Dizziness**	**Breathlessness**	**Headache**	**Vomiting**
Almost Certain	*So Bi Hwe* (Mixture of two or more active ingredients)	*Lambda Super* (Lambda-Cyhalothrin) *Akate Suro* (Diazinon)	*Sumitox* (Chlorpyrifos) *Lambda Super* (Lambda-Cyhalothrin)	*Lambda Super* (Lambda-Cyhalothrin) *Akate Suro* (Diazinon)	*Sumitox* (Chlorpyrifos) *Akate Suro* (Diazinon)	*Sumitox* (Chlorpyrifos) *Akate Suro* (Diazinon) *Lambda Super* (Lambda-Cyhalothrin)
Likely	*Lambda Super* (Lambda-Cyhalothrin)	*Sumitox* (Chlorpyrifos)	*Carbamult* (Promecarb)	*So Bi Hwe* (Mixture of two or more active ingredients)	*Carbamult* (Promecarb)	*Carbamult* (Promecarb)
Possible	*Akate Suro* (Diazinon)	*So Bi Hwe* (Mixture of two or more active ingredients)	*Consider* (Imidacloprid)	*Consider* (Imidacloprid)	*So Bi Hwe* (Mixture of two or more active ingredients)	*So Bi Hwe* (Mixture of two or more active ingredients)

Notes: The probability of health effects occurring: Almost Certain (100%), Likely (50%), Possible (≤25%)

	Consequence is **very critical** requiring immediate medical attention.
	Consequence is **major** requiring specific treatment to contain it.
	Consequence is **moderate** requiring normal routine management and effects fade after sometime.

3.4 *Farmer's Perception of the Impacts of Pesticides*

The use of pesticides is perceived to adversely affect the health of humans. While over 90% of the respondents were aware of the adverse impacts of pesticides on humans because of the visible signs they leave behind, only a few (less than 10%) knew of the effect on the environment (biodiversity) (Fig. 12.5).

During the study, the participating farmers shared their experiences related to the prolonged use of pesticides in cocoa production (Fig. 12.6) and reported on symptoms experienced. Regarding the effects on human health, the farmers reported skin

Table 12.5 Reported cases of pesticide poisoning (source: Conservation Alliance (CA), 2020)

Production landscape	Districts	No. of reported cases	Percentage of reported cases
Bia conservation area	Bia	8	34.8
	Enchi	3	13.0
	Sefwi Wiawso	3	13.0
	Juaboso	4	17.4
Kakum conservation area	Assin North	2	8.7
	Assin South	1	4.3
	Lower Denkyira	1	4.3
	Upper Denkyira	1	4.3
Total		**23**	**100.0**

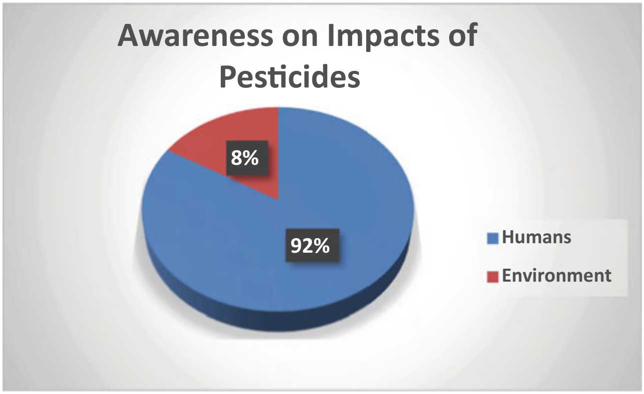

Fig. 12.5 Awareness on the impacts of pesticides (source: Conservation Alliance (CA), 2020)

irritation (more than 30%) to be the most commonly experienced effect on human health. Others included eye irritation (21%), dizziness (18%), vomiting (16%), and breathlessness (13%). About 5% of the farmers appeared indifferent to the adverse effects of pesticides and argued that such effects on humans could only arise from the state of the individual's health, particularly the toughness of the skin.

With respect to the less than 10% of respondents who reported impacts on biodiversity, about half of the reported impacts of pesticide use were perceived to cause the death of vertebrates (e.g. rodents, reptiles) as shown in Fig. 12.7. About 35% of reported cases involved harm to a wide range of beneficial invertebrate species (e.g. earthworms in the soil and other terrestrial habitats), and pollinators (e.g. bees, midges, and butterflies). About 15% of pesticide impacts reported were related to adverse effects on freshwater aquatic species (e.g. snails and water fleas), which were affected via water and aquatic plants exposed to pesticide residue.

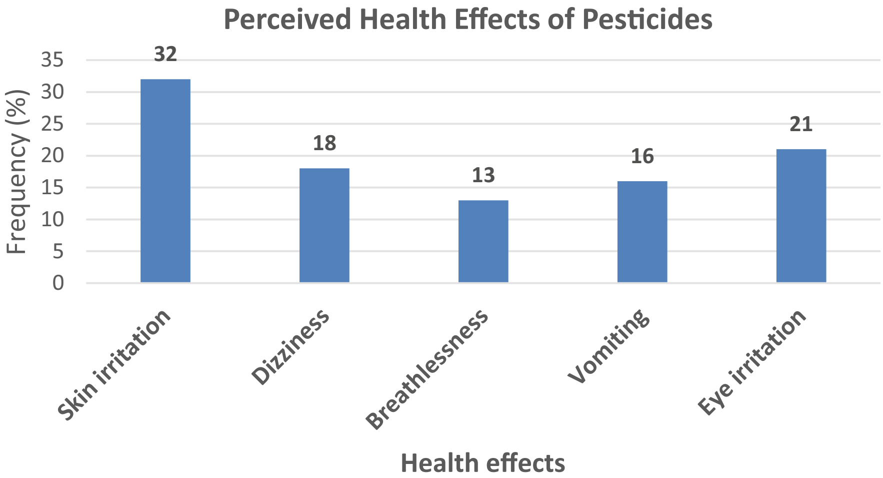

Fig. 12.6 Perceived health effects of pesticides (source: Conservation Alliance (CA), 2020)

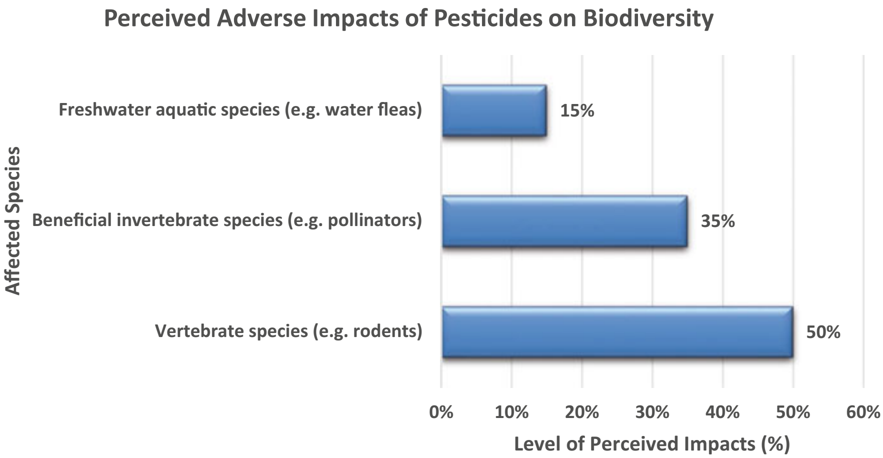

Fig. 12.7 Perceived impacts of pesticides on biodiversity (source: Conservation Alliance (CA), 2020)

3.5 *Effects and Benefits of Alternatives (IPM and Organic Pesticides) on Protected Areas and the Environment*

With respect to alternatives to conventional pesticides used by farmers that are ecologically friendly to protected areas and the environment, the study recorded about a 69.8% patronage of IPM and 30.2% of biopesticides (organic pesticides). The most commonly used biopesticides were neem tree (*Azadirachta indica*) extract (55%); pyrethrum 5EW, a natural substance purified from chrysanthemum flowers

Table 12.6 Benefits of alternatives (IPM and organic pesticides) (source: Conservation Alliance (CA), 2020)

Benefits	No. of recorded benefits	% of recorded benefits
Reduced environmental risk associated with pest management by encouraging the adoption of more ecologically benign control tactics	17	18
Protection of non-target species including flora and fauna	22	23
Reduced air and groundwater contamination	10	10
Alleviation of public concern about pests and pesticide-related practices	13	13
Promotes sustainable bio-based pest management alternatives, thus reducing the need for pesticides	15	16
Maintains or increases the cost-effectiveness of a pest management programme	19	20
Total	**96**	**100**

(31%); and milk bush (*Thevetia peruviana*) extract (14%). Additionally, 86% of the respondents attested to IPM and biopesticides being effective in pest control and protection of non-target flora and fauna. The study also assessed the benefits of adopting other alternatives (IPM and organic pesticide) and recorded 96 benefits from the landscape through monitoring reports of the FSD, WD, and EPA (Table 12.6).

According to the study, SEPL management by the community through sustainable practices such as IPM and biopesticide application had positive beneficial effects contributing to the well-being of humans and environment, as shown in Fig. 12.8. Therefore, this interdependent relationship among the three sustainability pillars through IPM and biopesticides offers prospects for local communities and farmers to adopt practices compatible with living in harmony with nature to enhance the ecological health of their landscapes.

3.6 Gender and COVID-19-Related Issues

The study also documented some gender and COVID-19-related issues in the landscapes, which were relevant to the biodiversity-health-sustainability nexus. The study revealed that 60% of male respondents and 58% of female respondents were aware that some pesticides were unapproved by COCOBOD. However, only 5% of the female respondents were able to specify these unapproved pesticides, as compared to 65% of the male respondents. Additionally, the study examined how the COVID-19 pandemic has impacted the purchasing power of males and females with respect to the use of approved and unapproved pesticides. Since the COVID-19 pandemic has negatively impacted the income of farmers, use of pesticides is based on affordability. The study revealed that male cocoa farmers (65%) were able to

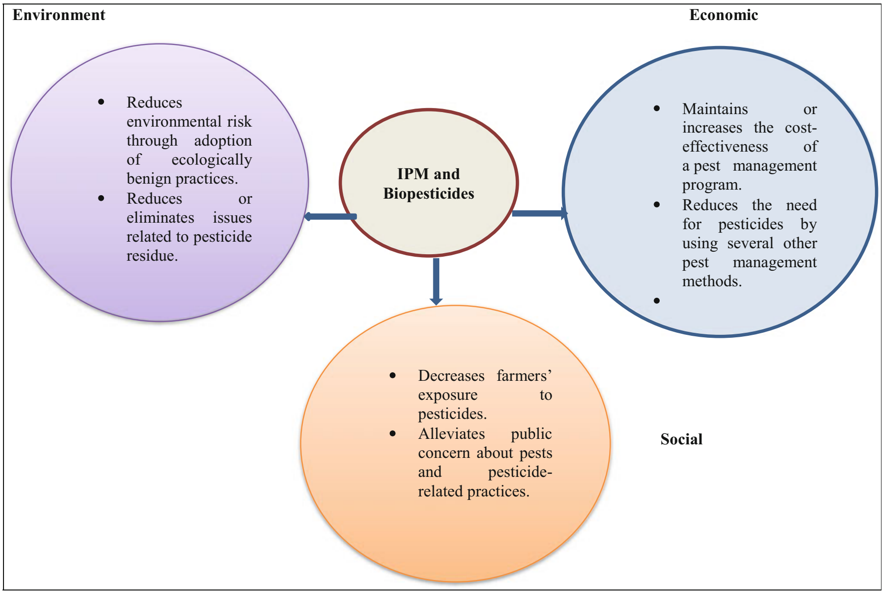

Fig. 12.8 Community conceptualisation of benefits of IPM and biopesticides (source: Conservation Alliance (CA), 2020)

afford approved pesticides more than their female counterparts (25%), since unapproved pesticides were found to be less expensive than the approved ones.

4 Discussion

The study found there to be an over-reliance on pesticides by cocoa farmers in addressing incidences of disease and pests on farms. This is to be expected considering that these pesticides are freely distributed to farmers to help increase national cocoa output. While the government programme has resulted in an increase in the national cocoa output from about 600,000 MT to 1,000,000 MT, it also negatively impacted the health of humans and the environment (Conservation Alliance (CA), 2020).

Some farmers were still reliant on unapproved pesticides, which are mostly HHPs. Even though the law forbids the importation, marketing, and use of unapproved pesticides, this regulation is not sufficiently enforced and the penalty is not enough of a deterrent to stop illegal practices, largely accounting for their widespread sale and use. Use of unapproved pesticides correlates with low purchasing power, perception of the poor effectiveness of approved pesticides, and ignorance about which pesticides are approved, especially in developing countries (Denkyirah et al., 2016). The Transnational Alliance to Combat Illicit Trade

(TRACIT) confirms that the use of these types of pesticides makes enforcement of regulations more difficult, while also increasing the danger to human health and the environment (Transnational Alliance to Combat Illicit Trade (TRACIT), 2019).

As observed by the farmers, pesticides cause prominent health and environmental impacts, having adverse effects on pollinators, soil organisms, and human health (e.g. acute headaches and breathlessness) (Özkara et al., 2016). In particular, pesticides cause significant damage and pose serious risks to a wide range of beneficial invertebrate species in the soil, vegetation, and aquatic habitats (Bernardes et al., 2015). These organisms play vital roles in ecosystem functioning and services, including pollination, regulating of organic wastes, nutrient cycling, food production, biological pest control, and water cleansing (Power, 2010). The most damaging ecological disturbances of excessive pesticide use include the existence of high concentration of pesticide residues in food chains and biodiversity loss (Boakye, 2012). A study by Dankyi (2015) found that neonicotinoids are persistent in Ghanaian soils even after several months to years of application and have a high potential of being leached into surface and underground water systems. According to a study by Pesticide Action Network (PAN) UK (2018), neonicotinoid pesticides in cocoa production/farming can present acute health effects. According to the PAN UK study, US farm workers have similarly reported skin or eye irritation, dizziness, breathlessness, confusion, or vomiting after exposure to HHP pesticides (e.g. imidacloprid). The same study by PAN UK highlighted serious harm to a wider range of organisms at the levels which threaten the essential ecosystem services of pollination, nutrient cycling, and natural pest control.

This study assessed alternatives to HHPs and showed that the majority of farmers favour IPM (70%) as potential alternative and an effective means of pest and disease control and maintenance of the socio-ecological health of the landscape. This was reinforced by the number of recorded benefits of IPM, including protection of biodiversity. According to Mboussi et al. (2018), IPM thus represents a better option for sustaining cocoa yield and enhancing the ecological health of landscapes in view of the multiple interrelated practices. A similar study by Dara (2019) showed that the adoption of IPM strategies and organic pesticides provides economic benefits by reducing pest damage to crops, thus increasing productivity. According to Pesticide Action Network (PAN) UK (2018), the adoption of IPM enhances benefits for biodiversity, the environment, and food productivity as compared to the use of synthetic (chemical) pesticides. IPM has greatly reduced pesticide poisoning incidences within the production landscape. Additionally, some community members integrate tree cultivation into their agricultural lands not only to reduce disease and pest incidences, but also to enhance the ecological health of the farmlands. As a result, 12 cocoa farms belonging to some cocoa cooperatives have been turned into demonstration plots for promoting best practices in pest and disease management within the project landscape. Additionally, the increased awareness on the evidence of ecological and health benefits of IPM and biopesticides has resulted in increased adoption among community members.

The study revealed that there is a low level of knowledge among women concerning the illegal practice of using unapproved pesticides, which are mostly

HHPs. This can be attributed to low education, less participation during sensitisation exercises, inability to read, and lack of involvement during group meetings, thus exposing women to greater risk from highly hazardous pesticides as compared to men. According to Kawarazuka et al. (2020), despite gender differences, research and training on pest and disease management often target farmers as a whole neglecting the specific needs of women and men. This study also revealed that the lower financial status of women is a key driver for women to use unapproved pesticides, which were mostly highly hazardous. Poverty is one of the key reasons why the envisioned sustainable cocoa sector is failing. The same poverty has compelled cocoa farmers, especially women farmers who are not able to purchase approved pesticides, to resort to cheaper but more hazardous pesticides especially in the face of the COVID-19 pandemic (Walker, 2021). Additionally, the high percentage of males in cocoa farming is likely linked with the involvement of the women in the cultivation of other crops and trading of food crops. Accordingly, most of the training programmes organised by COCOBOD have often targeted male cocoa farmers with the participation of very few women (Williamson, 2011).

5 Conclusion

This study sought to document the various methods commonly used by smallholder cocoa farmers to manage pests and disease incidence, and to establish their level of dependency on pesticides. The dependence on pesticides by farmers has adversely affected the socio-ecological health of the production landscapes. Governments are advised to take steps to phase out active ingredients of HHP pesticides from the pesticide value chain due to their adverse effects on human health and the environment. Regulatory agencies must be further empowered to regulate these products on the market and clamp down on unapproved pesticides with very deterrent penalties including lengthy imprisonments, huge fines, and suspension of operations of companies and individuals that disobey the laws. Additionally, policymakers are encouraged to promote the use of environmentally friendly pesticides, including biopesticides, which are relatively safe to humans and biodiversity. Steps must be taken to stimulate investments in the production and distribution of biopesticides so that they are available, accessible, and affordable to cocoa farmers. Furthermore, there must be intensification of farmer education and training on IPM coupled with intensified supervision and monitoring by extension officers to encourage the increased adoption of IPM to enhance the socio-ecological health of the cocoa landscapes in Ghana.

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